FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT: SELECTED REPORTS 1996 - 2000

Volume 2

REPUBLIC OF MALAWI

MINISTRY OF AGRICULTURE AND IRRIGATION

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Natural Resources Institute

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Volume 2. Farming Systems Research *(continued)*

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

SELECTED PROJECT REPORTS 1996-2000

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

VILLAGE FIELDWORK: TIMING AND DURATION OF FIELDWORK, SELECTION OF HOUSEHOLDS, PRIORITISATION OF ISSUES

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Preparation for village stay

Julie Lawson McDowall

27.3.97

Village fieldwork - timing and duration of fieldwork, selection of households, prioritisation of issues

Goals:
- to understand the 'general socio-cultural characteristics' of the area
- to identify the 'social and non-economic constraints' to IPM interventions
- to clarify the nature of our 'target groups' i.e. the 'resource-poor' and female headed households.

Prioritisation of issues for research:

- gender/age division of labour in agriculture: this should be structured around the crops on which the project is focusing [but not exclusively]
- gender division of labour within the homestead - this may have important implications for women's time use and availability for IPM interventions
- how access to income through off-farm employment and marketing is differentiated according to gender and relative wealth
- intra-household relations - particularly income and labour contributions of different members of the household
- typologies of households - what is the significance of the different types of households that we find - how are 'resource profiles' shaped by household structure
- relations **between** households - the relations that hold between the individual households in a cluster of households is as crucial for their survival as the production and consumption of the individual household. Households are both separate **and** joined. [Pauline Peters - personal communication]

Timing, duration of fieldwork and reporting back

Due to the 10 week period of paid/unpaid leave that I will be taking over June/July/August, the fieldwork period for me will be divided into two parts: an initial 3 month work period up to June, and then an agricultural year from September 1997 until September 1998; I emphasise that this fieldwork does not preclude other project work but would be pursued in parallel and be sensitive to project needs. Ms Chiumia will carry on in my absence but in January, will leave to begin the M.Sc at Bunda College.

The work programme should, therefore, be sensitive to Lawson-McDowall/Chiumia particular skills and needs - though the detail of this is not yet clear. Since we do not know a priori, the **'general socio-cultural characteristics'** of the area or **'social and non-economic constraints'**, or which of these may have most bearing on future IPM recommendations, I suggest that an initial workplan be produced now for the period April-June; then, at the end of this period, a workplan would be formulated for Ms Chiumia's solo work period, when I return in September, we would review our progress and plan the next phase of work up to Ms Chiumia's departure. This would also enable the work of the anthropologists to be adjusted to research needs of the project. Since we do not know what IPM strategies the project may ultimately recommend, we cannot now know precisely what we will need to know in order to assess the appropriateness of these strategies in the future.

What I suggest, then, is that the fieldwork is broken up into 4 'personnel' sections from April 1997 to September 1998

April - June 1997	Chiumia and Lawson-McDowall
June - September 1997	Chiumia
September -December 1997	Chiumia and Lawson-McDowall
December 1997- September 1998	Lawson-McDowall

and that at the beginning of each stage, we indicate the questions and issues in which we are most interested. At the end of each period, a report is produced. Notes would be written up on a weekly basis and put together under headings of household and mbumba , but would then be worked up under various headings - as per the issues and an interim monthly report would be available for team members to read and comment on. Some issues would be continuously pursued, e.g. division of labour, marketing, as indicated above. Other problems would present themselves seasonally, for example, how households deal with the hungry period between December and April.

April week 2 - end of week 1 in **May**	Settle into house, acquaint selves with that cluster, visit chief etc. to pay respects [who else?] Aquaintance with case study households and their clusters: we visit, explain aim of case study households, ask for cooperation. Administration of a 'baseline' questionnaire [similar to the b.q. proper]	1 day Two visits to meet all members and explain = 3 days work If there are approx 25 households and we are spending 3 days per week in the village - this will take about 8 working days to complete 12 village days / 3 = 4 weeks work
May week 2- **June** week 2 inc	Spend 3 days with each cluster, focusing on participating household using PRA/participant observation re household work, fieldwork and other activities e.g. marketing, ganyu Develop work programme for Chiumia during June-September period	5 weeks work

Selection of case study households: suggested criteria

n.b.
Although a participating household is being selected, the intention is to study the cluster in which the households are located in order to clarify inter-household relations within the mbumba.

Socio-economic criteria

- farmers participating in FSIPM on-farm trials - this will allow us to bring considerable knowledge of the farmer and his/her household and cluster to the experience the farmer has with the on-farm trials, this should also facilitate evaluation
- variation in relative wealth/poverty - to be gauged from Baseline Survey and what the team have found out while working with the farmer [n.b. although we have targeted resource-poor farmers, there is substantial variation between these farmers]

- male or female headedness - again, an FSIPM target group - including de jure and de facto female headed households
- different lineages: this should give us more insight into the role of the lineage and possible competition between lineages - there might be implications for communication within the village
- a household where there is a serious long term illness [to model the impact of AIDS/Tuberculosis in Southern Malawi] - to understand how this affects labour availability, family income and asset holding [need for medication and hospital treatment], the stress placed on inter-household relations through demands for assistance, differing gender experiences of AIDS[might there be a point when men are sent back to their matriliny or does the nuclear family continue to take responsibility?]

Technical criteria

- Ecological variation, particularly land type: hillside, dambo, munda
- different on-farm trials - striga, main trial, kasalera etc
- Access to dimba gardens ? - hypothesis: this has become an economically important resource and men are seeking to control their matriliny's dimba - what is the nature of competition for its use
- 'good/bad' farmers [or is this asking for trouble?]
- rental patterns in land?

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

TERMS OF REFERENCE: VILLAGE FIELDWORK

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Terms of reference for village fieldwork

In this document. I set out the methodology I propose to use for village fieldwork and list the issues that may have relevance to the work of the project.

Project activities to date
To date. the project team has. in cooperation with the extension services. selected the villages where we are to work. carried out a series of diagnostic exercises (P/RRA) focusing on crops. pest management and indigenous agricultural knowledge. Subsequently. farmers were selected to run on-farm trials. according to a rough socio-economic typology. and the on-farm trials have been set up. The first round of questionnaires for the baseline survey has also been completed.

Timing of project information needs
The project requires feedback and evaluation from the participating farmers throughout its lifetime. Howe.er. there will be stages at which some types of information will be needed more urgently than at other times. While. for example. it is important for us currently to understand why some farmers are unable to wait for our team to measure the bean crop before harvesting (hunger seems to be the answer). we will need to know much more about access to extension services once successful interventions have been identified. The final results of the first year's on-farm trials will not be known until the post-harvest statistical analysis and it is with the second year's trials that significant results are anticipated. The work of the anthropologist at this time. therefore. is to build up a thorough knowledge of the context as described in the terms of reference for the post.

Anthropologist's terms of reference
It is stated that the project requires the anthropologist to

- [ensure] all the research work undertaken is directed towards solving pest problems identified by farmers and that the proposed solutions are **within the resources of the majority of farmers**.
- build up **an understanding of the general socio-cultural characteristics, including identification of interest groups, of the areas of project activity**
- describe and quantify. where possible. **the social values of crop losses and identify farmers social and non-economic constraints to the implementation of pest management strategies**
- explore different ways of involving farmers in the implementation of the project
- examine **farmers perceptions of pest control and of the relative importance of pests and other constraints.**

Preparation for part-time village residence
I have spent the last three weeks in preparation for the village stays that will constitute a major part of the anthropologist's contribution to the work of the project. A small house within a compound has been rented in the village of Magomero. in Matapwata EPA. I have travelled to Zomba to meet other anthropologists and sociologists (Dr Pauline Peters. Dr Klaus Fiedler. Mr J de Gabriele and Ms Linda Semu) and to conduct a literature search at Chancellor College Malawiana Collection. in order to bring my reading (particularly of the older anthropological monographs) up to date.

Suggested methodology

I therefore suggest an open but structured methodology for the first year of village fieldwork. That is. those issues that seem most relevant (from experience. that arise naturally from project work. from reading secondary sources. from conversations with 'experts') should take priority in research. However. the listing of areas of interest below creates an artificial categorisation and separation that can conceal or elide complex interlinkages. For this reason. it is important that a holistic approach is taken.

It may be crucial. for example. with regard to the feasibility of possible interventions to understand the gender division of labour. However. the nature of the division of labour cannot be grasped in isolation from other social relations. Not only is work gendered but responsibilities or opportunities also vary according to income. age. marital situation. family structure. education or labour availability. Similarly. it may not be possible to understand the contribution made by husbands or brothers to a household or <u>mbumba's</u> finances without simultaneously pursuing the nature of matrilineal lineage organisation or how this is accomodating or being altered by male access to off farm employment or education.

Village residence
I intend to begin to spend 3-4 days a week in residence in Magomero. although when the project requires my presence. this will take priority. Normally I will be accompanied by Charity Chiumia. my research assistant. but I may try to spend some time unaccompanied for the sake of language practice. Charity too is likely to spend some time alone in the village as this will provide an opportunity to meet people in a more relaxed environment. (conversations with other non-Malawian anthropologists suggests that this will be useful).

Case study clusters
A set of household clusters would become the focus of in depth study. It is suggested that perhaps 4-5 clusters be selected initially which might contain between 15-25 households. These clusters will be chosen from the on-farm trial households. from different lineage groups and will be located in different ecological zones of the village. Variation in household type and cluster size will also be an important factor in cluster identification. It is hoped that key informants will be found both within and without this group of clusters.

The justification for not working with a larger group of households is not to be spread too thinly: that it will take time to build up mutual trust (anthropologist who have worked here over a long period estimate about a year of contact is required) but that such an investment will bring much better quality information and more honest evaluation of trials.

Participant observation
There seems to me to be a case for considerable participant observation focused on agricultural practices. This should clarify the gender and age division of labour and also give insights into indigenous knowledge concerning soil classification. pest and weed identification and perception and why certain crop combinations have been chosen (such as preference. constraints of poverty. with a view to sale or home consumption) and how they are valued.

Semi-structured interviews
At the same. time. a series of semi-structured interviews will be held. concerning the issues identified below and in order of priority (the project's need to know).

Language proficiency
The work of the anthropologist will be much enhanced by improved language skills. therefore time will be devoted to practice and learning within the village.

Issues

'Indigenous agricultural knowledge'

understanding of soil type and fertility [a hot/cold typology]

crops. rotation practices: preferences. risk spreading. use of different parts of plant.

pests. weeds: what sort of categories are these placed in. how are they named

experience with pest management strategies

identification of 'expert farmers'

communication networks concerning indigenous agricultural knowledge

Production

gender/age division of labour in agriculture

risk reduction strategies (multicropping)

reproductive responsibilities: homestead work

Off farm employment

types of income earning activities and who has access to what and why

urban-rural linkages - agricultural produce/income flows. access to health care. education and relaxation

importance of ganyu

patron-client relations

significance of seasonality in off farm employment - conflict with own farm labour peaks?

Markets for agricultural produce:

who grows what (male control of dimba gardens in mother's village. male tobacco and dairy farming)

who sells what (do men control vegetable sales. when do women sell vegetables?)

livestock: different types. who owns which type. who controls income

interest groups (e.g. tobacco clubs. dairy farmers)

Income flows

Is money managed on an individual basis? Are expenditure patterns gendered. if so. how?

What is the effect of the split in male responsibility between their own children and their sister's children?

Access to credit (from employers. relatives. friends. formal credit institutions)

Family structure: matrilineality and 'patrilineal influences'

households, homesteads and mbumba clusters - need better delineation of the role of each. relations between, mutual support or exploitation - if both, under what circumstances (labour, land, food, money - are they shared? along which lines? when?)

importance of 'dominant' lineages, role of chief

divorce/stability of marriages

role of uncles and brothers in organisation of homesteads (are men seeking a new role with more control over own children? How do uncles/fathers view their roles?)

tensions between wives and sisters for husband/brother resources - implications for male investment in land or family (e.g. who buys fertiliser or pesticide?)

head of household - what is understood by this term, who is and why? What is the impact of fraternal involvement for female headed households? Is a household without a husband female-headed according to the commonly accepted definitions of the phrase?

children and education - in whom is investment made and by whom

Land tenure and inheritance

map out clusters, discuss 'aberrations' to see rationale/how are viewed - whether these represent trends

how secure is female inheritance of land, are inheritance patterns changing? (there is evidence for this in urban/peri-urban contexts)

impact of land shortages - what is the impact of shrinking female entitlements vis a vis male access to urban/employment opportunities, pressure on natural resources

do brothers/husbands strive for land in mother's village - how do wives/sisters resist or encourage?

Consumption

food security - from own land: how much? how long does it last? What sharing mechanisms are in place? Food and meals, what is eaten, prepared by whom, how prepared, by whom purchased?
control of food - the hearth? Significance of separately prepared food being consumed as a mbumba?

food security strategies during lean periods - what crops? What activities?

Institutions/organisations

Do extension services reach female headed households or poorer households? How are these messages received? Are they acted upon

What role do institutions/organisations play in village life? (Chiefs, churches, mosques, women's church groups, schools, markets, health posts, town, admarc, government, police, bottle shop, groups focused on ritual activities, etc)

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

FIRST REPORT: VILLAGE STAYS, APRIL - JUNE 1997

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First Report: Village Stays 11.6.97

In this report, I shall cover four topics: my main concern is to describe what we have been doing, why we are working in this way, what problems we have encountered and what we have learnt so far. The next 3 months work programme is covered in an attached document.

Activities to date and methodology

For the last nine weeks, the anthropology team, Lawson-McDowall [LM] and Chiumia [CC] have been spending three days and 2-3 nights per week in Magomero village. I am pleased to report that our house is sound and our domestic arrangements smooth.

We have been spending these days with different households in five clusters: the Mazinga family, Mai Muthowa, Mai Kalonga, Simeon Magomero and with Mai Elizabeth, the daughter of Mai Marichi [see attached timetable]. We work with the family or the individual doing, insofar as we can, whatever would normally be done - whether this be fieldwork or domestic work: we start around 6.30-7.30am and then go back to our house to make notes and have lunch at about 12 noon. It is important to leave the family we are visiting at this point to avoid, where possible, being offered lunch as the tradition of hospitality requires. On our return visit to the family in the afternoon, time is normally spent relaxing, chatting and perhaps joining in some food processing. The programme means that we spend a day with each household every two weeks. The remaining day is spent visiting other farmers taking part in our trials and, increasingly, responding to invitations from other households.

	Activity		
	morning	**lunchtime**	**afternoon**
Stay 1			
16 4 97			Arrived village
17 4 97	Visited chief	write up notes	Visited Mai Mazinga and Mai Nantchegwa to ask if we might spend the day with them
Stay 2			
22 4 97	Went to Kambuwa to tell Chief about Open Day. Told Chief in Magomero Visited Mai Kusala	write up notes	Visited Mai Marichi
23 4 97	Visited Mai Kusala, Simeon Magomero, Mai Nantchenwga to discuss what we proposed to do Mai Nantchenwa not keen	write up notes	Visited Mai Mazinga, Mai Kalonga and Simeon Magomero [again]
24 4 97	Marichi family Mai Elizabeth Planting beans, shelling maize	write up notes	
Stay 3			
28 4 96			Visited Simeon Magomero and Mai Kalonga to chat and confirm appointments for following week
29 4 97	Mai Mazinga cluster Hoeing field [mbwera] for peas or beans to be planted	write up notes	Mazinga cluster, various food processing and chatting
30 4 97	Mai Kusala Pinching out peas. Collecting relish	write up notes	Visit to Mai Kusala
Stay 4			
6 5 97	*CC unaccompanied to village*		

7 5 97	Simeon Magomero - planting rape seedlings in dimba garden	write up notes	
8 5 97	Mai Kalonga - harvesting maize	write up notes	Spent with Mai Kalonga and family
Stay 5			
14 5 97	Mai Marichi cancelled - ill with cold Went to Kambuwa to get information on farmer evaluation from P Jere	write up notes	Went to see Mai Kusala - does not want to work with us
15 5 97	Mai Mazinga's cluster Processing maize	write up notes	More food processing, and chatting
16 5 97	Visiting other OFT farmers to let them know what we are doing and to ask about instructions concerning relay beans Mai Kalonga and Simeon to arrange next week Mai Sitima Mai Nasiyani Mai Lombola	write up notes	
Stay 6			
20 5 97	Mai Elizabeth cancelled due to daughter's illness Visited other OFT farmers Mai Costa Bambo Julius	write up notes	Visited Mai Kusala - but only to be convinced that she does not want to participate in the participant observation work
21 5 97	Simeon Magomero Transplanting rape and watering crops in dimba garden	write up notes	Afternoon spent with Mrs Simeon and visiting Kalonga and Mazinga Cluster
22 5 97	Funeral in house very close meant work was postponed Long visit from chief and also Mai Elizabeth	write up notes	Received various visitors at home. Mai Elizabeth [Marichi cluster]
Stay 7			
27 5 97	Mai Muthowa Collecting wood from hillside, preparation of velvet beans [kalongonda] and observation of preparation of kanyenya	write up notes	Visit to chief and inspection of vegetable nurseries
28 5 97	Mai Elizabeth [Mai Marichi's eldest daughter] Maize harvesting	write up notes	Visited Bambo Julius and spent afternoon at Mai Marichi's compound
29 5 97	Mai Mazinga's Maize shelling	write up notes	Visited Mai Kalonga and Bambo Simeon
Stay 8			
3 6 97	Mai Kalonga's - rain prevented field work	write up notes	visit from chief - tomorrow's plan to spend time with him in his dimba garden cancelled
4 6 97	Visit to Nansadi and Bvumbwe clinics with Mai Kalonga, daughter and sick grandson. Team able to take KA609 thereafter Visits to Mai Costa, Mai Marichi, Mai Muthowa	write up notes	Visits to Old Chief Magomero, Simeon Magomero and Mazinga cluster
5 6 97	Mai Elizabeth [Marichi cluster] Pounding maize and winnowing	write up notes	Home
Stay 9			
9 6 97	Bambo Simeon Cutting and carrying grass	write up notes	Mazinga cluster
10 6 97	Mai Muthowa Carrying grass from hillside	write up notes	home

Problems

The anthropology team has encountered four problems.

1. The first has been that two of the households originally selected for participant observation are not keen to be visited in this way. It has been made clear from the start that any household has the right to refuse our company and questions: this work can only be done with those who are well-disposed. What should be noted, however, is that it was difficult for the pertinent individual in these households to tell us directly that s/he would rather not be involved in the project work in this way. We had to be sensitive to hints and excuses. It was expected that some households would not be comfortable with the presence of strangers, however, and this should be regarded as a normal part of 'settling-in'.

2. The second difficulty is that at the moment, we are finding it hard to 'break away' from the On-Farm Trial [OFT] household to work with the other households in the cluster. We are perceived as the guests of the OFT household and when that household is unavailable, we have not yet managed to bridge the gap to spend time with the other households. It is hoped that this is a problem which will ease with time and further acquaintance. We must be sensitive to inter-household differences within the cluster [for example, in some clusters, it seems that very good relations hold between households: elsewhere, we detect tension] and be aware that it may not always be possible for us to be equally well acquainted with all households therein.

3. The third 'problem' has been Malawian hospitality! That is, it has been difficult to persuade the cooperating households to treat us less like guests and more like fellow workers so that they will allow us to share in a greater number of tasks. Although we have done a substantial amount of agricultural work, we have yet to succeed in being included in non-food processing domestic tasks. We are also aware that the more pleasant tasks are saved for us [for example, we have been unable to go grass cutting since our hosts regard this as hard and dirty work].

4. The fourth problem is one which in due course we may be able to overcome and is that we suspect a bias of either relative wealth or exposure to foreigners/visitors in the acceptance by us of the villagers concerned. At this stage, the finer details of socio-economic position are not yet available, but we are sensitive to the possibility that until we are able to associate more freely with the wider cluster [not just the household participating in the OFT] we are, in a sense, being selected by more confident members of the village. Patience is also required with regard to being able to participate in the wider social life of the village: we must await invitations rather than push ourselves where we are not yet wanted or expected.

What we have learnt issues arising

- **Family structures**
- **Agricultural activities**
- **Poor harvest and implications for food security**
- **Tensions in marriage/polygamy**
- **Men and marriage**
- **Division of labour/seasonality**
- **Natural Resources**
- **Vegetable growing, socio-economic status and livelihood strategies**

Family structures
Our initial task, whilst participating in household activities, was to understand the make up of the different families within the clusters where we work: for example, their ages, marital status, numbers of children, educational achievement and so on. We are now confident that a wide range of household types has been included.

- Female headed households - widowed, divorced, never married, not cohabiting but receiving support, with absent and non-supporting husband, young and old;
- Male headed - large, small, and childless, relatively well off and resource poor: matrilocal and patrilocal households [men from the village who have acquired land here and men who have married in, men from the village who have married here and men from outside];
- Households with good support from town and households with relatively little interaction with urban relatives. An effort has been made to identify where other relatives or household members may be found and to understand their involvement in the affairs of households or clusters.

An initial identification of the main economic activities of household members has been made and we hope that careful observation and questioning throughout the year will enable us to understand micro-entrepreneurial or exchange activities.

During this initial period, our main aim has been to establish a friendly relationship with these families so that in due course, with their active assistance, we will be able to construct models of the way their households and clusters function. Participant observation is already being extended to include detailed questions - this will carry on either in a semi-structured manner or formally through questionnaires - and will continue to be supported by continuing participant observation of their working and family life. By analysing the relationships, both economic and social, that we find within and between households and clusters, we should be well-positioned to extend this analysis to the wider village and to the other villages where we work.

Agricultural activities
The main activities in which we have taken part have been land preparation, seed planting, transplanting and watering vegetables, maize harvesting, maize and vegetable processing, carrying roofing grass and collecting wood and relish.

Many questions arise naturally whilst participating in agricultural work: for example, which crops and reason for their selection, what sort of yield is expected, current and past problems and seed types: at every stage, we have endeavoured to investigate the activity we are doing as closely as possible. The main subject has been how bad the harvest is due to the heavy rains and the high price of fertiliser that prevented many farmers from applying fertiliser in what they consider their normal fashion.

Poor harvest and implications for food security
A major topic of conversation has the unprecedently heavy rains and the unaffordability of fertiliser this year and the damage that has been done to the maize harvest as a result: people fear that this will be a hungry year and doubt whether ADMARC will cope with the demand for maize. Already there have been cases of theft of maize from fields and houses [it is rumoured that parents are encouraging their children to steal maize]: most are preferring to store their harvest indoors rather than in the nkhokwe: this is particularly true for older, female headed and isolated households. The Chief is most concerned for older people who will have no maize to sell and who are unable to either grow vegetables or seek employment. Others are predicting that there will be opportunities to buy assets being sold by impoverished co-villagers such as bicycles cheaply or to hire labour in return for food alone rather than cash payment. One older man said that he had not seen such a poor harvest in this area since the 1949 famine and another family predicted that the two months of December and January will seem to last two years. Already a farmer is planning to retain maize bran to sell later to be added to bran-free ufa since many families will cut out their evening meal and only eat an afternoon meal. The addition of bran means the nsima stays longer in the stomach and thus keeps hunger away.

The price of maize is considered to have remained relatively high [and has just been raised from MK125 to MK130 per 50kg by ADMARC]. In the market place, however, our informants have told us that the price per plate remains the same but that the portion of maize on the plate is being reduced - 'flattened'. They predict that this process will continue.

Beans
As the project well knows, maize is not the only crop to have been adversely affected by the weather pattern this year: many farmers did not plant beans due to the lack of later showers and few of those who did have seen a good harvest.

Tensions in marriage/ increase in casual polygamy
Several discussions have centred on the tensions caused by polygamy and the use of charms associated with jealousy and competition between co-wives. It has been suggested that there may be more polygamy now than before and that this polygamy often takes the form of informal liaisons rather than formal unions. If this suggestion is true, it has interesting implications for gender relations and some hypotheses are suggested below. First of all, however, it is important to try and establish whether this impression is true or false. Dr Pauline Peters, who has been running a 10 year study in the Zomba area will be an appropriate person to consult on this subject.

Hypotheses
-Is the value of women's entitlements [land, labour and social capital] becoming less vis a vis that of men due to the pressure on natural resources?
-Are the income earning activities in which men engage becoming more important to family survival than previously.
-Are men seeking to casualise relationships with women to avoid the demands of the woman's extended family [there is some limited evidence to that effect amongst elite men in Blantyre]

n.b. There is widespread condemnation of polygamy by most churches and the husband and the second wife are excluded from many congregations.

Men and marriage
There seems to be a preference for the local marriage of sons on the part of both the son and his maternal family. Where the son marries close by, both he and his maternal kin may benefit from the access this gives to each others resources. For example, sons may be able to use mother's dimba land and where their wives do not have kin, the husband's parents are available to help with childcare. Presumably other resources will also be available when necessary.

Division of Labour/Seasonality
Participant observation in the lives of the villagers of Magomero will continue until September/October 1998 so that a full agricultural year and the associated activities, as well as domestic and marketing work will be covered. It is important that we have detailed seasonal information on the length of working day, the distribution of tasks between men and women, between different age groups and according to household type.

Our information to date lays emphasis on the seasonal aspect of work: e.g. water collection in dry season takes much longer and requires women to walk much further and thus carry heavy burdens much further than is presently the case: or, in April and May, the hot weather meant that field work was only done in the early morning and late afternoon. We are also interested in the role of the matrilineal cluster as an important secondary economic unit for childcare and worksharing. There is evidence of some inter household help for agricultural activities, e.g. for harvesting [the Kalonga cluster] or for looking after elderly or sick members of the cluster [e.g. Mai Marichi is being cooked for by her daughters while the agricultural work is being done by her grandchildren]: but there is also evidence of inter-h in competition for shared resources [as in the attempt at appropriation of Simeon Magomero's dimba gardens by his maternal cousins].

Over the last nine weeks, our impression is that this is a relatively relaxed time of year. Although there are continuous and strenuous tasks for women in pounding or water carrying, for many, several afternoons a week are for relaxation. Work tends to be adjusted to current conditions: tasks may not be performed when it is neither too hot, too cold or too wet, as we saw with weeding and the care of bean plants.

Natural resources
Our participant observation and conversations with farmers have highlighted a range of pressures that exist on natural resources. The shortage of firewood is now serious and requires both men and women, but principally women, to spend considerable time in collecting firewood. Older informants have told us that in the past it was possible to catch fish in the Nansadi river and that there were indeed, fishermen. The fish are now finished although it is believed by villagers to be as much to do with soil erosion due to the cutting of river bank trees as it is to do with over fishing. Grass for roofing is also becoming scarce and where this grass is owned quite a lot of theft is taking place.

Vegetable growing, socio-economic status and livelihood strategies

The social anthropology team has taken a special interest in vegetable growing in the light of the FSIPM's project's possible involvement in IPM for vegetables and plans a more thorough survey of this activity through June, July and August. A checklist has been prepared [see attached].

It has become clear that vegetable growing is not an activity confined to one socio-economic group: that is, wealthier farmers but is also an important livelihood strategy for poorer farmers. Nor is it an activity solely carried out or controlled by men: women play an important role both in the cultivation and marketing of vegetables. However, it appears that the more valuable vegetables and larger scale production are perceived as principally male activities. No one could offer a concrete example of a woman in a female headed household who was involved in sizeable vegetable production.

Although vegetables have been grown for a long time, informants say that the marketing opportunities have expanded greatly over the last few years with the growth of the urban population. One joked that the women from all corners of the village now meet in town selling vegetables. There is considerable sophistication regarding markets: several village women travel as far as Chilomoni to access the higher prices available from selling house to house there.

The important variables in vegetable cultivation are the scale of the operation and the capital and labour thus required: this breaks down into the amount of land available: the type of vegetable grown: the allocation of labour by husband and wife: the marketing opportunities and transport needs: and how the income from vegetables is used.

- Dimba availability

Vegetable growing does not have to be on a large scale nor does it require ownership of dimba land. While dimba gardens may be available from the family of either the husband or the wife and this much reduces costs: rentals are nonetheless available for both small and large pieces of land and rents can be paid in small instalments. We have been told about rents varying from MK40 to MK265 per growing season [3-4 months].

- Type of vegetables

The type of vegetable grown is critical since this dictates the nature of inputs required and the marketing possibilities or requirements for the farmer. For example, rape, chinese cabbage and mustard are vegetables that can be grown by a poor farmer. The seeds are quite cheap and neither vegetable requires intense use of fertiliser or pesticides: both fertiliser and pesticides can be bought from Bvumbwe market in small quantities [pesticides are sold in by the coke bottle or a division thereof]. One farmer commented that 'rape grows like grass'. The leaves are not heavy and can be headloaded to local markets. Cabbages, on the other hand, require considerable capital: the seeds are expensive, much fertiliser is needed, pesticides must be applied, the labour requirements are high since considerable watering is necessary and the weight of the vegetable means that to access the high prices available at more distant markets, a vehicle must be hired. Tomatoes are something of an intermediate crop.

involving some outlay but not on the scale of cabbage. Vegetables such as peas, beans or sweet potatoes do not appear to be considered highly commercialised and are grown by men and women alike. Onions are a relatively new crop for this area, we were told, although commanding high prices and carrots are still not much grown here. The market for small scale production of chillies has somewhat collapsed in Magomero since the there do not seem to be buyers touring the village as in previous years: others are growing chillies on a larger scale and themselves transporting them to the Nali Company in Limbe.

It should be noted that vegetables requiring fewer inputs may be grown first in order to raise the capital to grow a more 'expensive' crop later.

- The allocation of labour

As elsewhere in the farming system in Southern Malawi, the division of labour is neither fixed nor inflexible: men and women are able to perform most tasks. In the cases we have seen to date, husbands and wives each work on vegetable cultivation. Informants said that the only task not performed by women is spraying vegetables with pesticides [however, it is theoretically possible that a woman could hire a man or persuade a male relative to do this for her]. All other tasks can be shared but it is usual that men take more responsibility for land preparation and perhaps the planting of nurseries. Transplanting, watering, weeding and harvesting are all tasks that are readily shared.

- Marketing

It appears that for lighter weight or smaller quantities of most vegetables, women take much responsibility for marketing. It remains to be established in this case, but elsewhere in Africa and many other parts of the developing world, a strong correlation has been established between the marketing of goods and control of income. It is important to keep in mind that for many poorer household, a model of decision making for expenditure is misleading. There are basic needs to be met and both husbands and wives have little choice as to their purchases. Examples were given of a polygamous marriage where the husband gave his wives vegetables to sell and they were to keep whatever they earnt. Other examples came from monogamous marriages where both husband and wife marketed vegetables, women selling rape, mustard and tomatoes while men would arrange for the marketing of the bulkier and more profitable cabbage crop: in this case, husband and wife would each have a say in expenditure of the profit. Where mothers give their sons dimba gardens, it seems that sons either give their mothers some money or some vegetables or both: this arrangement is not, however, as formal as renting. In other cases, women are active as 'middlemen' and buy and sell vegetables such as tomatoes as a business.

Summary of initial findings on vegetable growing

Our understanding to date, therefore, is that households of a range of income groups are able to take part in vegetable growing and that pesticides are a major cost among inputs. These costs are greatest for the larger vegetable producers who provide, for example, large amounts of cabbages on contract to local schools or who take vegetables as far as Limbe. However, these costs are proportionately large and play a significant part in the decision of the poorer households regarding which vegetables they try to grow and what sort of profit may be expected. It should be kept in mind, however, that as far as we know at the moment, women are seen as providing labour for vegetable growing rather than being the principal or commercial vegetable growers. This may have implications for the project's stated aim of working with female headed households. There are, nonetheless, a wide variety of different types of female headed households and at this stage, we should not assume that none of these benefit.

Endnote

It should be emphasised that it is important that we are able to guarantee our discretion and respect for privacy to the families with which we work. In subsequent reports, if detail is provided, initials will be used to describe households and clusters.

It should be also emphasised that this task as a project wide one. The economists are pursuing similar information albeit in a more quantitative form and all our Malawian staff are themselves already 'anthropological experts'. That is, all our project staff have the capacity to greatly enrich the project's work if they apply their knowledge of Malawian society - of village life, economic possibilities and constraints, how relationships normally work within families - to clarify what perceptions and agendas all stakeholders bring to this research. It is hoped that as the work of the anthropologists continues, we may be able to bring issues back to the project for all staff to investigate, debate or inform.

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

HEADSHIP, HOUSEHOLDS AND FAMILIES: THOUGHTS PROMPTED BY THE BASELINE SURVEY

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Headship, households and families: thoughts prompted by the Baseline Survey

- We need to ascertain whether the statistics produced by the Baseline Survey may be open to a range of possible interpretations and. with the requirements of the project in mind. seek to provide the most likely explanation. Where do we need to know more about the processes that lie behind the statistics: e.g. how female headedness comes about. the status of poor male headed households. the finer details of labour availability.

- What level of understanding do we need of these statistics or processes? What is 'good enough'? The question is complicated by the fact that at present the precise practices or interventions the project may ultimately disseminate are unknown but consultation is required to make informed decisions about where research should be focused.

- Given the importance of ensuring that the research agendas of the socio-economic and social anthropological teams are both complementary and relevant to the technical work. how can the qualitative methodologies adopted by the social anthropological team be used to further interpret and examine these findings? Where should qualitative work be more quantitative and quantitative work more qualititive?

- Where do we feel confident that elements of the farming system that must ultimately bear on the appropriateness of interventions have been correctly identified? Agriculture practice. current pest management and networks of communication [for information about the dissemination of technologies] including access to extension services. are clearly central. With respect to the social and economic context. I would suggest that to understand better the processes that lead to impoverishent. we should concentrate on the meaning and variability of the concept of 'the household'. the function of broader kin relations. the distribution of labour between different members of the household. and income generation and expenditure. If pest management for vegetable growing is likely to be a future path for the project. then the initial research on the responsibilities and activities involved should also continue.

An example of interpreting what lies behind the statistics: headship, households and families

I attach some thoughts on the meaning of the terms headship. households and families to show how a consideration of the interpretation of terms like this has implications for targeting. Since our remit is to work with resource poor households and female headed households - and the baseline survey supports findings from elsewhere that female headed households are disproportionately representated among the resourçe poor - two questions arise: to what extent is this group homogeneous [alike] and. if not. what level of disaggregation will the project require? [World Bank. 1995: Peters. 1993: Hirschmann and Vaughan. 1983]

'Households'?

The 'household' is usually defined as the basic unit of production. consumption. reproduction. socialisation and ceremonial and political interaction. Social scientists usually take as the 'household' whatever the people in a particular society themselves describe as the meaningful unit. The precise nature and function of the households can vary from place to place and over the lifetime of a household. For example. when a family has young children it faces different constraints to when the children are grown and some are living at home and contributing to household expenses.

Household or family?

It should not be assumed in advance that the constitution of the household or family is known for a specific society. [Moore 1988:54] There is enormous variation worldwide. The household and the 'family' [significant kin group] are not always identical: they may coincide precisely, overlap a great deal or be quite distinct. Matrilineal societies offer a good example of how a household defined by the conjugal unit, by a married couple, may not overlap with the most important kin links of either husband or wife.

The internal dynamics of the household

It is not always easy to understand the internal dynamics of a household - what the relationships are between the different members of the household - simply by looking at the formal structure of the unit e.g. 'female headed' or 'male headed'. Since we have all lived in households, we tend to think that we know how they work. Until recently, it was assumed by researchers that relations within the household were characterised solely by the pooling and sharing of resources, by altruism [e.g. mother love, the love between spouses]. Households were seen as corporate decision making units normally under the authority of a benevolent male head. Lately, it has been recognised that while altruism has a special place in intra-household relations, it is not the only type of behaviour found therein. [Kabeer 1991, Evans 199, Folbre 1986] There may well be competition and conflict between different members for the resources of the household. Negotiation and bargaining about rights and responsibilities take place within the household as each member seeks to bring about his or her preferred outcome. The ability of each member to influence the result depends on their gender, their age and their access to resources outside the household such as education, employment, state services or community leaders.

> 'The kind of preferences that are 'revealed' by individual behaviour are likely to reflect his or her position within the established hierarchy of interests within the household and options or constraints associated with it' [Kabeer 1995: 5]

For example, an educated middle aged woman in salaried employment is more likely to be able to influence events within her household than an semi-literate woman who depends on her husband's income. The relative power between husband and wife within the household may be partly understood in terms of what is called the 'breakdown' position: if the marriage fails, which partner is in the worse situation? [Kabeer 1995] What resources can each call upon in their own right?

'Headship'?

The notion of headship in matrilineal societies in Malawi must be looked at carefully: definitions from elsewhere in the world propose

> '...that member of the household as the head who has directly or indirectly the control over the resources and earning potentials of the household and this control is recognised tacitly or openly by other members....The actual determinant of headship is the ability to control and dispose of the resources of the household.' [Islam, 1991:5]

Headship in Malawi might appear to fall within this definition in regard to female headed households in the Southern region i.e. land is owned by the woman and she controls resources and earning potential: but even this ignores the contribution or autonomy of, for example, teenage boys who make food and sell it at local markets, and who then have some control over how this money is spent: or the substantial influence parents might have over their young single parent daughter who lives next door.

I would argue that here in Southern Malawi and with respect to the villages in which we work, the situation is much less clear than the above definition suggests. Indeed, we must beware imposing categories where they do not fit:

> 'If men and women have different or shared spheres of responsibility , headship may be difficult to attribute and the concept may not be relevant. In situations of shared power... researchers may attribute headship very often to males. [Lewis et al 1992:6]

Decision-making power

The idea of 'decision-making power' is found in much development studies literature but is too often associated with an actual, precise moment.

> 'A general problem with the discourse on households and their 'heads', is that it can encourage a unitary and monolithic notion of household decision-making' [Lewis et al. 1992:15]

'Decision-making' is rarely a clear cut affair but is instead a series of processes that take place at many different levels and in different spheres. [Lewis et al. 1992] The process by which an important decision is reached may be made up of a sequence of smaller and more diffuse conversations, decision, arguments and negotiations. Men and women or younger and older people might have responsibility or competence in different spheres so that there is a 'division of labour' in decision making. Or, there may well be situations where no decision is made, where a course of action is dictated by constraints on resources, normal practice or social pressure. For example, when asked why she planted a particular type of bean, a farmer might answer that this was all she had and that she could not afford to buy any other type. It is helpful to distinguish between who appears to be making a decision and how a decision is made.

Resources: access, management and control

The ability to influence decision-making is closely related to an individual's access to and management and control of resources. It is wrong to assume that in male headed households, men always dispose of resources. Where the FSIPM project is currently working, women have considerable control of resources as a result of their inheritance of land, the key productive resource: ready access to trading opportunities: the support inherent in the mbumba system and the fact that children stay with the mother on divorce. Many male farmers, by contrast, particularly in relatively new marriages, do not feel that they have clear access to or control of important agricultural assets. For example, male heads of households in the Zomba area offered saplings under a forestry project wanted to take them to their 'own' villages, that is, to their natal [birth] homes rather than plant [invest] where they did not feel they belonged. [David Chitedze, personal communication].

It is also important that we understand whether or to what extent men and women have separate or joint income streams: that is, do they earn and spend money independently, or how and when are cash or goods pooled? What processes of consultation commonly take place? It is also essential to understand local ownership regimes: what sort of property is owned by whom, is property owned jointly or separately? Without an understanding of how access to resources is shaped by relative wealth, education or gender, the influence each can bring to bear within the household is unclear and thus decision-making patterns will be obscured.

Relative value of male and female resource profiles

The rapid rate of population increase is reducing the value of women's natural resource endowments since land holdings are shrinking rapidly and soil fertility being depleted. It could be hypothesised that this has the effect of making male access to off farm income earning opportunities comparatively more valuable and so raises male status vis a vis that of women giving men more influence in the household.

Links between households

The importance of social networks for the survival of poorer households

Studies of the processes by which families and individuals become impoverished lay weight on the significance of social relations, that is, relations between individuals and between households or groups of households, in reducing vulnerability. The position of individuals within networks of kin, neighbours or their connections with key actors in the community, the state or the market and the claims that they can make on these people, are important elements in livelihood strategies

The nature of social relations

It was stated above that it should never be taken for granted in advance of detailed investigation that the 'household' and the 'family' are the same unit in a particular society. It is sometimes argued that by concentrating on the conjugal relationship and the household, other important relations and strategies may be obscured. It is generally agreed that the linkages between households make up an important part of the livelihood strategies of many households in Malawi. Within the matrilineal system, these links are mainly between mothers and the adult children who live in their cluster [normally daughters] and between adult siblings [brothers and sisters]. These links may constitute a 'domestic network' that provides material and moral support rather than this being provided by the bounded household unit. [Moore, 1988:62].

Moreover, the rights and responsibilities of adult males in a matrilineal system are shared between uncles, brothers and husbands. Brothers and uncles have some authority with regard to the actions of their sisters and nieces and the disposal or management of the resources of the mbumba. It is probable that the authority of brothers and uncles is being challenged more strongly than ever before by husbands and fathers, particularly in urban areas and where a husband's cash income is crucial to survival, but matrilineal male power is still significant and removes further important elements from the concept of the 'male headed household'. The matrilineal case in Malawi means that at least one element of the definition of the household, that it is the fundamental locus of 'ceremonial and political interaction' is only partly true: the mbumba group is the key unit for most aspects of 'political interaction', for example, in disputes over land. Further scrutiny of what rights and responsibilities are currently attributed to which male relative would be useful to clarify the nature of the 'male headed' household and to understand how or whether, if the absence of a male head is counted as the loss of a resource, the female headed household may be able to 'make good' this loss through kin networks. [Lewis et al. 1992:17]

Other vital links between households are those between mother and sisters who have separate households but who live in the same clusters. Megan Vaughan, working in matrilineal society in Southern Malawi, found that while there was a strong ideology of household self sufficiency which precluded taking grain from the nkhokwe of one's sister or mother, poorer households within the cluster, usually female headed, were able to share food at the point of consumption. In this way, by eating together and sharing the meal, the appearance of self sufficiency was maintained whilst crucial support was given to more vulnerable households. [Vaughan, 198?]

Less covertly, households within a cluster or which are related to one another can be seen to cooperate with childcare, cooking, small scale lending or giving of foodstuffs such as relish or fruits as well as in the more important life such as sadakas [memorial meals for the dead], weddings or funeral arrangements.

Households in Malawi?

Taking into account issues around the meaning of the household, headship, the importance of differential access to resources, what can we say at this point about male and female headed households in Malawi? It should be noted that the conditions under which households become female headed have been connected to situations of high migration, high insecurity and vulnerability and increasing socio-economic differentiation such as shifts in the organisation of agricultural production and changes in kinship structures that formerly provided a social security network.

Female headed households

Studies demonstrate that the 25% of households in Malawi that are female headed are, on average, poorer than male headed households. The Southern Region has the most female headed households [32% of the total] which are also the poorest: 60% of female headed households in the South are poor as compared to 33% in the North. [World Bank 1995] When all variables were controlled, the 1995 World Bank study suggested that female headed households have on average 79% of the income of male headed households. Most studies note a positive correlation between landholding size and the presence of men in the household labour force: that is. female headed households have smaller landholdings. One explanation offered is that men tend to remain in marriages where there was enough land to make their labour productive.[Hirschmann and Vaughan. 1983] Male land rental in the south might also help explain this statistic.

The same study found for female headed households that

- 33% are married
- 33% are divorced
- 24% are widowed
- 12% are single

and that the divorced and widowed households are likely to be the poorest. These findings also indicated that age is an important factor in impoverishment. no matter what the marital status of the household. The older the woman. the more likely she was to be poor.

But not all female headed households are poor
These figures suggest what current research in development studies warns against. the danger of assuming that female headed households are universally impoverished. It is well known that de jure female headed households [households where the woman is divorced. separated. widowed or single] and de facto female headed households [households where the man is absent for 50% or more of the time] may be quite differently situated

De facto female headed households may be better off than many male headed households
Peters found a family division of labour in male headed households in the Zomba district: the wife concentrated on farming while the husband worked off farm. [Peters 1993] A de facto female headed household might be supported by regular remittances from a husband working in town with which are purchased household necessities. seeds. fertiliser and extra labour at peak periods. This is quite unlike the situation of an elderly widow. living alone and receiving little support from sons who live far away. Female headed households can therefore be both rich and poor. Furthermore. for the purposes of IPM trials and extension. the female farmer might be the main point of contact even for male headed households.

A transitory state?
Research within Malawi also suggests that female headedness. particularly for younger women. is often transitory: marriages are fragile and a household that is female headed this year may be 'male headed' the following year. [Peters. personal communication] [Might this explain some of the similarities between male and female headed households in the baseline study that appear initially counterintuitive e.g. the non significance of difference in decline in fertiliser use?]

Male headed households

What resources?
When looking at male headed households. it is hard to see clear lines of control and disposition of productive resources. The matrilineal system [inheritance from the mother by the sisters] gives women customary tenure of cultivated land and women retain their land in case of divorce or widowhood. On the other hand. men are more likely to have access to better paid wage labour. to have received higher levels of education than women and to be more mobile than women. Where men marry within their natal village. they may have access to some of the productive resources of their own mbumba.

Shared and differential responsibility for crops
It is important to try and delineate the most common patterns of individual or shared responsibility for the various stages of production. processing or marketing for individual crops if we are to understand who does what and when.

While there are crops for which women take more responsibility for cultivation. storage or marketing. for example. maize. beans. ground nuts and pigeon peas. it seems to be primarily men who control the higher value crops such as cabbage or tomatoes. Men tend to obtain or rent land for burley vegetable production, buy inputs such as fertiliser and pesticides and control the cultivation of most burley and vegetables. However, there is considerable flexibility in the division of labour in agricultural work and men and women may well share the same tasks on the same crops: men who grow burley and vegetables normally rely on considerable inputs of labour from their wives. Some women are beginning to grow burley and to expand their traditional vegetable production.

Post harvest

How the crop is marketed and what happens to the profit is also important. After harvest, many husbands, with variation according to the bulk and value of the crop, hand over a substantial proportion of the vegetable crop to their wives for marketing. It is generally accepted [and personal communication in the village confirms] that both where women contribute their labour and market the vegetables, this makes it easier for them to claim a share of the cash generated and a say in how the money is spent.

Polygamous male headed households [1]

Polygamous male headed households are an important sub-group of male headed households that have a low profile in the existing literature. The nature of the polygamous relationship can vary considerably in formality, the material and emotional support given by the husband, the amount of time he spends with each family, geographical location, the duration of the relationship and the social status of the inviduals involved. Polygamy therefore presents a number of issues for a project concerned to work with the resource poor.

It seems to be the case that even where a first marriage has been formal, second marriages tend to rest on an agreement between the man and the woman alone, rarely involving marriage guardians or any ceremony. Consequently, second marriages may well be less secure than first marriages. Some second wives seem more like 'girlfriends' in that they see little of their 'husbands' and only receive irregular maintenance or visits.

Whatever the nature of the relationship, it follows that where a man has two wives or two families, he is unable to offer the same level of support to each that could be offered to one wife and family. By support is meant his time, labour, money and general level of involvement. This is particularly so in the matrilineal system of southern Malawi since co-wives are unlikely to be co-resident [or even to know each other] and the man has to travel between two homes. Nor does it seem to be only better off men who take second wives, several examples from Magomero involve men who are not able to offer much material support to either wife. It seems likely that a polygamous husband's shared responsibilities may well have implications for his contribution to each household's decision making and for the socio-economic status of each household that he 'heads'. Income streams are more likely to be separate as each wife will be anxious to make sure that she gets her fair share and does not indirectly benefit the other wife.

It is not clear to what extent the polygamous husband loses social status but second wives seem to feel a loss of prestige: both are excluded from the majority of Christian churches. Considerable bad feeling is caused by polygamy on the part of women [most of the stories about spells or charms that we have heard in Magomero have been related to emnity between co-wives]. I suspect that polygamy may often be underreported by women due to the low status it bears. It might be hypothesised that these tensions are likely to undermine a man's willingness to invest in the resources that belong to each wife and to make him keener to use the resources over which he has control such as rented land or his wife's labour. [Colonial authorities certainly considered female ownership of land to be a cause of male underinvestment in agriculture and tried to legislate against it] [Marwick, 1960]

Polygamous households are therefore a category that requires more empirical investigation. It may well be that these households are overrepresented among poorer male headed households.

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[1] N.B. I am not sure how the situation differs amongst Muslim communities where polygamy is religiously sanctioned.

Conclusion
This discussion has examined the meaning of some key terms used by the FSIPM project [and more broadly in Malawi] such as 'headship'. 'household'. female headed households and maleheaded households. The object of the exercise was to show how these terms are not self explanatory but serve as a shorthand for a range of possibilities regarding their nature and function. More detailed research may be required into these seemingly 'natural' concepts if we are to have a clear idea of what constraints and possibilities are faced by the farmers who constitute our 'target' group.

Given our ignorance as to the interventions which the FSIPM Project will ultimately promote. it is not possible to know precisely what information we need about the socio-economic context at this stage. Nonetheless. a critical and empirically based review of some of the central terms employed seems a useful route. It might already appear likely that a subset of female headed households. the de jure household headed by an older woman. may be both among those in deepest poverty but among those who would find almost any pest management strategy difficult to implement due to their scarce supplies of capital and labour. Similarly. the prevalence and situation of polygamous households may warrant closer investigation.

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ANTHROPOLOGICAL STUDIES FOR FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

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ABSTRACT

The paper presents the contribution of Social Anthropology team to the Farming Systems Integrated Pest Management Project. The team's main village field work is through case study clusters in Matapwata EPA in which information on agricultural activities is collected. This has been extended to include social and cultural issues through activity diaries. This work will contribute to the requirement that the proposed integrated pest management intervention be within the resources of the majority of farmers. The team also produced a detailed questionnaire to find out farmers' experiences, expectations, anxieties and suspicions of the Farming Systems Integrated Pest Management Project and other interventions. The team took part in the farmer evaluation of the main trials to determine farmers opinions on crop cultivation problems, and the relationship between farmers' normal practices and the trial interventions. In this context we then seek farmer' views on diferent aspects of the technologies being tested and their perceived effectiveness or lack of it.

INTRODUCTION

One of the basic threads to the farming systems approach is a concern with small-scale farming families who generally reap a disproportionately small share of the benefits of organised research, extension and other developmental activities (Rivera,1986). This agrees with the aim of the Farming Systems Integrated Pest Management Project of providing resource poor farmers with practical integrated pest management strategies that will reduce crop losses by pests. In order to have these strategies sustainable, the behaviour of these resource poor farmers has to be well understood. As such the Social Anthropology team is concerned with micro level analysis of issues affecting these farmers in order to have a true portrait of them. This is a response to the perception expressed by Chambers (1983), that outsiders' views of the poor are distorted by lack of contact, communication and personal exposure. In view of this challenge the team is always in contact with the farmers through case study clusters to ensure that the interventions introduced should solve their problems, meet their needs and not overtax the resources available to farmers.

The aim of farming activities study is provision of in-depth information of households and their clusters to allow understanding of socio-cultural or micro-economic constraints on and opportunities for farmers in their livelihood strategies. This work will contribute to the requirement that proposed IPM interventions be within the resources of the majority of farmers. By monitoring agricultural activities done by each member of the household, the team is able to understand how decisions are made regarding agricultural production while at the same time understanding farmers knowledge and practices as reported by (Jere,1997) that the FSIPM Project realises that farmers' knowledge and practices as regards pest and crop protection are very rich and diverse because they have been practicing a lot of Pest Management Strategies (PMS) for a long time on their own.

An extension to the farming activities study are activity diaries that were being kept by one or two members in each cluster. This involved those people keeping the diaries to take note of each and every activity whether social, cultural, economic and agricultural done by each members of the cluster (both adults and children). This is a holistic approach to understanding the farmers' livelihood strategies as it captures all the activities done by every member of the cluster and provides some indication of how these in the long run will affect IPM strategies.

The study on Farmers experiences, expectations, anxieties and suspicions of the FSIPM Project and other interventions was aiming at assessing farmers' understanding of the trials both in the first and second season and if they have had any problems; how they saw the project at onset.

It was also the teams objective to have background information on the villages' exposure to outsiders as this may have an implication on farmers behaviour. Finally it aimed at assessing level of farmer participation in the trials as this is a pre-requisite in a participatory research project.

Farmer Evaluation

Ideas for farmer evaluation have been derived from literature sources (e.g. CIAT manuals), comments from Savitri Abeyasekera and Roger Sterne (SSU, Reading) and from last year's experience (Paul Jere). The 1996/97 evaluation report highlighted the issue of complexity of trial design and lack of alternatives for comparison visible to the individual farmer because the design involved incomplete replication with a large number of treatment combinations and only one experimental field per farmer matched with a "farmer's plot" which had the farmer's preferred spacing of maize with beans and/or pigeonpeas. Thus farmers were unable to express preferences between alternatives which were clear to them.

This year trial design has been radically simplified by 1. reducing the number of treatments per intercrop: and 2. increasing the number of (smaller) plots to four per farmer with all major alternatives visible to each farmer. Note that this design still leaves combinations of varieties of beans and pigeonpea with maize seed dressing or banking unreplicated on each farm since it appeared reasonable to believe that interactions would not be discernible by the farmers whereas the relative performance of varieties and the presence or absence of banking or seed dressing would be things which farmers could easily understand and evaluate. Any interactions between bean varieties and pigeonpea varieties or between each of these and seed dressing or banking will be detectable in the statistical analyses of yield and plant survival.

METHODOLOGY

Farming activities

The project covers two Extension Planning Areas (EPAs) namely Matapwata and Mombezi in the Shire Highlands RDP under Blantyre ADD. Social Anthropology team monitors agricultural activities in five of sixteen households in Magomero village that are taking part in on-farm trials, in Matapwata EPA. This takes one and a half days per week and will go until October 1998. This process started with village stays in which the team had part-time residence in the village during which background information of the clusters was collected which included: matrimonial and family details, residence, education, household work, production and agricultural information..

When this activity was started in April, 1997, farmers were asked to recall details of past activities i.e. when were their fields prepared, planted, weeded, banked, which crops, for how long did each activity last, who was involved. It was observed that most farmers had problems with accurate recall. The study will cover a full agricultural year from October 1997 to October 1998 so that farmers are asked about activities shortly after they take place and in some cases the team has actually had hands on experience of these activities during the village stay. In this way the team knows the duration for each activity.

Activity diaries

Activity diaries started in January 1998 to June 1998 with thirteen people involved in recording the activities. Then from July to December, 1998, the best three of the thirteen were selected to continue and will keep on with these activities so that the team keep track of the activities.

Farmers experiences, expectations, anxieties and suspicions of the FSIPM Project and other interventions

A detailed questionnaire on Farmers' Experiences, Expectations, Anxieties and suspicions of the FSIPM Project and other interventions was administered to 40 farmers, 20 in each EPA in the months of May and June 1998, and the data is currently being analysed

Farmer evaluation

Interviews were conducted using an open-ended questionnaire with 6 participating farmers from Mombezi and Matapwata, which established a number of issues which were of particular interest to farmers. Each interview began with a statement of researcher neutrality, to reassure farmers that negative views were welcomed as well as positive ones. It was explained that the interviewers wished to learn whether the interventions being tested

- were useful or not useful
- would create problems of labour or expense or availability of inputs for an ordinary farmer
- can be improved (and if so, how).

Much time was devoted to eliciting the farmers' own criteria for evaluating varieties since these qualites will govern the acceptability and uptake of any new varieties which we may wish to introduce.

A more detailed questionnaire incorporating insights gained from the open-ended evaluation, was designed by the project team as an excel spreadsheet, with the assistance of Dr S. Abeyasekera and Dr I. Wilson of the Statistical Serices Unit, Reading University. A sample of 40 farmers was interviewed twice each between April and June to cover issues relating to maize and beans. It was found that farmers were unable to distinguish which plots had which pigeonpea varieties so the plots were remarked and the farmers were taken to the plot and shown the different varieties. A further visit to each farmer will be made in September to cover pigeonpea evaluation.

RESULTS AND DISCUSSIONS

Farming Activities

Variations have been observed within and between clusters as regards planting, weeding, banking, and fertiliser application. The team observed that this year has been a relatively difficult year for most farmers to successfully complete activities like weeding and banking owing to shortage of labour. Labour shortage dates back to last year when most farmers had a very poor maize harvest. As such very poor households have been constantly relying on piece works for survival. This meant work in their own fields being delayed. Also in some of the households fields were abandoned for weeding or banking due to poor stand of maize which they thought was not worth the effort.

Only a few households were able to apply fertiliser in their fields because most of the farmers were food insufficient and so opted to use their money for buying food not fertiliser, as a result maize harvest was still poor. In some cases two households could contribute towards a bag of fertiliser and share.

The team also observed that most farmers buy their seed from local markets or from a friend in the village and this means recycled seed. Also observed in this study is that farmers invest more effort in a field which they are sure to get a lot from.

The team has in the process been identifying all off-farm or marketing activities within the relevant household and as far as possible, within the wider cluster. It has been observed that at least one woman in each cluster is involved in marketing of agricultural produce as a source of income and this is regardless of household status. Through these marketing activities some farmers were able to hire labour for their fields.

By looking at allocation of resources such as land (thus looking at how many fields each household has) the team has observed that preference is given to women because they stay in the village while men marry away. In some cases men are entrusted to use a dimba garden but normally share a bit of the harvest to his parents. It was also the team's interest to know the size of the fields to have a picture of how much land each household has.

Activity Diaries

During this process there are issues that have come out clearly some of which follow:

- Farmers share planting materials and some buy locally in the village or at local markets. this was observed in all the five clusters.
- Lack of fertility in the field influence farmers decision on weeding and banking and this was observed in four of the five case study clusters
- Funerals and illness delay agricultural activities. this was observed in all the five clusters.
- Food insecurity also delays field activities e.g. some farmers opting to work in a neighbours field for food while their fields are also due observed in four of the five clusters
- Young children contribute effectively to household labour and sometimes are left at home to take care of very young children. evident in all five clusters.
- Members of the same cluster hire each other for labour (e.g. in one cluster a relative has been employed as a labourer permanently) and some times close friends are hired for labour. This is also evident in all clusters.
- It is mostly women who are very active in marketing of vegetables and other farm produce in local markets and even as far as Limbe and Blantyre. and men mostly as vegetable producers especially cabbage and tomatoes with some pesticide use involved.

Farmers experiences, expectations, anxieties and suspicions of the FSIPM Project and other interventions

The questionnaires are currently being analysed and below are some issues that came out of this study

- 10 of 13 dambo farmers in Mombezi EPA understood the purpose of the trials as addressing whitegrub problems while three quarters of the farmers in the upland said the project wanted to assess soil fertility in their fields.
- When the project first came to the village. some farmers thought that it wanted to distribute free farm inputs such as fertiliser. others said the project came to teach them modern farming methods while the rest. most of whom did not attend introductory meetings thought the project wanted to steal their land (why making plots in their fields).
- There has been very little exposure to agricultural projects. main experience being farmer clubs through which farmers were getting fertiliser on credit and most of which were a failure.
- Three quarters of the farmers said that contact has been very good with the team and one quarter says that there was very little contact with team.
- Many farmers said that the best aspect of taking part in the trials (first season) was that the team provided free seed for the plots and gave back whatever the team harvested from them. Others appreciated planting pattern of beans (two planting stations between two maize plants) which they believed gave a good yield. Only one farmer said that there was no benefit in taking part in the trials
- Almost all farmers in the two EPAs said that they were worried about lack of fertiliser in trial plots in the first season. Most farmers in the dambo (especially in Mombezi EPA) in addition were worried because of too much rain during the first season that led to little or no harvest at all. On the other hand. most farmers said that they had no problems with the trials this year since fertiliser was applied on trial plots although few farmers have said that the maize harvest will not be very good high because of early fertiliser application.

Farmer evaluation

Some initial findings are already emerging from the questionnaire survey.

- Most farmers had no difficulty using a 1-5 rating scale. though one lady needed to see this scale visualised by using 5 stones of differing sizes to imply more or less good. She was able to score qualities of bean varieties by touching the appropriate sized stone with a stick.
- Gender had an influence on farmers' ability to answer questions and the kind of answers given. For example women valued the good poundability of Masika maize variety. while men were unaware of this characteristic.
- As indicated above. most farmers were unable to make specific comments about the performance of different pigeonpea varieties. though this did not seem to be the case with beans.
- In general farmers felt that Masika was a good variety and rated it about 4 out of 5 on a one to five scale where 1 is very poor and 5 is very good. This rating was as good as or better than most other varieties.
- Many farmers are adopting the project's 90 cm maize spacing. especially between rows though also often within the row. Others however feel that yield is being lost due to low plant population.
- Farmers frequently had few or no varieties of beans or pigeonpeas to plant.
- Farmers consistently expressed the view that if a single fertilizer dose is applied. this must be applied between knee-height and tasselling stage. Our application soon after emergence was considered likely to lead to yield losses.
- The "local check" bean variety. Kaulesi. is generally preferred to all other varieties.

CONCLUSION

Social Anthropology team is now associating freely with all households in the case study clusters. not just the household participating in on-farm trials. unlike in the first year when we were seen as guests for the participating households only. As such the team is now able to get information that would have been very sensitive before our acquaintance. This also facilitates the team's understanding of socio-economic.cultural or micro-economic constraints on farmers' livelihoods. It is therefore imperative to say that the beneficiary has to be well understood in order to have sustainable interventions and in combination with insights from farmers' experiences the team will be able to make relevant recommendations in the near future. However. patience is required with regard to being able to understand these farmers as micro level analysis is required in this context.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

CASE STUDY MONITORING,
OCTOBER 1997-JANUARY 1998:

HOW FARMERS SAW US AND EACH OTHER

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1. INTRODUCTION AND METHODS

Why case study monitoring?

The objectives of the case study monitoring have been set out in earlier papers but will be briefly reiterated. By following the activities of five on farm trial households and their geographically immediate kin group over the project lifecycle, we hoped to develop an extensive and intensive qualitative and narrative knowledge of each household. This work differs from the Baseline/Panel Survey [although it includes OFT households that are covered by the Baseline Survey] both because the group being studied is smaller but also because a more intimate acquaintance over several seasons permits the investigation of a series of issues pertinent to IPM in depth and as dynamic processes, particularly those concerning relations between individuals, within households and between related households.[1] The questions addressed are as follows:

I. What is our target group?
To understand more about our target group, that is, resource poor households and poor female headed households, and how socio-economic differentiation might result in different 'recommendation domains' for integrated pest management strategies. In particular, through a qualitative approach that seeks to understand the processes that create and sustain poverty, to identify how different members of the farming community face specific constraints regarding the key resources of cash, labour and inputs

II. What aspects of intra and inter household relations might bear on IPM?
To characterise relations within and between households where these bear on access to and control of resources for agriculture and, by implication, for integrated pest management. For example, who in the household or mbumba [geographical grouping of households related through the maternal line] is available for fieldwork? How is labour divided according to age or gender? To what extent might households within the same mbumba assist one another?

III. How do farmers perceive the work of the project?
To monitor how the integrated pest management activities of the project are being perceived by farmers and to develop an appreciation of the local understandings of the problems faced.

Methodology

The households were selected from the on-farm trial households to represent a different type of household situation based on household type and constitution. The social anthropology [SA] team spent approximately 2-3 days per week in the village of Magomero [this included overnight stays until the end of January, 1998] and continued to visit five on-farm trial [OFT] households on a weekly or fortnightly basis throughout the period.

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[1] cf. Peter de Vries [Battlefields of Knowledge, 1992] suggests, 'whereas statistical theory is dependent upon formal theory, case study analysis is dependent upon establishing logical connections between a number of variables in a case study...Case studies therefore, serve to establish the validity of a particular theoretical principle..not by achieving statistical significance but through their ability to elaborate a theoretical principle by confronting it with the complexity of empirical reality.' [1992:68] cited in Matsaert et al. 1998

From October onwards, there was a shift in emphasis in the research approach. Between April and June, the SA team had focused on getting to know the five OFT households, located in different mbumba . The SocAnth team took part in normal agricultural and domestic activities while engaging in informal and open ended interviewing about the farming system.[2] From October onwards, the number of households included in the process was expanded to include the other twelve households in the OFT household mbumba and the interviewing became more structured. The good quality of the relationships that were developed with the OFT households has allowed considerable openness in feedback on the problems or perceptions of the work of the FSIPM project and on a wide range of issues pertinent to their livelihood strategies [the whole farming system].

The inclusion of all the households in the mbumbas of the five OFT households has permitted the observation of a greater range of household types: twelve with married couples at their head of which two are or have become polygamous relationships, three headed by women, and two in an unstable situation. It has also allowed us to understand how households can be economically stable, managing and or vulnerable and to interrogate the supportive and competitive relations between the households. This approach also permitted comparison of livelihood strategies between mbumbas according to their size and socio-economic status.

Interviewing focused particularly on recording the type of agricultural and off-farm activities being carried out by different members of the farming households in order to understand the gender and age distribution of agricultural and off-farm labour. By January, this activity was converted to self recording of activities for the whole mbumbas by selected literate members [n.b. the information collected in these activity notebooks will be analysed during the 1998-99 season].

The themes that emerged during this period were as follows:

1. The constitution of indigenous knowledge regarding experimentation and farmers' perceptions of the experimental plots.

2. Relations within mbumbas: support and competition

3. Relations between mbumbas: kin and neighbours, social security networks

4. The 1997-98 season: a difficult year - the failure of the 1996-97 maize harvest and fears of a drought from el Nino

[2] The geographically proximal matrilineal descent group, once a single household, now divided into the households of mother and daughters, constitutes one of the two primary forms of social organisations at the village level, the other being the household.

A summary of activities and issues arising by month is given below.

Magomero: issues arising by month, 1997-98 Farming Season

Month	*Activities*	*Issues*
October	Land preparation Search for seeds Grasscutting Roof repairs Watering vegetables in dimba Women marketing *Project involved in trial design*	Food shortages Seed shortages Fear of El Nino effect Greater confidence in FSIPM project Willingness to take part in weed science trials
November	Land preparation Search for seeds Grasscutting Roof repairs Watering vegetables in dimba Planting Women marketing *Project sets up trials: ridging and planting*	Anxieties about the rains Food shortages Seed shortages Fear of El Nino effect
December	Weeding Some fields left unplanted Ganyu labour begins Marketing for most women has tailed off Banking in mid-late December *Trial plots receive fertiliser, are weeded, monitoring commences*	Conflict between labour demands on own fields and need for cash Search for seeds continues for a while
January	Banking continues Search for fertiliser is intense Some fields are abandoned due to lack of weeding and fertiliser Marketing of green maize and winter season vegetables begins *Trial plots are banked or not banked, monitoring continues, evaluation is planned.*	Anxieties about lack of fertiliser particularly as season looks good Relief with green maize harvest

2. FARMERS, EXPERIMENTS AND GAPS IN UNDERSTANDING

Non-participatory trials

The FSIPM project has encountered a range of problems in trying to make the on-farm trials participatory. It is now accepted that the FSIPM project did not inherit a basket of proven IPM technologies with which it could carry out participatory adaptive research. This meant that the various technologies needed to be tested via rigorous statistical analysis and frugality of replication in 1996-98 which limited the extent to which the research could be participatory, permitting at best a mix of contractual and consultative involvement of farmers. [Biggs, 1989] In addition, it has been hard to increase transparency in the implementation of trials [farmers were often not included in crucial events such as planting or fertilising] which inhibited evaluation in 1996-98.[3] While our chances of moving towards consultative and even some collaborative work in 1997-98 are good, it is worth examining some underlying issues.

The SA team received queries and comments on the trials from the case study households that did not initially come from other OFT households in the project area. Following the 1997 DFID Output to Purpose Review, farmers' perspectives and understanding of the project became the subject of formal investigation. The information that stimulated this enquiry and the issues that it illuminates are discussed here.

Greater confidence in the project

On the positive side, a year after the commencement of the project, it was clear that there was much greater confidence on the part of the farmers regarding the intentions of the project. This was demonstrated by the comments made on the receipt of compensation for maize: farmers said that they had not been sure if this compensation would really be given and were both surprised and relieved when they received their maize. The compensation acted as a signal to other farmers who had initially been suspicious of the project [the most common rumour was that we planned to steal or somehow alienate a part of their land] and resulted in a widespread readiness to take part in the Weed Science trials set up in Magomero village for the farming season 1997-98 and interest elsewhere in the project area in taking part in the trials.

[3] This meant, for example, that a significant proportion of farmers were not aware of the number or type of bean or pigeon pea varieties that had been planted and were therefore unable to compare their differences. See forthcoming report on Evaluation for 1997-98.

The case study farmers commented on how much they had appreciated the field days and field visits. These had provided an opportunity to learn about the project and the station but it was also gratifying to be taken seriously as farmers by being driven to other villages or to be guests 'kwa research' [as Bvumbwe is known]. We would argue that psychological factors such as these cannot be underestimated in creating an atmosphere of mutual confidence in which farmers are prepared to work with the project staff on designing and running trials rather than to simply hand over land and do the tasks they are asked to do. Previous and current experience of government and non-government intervention. coupled with the widespread disillusionment with democratic government. make the majority of farmers cynical with regard to outsiders and their activities in the village.[4] It is an achievement on the part of the project to have overcome farmer's justified suspicions and we now have a basis of trust on which we can build over the next season to make our trials more participatory.

Farmers and pest management: the forgotten purpose

However. while it is essential in any form of participatory research that farmers have confidence in the probity and commitment of the outsider research team. it is also necessary. if we are to move beyond the contractual stage [use of the farmer's land and labour] that the research goals should be internalised by farmers [if not in part set by them]. Work with the case study households demonstrated that most did not understand the purpose of the research. This is primarily due to the fact that project personnel underestimated how the conceptual frameworks and problem prioritisation of farmers quickly overrode the explanations we had given in the initial diagnostic stage.

In the run up to the first set of trials in 1996. after village meetings to explain the purpose of the project work farmers had identified their main food crops and the chief pests of these crops during the a set of rapid rural appraisal exercises. This series of meetings focusing on pests was followed by clear and comprehensive explanations of the purpose of each trial with the participating farmers in each village - as we thought. However. discussion between October 1997 and January 1998 that for the majority of the case study households the focus on pest management had slipped from view.

The extent of this problem emerged through discussions of fertiliser application. The case study trial farmers were relieved that in 1997-98 we were to apply fertiliser to the plots. As they explained. it had made no sense for a wealthy project to omit fertiliser in the previous year since only fertiliser could deliver a good harvest in their impoverished soil. If we wanted to demonstrate yields. we needed to use fertiliser. They told us that the poor harvest in the first year had led to a widespread lack of confidence in the project's farming abilities. Mai Elizabeth. for example. told us that she had expected a super-hybrid that did not require fertiliser and was disappointed when she saw the poor harvest. Compensation for maize restored good faith but not confidence. None were aware that the project could. in principle. have learnt as much from fertiliser-free yields as from yields with fertiliser because we were interested in pest damage.

Demonstration plots: a dominant model

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[4] Considerable bitterness arose with the failure of a fertiliser credit scheme in late October [?] promoted by the local [Thyolo] MP but understood to be supported by the extension services. In short. both local chiefs and villagers were informed that they could register to receive a bag of early maturing maize seed and two bags of fertiliser. the loan to be effectively interest free since repayment would consist of the equivalent value in maize after the 1998 harvest. Although Magomero farmers retain a healthy degree of scepticism concerning any local extension or political initiative. many were hopeful that this scheme would be implemented. Unfortunately. it turned out to be intended for a nearby district and not to include Thyolo. This example of a failed intervention is mentioned because it characterises many others: villagers' expectations are raised by an outsider group. there is much misinformation concerning origins and details of the proposed activity and in due course. no more is heard. This is the environment in which projects such as the FSIPM project have to work and this example should make it easier to understand why villagers are initally suspicious of outsiders but at the same time reluctant to turn down any free inputs.

The first element in the mismatch between the experimental framework through which the project viewed the trial plots and that of the OFT farmers is the farmers' experience of demonstration plots run by extension officers. Most farmers understand plots established by outsiders to be for the purpose of demonstrating the yield capacity of a new variety. The goals of the project were therefore thought to be the demonstration of high yielding varieties while, some thought, verifying the suitability or the condition of local soils. The second element is more complex and concerns the gap between the models of experimentation used by researchers and farmers' day to day practices of trying out something new.

At this point, therefore, the benefits of taking part in the project were seen to be :

- free inputs
- a guaranteed harvest for a small portion of land
- association with team members that might result in sales of agricultural produce or livestock.
- occasional free transport
- high prestige outings [visits to other villages and to the station].

The notion that farmers themselves could and were expected to contribute to an experimental process concerned with reducing pest damage could not be found within the case study households and their mbumbas.

Why had pest management been forgotten?
Our mistake was to assume that the explanatory process that we went through at the start of the 1996-7 season would be sufficient and not to have taken into account that the methodology we employ is quite alien to the majority of farmers.

Farmer experimentation?
If we are saying that farmers do not share our experimental framework, what framework or frameworks are they using? For an activity to be called experimentation, it requires firstly 'the creation or initial observation of, conditions or treatments' and secondly 'the observation or monitoring of the subsequent results or effects'. [Okali et al. 1994] The Farming Participatory Research literature, from which the following discussion is taken, suggests that there are three types of farmers when it comes to experimentation.[5]

1.Progressive farmers are those who have access to plentiful resources, services and information

2.Innovator farmers who are not necessarily better off than their fellow farmers but are known within the local community as having a tendency to try out new ways of doing things more than the average farmer.[Van Veldhuizen, 1994]

3.The average farmer who, in his or her day to day farming practice, will take new understanding from observations that occur in conditions which are not controlled and which are therefore specific to a place or a season.

[5] See Okali et al 1994, van Veldhuizen et al 1997a, van Veldhuizen et al 1997b, Biggs, 1989

The degree to which the trying out of something new is systematic is crucial in understanding the difference between the conceptual frameworks brought to the FSIPM project trial plots by the project staff and by farmers. Project staff planned these experiments scientifically on the basis of certain hypotheses. From these were derived the pertinent variables. treatment levels. controls and non treatment. the layout of the plots. the timing of interventions and data collection and the form of analysis. The first two types of farmer-experimenters are also able to some extent to consciously create conditions and observe results in a more or less systematic fashion. Progressive farmers may have both the knowledge and resources to run simple but scientifically valid experiments. The last type of experimentation is the the least systematic and has been called a 'continuous innovative process' .'reactive experimentation'. 'proto-experimentation' or 'tacit knowledge gained from reflection-in-action'. [Van Veldhuizen 1997:149. Okali et al. 1994:130] It is likely that this is the most common form of experimentation. available at any level of resource holding. and 'probably provides much of the basis for the long term evolution of farming systems'. [Okali et al. 1994:130] In the short run. however. this type of experimentation offers little that can be proven. It is important.however. to keep in mind that these categories are not fixed.

Characterisations of farmer experimentation have outlined limits to their efficacy. The crucial notion of a 'check' may be missing: farmers may not compare results from similar units of space at the same time but assess a single treatment against a previous season's harvest or crops in a nearby field. Farmers may well lack resources and equipment and use non-standard procedures. This means that when a farmer is trying to understand observations. the information is put together in an intuitive fashion and in the context of his or her long term acquaintance with the micro-environment of their farm and the vagaries of the particular agricultural season. 'a type of running summation'. [Okali et al. 1994:131. Van Veldhuizen 1997].

This means that it is all too easy for farmers to draw false conclusions by taking the most obvious difference between two occurrences as the cause and thus misunderstand the underlying reasons for a particular effect or result. Farmers. particularly small holders. may well not know about non -visible biological processes. [Van Veldhuizen 1997].

What does this discussion tell us about the farmers with whom the project is running trials? First of all. excluding the Mangunda sweet potato growers. our farmers are resource poor. Given that there are likely to be only a very few innovators within this population. the majority will fall into the category of reactive experimenters or proto-experimenters. Their experience of running a systematic and comparable experiment will therefore be non-existent or extremely limited. This would explain why farmers tended to abandon or uproot and replant plots where trial crops had failed. Mai Muthowa laughed at how we collected dead specimens: Mai Kalonga said that we took a strange type of harvest. These reactions came about firstly. because it was not understood why the project needed to ascribe causes of death. that it could indeed do this and needed to in order to relate these to its interventions and secondly. where resources are in such short supply. letting something fail in order to learn is a luxury . A failed crop. according to our farmers. requires an immediate decision about the resources that are being invested in it or alternative uses to which it could be put.

Secondly. it means that the focus in 1998-97 on farmers with specific pest problems and plans for more participatory monitoring and evaluation should go some way to overcoming the gap between our perceptions and those of farmers. While 'yield' will remain the predominant criterion of success. it will be easier to relate yield itself to pest damage or varietal resistance thereto.

Finally. this discussion leads us to question once again what our role should be regarding farmers knowledge and understanding of these experiments. Participatory technology development tends to fall into two schools of thought and practice. The first is that outsiders should support and record the processes and results of farmer experimentation but not interfere with these processes. The second is more interventionist: researchers may try to improve farmer understanding of non-visible processes. seek to provide a wider choice of technologies or enhance farmer experimentation through more systematic design and greater comparability. By offering new technologies the FSIPM project has already placed itself in the second camp. Over the next year. should the IPM project allot more time to examining

1. the current state of farmer knowledge regarding the pests and diseases at which the trials are aimed and/or
2. the nature of farmer experimentation at level 2. farmer innovators. rather than level 3. proto-experimentation ?

The purpose of this would be to provide a baseline on which to design future extension material. This question leads us on to a brief discussion of the state of indigenous knowledge regarding pest management.

The constitution of indigenous knowledge
To date the project has been unable to identify more than a couple of local practices for pest management [one of which. seed dressing with Sevin. was actually damaging to both maize and bean seeds]. It could be that a local paradigm of seeking a solution to problems within the context of existing resources and practices has been replaced by a high tech paradigm. As we see with vegetable production. farmers already know an effective method for dealing with pests. that is by buying and applying chemicals. The barrier to implementing this solution is economic: subsistence crops such as maize. beans and pigeon peas do not justify high expenditure on pesticides when money is in such short supply that many cannot afford sufficient fertiliser. This point takes us to the fact that soil fertility is considered by most to be a much greater constraint on production than pest damage.

However. it is possible to argue that even if a high tech paradigm of pest management has undermined local innovation or experimentation in pest control. historically neither soil fertility nor pests were problems that farmers had to deal with. When land was plentiful. problems of pests or declining soil fertility were dealt with in the same way: the old piece of land was abandoned and a new piece opened up. Local knowledge. in the sense of 'skills and understanding adapted to the peculiarities of the local agro-climatical and socio-economic environment' . has to be relevant and the necessity of dealing with pests that might be found in a more intensive system has been lacking until recently. The argument that. at the end of the twentieth century. 'small-scale farmers are in transition and their practices disrupted' is true for Southern Malawi. [Bentley and Andrews 1991. cited in Okali. 1994:91]. Some would argue that this has been the case here for the last one hundred and fifty years given the extent of forced population movements and fluctuations in economic conditions in the country and region [White 199?]. Furthermore. as Mosse reminds us. where local knowledge is still under discussion or is in dispute. it is unlikely to be accessible to outsiders. [Mosse. 1993]

Where does this leave us? It returns us. we would argue. if pest management rather than crop management is to be the focus of future projects. to the necessity of assessing the state of local knowledge with regard to such pests and diseases and deciding if. where and farmer understanding of these problems might be usefully enhanced.

3. RELATIONS BETWEEN HOUSEHOLDS IN THE SAME MBUMBA

Interest in intra-mbumba relations was motivated by our lack of knowledge about resource flows between households and whether these might have an impact on the potential for households of differing socio-economic status to take part in IPM activities. Might exchange of labour between closely related labour rich and labour poor households give entrance by all to labour intensive IPM activities? Might equalising gifts of agricultural inputs or cash between households of different socio-economic status within the same mbumba make it possible for all to access pest or disease resistant varieties? These were the questions that motivated this line of enquiry.

Earlier research suggested that there was considerable mutual support between households but that, as the nexus of resource distribution, competition could also be severe. Vaughan found an ideology of individual household self-sufficiency which meant that the sharing of resources had to be disguised and took place at the point of consumption. [Vaughan, 1987] Davison also marshals evidence to support the argument that women in Southern Malawi have preferred to work banja or household production. [Davison 1995] Marwick argued that the main cause of witchcraft accusations had its basis in competition for resources between members of the same mbumbas. [Marwick, 1964]

Families in an mbumba tend to be of similar socio-economic status. Local perception is that this is to do with the wealth and habits of the parents, that is, whether they passed on to their children a reasonable inheritance, good practices or bad habits. Observation and discussion make it clear that similarity within the mbumba must also be partly accounted for by some processes of redistribution between current members of an mbumba: mutual support is expressed through gift-giving, loans, some exchange of labour and everyday co- performance of a wide range of domestic activities.

A preliminary conclusion is that intra-mbumba relations are, broadly speaking, neutral regarding IPM interventions. This is because

a) The flow of cash or kind between households does not in any way equalise the socio-economic situation of households in the same mbumba although they may offer important economic opportunities and provide a minimum security net.

b) Labour exchange is limited, takes place between related women rather than unrelated married in men, and is more likely to be for domestic tasks than agricultural work.

c) There is increasing competition between households for resources that is increasing the process of individuation.

Finite resource flows

There are resource flows within mbumbas both in the form of gifts and exchange. For example, in the case study group: Mai Mazinga received half a bag of fertiliser from her daughter. Mai Elizabeth, her daughter and her niece took over cultivation on Mai Marichi's land when Mai M became too ill to work and Mai Elizabeth then supported Mai Marichi. Mr Mazinga gave cabbages to all the members of his wife's mbumba when he harvested them and gives tomatoes for onward selling to his mother and lets his sisters have tomatoes for sale at a reduced price. The Mazinga sisters sell their mother's gift of tomatoes at the market, taking a small portion of the profit to buy relish, because she does not like to go herself. Mai Mazinga then keeps an eye on their children in return. None of this gift giving or exchange is sufficient to eliminate economic differences between the households.

This means that there can be considerable variation in the experiences of households within an mbumba. Mai Mazinga was unable to give her daughter. Hilda. the seeds that a mother should provide for a daughter in her first year of individual cultivation. Hilda had to approach her father's relatives for the seeds. Mai Theresa Mayenda. the mother of the stable and food secure Chimvula cluster and her very elderly husband were short of seeds for planting this year. nor could they afford fertiliser in time to apply it. Despite the fact that all of their children and grandchildren had sufficient seed and at least some fertiliser. there was no obligation to shared these inputs with the elderly couple. Mai Muthowa and her husband [a recently arrived and disreputable individual] were in dire need of both food and agricultural inputs during 1997-98. Not only did her daughters share very little food and no agricultural inputs but one asked for the return of the small field that she had lent her mother the previous year on the grounds that her mother was too old to need the land. This land. of course. originally belonged to the mother. Mai Anderson has only one wrap but neither her aunt. Mai Elizabeth. or her cousin. Binette. who have quite a good selection of clothes feel it is up to them to provide what Mai Anderson's husband fails to give her. The Marichi households take gifts of relish to Mai Costa and in return. Mai Costa gives them a reasonable deal on land rental.

Limited labour exchange
The independence in agricultural work patterns identified by earlier writers [Vaughan and Davison] continues. The only task which is commonly shared is the harvesting of maize in return for brewed beer. Apart from occasional individual arrangements between two sisters or mother and daughter. any other field work is only carried out under ganyu arrangements. i.e. it is paid. Nor does being employed by one's relatives guarantee a decent rate. Simeon Magomero complained that his elder brother was paying him one of the lowest rates in the village: four tambala per five planting stations. Relatives should give each other first refusal on any opportunities to earn money through ganyu labour. however.

Domestic labour. such as childcare. shelling maize. carrying water or preparing relish may well be shared between women. The nature of such arrangements is informal but failure to reciprocate can result in retaliation which ranges from pointed and public jokes to the breakdown of relations between households. Mai Mazinga was seen to be working with deliberate slowness when sharing the task of shelling her third daughter's maize with her other daughters. When asked why. she said that she was merely working at the speed her third daughter had worked when shelling Mai Mazinga's maize. By contrast. Mai Elizabeth is planning to move house to get away from her parasitic sister [see below] and Mai Naluso from her poorer mother and sister. However. where women have access to the occasional and informal assistance of mother and sisters. particularly with childcare. they are free to carry out a much greater range of activities. for example. to go to distant fields or to the market: this is the case with both the Muthowa and Mazinga clusters where a grandmother who is frequently at home allows adult daughters to be away for long periods. The Simeon children. similarly. usually go to their paternal grandparents when their parents have to spend mornings in the fields. However. it is usually preferable to 'keep things in the family' and where a son or daughter has reached the age of 8 or 9. this child can be left in charge of smaller siblings. the presence in the mbumba of other concerned adults makes this a more satisfactory arrangement.

It is important to note that domestic assistance may not be given willingly but because the giver feels that he or she has been given little choice in the matter. Mai Elizabeth. of the Marichi mbumba. complained in December 1998 that her sister. Mai Yasini. had taken to going away for the day. either to buy or sell goods. leaving her four youngest children at the house [which is next door to Mai Elizabeth's house]. Mai Yasini was so short of food and money. due to her husband's imprisonment and the bad harvest of 1996-7. that she could leave no food for the children who then spent their time hanging around Mai Elizabeth and Mai Marichi. hoping to be included in their meals. which. of course. they were. Mai Elizabeth's proposed solution to the problem of an impoverished and ill-connected sister is to plan to build herself a house at some distance.

Individuation: e.g. consumption of meals and land tenure
Earlier researchers [Vaughan. 1987] argue that historically, under normal circumstances, households in common mbumbas in southern Malawi had eaten together and redistribution of food had taken place at the point of consumption without undermining the ideology of individual household self sufficiency. Vaughan showed how this practice broke down under famine conditions in 1949 and the evidence today is that poorer families no longer eat together. This change in practice is likely to be partly in order to avoid the obligation for redistribution that this would incur. Within the five mbumbas and nineteen households in the case study group, only two examples of [almost] common consumption were found. The Mazinga women would serve food at home at lunchtime but then sit together to eat the food and two cousins within the Chimvula cluster would eat together at lunchtime. Thus, it seems today, that within this small sample common consumption is only taking place between four same generation households of approximately equal wealth and in the absence of their menfolk, that is, at the midday meal and not the evening meal [this would be reinforced by the avoidance required between mother in law and son in law].

Current pressure on resources and the reluctance of husbands to see their earnings or profit disappear among their wives' maternal relatives appears to have resulted in increasing competition for the joint natural and human capital of the mbumba. Peters suggests that female sisters and cousins are now competing for land that might be inherited from a grandmother. [cited in Davison. 1995] An example from the case study households, revealed in late 1997, came from Simeon Magomero. When he and and his wife were in Thyolo hospital for three months being treated for TB during the 1996-7 agricultural season, his younger aunt's sons started using his two fields and dimba garden without his permission. They started selling the green maize from the dimba which Simeon's wife had planted, one of them started vegetable growing in the dimba and the other two each planted sweet potatoes in a field. Simeon stopped them when he found out what was happening but waited to let them harvest their crops. Simeon's wiife said that in her opinion the cousins thought that Simeon would not recover and wanted to be the first to lay claim to this land.

An interesting example of intra-mbumba competition for resources arose from a direct project intervention, the activity notebooks. The dilemma of whether or not to pay the record keepers was resolved in favour of paying them on the grounds that we were asking for a substantial commitment of an individual's time and it was unlikely that we would find sufficiently motivated volunteers to keep adequate records. The results of this were mixed. Those about whom records were being kept felt strongly that they were entitled to a share of the money earnt by the record keepers. In the Chimvula mbumba where most households are stable, reasonably comfortable and there is substantial inter-household support, there was no problem, everyone received a share of the money and the business was regarded in a good humoured way. In the Mazinga mbumba, by contrast, considerable bad feeling was caused by Mr Nangwale's refusal to give a share of his earnings to the Sukhali and Mukhumba sisters. They were so cross that they forbade him to report on them and by the time the two sides had been brought together to discuss the problem, he was no longer willing to record their activities. The Nangwale household is already the wealthiest household in the mbumba and it seemed that Mr Nangwale's sisters in law felt that he was profiting unfairly at their expense.

We would argue, therefore, that it is not a coincidence that the best relations betwen households in this small sample is between the households in the wealthiest mbumba. High levels of food security mean that there is little competition for resources and the households are able to see that cooperation is likely to enhance their situation. There is, of course, considerable synergy between overall well-being and mutual cooperation at this level. By contrast, it is easy for households in poorer or more unevenly matched mbumbas such as the Marichi's, Muthowa's or Mazinga's to begin to regard each other more as rivals for resources, each trying to leach a little of the other's slender profit of food, cash or time.

As far as IMP interventions are concerned, therefore, our audience is made up of individual households rather than matrilineal descent groups.

4. INTER-MBUMBA RELATIONS: KIN AND NEIGHBOURS, SOCIAL SECURITY NETWORKS

Good relationships between mbumbas can make a significant difference to the well being of each. The poorer mbumba gains in terms of access to resources while the wealthier mbumba benefits from the availability of labour at times of peak labour demands and from having a good reputation as a generous neighbour. This is particularly important where beliefs in witchcraft arising from jealousy are strong.

Kin networks and proximity are the two most important determinant of inter-mbumba relations. Members of related mbumbas in the same village tend to visit each other frequently without formality. Neighbouring mbumbas often develop close connections. for example. the children of neighbouring mbumbas are called 'brother' and 'sister'. A good illustration of close association between four unrelated but neighbouring mbumbas is centred around the Marichi cluster and their relationships with the mbumbas Julius and Costa. What is discussed here is relation beyond the normal social intercourse between neighbours where each household would. as a matter of course. participate in the significant rituals of its neighbouring households [visiting after births. taking part in funerals. attending weddings. or sadakas] which further enhance social bonds.

Marichi-Julius-Costa
The Julius mbumba is by far the richest out of these four. Bambo Julius is the biggest landowner in the village and often needs ganyu labour for weeding and banking. The Julius's also have surplus produce. e.g. green maize or tomatoes. which they are either unable or unwilling to sell themselves but which others can purchase for onward selling. The members of the Marichi cluster associate themselves closely with the Julius mbumba. Not only do they visit frequently and would be at hand for each other were there an emergency but they provide ganyu labour for land preparation. weeding and banking. Both Mai Yasini and Mai Elizabeth buy surplus agricultural produce at a reduced price. Mai Yasini told us that she had been able to buy green maize for K17 rather than the K25 that was first asked 'because we know each other' ('...chifukwa timadziwana'). This relationship of trust also permits the members of the poorer household to ask for and receive credit [i.e. to pay after the goods have been sold] which permits those without capital to start or continue in small scale trading. Small gifts are exchanged between members of the two clusters to cement their friendship.

The Costa mbumba is something of a misnomer since the only members left in residence are Mai Costa. an old and asthmatic woman. and her 13 year old nephew who has come to stay and help with the work in return for food and board. Both of Mai Costa's daughters are dead and their children are living in the towns. The friendship between the Marichis and Mai Costa is longstanding. Mai Costa named Mai Elizabeth's daughter while Mai Elizabeth nursed Mai Costa's younger daughter in her last illness. Mai Anderson and Mai Elizabeth both rent pieces of land from Mai Costa at a reduced price and Enoch has a piece of Mai Costa's land at no charge on which he grows vegetables. All take relish to Mai Costa and keep an eye on her. They were principal participants in the funeral feast. sadaka. that Mai Costa held in memory of her dead daughter. Mai Elizabeth plans to build a new house near Mai Costa's house on the hillside at Mai Costa's invitation.

Similar relationships could be traced for the Muthowas. the Chimvula. the Mazinga and the Magomero households with neighbouring and related mbumbas.

Ganyu and social networks
The above example illustrates that before we can conclude that seasonal agricultural labour interferes with a household's ability to manage its fields properly and hence to succeed in its livelihood strategy. it is important to see this labour in a broader social context. Where the significance of the connection between employer and employee is an established patron-client relationship. however disguised as egalitarian neighbourly behaviour. it may have importance for the long term survival of the poorer household.

Within the five clusters where the social anthropology team has been working, 'ganyu' is normally done for relatives, neighbours and associates. Therefore, the apparently simple contractual arrangement for weeding or banking may be set within a 'nest' of other relationships. The 'employer', for example, may be a brother [Mr Bonongwe and Simeon Magomero and Simeon's sister] a friend and confidant [Marichis and Julius] , a wealthier neighbour who not only gives bran, madeya,on credit but who, previous to this loan, may have made gifts of seeds [Muthowa and Julius]; a source of fresh produce for marketing [Marichis and Julius - tomatoes, maize]..

Consequently, ganyu labour may be one strand in a network of ties between households which may, over time, provide something of a safety net for poorer households by linking them to wealthier households and clusters from which small amounts of credit or assistance may be forthcoming. Farmers themselves certainly identify an component of social assistance within the contracting of labour for agricultural activities; they say that giving your neighbours the first chance to earn some money or food is a way in which you can help them. The implications of this for IPM are that we must not rush to condemn activities which 'distract' farmers from their own fields during the peak work period without understanding the role that these activities play an overall livelihood strategy.

4. A DIFFICULT YEAR

The final issue that will be discussed here that farmers' chief concern during the October-January period was how difficult a year this had been. This is primarily due to the failure of the 1996-7 maize crop due to heavy and persistent rains. Farmers' own maize ran out very quickly. out of thirteen maize cultivating households where five had been self-sufficient or two thirds self sufficient in maize during 1995-96. none were in 1996-97. Market prices for maize were high and supplies uncertain. Without the Mozambiquan maize brought in by local traders. the situation would have been even more serious in Magomero village. This shortfall in the supply of the staple food meant that many farmers were chronically short of both cash. agricultural inputs and food through the September-January period and that even better off households had to choose between food and fertiliser. Anxiety was compounded by government warnings. mostly via radio. of the potential effects of El Nino and the need to plant early maturing maize varieties.

Food shortages
Many of the households in the case study group found themselves short of food during this period. For the households such as Mai Elizabeth or Mai January. this meant occasionally missing meals. eating more wild relish. mixing more maize bran with ufa flour. For the poorest households in the study group such as Mai Muthowa or Mai Yasini. this meant not eating maize for several days at a time. eating wild relish and visiting wealthier relatives and friends in the hope of receiving gifts of food.

Seed shortages
Many households found themselves short of seeds where these needed to be bought and had not been saved from the previous year. Few of the poorest households looked for maize seeds until the rains had started since. as they said. it would be too easy to give in to hunger and eat the seeds rather than save them. Several households prepared fields only to abandon them later when it proved impossible to find sufficient seed for planting. Mai Yasini did not prepare her hill field due to lack of seed. Mai Muthowa was unable to plant half of her large hill field because she had not been able to find enough seed despite visiting relatives and friends and taking seed on credit for ganyu.

Labour
The severe shortage of cash for food and agricultural inputs put great pressure on poorer households to seek ganyu labour and on those who could. to increase marketing activities. This intensified the normal conflict at this time of peak labour demand between working on one's own fields and earning money for food and inputs. Six out of thirteen maize growing households experienced conflicts over how to allot their labour which led to late weeding or banking.

The need for cash resulted in fiercer competition than usual for ganyu labour. Adults were taking contracts for weeding or banking in order to reserve the work for themselves and children did not get their usual access to piecework. Average payments for weeding were 4-6 tambala per 3-4 planting stations. Many paid for ganyu in kind and with madeya [maize bran] rather than maize flour.

Female headed households and poorer male headed households who either produced goods for sale. could command the capital or who sought out other goods for sale. spent much time in marketing during this period. This was true of Mai Elizabeth. Mai Yasini and Mai January. for example. This was particularly the case where households had older children on whom they could rely for assistance in their fields. Women also went to the market to sell goods on behalf of relatives [usually male but also older women] for which they would receive a small payment.

Fertiliser shortages

The pressure on human resources continued into 1998 with the search for money for fertiliser, which this year cost considerably more than ever. Even relatively secure and well off households such Mai Kalonga's or Mai Naluso's were unable to buy their normal amount of fertiliser and out of the thirteen maize growing households, six households that had regularly purchased fertiliser in the past applied none at all and four applied less than usual. This led to some further abandonment of fields where labour pressures had prevented good weeding practices and which would now not receive fertiliser as farmers felt that it would be a waste of their time to bank this land.

Summary

The experiences of the season 1997-98 revealed how vulnerable are many of the households in the target area and showed us something of the processes of poverty. One bad harvest led to hunger, seed shortages, no money for fertiliser and severe competition for poorly paid agricultural labour. Fields were abandoned initially after they had been ridged , for lack of seed, or after planting because the need to find money for day to day needs forced farmers to divert their labour to contract labour for others (in return for cash or food) or to small scale trading. Immediate needs overrode farmers' desire to take a longer term view and safeguard the coming harvest. Members of the households concerned were well aware that this was happening but felt that they had no choice.

6. CONCLUSIONS:

In this report. we have covered farmer perceptions of the project and farmer experimentation. relations between households in the mbumba and relations between mbumbas and. finally. we have described how difficult 1997-98 was for the case study household farmers in the village of Magomero. The main conclusions to be drawn are that

- The project might do well to investigate farmer experimentation in order to overcome the gap between farmer frameworks and researcher frameworks that has impeded our work to date
- Local models of pests and diseases might be of importance for future work or dissemination
- Gift giving or exchange relations within mbumbas do not impede on the self-sufficiency of the banja household and the household is the target unit for IPM interventions
- The maintenance of patron-client like bonds between related or neighbouring mbumbas may be vital for the long term survival of the poorer mbumbas and should not be interfered with without substituting alternative forms of support.

What next?

Over the next farming season. we plan to investigate the issue of decision-making and independence within the household unit[6]. Where men and women take responsibility for different types of income generating activities. where women own the land and where men. it is argued. are reluctant to invest in household agriculture due to the insecure nature of marriage but prefer to pursue off farm activities. decision-making is unlikely to be either simple or monolithic. Such an investigation will allow us to better understand how access to and control of resources for agriculture. such as cash. inputs and labour. are determined. This information is necessary if we are to understand the opportunities and constraints for IPM or integrated crop management.

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[6] For example. teenage boys often form a subunit within the household that. from the time of initiation onwards. begins to establish a separate economic identity. They build their own houses. begin to seek independent income generating opportunities [usually using family resources or via contract labour]. start to pay own way at school. own soap. own clothes although they may still eat with family unless it is very poor. All this means that their labour is not available on demand because they are not receiving full support from parents

ANNEX: LIST OF CASE STUDY HOUSEHOLD MEMBERS

OVE-RALL IDENTIFIER	CLUS-TER NO	HOUSEHOLD NO	PER-SON NO	HOUSE-HOLD NAME	INDIVIDUAL NAME	AGE	SEX	RELATIONSHIP TO HOUSEHOLD HEAD	NUMBER OF PLOTS	PRESENT OR ABSENT
On farm trial households are highlighted with bold. There are a total of 17 households										
MUTHOWA										
1101	1	1	01	Muthowa	Mr Muthowa	70	M	head 1	0	1
1102	**1**	**1**	**02**	**Muthowa**	**Mai Machemba Muthowa**	**60**	**F**	**spouse 2**	**4**	**1**
1103	1	1	03	Muthowa	Musowa Bulaya	17	M	child 3	0	0
1204	1	2	04	Naluso	Mr Naluso	37	M	1	1	1
1205	1	2	05	Naluso	Agnes Machemba Naluso	38	F	2	5	1
1206	1	2	06	Naluso	Elaton Naluso	21	M	3	0	1
1207	1	2	07	Naluso	Christopher Naluso	16	M	3	0	1
1208	1	2	08	Naluso	Esther Naluso	14	F	3	0	1
1209	1	2	09	Naluso	Juma Naluso	10	F	3	0	1
1210	1	2	10	Naluso	Jimmy Naluso	7	M	3	0	1
1211	1	2	11	Naluso	Victoria Naluso	6	F	3	0	1
1212	1	2	12	Naluso	Felisita Naluso	3	F	3	0	1
1313	1	3	13	January	Mr January	45	M	1	0	1
1314	1	3	14	February	Esther Machemba January	35	F	2	5	1
1315	1	3	15	March	Roderick Mkwezelamba	20	M	3	0	1
1316	1	3	16	April	Joyce Mkwezelamba	10	F	3	0	1
1317	1	3	17	May	Charles Zabwino Mkwezelamba	7	M	3	0	1
1318	1	3	18	June	Dyson Sipili	4	M	3	0	1
1319	1	3	19	July	Chrissie January	1	F	3	0	1
MAZINGA										
2101	**2**	**1**	**01**	**Mazinga**	**Mai Mazinga**	**55**	**F**	**1**	**2**	**1**
2102	2	1	02	Mazinga	Mercy	18	F	3	1	1/0
2103	2	1	03	Mazinga	Tokozani		M	3	0	1
2104	2	1	04		Charity	1	F	grandchild 6	0	1/0
2205	2	2	05	Nangwale	Mr Nangwale	40	M	1	1	1
2206	2	2	06	Nangwale	Martha	31	F	2	2	1
2207	2	2	07	Nangwale	Enifa	11	F	3	0	1
2308	2	3	08	Sukali	Frank Filipo	30	M	1	0	1/0
2309	**2**	**3**	**09**	**Sukali**	**Femia**	**27**	**F**	**2**	**2**	**1**
2310	2	3	10	Sukali	Mundelanji	8	F	3	0	1
2311	2	3	11	Sukali	Roderick	5	M	3	0	1
2312	2	3	12	Sukali	Regina	2	F	3	0	1
2413	2	4	13	Mukhumba	Mr Mukhumba	30	M	1	0	1
2414	**2**	**4**	**14**	**Mukhumba**	**Olaliya**	**25**	**F**	**2**	**3**	**1**
2415	2	4	15	Mukhumba	Donata	8	F	3	0	1
2416	2	4	16	Mukhumba	Gladys	6	F	3	0	1
2417	2	4	17	Mukhumba	Charles	3	M	3	0	1
2518	2	5	18	Mazinga	Hilda	20	F		1	1/0
2619	2	6	19	Mazinga	Uncle	65	M	other 7	?	1

OVE-RALL IDENTIFIER	CLUS-TER NO	HOUSEHOLD NO	PER-SON NO	HOUSE-HOLD NAME	INDIVIDUAL NAME	AGE	SEX	RELATIONSHIP TO HOUSEHOLD HEAD	NUMBER OF PLOTS	PRESENT OR ABSENT
MARICHI										
3102	**3**	**1**	**02**	**Marichi**	**Elizabeth**	**45**	**F**	**1**	**2**	**1**
3103	3	1	03	Manyela	Enoch January Manyela	23	M	3	0	1
3104	3	1	04	Manyela	Binette January Manyela	21	F	3	1	1
3205	3	2	05	Yasini	Mr Yasini	45	M	1	1	0
3206	3	2	06	Yasini	Lestina Yasini	38	F	2	1	1
3207	3	2	07	Yasini	Lyton Yasini	18	M	3	0	1
3208	3	2	08	Yasini	Theresa Yasini	16	F	3	0	1
3209	3	2	09	Yasini	Kassim Yasini	10	M	3	0	1
3210	3	2	10	Yasini	Mayi Yasini	7	F	3	0	1
3211	3	2	11	Yasini	Jalassi Yasini	6	M	3	0	1
3212	3	2	12	Yasini	Mistake Yasini	3	M	3	0	1
3213	3	2	13	Yasini	Thamandani Yasini	0.5	F	3	0	1
3314	3	3	14	Wisikesi	Leverson Wisikesi	23	M	6	0	0
3315	3	3	15	Wisikesi	Chrissie	19	F	6	0	0
3316	3	3	16	Wisikesi	Witness Wisikesi	17	M	6	0	1
3317	3	3	17	Wisikesi	Egly Wisikesi	14	F	6	0	0
3418	3	4	18	Anderson	Matheus Anderson	30	M	1	1	1
3419	3	4	19	Anderson	Stellia Naphiri Anderson	22	F	2	1	1
CHIMVULA										
4101	4	1	01	Mvula	Ephraim Mvula	90	M	1	0	1
4102	4	1	02		Theresa Mayenda	70	F	2	1	1
4203	**4**	**2**	**03**	**Kalonga**	**Mai Kalonga**	**40**	**F**	**2**	**2.5**	**1**
4204	4	2	04	Kalonga	Mr Nakatha	45	M	1	1	1
4205	4	2	05	Kalonga	Alekereni Dyson	16	F	3	0	1
4206	4	2	06	Kalonga	Christina Munderanji Dyson	9	F	3	0	1
4307	4	3	07	Namangwiyo	Mr Namangwiyo	30	M	1	0	0
4308	4	3	08	Namangwiyo	Elube Dyson	20	F	2	1.5	1
4309	4	3	09	Namangwiyo	Mphatso Namangwiyo	1	M	3	0	1
4410	4	4	10	Chigonamadzi	Mr Chigonamadzi	60	M	1	1	1
4411	4	4	11	Chigonamadzi	Essube Chigonamadzi	49	F	2	2	1
4412	4	4	12	Chigonamadzi	Divason Chigonamadzi	22	M	3	0	1
4413	4	4	13	Chigonamadzi	Joyce Chigonamadzi	20	F	3	0	0
4414	4	4	14	Chigonamadzi	Masauko Chigonamadzi	14	M	3	0	1
4415	4	4	15	Chigonamadzi	Floria Chigonamadzi	8	F	3	0	0
4516	4	5	16	Chimvula	Joseph Ephraim	35	M	1	2	1
4517	4	5	17	Chimvula	Patricia Ephraim	28	F	2	0	1
4618	4	6	18	Mazinga	Mr Mazinga	37	M	1	2	1

OVERALL IDENTIFIER	CLUSTER NO	HOUSEHOLD NO	PERSON NO	HOUSEHOLD NAME	INDIVIDUAL NAME	AGE	SEX	RELATIONSHIP TO HOUSEHOLD HEAD	NUMBER OF PLOTS	PRESENT OR ABSENT
4619	4	6	19	Mazinga	Joyce Mazinga	32	F	2	2	1
4620	4	6	20	Mazinga	Linus	13	F	3	0	1
4621	4	6	21	Mazinga	Theresa	10	F	3	0	1
4622	4	6	22	Mazinga	Janet	3	F	3	0	1
4723	4	7	23	Chigonamadzi	Rodsen	24	M	1	0	1
4724	4	7	24	Chigonamadzi	Mrs no 2	20	F	2	0	1
5101	**5**	**1**	**01**	**Magomero**	**Simeon Magomero**	**31**	**M**	**1**	**1**	**1**
5102	5	1	02	Magomero	Mai L Magomero	25	F	2	1	2
5103	5	1	03	Magomero	Napiri Magomero	7	F	3	0	1
5104	5	1	04	Magomero	Manuel Magomero	4	M	3	0	1
5105	5	1	05	Magomero	New baby Magomero		F	3	0	1
5206	5	2	06	Chimvula	Rickson Chimvula	30	M	1	1	0
5207	5	2	07	Costa	Ronica Costa	21	F	2	1	0
5208	5	2	08	Costa	Violet Kamaliza	18	F	7	0	1
5209	5	2	09	Costa	Obed Costa	26	M	7	1	1

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

SOME PRELIMINARY FIGURES ON AGRICULTURAL LABOUR ALLOCATION FOR OCT 1997- MAR 1998

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SOME PRELIMINARY FIGURES ON AGRICULTURAL LABOUR ALLOCATION FOR OCT 1997 - MAR 1998

The following graphs are preliminary results from recording the activities of 17 households during October 1997 to March 1998. These results do not included information collected in the activity notebooks by mbunda (matrilineal descent group) members themselves.

The data below should be read with great caution. First of all, the sample is very small and secondly, it is likely to underestimate time spent on agricultural production. Problems with the qualitative nature of the early recording methods may mean that the formulae by which gaps in the information were reckoned may need to be revised. A system for triangulation is currently being sought - and to this end comparison with the socio-economists study of the "six week window" will be very useful.

Duration (days) worked for six activities from 10.11.97 - 16.3.98

Figure 1 plots the total number of days worked against six agricultural activities, specifically planting, weeding, fertilising, second weeding, banking and Mbwera. As can be seen from the time series graph figure 3 below this order is roughly chronological. In absolute terms weeding consumes the greatest amount of time (49 %), followed by banking (31%) and planting (13%), the three other activities make up the remaining 7%.

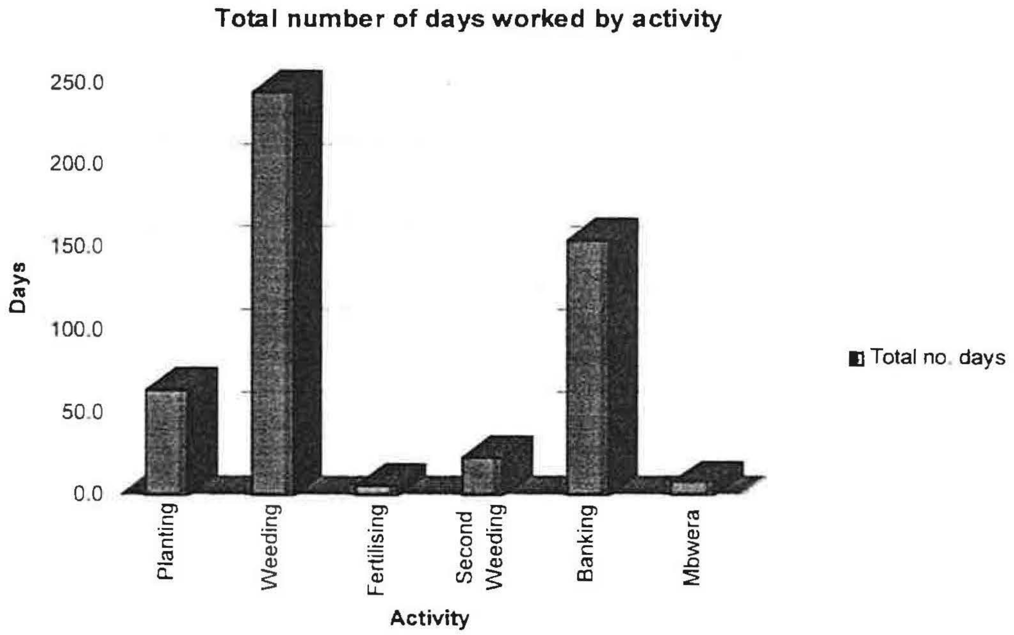


Figure 1

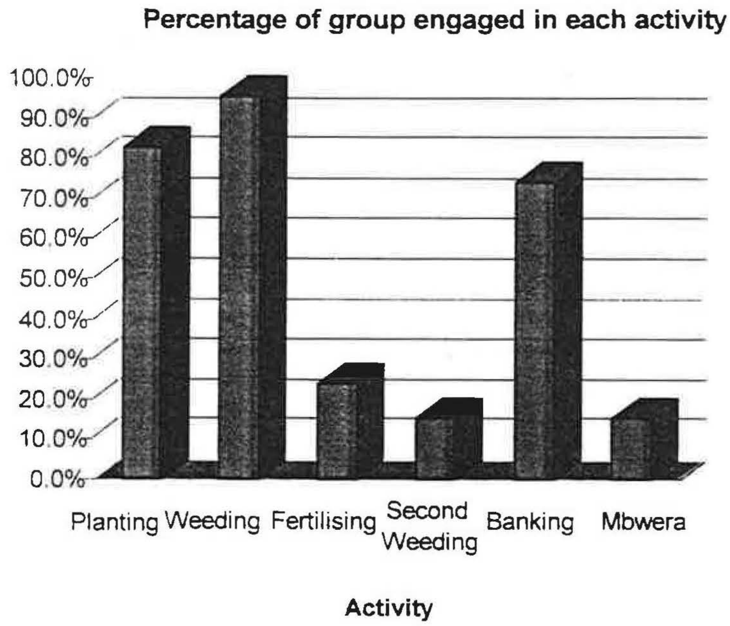
Casual hired labour

As with all the graphs, except figure 3 , the sample represented in figure 1 excludes casual hired labour. Casual hired labour totaled 67.5 days and was used for all activities except fertilising and Mbwera, the predominant use being for weeding, 39 days or 57%, slightly above the percentage for own labour. The work was carried out on the Marichi and Chimvula clusters' land and was done wholly by women and children.

Proportion undertaking each agricultural activity

The graph in figure 2 shows the percentage of people from the sample group who undertook each of the six activities considered. Although not in the same order, the three activities on which the greatest amount of time was spent are also those which were undertaken by the greatest proportion of the group, planting (96%), weeding (83%) and banking (74%). The other three are minority activities with fertilising being undertaken by less than a quarter of the group.

Figure 2



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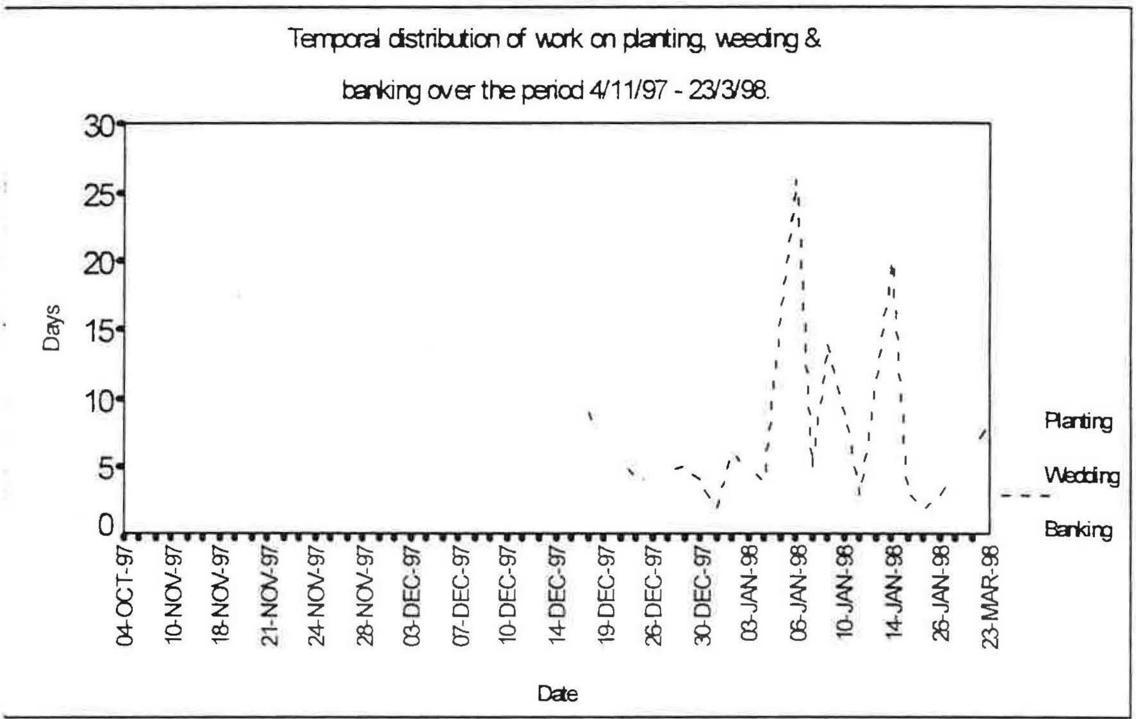
Distribution across sample period of days worked on the three main agricultural activities

Figure 3 shows the temporal distribution of work for the three main agricultural activities over the period of study. With some overlap, three distinct phases emerge. Firstly, an intense burst of planting activity in the days following the rains in mid November which continues at a much lower level over the following week and is then sporadic for a further week. The small amount of weeding activity from 11-20 November is for early maturing varieties planted on dambo fields. Weeding starts at the end of November, about ten to twelve days after the peak of planting, and continues at its peak levels over the subsequent week. There was then another significant period of late weeding between 19-28 December. Finally, banking activity commenced about six weeks after peak planting (under 'ideal' conditions banking would have been completed within six weeks of the planting peak which follow the rains) and was more or less completed within the following fortnight.

Figure 3



The peaks (maximum values) for each of the three activities was very similar, 25-26 days work, suggesting this was close to the maximum labour output of the group. If this was the case then maximum labour output, or close to it (20 – days), was achieved six times over the two months of the study, once during planting, three times during weeding (with a significant later burst) and twice during banking. If the banking activity was brought forward into the six week period then two obvious lulls would appear to follow firstly after the initial burst of planting and secondly, immediately after the first spurt of weeding. However, if banking was completed within the ideal 'six week window' it would coincide with the period of 'late' weeding (peaking at 18 days labour) identified in figure 3.

This suggests the relatively quiet period following weeding indicated by last year's work may not be typical but may be the result of a particularly hard season when many members of the case study households were involved in marketing or agricultural labour in order to meet daily food requirements. However, a caveat to the above argument is the need to identify the extent to which 'late' weeding is second weeding and therefore more of a substitute for, rather than a preliminary to, banking (this information was collected and such a differentiation will be included in subsequent drafts).

Average duration worked by gender and activity

Figure 3 takes the proportion of those who undertook each type of work and compares the mean number of days worked. For each activity a mean is given for women and men. Figure 4 summaries these gender differentiated averages for the three main activities (defined in terms of total duration and proportion of the group participating) planting, weeding and banking.

Figure 4

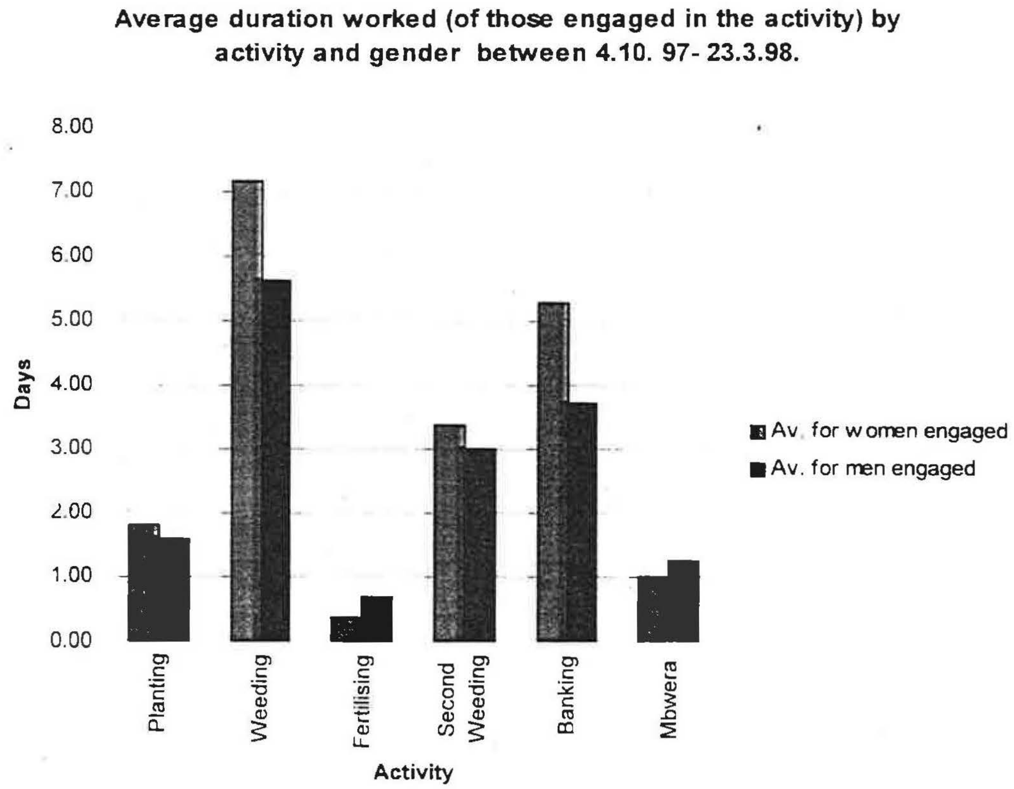
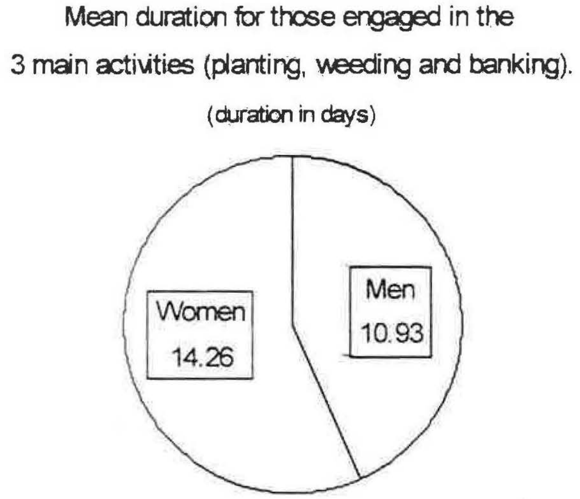


Figure 5



On average a woman in the sample group carried out more work on four out of the six activities, a man on average doing more work only on fertilising and Mbwera (which together represents about 7.5% of the total amount of work). Taking the three main activities, as defined above, on average a woman worked three and a third days more (or 30% more) than the average male over this period.

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

THE CASE STUDY HOUSEHOLDS: SUMMARY NOTES

by

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CASE STUDY HOUSEHOLDS: SUMMARY OF DATA

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Introduction

The following tables summarise the data collected on the case study households to date. These summarise are intended to be informal portraits which will provide the reader with a sense of the variety of household livelihood strategies, how these might develop over time and of how each household differs from its relatives and neighbours: more comprehensive notes exist elsewhere.

Notes on case study households briefing:

- **'Head of household'** may well be a misleading term where [as I have argued elsewhere, Lawson-McDowall ' Headship, households and families' 1997] husbands and wives take responsibility for separate elements and own differing resource endowments in their package of livelihood strategies . This creates areas of considerable autonomy. [N.B. more work will be done on household decisionmaking and income and expenditure during the 1998099 season].

- **'Active children'** are those who contribute substantial labour to the household and/or earn money for their own clothing, soap and snacks by ganyu labour or vegetable growing [boys only]. n.b. Parents usually continue to include teenage children and young adult children living within the mbumba in the main family meals. Parents, in particular, mothers, will also help their children to start various enterprises such as vegetable growing or snack preparation.

- **Domestic labour** covers not only sweeping, washing and cooking food but also collecting firewood [from the hills or estate, a strenuous morning's work], pounding grain, walking two miles to the mill to mill it and carrying water.

- **'Employment'** means regular paid labour

MBUMBA NO 1: MACHEMBE [MUTHOWA]

SUMMARY: An mbumba where the elderly mother and her latest husband are very poor. the eldest daughter and her husband constitute an economically reasonably stable household and the younger daughter and her husband of one year are struggling rather harder to get by. Another daughter lives in town and Mai Muthowa lives in her house. Their hillside plots and seasonal access to a well offer a variety of microenvironments for crop growing. The family descends from some of the earliest settlers in the village. In the next generation. seven girls [so far] will share 2.93 hectares of land.

SUMMARY: An older woman with a useless third husband. fallen on hard times. often hungry and as endebted as fellow villagers will allow.

Household head	Mai Muthowa
Spouse	Mr Muthowa
Dependent children	None
Active children	None
Landholding	1.14 hectares: mostly difficult to access hillside
Subsistence agriculture	Does poorly
Constraints to production	Everything: difficult land. lack of inputs. lack of labour and poor health [1997-98]. Most of Mai M.'s seeds were begged from friends and relatives. She could not plant most of her big hill field due to the shortage of seed: at one point she had some maize for planting but was so hungry that she ate it. She has not had fertiliser for a long time. During the peak work period. the couple had very little food and Mai M took food as advance payment for ganyu labour. Her need to do ganyu labour during weeding and banking time meant that her own fields were not well cultivated. Mr Muthowa does not contribute much in the way of labour or cash
Income Generating Activities	Occasionally sells firewood and velvet beans. husband makes baskets
Employment	None
Other interesting information	A keen participant in the on-farm trials. We are her one guaranteed source of agricultural inputs. Married twice before. Mai M. has been unlucky to end up so poor. Her first husband was a foreman on a tobacco estate and was well off. He divorced her because he could not cope with the fact that seven of their twelve children died while young. Her second husband had his own land in Chinthuli. where she went to live. but died of TB. She has four children living outside the village but only one. a daughter. ever helps her.

SUMMARY: Best off household in mbumba, pursuing a variety of livelihood strategies in a coherent fashion

Household head	Mr Naluso
Spouse	Agnes Naluso
Dependent children	Five
Active children	Elaton and Esther
Landholding	0.78 hectares
Subsistence agriculture	Reasonably successful. family works well together and are often self-sufficient
Constraints to production	1997-98 Had no money for fertiliser. This led to the abandonment of a distant field after it was half banked since the crop would have been too poor to warrant the effort of walking there.
Income Generating Activities	They grow some vegetables. Mai A sells tomatoes in Blantyre and Limbe. When she has enough money she goes to distant Chilimoni because it is easy to sell vegetables there. She also sells velvet beans locally. Elaton and Christopher each have a small plot where they grow vegetables. they use the money for clothes. schoolfees and soap.
Employment	Mr N works as a guard on the Ramus Tobacco Estate
Other interesting information	The Naluso's do not appear to have that much time for their relatives in the mbumba and are building a house at some distance. This interfered with their fieldwork in the 1997-98 period.

SUMMARY: Thrice married woman whose main work partner is her eldest son, pursuing a variety of marketing opportunities. Support from new husband on the increase

Household head	Mr January
Spouse	Mai Esther January
Dependent children	Four
Active children	Rodson
Landholding	0.54
Subsistence agriculture	Only a part of their overall livelihood strategy
Constraints to production	Mr January is rarely around to help. most of the work is done by Mai Esther and Rodson Mai Esther finds herself too short of time to do enough fieldwork. she has to keep up the marketing or they will have no food
Income Generating Activities	Mr January sells dried fish at local markets which he brings from Mozambique Mai Esther is an active vegetable trader: she buys in bulk in Nansadi and Bvumbwe and goes to Chitawira and Chilomoni to sell them from house to house. Out of season or when she has no cash. she collects wild relish for sale Roderick does labouring work in the school holidays and also grows some vegetables
Employment	None
Other interesting information	Mai January was given a small but fertile dimba garden by her uncle [mother's brother] because he was very fond of her.

MBUMBA NO 2: MAZINGA

SUMMARY: Mai Mazinga is the mother of the current chief and the sister of the old chief. Her husband was also the chief of another village. The chief's courts are held weekly at this mbumba. Although well connected, none of the residents of this mbumba are very food secure except for her eldest daughter and her husband. Mai Mazinga's two youngest daughters are in the process of moving out of her house. Each has started to cultivate her own field, each has a baby and spends some time staying with her in-laws and one has a husband who is building her a house. In the next generation, 8 girls [to date] will be sharing 3.2 hectares.

SUMMARY: A hardworking widow who is food secure due to her children rather than to own resource endowments.

Household head	Mai Mazinga
Spouse	None
Dependent children	One
Active children	Partly shares work with her youngest daughter, Mercy, who has a small child.
Landholding	0.84 hectare – Mercy's 0.34 hectare
Subsistence agriculture	A hardworking farmer
Constraints to production	Lacks cash for fertiliser
Income Generating Activities	Via her daughters, sells maize and vegetables. The vegetables come from the dimba garden she owns cultivated by her successful eldest son
Employment	None
Other interesting information	n.b. Mai Mazinga does not get enough in return for her dimba garden to buy fertiliser: the only fertiliser that she had in 1998 was a gift from her eldest daughter. Without the assistance of her eldest son and daughter, Mai Mazinga would not be food secure. When her land was measured, Mai M did not include the dambo field used by her son.

SUMMARY: A competent and entrepreneurial vegetable growing couple

Household head	Mr Nangwale
Spouse	Mai Martha Nangwale
Dependent children	Enifa is in school
Active children	but helps a lot around the house
Landholding	0.61 hectare
Subsistence agriculture	The Nangwales are good farmers and make their living entirely from agricultural production: they work together on all tasks. They do not normally have to buy maize.
Constraints to production	Land shortage and damage from livestock.
Income Generating Activities	Producing and selling vegetables [tomatoes. peas. mustard and cabbage]. Mai M also buys and sells maize bran Mr Nangwale bought two beef calves last year in the hope of ultimately buying a dairy cow. he is also branching out into African Medicine which he has been learning from older members of his family.
Employment	None
Other interesting information	The Nangwales are a formidable team. Both are very diligent farmers and take pride in what they have earnt as a result: their small but beautiful house and Mr Nangwale's bicycle. Their good relationship with other households. including Mr Nangwale's village relatives. have enabled them to borrow for free or rent land on good terms. Other members of the cluster provide their ganyu labour. There may be some jealousy within the mbumba of the Nangwale's success. Mr Nangwale was one of our recorders of daily activities but when he refused to share his earnings with the recordees. they boycotted him.

SUMMARY: Young couple in vulnerable situation made worse by husband's recent second marriage

Household head	Mr Frank Sukhali
Spouse	Mai Femia Sukhali
Dependent children	Three
Active children	The eldest daughter. Mundelanji. who is 8. often stays home from school to keep an eye on her younger brother and sister
Landholding	0.55
Subsistence agriculture	Mai F does most of the farming since her husband is away all day. She and her sister. Mai Mukhumba. often work together.
Constraints to production	1997-98 were short of seeds so left one field half planted and only had enough fertiliser for one field. Mai F decided not to bank this field since the crop was so poor.
Income Generating Activities	Mai F sells tomatoes which she buys from her brother [Chimvula cluster] and from other producers. This is not a year round business because she is always short of capital. She goes to the market to sell other people's produce. e.g. her mother or her cousin. for this she would receive a small amount e.g. K10
Employment	Frank Sukhali is employed as a construction worker on Henderson's Estate
Other interesting information	The Sukhalis had produced all their own maize until 1997 and used fertiliser on both fields in 1995-6 In February 1998. Mr S. took up with a second wife and is now dividing his income between two households. The youngest child is chronically underweight. her mother complains that she cannot afford to buy the extra food recommended by the clinic.

SUMMARY: Young couple reasonably food secure due to formal employment and vegetable growing

Household head	Mr Mukhumba
Spouse	Mai Olaliya Mukhumba
Dependent children	Three
Active children	Eldest daughter. Donata. stays home from school quite often to look after younger sisters
Landholding	0.45
Subsistence agriculture	Have divided the dambo field and grow half maize and half vegetables. Mai M does most of work for subsistence agriculture
Constraints to production	
Income Generating Activities	Vegetable growing: both work hard on vegetable growing although wife does bulk of work. She sells vegetables at local markets and he sells the cabbage with has to be transported by vehicle. From time to time Mai O will sell vegetables. flying ants. etc. She also markets on behalf of relatives such as her uncle or male cousin.
Employment	Mr M has a job at Henderson's estate chopping wood for tobacco curing
Other interesting information	

MBUMBA NO 3: MARICHI

SUMMARY: This cluster is a second and third generation immigrant family. Mai Marichi and her husband came from Mozambique via Zimbabwe whilst in the employ of a British family involved in tobacco marketing. They were given land by the then chief of Magomero but were obliged to give up two separate allotments of land in succession when other villagers challenged their entitlement. The mbumba. now made up of the Marichi children and grandchildren has ended up with a small amount of mostly poor hillside land. The members work hard to maintain their relationships with neighbouring clusters. particularly Julius. Nantchengwa and Costa which brings them cheap agricultural goods for onward sale. opportunities for cheap land rental and exchange of ganyu labour. There are three partially independent young men within the mbumba. This mbumba will face severe land shortage in the next generation since currently seven girls will have to share 3.18 hectares of mostly poor hillside land.

SUMMARY: Go ahead divorcee educating her children through small scale marketing

Household head	Mai Elizabeth
Spouse	None
Dependent children	Binette in Form 3 and Enoch in Form 4
Active children	Binette and Enoch both help when not studying: Enoch takes main responsibility for fieldwork.
Landholding	
Subsistence agriculture	Fairly successful. takes second place to her business activities. able to afford fertiliser and ganyu labour - although not as promptly as she would wish.
Constraints to production	Lack of labour. Mai E has a bad back.
Income Generating Activities	Mai E spends 3-4 days a week on her marketing activities: she has sold: tomatoes. groundnuts. cassava and maiz. She sells both her own product and buys from others. mostly at local markets. Her capital has been borrowed from friends. Enoch grows some vegetables
Employment	None
Other interesting information	A very go entrepreneurial woman whose second 'husband' continued to support the family for several years after they stopped living together: however. since June 1997. Mai E. has earnt most of the family income and is determined to continue to educate her children. Mai Marichi was dependent on Mai E. for the year before the mother died Mai E. experimented with Chitutu maize.

SUMMARY: Polygamous husband in jail leaving wife to cope with 5 small children, little land of her own, scarce capital for marketing and no experience of being in business by herself.

Household head	Mai Yasini
Spouse	Mr Yasini, in jail for goat stealing
Dependent children	Five
Active children	Lyton and Theresa both help with the fieldwork Lyton is supporting himself at school and buys food there with money from ganyu labour
Subsistence agriculture	Mai Y owns a poor hill field but has the use of a dambo field belonging to her husband
Constraints to production	Lack of cash meant no fertiliser for the first time since 1984 and insufficient seed for the hill field Shortage of labour
Income Generating Activities	In 1997 Mai Yasini sold maize, firewood, cassava, green maize which she was able to buy cheaply from her neighbours, the Julius' mbumba and is now selling maize bran.
Employment	None
Other interesting information	In 1997, when we first met Mai Yasini, things were very bad. The 1996-97 harvest was lost because the active members of the household were attending the court where Mr Yasini was on trial; Mai Y was heavily pregnant, she had no money and little idea how to earn any. With [reluctant] support from Mai Elizabeth, she began small scale marketing of vegetables and firewood; currently she stays 2-3 days at a time in Limbe marketing maize bran from the factory there, sleeping outside the factory.

SUMMARY: Young, poor and childless couple struggling to get by with a mix of agricultural labour and some vegetable production.

Household head	Mr Matheus Anderson
Spouse	Stellia Naphiri Anderson
Dependent children	None
Active children	None
Subsistence agriculture	Mai S owns one hillside field and they rent a dimba garden from Mai Costa: Mr A has some land to use from his mother's mbumba
Constraints to production	Cash. labour and thieves who stole last year's vegetable crop
Income Generating Activities	They grow vegetables on the dimba land for half the year. Mai S sells their vegetables
Employment	Mr A works for a grocery store owner in Chiwoko village. looking after the man's farm for half the year. Both do ganyu labour
Other interesting information	During the 1997-98 season. the Andersons had a very mixed experience with their agriculture. They experimented with new Katswiri seed having heard of its high yielding potential on the radio. However. when the time came to apply fertiliser. they only had enough money to buy two plates of fertiliser and when they should have been banking their maize. they had to do ganyu labour for the Julius's and other friends because they had no money for food.

MBUMBA NO 4: CHIMVULA

SUMMARY: A large and prosperous mbumba with all male headed households and a strong sense of solidarity amongst the three generations of women who own the land. The younger men within the mbumba are employed by their aunts and uncles to help with vegetable production. The women all harvest their maize together: each taking it in turn to brew thobwa [unfermented beer]. The grandmother. Mai Mayenda. came as a child with her parents from Mozambique and remembers when the area of Magomero was covered by forest. Her parents established a claim to this area after a clearing was made by the local estate.

SUMMARY: An elderly couple now struggling to get by

Household head	Mai Theresa Mayenda Chimvula
Spouse	Mr Chimvula [very elderly and not well]
Dependent children	None
Active children	Are all living separately
Landholding	0.5 hectare - but land which she claims to have encroached from the government on a hillside. having given all her own land away to her daughters.
Subsistence agriculture	Mai T does most of the work since her husband is very old: he does. however. do what he can.
Constraints to production	Mai T was short of seeds in 1997-98 and then became ill and could not finish banking her field. She later swopped her goat for some fertiliser but it came too late to apply.
Income Generating Activities	Mai T owns a goat and some chickens: she sells firewood from time to time and she is also a well known practictioner of African medicine for which she receives some gifts.
Employment	None
Other interesting information	

SUMMARY: A stable and well to do male-headed household with good family support

Household head	Mr Chigonamadzi
Spouse	Mrs Essube Chigonamadzi
Dependent children	Three including one who is now mentally handicapped following cerebral malaria
Active children	One. Divason. who works with his uncle in vegetable growing as well as helping his parents
Landholding	1.03 hectares
Subsistence agriculture	They are successful farmers all of whose adult children can be rallied for a day's banking.
Constraints to production	Had to cut back after the disastrous 1996-7 season: they gave up a field that they were renting 1997-98. the application of fertiliser was delayed due to the death of a cousin of Mr C. A pregnant sow was stolen.
Income Generating Activities	They are raising a pig that was given to them by a son living nearby. Mai E owns chickens
Employment	Mr C is a night guard on the Ramsey Estate [previously he went three times to the mines in South Africa and once to a sugar cane plantation in Zimbabwe].
Other interesting information	There is considerable gift-giving and cooperation between parents and adult children. In 1997-98. they are experimenting with boxes for growing cassava They have a tin roofed house

SUMMARY: Entrepreneurial widow has now married an equally go ahead man

Household head	Mr Nakatha
Spouse	Mai Kalonga
Dependent children	One
Active children	Alekereni works on a tobacco estate but does not help mother with field work. Christina does quite a bit around the house
Landholding	0.36 hectare – free use of her daughter's hillfield 0.3 hectare
Subsistence agriculture	Mai Kalonga, her husband and her married daughter Essube all work together: visiting each other's fields one by one. Mai K is an active farmer and is usually food secure for 2/3 of the year.
Constraints to production	This year Mai K bought only 2/3 as much fertiliser as usual due to the previous bad season
Income Generating Activities	Mr Nakatha has his own fields where he grows vegetables and Mai Kalonga is helping him. He also buys and sells produce such as green maize and takes it to market himself. Mai Kalonga sells tomatoes at Kanje market. She also owns a goat and chickens: she was managing well even before she remarried.
Employment	None
Other interesting information	Hard to decide who should be the household head as these two seem equal partners and each retains responsibility for their own livelihood strategies whilst cooperating with the other where appropriate

SUMMARY: Very successful youngish vegetable growing couple keeping their family deliberately small

Household head	Mr Mazinga
Spouse	Mai Joyce Mazinga
Dependent children	Three
Active children	The two eldest girls not only do much of the domestic work but also did all the watering of 1600 tomato plants in the dimba in 1997-98.
Landholding	1 hectare plus Mr Mazinga's mother's hybrid
Subsistence agriculture	Are able to afford [recycled] hybrids and fertiliser. They had been mostly self-sufficient in maize until 1996-7
Constraints to production	They rent both a dimba garden [K200-400 for 3-4 months] and munda field. Mai Joyce's younger brother is their paid labourer for the mornings.
Income Generating Activities	Mr Mazinga is an expert tomato and cabbage grower, having learnt his skills while working at Bvumbwe. All the family contribute labour to this enterprise. His mother will pick a share of the vegetables since it is her field. Both husband and wife do the marketing: he takes cabbages to Bvumbwe, she sells tomatoes and leafy vegetables at Kanje
Employment	None
Other interesting information	Mai Joyce, with the support of her husband, is a strong advocate of family planning and has limited her family to three children. This is despite the strong disapproval of her grandmother [who had 17 births with 7 living children] and her husband's mother. They have a tin roofed house

SUMMARY: Newly married woman with small child whose husband works in town; rural livelihood still closely bound up with mother's farming

Household head	Mai Elube Dyson Namangwiyo
Spouse	Mr Namangwiyo
Dependent children	One
Active children	None
Landholding	0.26
Subsistence agriculture	Mai E has only just become independent of her mother and they still work closely together. Her husband's job pays for fertiliser.
Constraints to production	Labour: Mr N sent money to hire labour when he could not come himself for land preparation in 1997. Mai E preferred to spend the money on food and soap for her mother and herself and her mother then helped with the land preparation Mai E has lent her mother her hill field because she herself does not have time to work it
Income Generating Activities	Mai E tried tomato marketing in 1997-98 but gave up after losing a basket load crossing a fast river.
Employment	Mr Namangwiyo cooks for a shop owning family in Ndirande and comes home once a month
Other interesting information	

SUMMARY: Man who has stayed with his natal family since his wife lacks land. Is successful vegetable grower but rents all land.

Household head	Mr Joseph Chimvula
Spouse	Mrs Patricia Chimvula
Dependent children	None
Active children	None
Landholding	None
Subsistence agriculture	None
Constraints to production	Have to pay for land. labour and inputs - is more vulnerable than most to market fluctuations. They regularly employ Rodsen Chigonamadzi. They complain that the market is being flooded with tomatoes and cabbage but are not sure what else they could grow.
Income Generating Activities	Husband and wife work closely together on vegetable growing and selling: tomatoes.. cabbage. green maize. sweet potatoes. peas and mustard They own a pig and nine piglets
Employment	None
Other interesting information	Mai P comes from Chiradzulu but has no land there

SUMMARY: Young man working for uncle.

Household head	Rodsen Chigonamadzi
Spouse	Young woman arrived in November 1997 from Nkawera
Dependent children	None
Active children	None
Landholding	None
Subsistence agriculture	None
Constraints to production	
Income Generating Activities	
Employment	Works for his Uncle Joseph in the mornings and looks for other ganyu labour in the afternoon
Other interesting information	

MBUMBA NO 5: COSTA [SIMEON MAGOMERO]

SUMMARY: Only two households live at this cluster since the Costa parents spent most of their adult life in Zimbabwe where the older brothers and sisters still live. As a result. their entitlement to land in the village was diminished and the Costa sisters only have small plots. Only three sisters were in Malawi. One lives in Blantyre. one has just left for Zimbabwe and the other is married to Simeon Magomero. Their father is remarried in Mikolongwe village but comes back to the mbumba when he falls out with his new wife. Not sure how many female children will have to share this small portion of land.

SUMMARY: Young family struggling with debilitating TB

Household head	Simeon Magomero
Spouse	Mrs Magomero
Dependent children	Three
Active children	None
Landholding	Mai M only owns 0.24 hectare and Simeon has 0.37 hectares
Subsistence agriculture	
Constraints to production	Illness: both have been suffering from TB since we have known them. Mai M seems to have recovered in part but couldn't contribute much labour during 1997-9 since she was heavily pregnant. Despite their illness. both try hard to keep up production since it is their main form of income. A shortage of labour means that they do not use one field because its bad weed infestation would require too much work.
Income Generating Activities	Vegetable growing by both husband and wife Mrs M markets vegetables Simeon's brother gave him a sewing machine to rent out.
Employment	None
Other interesting information	

SUMMARY: A childless couple in a polygamous marriage that fell apart as we watched

Household head	Rickson Chimvula [of the Chimvula cluster]
Spouse	Ronica Costa Chimvula
Dependent children	None
Active children	Ronica's brother and niece live with her but are economically self-sufficient
Landholding	Ronica owns 0.12 hectares and Rickson 0.16 hectare [next to a well]
Subsistence agriculture	Ronica was responsible for growing the staple food crops. She told us that she could not be bothered to bank her fields because it was too much work. She could not afford fertiliser in 1997-98
Constraints to production	The marriage is polygamous and there is rivalry between the two wives. The other wife once harvested all the vegetables - on which both women had worked - and sold them all.
Income Generating Activities	Mr C is a vegetable grower. Ronica sold vegetables intermittently at Bvumbwe and Kanje markets.
Employment	None
Other interesting information	At the end of February, Ronica left her husband and went to visit relatives in Zimbabwe saying that she would not be coming back.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

FARMER DECISION MAKING AT HOUSEHOLD LEVEL: A STUDY FROM MAGOMERO VILLAGE

A Consultancy report for FSIPM Project

November 1999 – January 2000

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Terms of reference

In collaboration with the Social Anthropologist, to carry out four consultancies involving background research, the design and administration of questionnaires and semi-structured interviews, data entry and processing and report writing. The topics for consultancies follows:

1. Decision making at the household level for agricultural inputs

2. Resource flows between households

3. *Ganyu* labour

4. Preparation of materials for the FSIPM Project Workshop (November, 1999)

Expected outputs include reports on:

1. Decision making at household level for seeds and fertiliser

2. Resource flows between households

3. *Ganyu* labour and social relations and

4. Paper and presentation for FSIPM Workshop

(Offer of engagement, December, 1999)

Outputs 2 and 3 will be reported by the Social Anthropologist

The work covers the period starting November, 1999 to January, 2000

Introduction

The report centres on farmer decision making for agricultural inputs at household level, for a set of farming households involved in the Farming Systems Integrated Pest Management Project in Southern Malawi. Decision making is an important element in Farming Systems research and has implications for technology development. As Barlett (1980) indicated, agricultural development involves change in two dimensions: the kinds of crops grown and the way in which they are grown. It is important to find out how decisions on crop production are made within the household and who actually make the choice. This becomes more important when one considers that a farmer's decisions may be influenced by his/her experiences with previous technologies and by what other people have been growing (Mbithi, 1996) which, in the long run, may affect perceptions of new technology and the farmer's decision goals. A farmer's choice of crops is also indicative of immediate goals of consumption as well as of future goals such as investment in more high value crops, livestock or other assets, for example, a bicycle or new house.

Evidence shows that farmers in southern Malawi are responsive to opportunities when it comes to decisions concerning agricultural inputs. Peters (1999) observed an increased use of both hybrid and local maize with the introduction of new maize clubs with subsidised fertiliser. A similar pattern is clear from the case study households where more than half of the households responded to the opportunity offered by new ADMARC clubs to obtain fertiliser on loan. This demonstrates a relationship between interventions elsewhere in the farming system and decisions concerning choice of crop.

The findings in this work show that husbands take most decisions concerning 'major' crops such as hybrid maize and other high value crops, while wives dominate when it comes to local maize and lower value crops. This finding suggests that both husband and wife have a measure of autonomy in the domains of production and consumption. Orr et al (1999) in their study of the economic potential of IPM for dimba crops found a similar situation: the husband had total control over dimba crops while the wife controlled upland crops. Although each spouse may be operating in different spheres, this study shows some flexibility firstly, as to who is responsible for getting seed regardless of who actually made the choice and secondly, in the source of money, suggesting agreement and co-operation in implementing the choice of crop. This is the type of negotiated relationship among household members that Himmelweit (1997) characterises as co-operative, whether by formal agreement or informal understanding. However,this co-operation may not necessarily extend to high value crops such as vegetables where husbands assume total responsibility in terms of choice and obtaining seed and wives provide only labour rather than expertise.

Rationale for research

The general objective of this research was to explore how decisions on agricultural inputs are made within a set of households that make up the case study for the project. This research is part of the contribution of the social anthropology team to the requirement that the findings and recommendations of the project respond to the felt needs of resource poor farmers (Resource pack, 1996). It is part of the project investigation into social differentiation in terms of gender and understanding in agricultural production.

How decisions on agricultural production are made within a household is vital to the household members' livelihoods and has important implications for technology development and dissemination. These have been important elements in project activities. This is the case because understanding processes of decision making is likely to shed light on who is most likely to influence the adoption of a particular technology. Although the sample is small, the results are indicative. This work therefore complements earlier works by other disciplines in enhancing understanding of the farmer and farming households who may be the target for the project's recommended interventions.

Household decision making models

There are several household models that predict the outcome of decisions made by husbands and wives. Each type of model has its own implicit conception of gender, of what it is in economic terms that distinguishes men and women (Himmelweit, 1997). The findings of this research suggest that what is found here in southern Malawi is a cooperative model of decision making in which the partners bargain from positions of relative strength to arrive (many times) at an outcome that is agreeable to both sides. Neither partner is able to dictate outcomes to the other and we find complex interactions around agricultural decisions so that while one might select a seed, the other is willing to purchase the inputs or provide the cash for it. Definitions of two important models cited in Himmelweit, 1997, are given below:

Definitions

Co-operative model
This model portrays husband and wife as co-operating where there are shared benefits. There could be a formal agreement of what each individual is supposed to contribute to the household or an informal understanding (i.e. each individual is cautious about implications of each other's choices to the household). Cooperation depends on bargaining and negotiation. It would be important in wider study

of this subject to look at the respective bargaining position of each household member, for example, what assets they have access to or control of, be they economic, natural, human or social. This 'fallback' position is what gives individuals bargaining power so that, if all else fails, they are able to opt out of a relationship that is no longer of benefit. Women's ownership of land, children and residence with their own relatives gives women substantial clout in any bargaining in southern Malawi. On the other hand, families are much less vulnerable where there is a male partner who brings in his own cash income, contributes labour and money for necessities such as food, health care and education.

Non-Co-operative model

In this model, each individual has a choice as to how much they contribute to the household without compromising or negotiating with the other. For example, it might be the man's job to earn money for the household while the wife takes care of the domestic work. This means the standard of living would depend on what each individual actually contributes to the household. The husband might not work very hard or spend his money on his own leisure pursuits while the wife might be very houseproud or neglect her duties in favour of visiting her relatives. What tends to happen in this situation is that each partner will contribute in part according to how much effort they see the other partner making. Given that Mr X gives 60% of his earnings to his wife, she will gauge how much housework she will do in return so that she does not feel taken advantage of. Non-co-operation is therefore the outcome reached when each member of the household takes the other's decision as given (e.g own choice allocation of money and time). (It should be noted that this model ignores unequal gender relations, the special nature of childcare demands or the longterm nature of many households).

Methodology

Questionnaires on household decision making for agricultural inputs (1998-99 growing season) were administered to all (nineteen) case study households which the social anthropology team has been monitoring for agricultural activities since 1997. These households reside in five matrilineally related clusters, ranging from two to six households per cluster. These households were selected from on-farm trial households and they represent a range of household situations based on household type and constitution (Lawson-McDowall et al, 1998).

In this group, for example, there are eight male heads of household and their wives who rely chiefly on vegetable production and marketing as the main source of income (Lawson-McDowall et al, 1998), two headed by women, one of whom has no given source of income while the other is an elderly woman who recently sent away her husband and now relyies on income from ganyu done by her older son who is temporarily staying with her. There are two polygamous heads of households (one in paid work and the other a dried fish seller at local markets). A household with a young couple who are struggling because they do not have a reliable source of income, four male heads of household where husbands are in full time employment (one works in town as a shop attendant and the other three work at the nearest tobacco estate), and finally, one male head of household where the husband is in prison and the wife buys and sells maize bran (madeya) to earn money.
Apart from monitoring of agricultural activities, the households were also the focus for micro analysis of agricultural, socio-economic and cultural activities through participant observation and village stays. It was through this process that the team became better acquainted with the households.

The data collected were coded and subjected to analysis in Excel

Results

1. Farmer decision making for hybrid maize

Table 1 addresses three questions that asked what farmers planted in the 1998/99 season, who made the decision on the choice of crop and who was responsible for getting seed. The pattern of decision making, as indicated from the table 1.0 shows that in 11 out of 19 cases, husbands took the decisions while wives took only made 5 out of 19 decisions. There were only two cases where decisions were made jointly and 1 case where a son took the decision. Interestingly, when it comes to specific varieties, most of those choices by husbands (in this case 9 out of 11) were made for MH18, the most popular hybrid maize grown in the project's area (FSIPM Project 1997/98). However, responsibility for getting the seed is shared between husbands and wives. For MH18, for example, husbands selected the variety in 9 cases but were actually responsible for only 6 cases of getting the seed while wives made choices only in 2 cases and sourced the seed in 6 cases. Overall, wives were responsible for getting seed in more often that they were for selecting the seed (wives implemented 10 out of 19 decisions compared to 8 out of 19 decisions by husbands). This indicates wives do not object to implementing the decisions made by their husbands. This suggests that husbands and wives are able to compromise or negotiate even though the choices are rarely joint (2 cases out of 19). On the other hand, children's contribution to household decision making for agricultural inputs is limited (1 out of 19 cases). The single case of a son making the decision and being responsible for its implementation is where he grew MH 18 as a *dimba* crop to sell as maiz,e the proceeds of which he controlled. This is similar to what has been observed where young men control their own enterprises such as vegetable growing (Lawson et al, 1998).

Table 1 Decision making and responsibility for getting seed

Crop	Who made decision				Total	Who was responsible for getting seed				Total
	Husband	Wife	Both	Son		Husband	Wife	Both	Son	
MH18	9	2	1	1	13	6	6	0	1	13
NSCM 41	1	2	1	0	4	1	3	0	0	4
Chitute	0	1	0	0	1	0	1	0	0	1
Katswiri pan	1	0	0	0	1	1	0	0	0	1
Total	11	5	2	1	19	8	10	0	1	19

Source of money versus who made decision

Farmers were first asked what was given in exchange for seed and, as **Table 2** shows, the three responses included cash, exchange for labour, gifts (from mothers or sisters within the clusters, from friends and from in-laws) and 'nothing' in case of recycled seed. Cash accounts for only 7 of the 19 cases, suggesting it is not the only means for getting seeds. These forms of exchange demonstrates channels through which new crop varieties can spread and at the same time shows that farmer's choice of crop may be dictated by the affordability of the seed and what is available to him/her at the time of planting. The question of where the money for purchasing seed came from revealed a range of activities from the sale of labour (*ganyu*) and own vegetable sales to sale of tree fruits such as avocado pears, with own vegetable sales contributing 4 of the 7 cases. This result tallies with Orr et al's. (1999) findings that income from *dimba* helps most farmers to purchase agricultural inputs. Where the farmer is unable to purchase seed or get it through other means, ganyu labour becomes one of the options (1 of the 7 cases).

When it comes to the relationship between who chose a variety and the source of money, we found no significant difference in decision making between husband and wife. This suggests that once decisions are made, the money may come from anywhere regardless of who earns it.

Table 2 Source of money versus who made decisions

Source of money	Who made decision				Total
	Husband	Wife	Both	Son	
Ganyu	0	0	0	1	1
Own vegetable sales	2	1	1	0	4
Tree fruit sales	0	2	0	0	2
Total	2	3	1	1	7

Source of seed versus who made the selection

This question asked where the farmer acquired the seed. As **Table 3** indicates, the most popular source was the recycled seed that was kept from previous harvest (6 cases of the 19). Evidence from the farmer evaluation survey, 1998, shows that MH18 is the mostly recycled of all hybrid varieties (FSIPM project, 1998). Apart from using recycled seed, farmers also acquired it through gifts from mothers or sisters, friends and in-laws. Experience with the case study households shows that these gifts may be asked for when the farmer is in need of seed. Table 1.2 also shows a wide range of sources where the farmer can get seed. The in-village sales offer farmers an opportunity to get seed within easy reach. However, when it comes to decision making, there is not much difference between husbands and wives regarding the source of seed (9 of the 19 cases for husbands and 7of the 19 cases for wives). Differences come in when individual sources are considered separately, for example, in 6 cases husbands decided to use recycled while wives made no choice at all. Wives dominated those choices made regarding seeds that were gifts[1] (5 of the 7 choices made by wives were from gifts while only 1 of the 9 choices by husbands were from gifts). It probably demonstrates that wives are very active in the informal networks and can contribute much to the dissemination of a new seed if found it suitable.

Table 3 Source of seed versus who made the selection

Source of seed	Who made decision				Total
	Husband	Wife	Both	Son	
Market	0	1	1	1	3
Recycled seed	6	0	0	0	6
In-village sales	1	1	0	0	2
Gift from mothers/sisters	0	1	1	0	2
Gift from friends	1	2	0	0	3
Gift from in-laws	0	2	0	0	2
Loan from ADMARC	1	0	0	0	1
Total	9	7	2	1	19

2. Local maize/Bantamu

The local variety is clearly the most popular maize variety grown by farmers and 64.3 % of main trial farmers were using this variety (FSIPM Project, 1998). This is probably because the variety qualifies in terms of most desirable attributes for consumption, these include: poundability, storage, rot resistance in the field and marketability among others. These attributes are similar to that of Bantamu, a variety that was grown by almost all households in one cluster. Due to its similarities with the local variety, Bantamu was place together with local variety for the purposes of this study.

Referring to table 2.1below, it shows that wives took the upper hand both in decision making for the choice of the crop and responsibility for getting seed, 7 of the 14 cases of choices were made by wives while husbands made 4 of the 14 cases. Husbands took responsibility for getting seed 4 out of 14 times, wives did so 10 times out of 14. This suggests an overall responsibility for wives while still in co-operation with the husbands.

Table 4 Decision making and responsibility for getting seed

Crop	Who made decision				Total	Who was responsible for getting seed				Total
	Husband	Wife	Both	Son		Husband	Wife	Both	Son	
Local Maize	3	5	3	0	11	3	8	0	0	11
Bantamu	2	2	0	0	3	1	2	0	0	3
Total	4	7	3	0	14	4	10	0	0	14

[1] Wives decided what seed they were going to plant and then seek it out from mothers or sisters and friend, although in few cases they planted it because they were given.

3. Beans

Chimbamba and Kaulesi were the most commonly grown varieties across clusters, which is consistent with the findings in the farmer evaluation survey where it was found that most farmers preferred these two varieties to Kalima, Nagaga and Napilira, the other project trial beans (FSIPM Project, 1998). None of the 19 households planted any other project varieties (this further supports with the lower scores farmers gave for the three varieties during farmer evaluation). Nyadanawo and Kazitheba were popular varieties in households that are active in vegetable production where they are grown for sale.

Just like the questions on hybrid and local maize, the question of who made the decision on the choice of the crop also applied to beans. As indicated in table 3.0, wives took more decisions concerning beans but there is little difference with husbands (in this case 7 of 20 cases were made by husbands while for wives 10 of 20 cases). Only in 3 cases were joint decisions made. Interestingly, there is an exact match when it comes to who took the responsibility for getting seed suggesting that both husbands and wives implemented their respective choices.

Table 5 Decision making and responsibility for getting bean seed

Crop	Who made decision				Total	Who was responsible for getting seed				Total
	Husband	Wife	Both	Son		Husband	Wife	Both	Son	
Chimbamba	2	5	0	0	7	2	5	0	0	7
Kaulesi	2	3	0	0	5	2	3	0	0	5
Nyadanawo	1	1	0	0	2	1	1	0	0	2
Kazitheba	2	1	3	0	6	2	1	3	0	6
Total	7	10	3	0	20	7	10	3	0	20

When it comes to the source of the money (table 3.1 in the annex), overall, husbands were responsible for 7 of 14 cases while wives 6 of 14 cases. This trend is almost the same as that for local and hybrid maize. Own vegetable sales alone accounted for 7 of the 14 cases, as a source of money for purchasing bean seed, seconded by money from salary (4 of 14 cases). There is a single case where the wife sold maize from own stores in order to buy bean seed. This normally happens when a household has no immediate source of money at the time of planting.

Table 3.2 (annex) gives a range of sources where farmers got their seed, with the market being the popular source. Unlike maize (both local and hybrid) where most households kept seeds, there was only one case where recycled bean seed was used. This probably suggests the difficulty farmers face in keeping beans for seed while they also need them for consumption. Kaulesi and Chimbamba are very marketable while Kazitheba and Nyadanawo are sold green (i.e before seed development). It is possible to take seed from employer on loan in case of working husbands (1 case out 20). It is interesting to note that gifts are playing an important part as sources of seed and this trend applies to all seeds and most choices are made by wives.

4. Pigeon peas

The results shows that the case study households planted two varieties of pigeon peas namely, local and 'research'[2] (commonly known by farmers as 'wa research'). As shown in table 4.0, husbands were not much involved in the choice or sourcing of this crop. (1 of 20 cases, while wives are responsible for 16 of 20 cases). This is probably because the crop is not grown to a larger scale in the area, despite its importance as a cash crop (Orr et al, 1999). Although wives are responsible for a lion's share of the

[2] Farmers named any other variety apart from local as research meaning it's a hybrid

choices, it does not necessarily mean a non-co-operative situation between husbands and wives since husbands often contribute cash towards purchasing the seed.

Table 6 Decision making and responsibility for getting seed.

Crop	Who made decision				Total	Who was responsible for getting seed				Total
	Husband	Wife	Both	Son		Husband	Wife	Both	Son	
Local	1	11	2	0	14	1	13	0	0	14
Research	0	5	1	0	6	1	5	0	0	6
Total	1	16	3	0	20	2	18	0	0	20

Sources of money for purchasing of pigeon peas are not very much different from those of maize and beans, table 4.1(annex). The only difference is the sale of cooked food which account for 1 of 20 cases. The main source was from husband's salary. This reinforces the idea that money may come from either spouse regardless of who makes the decision.

When it comes to source of seed, the market was the main source accounting for 8 of 20 cases, seconded by gift from mothers or sisters, 4 of 20 cases (table 4.2 in the annex). Wives are again controlling choices connected to gifts as already noted with the maize and beans.

5. Other Crops

i. Vegetables/ high value crops

Eight case study households grow vegetables as the main source of income and the type of vegetable grown gives an immediate insight into the scale of enterprise (Lawson-McDowall, 1998). Vegetables like chinese, rape and mustard are lower value whose input requirement are also low. This is probably why even wives took decisions on the choices of these. However, husbands made most decisions accounting for 11 of 23 cases (table 5.0). This reinforces our understanding that vegetables are husbands' sphere of production. While this is so, they do not have total autonomy, evidence from Orr et al, (1999) shows that wives may contribute labour in vegetable growing by assisting in watering, for example.

Table 7 Decision making and who was responsible for getting seed for vegetables

Crop	Who made decision				Total	Who was responsible				Total
	Husband	Wife	Both	Son		Husband	Wife	Both	Son	
Tomatoes	4	1	2	1	8	6	1	0	1	8
Cabbage	2	0	1	1	4	3	0	0	1	4
Onions	2	0	0	0	2	2	0	0	0	2
Chinese	1	0	1	0	2	2	0	0	0	2
Rape	1	0	1	0	2	2	0	0	0	2
Mustard	1	0	1	0	2	2	0	0	0	2
Sweet potato	0	1	0	0	1	1	0	0	0	1
Irish potato	0	0	2	0	2	2	0	0	0	2
Total	11	2	8	2	23	20	1	0	2	

ii. Lower value crops

Table 5.1 gives a wide range of crops that are mostly grown alongside maize. Peters, (1999) noted that these crops are used for home consumption and sale. Just as with pigeon peas, wives dominated the decisions taken on the choices of these crops (36 of 42 were choices made by wives while husbands made 5 of 42 cases. Similarly, Wives took overall responsibility of getting seed (40 of 42 cases while husbands only 2 of 42 cases. The results for vegetables and lower value crops gives an immediate impression of two spheres of production with each individual taking overall responsibility.

Table 8 Decision making and responsibility for getting seed for 'low value crops'

Crop	Who made decision				Total	Who was responsible for getting seed				Total
	Husband	Wife	Both	Son		Husband	Wife	Both	Son	
Cowpeas	0	10	0	0	10	0	10	0	0	10
Sorghum	0	6	0	0	6	0	6	0	0	6
Pumpkins	1	10	0	0	11	1	10	0	0	11
Groundnuts	4	5	1		10	1	9	0	0	10
Velvet beans	0	2	0	0	2	0	2	0	0	2
Nkhungudzu	0	1	0	0	1	0	1	0	0	1
Cassava	0	2	0	0	2	0	2	0	0	2
Total	5	36	1	0	42	2	40	0	0	42

No new sources of income are identified in table 5.2 (annex), which suggests that these are the main source through which most farmers get money. As previously noted the source of money may come from either spouse regardless of who took the decisions.

The sources of seed for both vegetables and other crops ranges from market, in-village sales, gifts and gifts (table 5.1), not different from the sources for the above crops. There are still more cases of wives deciding to plant a crop and then seeking the seed as a gift from relatives or friends.

6. Decision making on fertiliser use

In Malawi, if maize requires fertiliser, in the great majority of cases it requires nitrogen above all (Ministry if Agriculture and irrigation, 1999). This would however, work best if the fertiliser were applied twice. Experience in the project area shows that most farmers can not afford double applications of fertiliser due to limited cash.

Farmers were asked who made the decision to obtain fertiliser. As indicated in table 6.0 in the annex, husbands made 8 of the 14 decisions on obtaining fertiliser as compared to 4 of 14 cases for women and 2 of 14 for joint decision. These results are consistent with their respective spheres of production as noted from earlier discussion on crops. Since husbands took a major role in vegetable and hybrid maize production, this partly explains why they made more decisions about fertiliser use. Likewise, women are the experts for crops that need little or no fertiliser at all such as pigeon peas, cowpeas sorghum among others. Gladwin et al reported that if productive inputs like fertiliser could be re-allocated within the African household from men to women in some societies, the results could mean an increase in output of 10 –20% (Alderman et al., 1995 and Gladwin et. Al, 1998).

Farmers were also asked how they come to the decision to obtain fertiliser. All fourteen households indicated that fields are not fertile so they need fertiliser to boost their crops. It was interesting to explore whether it was really a decision for farmers to obtain fertiliser or if it was just normal behaviour. It emmerged that all household s that applied fertiliser do so if they can.

A range of activities were carried out to find the cash to purchase fertiliser. These ranged from liquidation of assets such as selling a goat (this was not done for purchasing of seeds but fertiliser is very expensive, for example, a 50 kg bag of CAN costs K680. Own vegetable sales formed a major part both in seeds and fertiliser, signifying importance of vegetable growing in their livelihood (8 households grow vegetables as the main source of income). Other households (4 cases) had to engage in the sale of maize bran (madeya) in order to obtain fertiliser. The main source of money, as the table shows, was loan. This was so because farmers responded to the opportunity of new clubs set by ADMARC (9 cases). The main sources were therefore loans from ADMARC, sale of own vegetables, and buying and selling madeya (farmers obtained some madeya by spending two to three weeks in urban maize mills collecting the bran.

Asked what type of fertiliser farmers applied, CAN was popular among the households (13 cases as compared to 7 cases of 20:20:0 and Urea, 23:21:0 and mixture of Urea and 20:20:0+CAN (1 case). Considering that most of these households only apply fertiliser once, the choice of CAN was not appropriate according to recommendations by Ministry of Agriculture and Irrigation, (1999), which states that for the farmer who cannot afford the entire recommended fertiliser package should use Urea, the fertiliser that provides the most nitrogen for least cost. Farmers do not probably have this information.

When it comes to the question of source of fertiliser, ADMARC was the main source for both loan and purchases with loans accounting for 14 of 23 while in 2 of 23 cases the fertiliser was purchased. In 5 of 23 cases fertiliser was bought at Bvumbwe market and some households even got fertiliser in the village (starter pack sales –a businessman went to Nsanje to buy fertiliser where (it is believed) farmers do not apply fertiliser although they received starter packs from government so they sale on the fertiliser.

Although most of the decisions were made by husbands, more co-operation was noted in the getting of the fertiliser. This suggests shared responsibilities between husband (11 cases) and wives (7 cases) and joint responsibility in 3 cases.

It is interesting to note that the exchange for fertiliser was either cash or loan and these were in almost equal cases (11 of 23 for cash and 12 of 23 for loan). This shows the difficulty farmers will have if they have limited cash and cannot access a loan either. It means alternative fertiliser sources such as green manure would be a viable option for most farmers.

Social networks have proved to be influential to household decisions on the choice of a crop as there is much sharing of seeds as gifts. However, this is not true for fertiliser due to its high costs. As indicated in table 6.0, in the annex, 19 of 23 cases did not share fertiliser as compared to 4 who did. Even in these 4 cases the sharing of fertiliser was not a gift but a means of sharing costs (i.e. where two households shared a 50 kg bag where they could not afford a full bag. This therefore implies inter-households relationships or other social relations may affect the decisions on crop choices but not on fertiliser.

Table 9 Decision making on fertiliser use

Question	Response	Total
Who made the decision to buy fertiliser	Husband Wife Both	8 4 2
How did you come to the decision to obtain fertiliser?	Field not fertile	14
Was is a decision or just normal behaviour?	Normal behaviour	14
How did you get fertiliser?	Took loan Sold own vegetables Bought and resold madeya Sold goat/pig Salary Sold own and bought vegetables	9 5 4 3 1 1
What type of fertiliser?	CAN Chitowe (20:20:0)	13 7

	Mixture (CAN+20:20:0	1
	Urea	1
	23:21:0	1
What was the source?	Loan from ADMARC	14
	Market	5
	Purchased from ADMARC	2
	In-village sales	2
Who went to get fertiliser?	Husband	11
	Wife	7
	Both	3
	Son/Daughter	2
What was given in exchange?	Cash	11
	Loan	12
What was the source of money?	Salary	2
	Sold pig/goat	1
	Maize bran (Madeya)	2
	Own maize sales	3
	Sold own and bought vegetables	2
		1
Was this fertiliser shared?	Yes	4
	No	19

Conclusion

This was a small-scale study yet we believe the results are indicative of broader patterns from our interactions with on farm trial farmers and other studies we have carried out. The findings in this work suggests that husbands and wives makes choices in separate spheres of production but that while one may take the lead, there is overlap in terms of provision of resources such as labour or cash. It shows clearly that husbands control high value crops such as vegetables while wives control low value crops such as pigeon peas. Despite these separate spheres, there is flexibility in implementing decisions even when made by the partner. This suggests a high level of cooperation at other stages in agricultural production. For example, a husband might support the wife with cash while the wife would help with watering 'his' vegetables. Interestingly, there was husbands and wives appeared equally involved in choices and responsibility for beans which suggest an equal interest in the crop. The work has helped to identify domains of recommendations, meaning project recommendations for crops need to consider who actually take the upper role in the selection of the crop. For example, women would be better targets for pigeon peas, vegetables for men while beans for both.

Social relationships play an important role on decisions for crops. For all crops considered in this work, gifts were given or asked for and these are mainly among sisters and their mother in the matrilineal cluster, friends or in-laws. This demonstrates networks through which new seed can be disseminated if farmers like the seed. Again, availability of the seed is likely to influence decisions because farmers may want a variety which is not available on the market and so be forced to find an alternative.

More than 50% of the households responded to the opportunity of getting loans offered by new ADMARDC clubs. This suggests that soil improving technologies would be a viable option for most household. It also shows how much farmers need credit for fertiliser.

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Annex 1- Table of activities

Table of activities

Date	Activities
23.10.99	Literature search (UK+Lilongwe)
02.11.99	Literature review -BARS
03. 11.99	Farmer selection for pre-testing, literature review
04.11..99	Took part in Farmer-Exit Strategy Workshop (BARS)
05.11.99	Pre-testing ganyu questionnaire
08.11.99	Literature review, translating ganyu questionnaire
09..11.99	Interviews (ganyu questionnaire) with Mai Kalonga, Namangwiyo, Chigonammadzi, Mayenda, Mazinga and Chimvulato
10.11.99	Interviews (ganyu questionnaire + Decision making) with Mai Mazinga, Nangwale,Sukali, Mkhumba, Machinjiri
11.11.99	Interviews (ganyu and decision making) with Mai January, Marichi, and Anderson
12.11..99	Interviews (ganyu and decision making) with Muthowa, Yasin and Simeon
15.11.99	Staff meeting, translating questionnaire (resource flows between households)
16.11.99	Interviews (resource flows –round 1) with Mai Mazinga, Nangwale, Sukali, Mukhumba and Machiniri
17.11.99	Interviews (resource flows –round 1) with Mai Chigonammadzi, Mayenda, Simeon, and Chinvula
18.11.99	Interviews (resource flows –round 1) with Mai Namanwiyo, Muthowa, January, Yasini and Anderson
19. 11.99	Interviews (resource flows –round 1) with Mai Naluso, checking finished questionnaires.
22-23	On leave
24.11.99	Preparation of paper for presentation at project workshop
25.11.99	Preparation of paper for presentation at project workshop
26.11.99	Preparation of paper for presentation at project workshop
06.12.99	Editing paper presented at the project workshop
07.12.99	Interviews (Resource flows- round 2) with Mai Kalonga, Namangwiyo, Nangwale, Mazinga, Machinjiri and January
08.12.99	Interviews (Resource flows- round 2) with Mai Chigonammadzi, Mazinga, Chimvula, Mayenda, Mukhumba , Sukali and Simeon
09.12.99	Interviews postponned (farmers receiving starter packs), data entry in SSPS Mayenda, Mukhumba , Sukali and Simeon

Date	Activities
10.12.99	Interviews (Resource flows- round 2) with Mai Marich, Yasin, checked collected data
13.12.99	Interviews (Resource flows- round 2) with Mai Muthowa, Naluso, coding decision making questionnaire
14.12.99	Coded household names on questionnaires an listed all coded in excel
15.12.99	Continued listing all codes in excell
16.12.99	Compared all questionnaire on universal relationship codes, Checked resource flows for November, coded asset questionnaire

Set up of ganyu questionnaire, coding

20.12.99	Putting codes on questionnaires, Ganyu and decision making
21.12.99	Finished coding on ganyu and set up asset questionnaire, data entry –asset questionnaire
22.12.99	Coding on resource flows questionnaire, set up coded for resource flows (cooperative work, gifts and food, set up data entry for resource flows, data entry on hiring ganyu
04.01.2000	Interviews (Resource flows- round 3) with Mai Muthowa, Mai Naluso, January, Nakutho, Mayenda asset questionnare with Muthowa
05.01.2000	Interviews (Resource flows- round 3) with Mai Yasini, Marichi, Anderson Mazinga, Nangwale, Sukali, Mukhumba, Machinjri, Simeon, Chimvula, Chigonammadzi and Namanwiyo

Coding remaining questionnaires, data entry resource flows January, learnt pivot tables

07.01.2000	Checking/reading entered data for January Resource flows, analysis-pivot tables for doing ganyu
11.01.2000	Analysis –pivot table for hiring ganyu
12.01.2000	Analysis- redoing pivots for doing and hiring ganyu

Doing and hiring ganyu-gender analysis for 1998/99 season and November, 1999.

Gender analysis for doing and hiring ganyu

18.01.2000	Resource flows pivot tables-cooperative work, gifts and food
19.01.2000	Resource flows pivot tables-cooperative work, gifts and food
20.01.2000	Gendered pivots for filtered data-local maize, pigeon peas and gifts

Reading through filtered data pivots –1/2 day

24.01.2000	Analysis –fertiliser use, literature review
25.01.2000	Literature review, report writing

26.01.2000 – 31.01.2000 report writing.

Annex 2. Tables

Table 2.1 Source of money versus who made decisions for local maize

Source of money	Who made decision				Total
	Husband	Wife	Both	Son	
Salary	0	1	0	0	1
Own vegetable sales	2	1	0	0	3
Bought and sold vegetables	0	0	1	0	1
Total	2	2	1	0	4

2.2. Source of seed for local maize versus who made decision

Source of seed	Who made decision				Total
	Husband	Wife	Both	Son	
Market	1	2	0	0	3
Recycled seed	1	4	2	0	7
In-village sales	1	0	0	0	1
Gift from friends	0	1	0	0	1
Gift from in-laws	1	0	1	0	2
Total	4	7	3	0	14

3.1. Source of money for beans versus who made decisions

Source of money	Who made decision				Total
	Husband	Wife	Both	Son	
Salary	3	1	0	0	4
Own vegetable sales	4	2	1	0	7
Bought and sold vegetables	0	1	0	0	1
Own maize sales	0	1	0	0	1
Fish sales	0	1	0	0	1
Total	7	6	1	0	14

3.2. Source of seed for beans versus who made decisions

Source of seed	Who made decision				Total
	Husband	Wife	Both	Son	
Market	4	5	1	0	10
PTC/ADMARC	1	0	0	0	1
Recycled	1	2	2	0	4
In-village sales	1	0	0	0	1
Loan from employer	0	1	0	0	1
Gift from mothers/sisters	0	1	0	0	0
Gift from in-laws	0	1	0	0	0
Total	7	10	3	0	20

4.1 Source of money for pigeon peas versus who made decision

Source of money	Who made decision				Total
	Husband	Wife	Both	Son	
Salary	0	6	0	0	6
Own vegetable sales	1	2	0	0	3
Cooked food sales	0	0	1	0	1
Total	1	8	1	0	10

4.2 Source of seed for pigeon peas versus who made decision

Source of seed	Who made decision				Total
	Husband	Wife	Both	Son	
Market	1	8	0	0	9
Recycled	0	2	0	0	2
Gift from matrilineal kin	0	1	0	0	1
Gift from mothers/sisters	0	4	3	0	7
Gift from in-laws	0	1	0	0	1
Total	1	16	3	0	20

5.0. Source of money for other crops versus who made decision

Source of money	Who made decision				Total
	Husband	Wife	Both	Son	
Salary	4	2	0	0	6
Ganyu	2	4	4	0	10
Own vegetable sales	6	6	2	2	16
Bought and sold vegetables	1	2	0	0	0
Sold own maize	0	1	0	0	0
Cooked food sales	0	0	1	0	0
Total	13	15	7	2	32

5.1. Source of seed for other crops versus responsibility for getting seed

Source of seed	Who made decision				Total
	Husband	Wife	Both	Son	
Market	9	10	5	0	24
Recycled	2	11	2	0	15
In-village sales	4	0	2	2	8
Gift from mothers/sisters	1	0	0	0	1
Gift from friend	0	3	0	0	3
Gift from in-laws	0	3	0	0	3
Garden den shop	1	0	0	0	1
Total	17	27	9	2	55

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

Village Level Safety Nets:
a study of resource flows between closely related households

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Abstract

This report is of a study of resource flows within four groups of closely related households between October 1999 and January 2000 in a village in southern Malawi. . The research aimed to map resource flows between closely related households and to see what this might imply for adoption of new pest management strategies. We found that for some of the households within these groups, the transfers were a form of safety net that protected them against serious poverty or vulnerability. For others, the exchanges and gifts made only a small contribution to their livelihoods but helped to maintain important social relations. The major recipients of assistance were, as expected, elderly parents, young women – either pregnant or with small children and with little male support – and the sick. However, the elderly parents included here received very different levels of support from their children and grandchildren, ranging from near neglect to virtual maintenance. The support given did not appear to depend on the overall wealth of the households in the respective clusters. The 'able' poor were assisted through being given the first chance to do casual agricultural labour for their relatives, neighbours and friends. Many studies of 'coping strategies' (how people adapt to or cope with poverty or vulnerability), which include safety nets, are handicapped by a survey or rapid appraisal approach unsuitable for this topic[1]. The findings of this research, though small scale and indicative, are therefore relevant to the debate on formal and informal safety nets currently taking place in Malawi. The success of the methods used for the study have implications for how future research on this topic might be carried out.

Acknowledgements
Thanks go to Dr Pauline Peters for her help in conceptualising and planning this work.

[1] See Devereux, 1999 and Marland et al, 1999 for a discussion of appropriate methodologies.

1. Introduction

This report is of a study of resource flows within four groups of closely related households between October 1999 and January 2000 in a village in southern Malawi. The research aimed to fill gaps in project knowledge about resource flows between closely related households and what this might imply for adoption of new pest management strategies. We could find little in the literature about to what extent economic linkages between households in related hamlets might influence their ability to take up new agricultural technologies. For example, did better households supply seed to their poorer relatives or would younger and fitter members of the extended family do fieldwork for their less able parents and grandparents? We also saw an opportunity to contribute to the wider debate on informal resource transfers or informal safety nets (ISNs) by providing a case study. Both the government of Malawi and the donor community are interested in how the poor manage chronic and episodic poverty, not least to help in the design of formal safety nets.

It is known that for poorer households labour is in short supply at critical times of the year. Trial farmers rejected labour intensive technologies for pest control. Not only is fieldwork available during the rainy season but hunger and the need for expensive agricultural inputs also peak. The urgent need for cash felt by most smallholders is usually met in this part of Malawi through casual agricultural labour (*ganyu*) or, for the moderately better off, petty trading (*gaini*). *Ganyu* is generally believed to take smallholders away from fieldwork. Trading, if successful, may allow the smallholder to employ labourers for fieldwork so that s/he continues with more profitable activities.

Prior to this work, we had found limited evidence that households in the same mbumba supplied unpaid labour to other households. Some hamlets still harvest maize together and most join *thandizi* labour groups with other relatives, friends and neighbours to help with housebuilding (carrying water for mud bricks, grass for thatching etc). Sweet beer is served as refreshment but the main expectation is of reciprocal assistance. Between themselves, related or neighbouring women or families arrange to share childcare, or to carry water or collect firewood for someone who is sick or a woman who has just given birth. Women cook together for funerals, weddings or other special occasions

A large minority of Malawian households are also chronically short of food and cash. The amount of sharing and mutual support that exists has important implications for introducing new technologies. If the better off households who gain access easily to new materials or practices pass these on to poorer households then the adoption of innovations would proceed much more quickly. We had little direct evidence for other sorts of resource transfers between households within hamlets, however. We had observed the sharing of snacks (bananas, mangoes, millet), special treats (dried fish, goat meat), harvests of vegetables or fruit or of gifts from relatives and friends outside the hamlet. Two great-grandmothers too old and sick to work (who died during the course of the study) had been supported by their children (primarily daughters) and grandchildren. However, the apparently vulnerable position of some other older members of the hamlet made us wonder how much help these households were receiving. How did they get by? In particular, several women in their 60s, either widowed or whose husbands were too old, sick or lazy to contribute too much, had complained of seed shortages, a lack of fertiliser, being obliged to do *ganyu* labour – so neglecting their fields – and other difficulties. Casual questioning resulted in contradictory replies. The older members denied receiving any substantial help whilst their adult children claimed to provide considerable support.

Other work on poverty and vulnerability?

Turning to the literature on poverty and vulnerability for Malawi only provided limited insights to how much poor households were being helped or by whom (see Pearce et al, 1996; Smith, 1998; Devereux, 1999; Marsland et al, 1999). Two recent overviews of coping strategies by Marsland et al and Devereux found reported remittances were low: estimates of contribution to total household income ranged between 0-6.5% and averaged around 2.5%. This implies informal resource transfers are unimportant in helping poorer people cope or adapt to difficult periods or sudden shocks. What we had observed suggested otherwise: it seemed as if some people might be heavily dependent on assistance.

However, the authors pointed out that there were serious methodological problems with the research they examined.[2] These lie firstly with the subject matter. A large part of such transfers are small, occasional or, possibly, seasonal, made in food, clothes or other kind and usually take place within extended family units. Recipients are not proud of their neediness and often conceal the level of help they receive. It is hard to capture the nature of safety nets with large-scale surveys looking at formal, regular, relatively large and market based transfers, usually in the form of cash.

The aggregation of data presents a similar problem. If total transfers are averaged across the whole sample, they appear small. This disguises how important transfers are for the minority who depend on them for survival. As a result, formal survey approaches lead to much lower figures for informal resource transfers than community level case studies. A 1998 survey found that only a few of more than 600 households said that they received gifts or remittances to any significant level (Mthindi et al, 1998, cited in Devereux, 1999). The same study included focus group discussions where participants placed help in kind and cash from friends and neighbours high on their list of ways in which they coped with shortfalls. Peters, 1999, reporting on a longitudinal study of 250 (slightly better off) farming households in the Zomba area, found that approximately 14% of total income came from household members living or working elsewhere. (This is not the same as support from other households in a related hamlet which is the focus of this study).

The debate on ganyu

A key issue in discussions of how poor households cope is ganyu labour.[3] Ganyu labour is defined as

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[2] The following discussion is taken from Devereux.

[3] See Whiteside, 1999: Devereux, 1999: Marsland et al, 1999 and Peters, 1999 for a full coverage of the debate on *ganyu*.

> 'any off-own-farm work done by rural people on a casual basis; usually covering a period of days or weeks, remuneration may be in cash or in kind (such as food), and is often, but not exclusively calculated as piecework. *Ganyu* may be done for relatives, neighbours, smallholders further afield, for estates or even in other countries. The work is often, but is not exclusively, relatively unskilled and agriculturally based. Men, women and children can all do *ganyu*.' (Whiteside, 1999:5)

The need to earn cash or food in the short run also has serious implications for farmers' ability to adopt technologies with higher costs in money or labour requirements. In this study, the main types of *ganyu* labour were ridging fields before planting and weeding and banking in December and January. Such labour has important safety net characteristics since the fieldwork becomes available at the time when own stores of maize have run out, green maize is not commonly available and the harvest is still some way off. It was once thought that *ganyu* was only done as a last resort because the work is demanding, the pay is very low and it takes farmers away from their own production at a critical stage in the agricultural cycle[4]. Recent work makes it clear that after own farm production, *ganyu* labour is the most important livelihood strategy for most poor households in many areas of Malawi. Peters, 1999[5], found that 59% of smallholder households with less than 0.7 ha of land reported *ganyu* as a primary source of income compared with only 26% of households with more than 1.5 ha. This means that *ganyu* labour has become a normal part of many poor households 'portfolio' of activities despite its drawbacks. This can only be due to the absence of better paid work.

All studies point out that there is a social dimension to *ganyu* beyond the commercial exchange of work for cash or kind. However, little is known about how far *ganyu* functions as an informal safety net or in what networks of relations it might be embedded. Pearce et al, 1996, found suggestions that relatives and neighbours were hired first. Others note preferential rates for kin and friends. It is also generally agreed that *ganyu* labour stigmatises a household. It shows that they have run out of their own maize and have no better option.

The aim of asking this small group of households about their participation in the *ganyu* labour market was principally to explore the social dimensions of this work. To see who worked for whom, doing what, why, for how much and how this work fitted into broader livelihood strategies or was viewed by others.

The objectives of the study are therefore to:

- Record the resource flows between households within four hamlets
- Identify the chief recipients and donors of assistance

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[4] Whiteside, 1999:17, 'Competition between *ganyu* and own farm labour can be critical – a two week delay in preparing fields can lead to a yield reduction of a quarter.'

[5] Cited in Marsland et al, 1999: Annex 1 and Whiteside, 1999:10 from a first draft of her 1999 paper.

- Differentiate between forms of assistance and assess their impact on wider livelihoods

The Project

The goal of the FSIPM Project was to provide small-scale, resource poor farmers with acceptable IPM strategies to reduce pre-harvest crop losses by pests. From 1996 to 1999, the project ran on-farm trials with selected farmers in 4 villages in Mombezi and Matapwata EPAs in the Shire Highlands Rural Development Project (RDP) in Blantyre Agricultural Development Division (ADD). In these trials, a range of pest management (and later, crop management) strategies, have been tested for maize, beans and pigeon peas over three agricultural seasons.[6]

The complementary task of the project's social scientists was to ensure the technologies tested were appropriate to the farming system of the area. This is characterised by intensive intercropping of maize with a range of legumes, root crops and other vegetables on very small landholdings (60% of households in the RDP have less than 0.5 hectares of land). A recent study has estimated that approximately 1/3 of income is earned off farm, 1/3 comes from sales of agricultural produce (mostly from vegetables or burley tobacco in these EPAs) and 1/3 is from self-subsistence (measured in maize) (Peters, 1999). Poorer households depend more on off-farm income and better off households on own-farm production and sales. The task of describing the farming system and understanding farmers' preferences entailed investigating the livelihoods, assets base and developmental context of the target villages. To this end a three-year panel survey of 120 was conducted and eighteen households in one village, Magomero, in Matapwata EPA, were incorporated into an in-depth case study. Monitoring and evaluation of the trials were carried out with farmers. Other, discrete topics were investigated throughout the life of the project.

2. Methodology

Between November 1999 and January 2000, the FSIPMP carried out a study within the four hamlets of closely related households based on a mother and her married daughters, their spouses and children. These 18 households have been co-operating as a case study set with researchers since 1997 and their constitution, circumstances and relationships are well known. Over a 10-week period, four visits were made. In the first round of interviews, household members were asked for whom they had done *ganyu* labour in the 1998-99 agricultural season and whom they had employed to do *ganyu* labour (see Annex A for the questionnaire form). Three subsequent visits were made at 2.5 week intervals in which every household was asked about gifts (including food) given or received and work done for others (see

[6] The technologies encompassed host plant resistance, cultural practices and some chemical pesticides against witchweed (*Striga Asiatica),* whitegrubs and termites in maize, bean fly in *Phaseolus* beans and *Fusarium* wilt in pigeon peas.

Annex B). It should be kept in mind that small amounts of food or similar gifts in kind (paraffin, matches, salt etc.) are notoriously hard to recall so that this results are only approximate.

The case study households from 1997

The case study work on which this research draws began in early 1997 with five households taking part in the on-farm trials. It was quickly enlarged to include the cluster[7] of closely related households (the *mbumba* or *mudzi*) within which the original household was based (see Annex A for a description of social organisation in matrilineal societies in southern Malawi). This approach aimed to investigate various subjects through in-depth discussions, participation and observation but also to understand existing relationships within and between households in the sororal hamlet. A dearth of recent social anthropological work on social organisation in southern Malawi[8] meant that getting to know a group of households with a range of different typologies and characteristics, combined with the baseline survey work and the use of secondary sources, was an efficient way to grasp social organisation[9].

A limitation of this study is that in most instances we did not carry out the interview with husbands who had married in from outside because most work on estates or trade on their own account and are usually away during the day. However, the picture is incomplete without knowing to whom this very important group of cash-earning men give money or other goods. An informed guess would be that they have some obligations to their parents, sisters and also to any matri- or patri- lineal relations who are close at hand. This obligation may well vary according to distance, the closer the relatives, the greater the demands. At least two men in this group have two wives so support a second household.

In the following section, the results of the study are presented, hamlet by hamlet. The flows are mapped in a diagram and then discussed in the context of the member households of the cluster. The results on *ganyu* labour are given separately in the succeeding section. The final part of the report discusses the findings and their implications.

3. Results

3.1 Resource Flows

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[7] Although the study was carried out within five clusters, by the time of this research, one cluster had been reduced to a single household and is therefore excluded.

[8] See Marland et al, 1999, for a discussion of this topic

[9] The limitations of a case study approach are that it is hard to generalise from such a small group and their characteristics may differ from the population at large.

Hamlet no 1: Mazinga

Near maintenance

Figure 2 below shows the near-maintenance case. Here the flow of resources is to a woman in her early 60's from her four married daughters who live alongside her. Over the 70 day period, they gave their mother about 35 meals worth of maize flour (*ufa*), the staple food. As Mai Mazinga was eating only one meal of nsima (the porridge made from *ufa*) and relish a day and taking 'snacks' such as cassava, groundnuts, velvet beans or bananas for the other meal(s) of the day, her daughters provided approximately half of her needs. In addition, Mai Mazinga was given at about 3 weeks food by her two sons[10], also resident in the village, and some gifts from other relatives. Out of 70 days, she received 56 meals from her children. Interestingly, her eldest daughter, who is the best off in the hamlet, did not give as much to her mother as the two middle daughters who are less well off. Mai Mazinga was only able to give pumpkin seeds and a small gift of matches and paraffin in return to her daughters.

The context

Mai Mazinga is in a widow in her 60's and has 8 living children. Four of her daughters live in her hamlet, one son is a teenager and is still dependent on her, while her other two sons are married within the village[11]. She is the sister, widow and mother of headmen but is still very poor. Her four daughters are all married with families.

The eldest, Mai Nangwale is comfortably off. She and her husband grow vegetables for the market together. Her husband has a calf and is aiming to get into dairy production and has also begun to practice traditional medicine. Mai Nangwale has only one daughter in her mid-teens. The Nangwale's offer *ganyu* labour within the hamlet from time to time. Mai Mazinga stepped in to take over work that had not been finished by the husband of her fourth daughter.

The second daughter is less comfortably situated. Her husband works as a construction worker on a nearby estate but in 1998 took a second wife and now divides his time and income between the two households[12]. Their youngest child is chronically malnourished and Mai Sukhali complains that she cannot afford to buy the pulses and oils that the clinic recommends for her daughter. Nonetheless, Mai Sukhali gave her mother 13 meal's worth of *ufa*. Mai Mukhumba, on the other hand, seems to be in a more stable position. Her husband works on a nearby estate but also helps her to grow vegetables, including high value cabbages, in their dimba garden. Children in the cluster help with any work that is being done e.g. Mai Nangwale's daughter helped Mai Sukali to carry tomatoes to the market and all the bigger children carried mud for scrubbing walls.

Mai Mazinga is lucky in having two sons are doing well as vegetable growers who live in the village. One uses dambo land rent-free belonging to his mother. He gives her vegetables to sell in return (which her daughters carry to market and sell on her behalf) but not enough to keep her through the deficit season without assistance from elsewhere. Nor can she afford to buy fertiliser.

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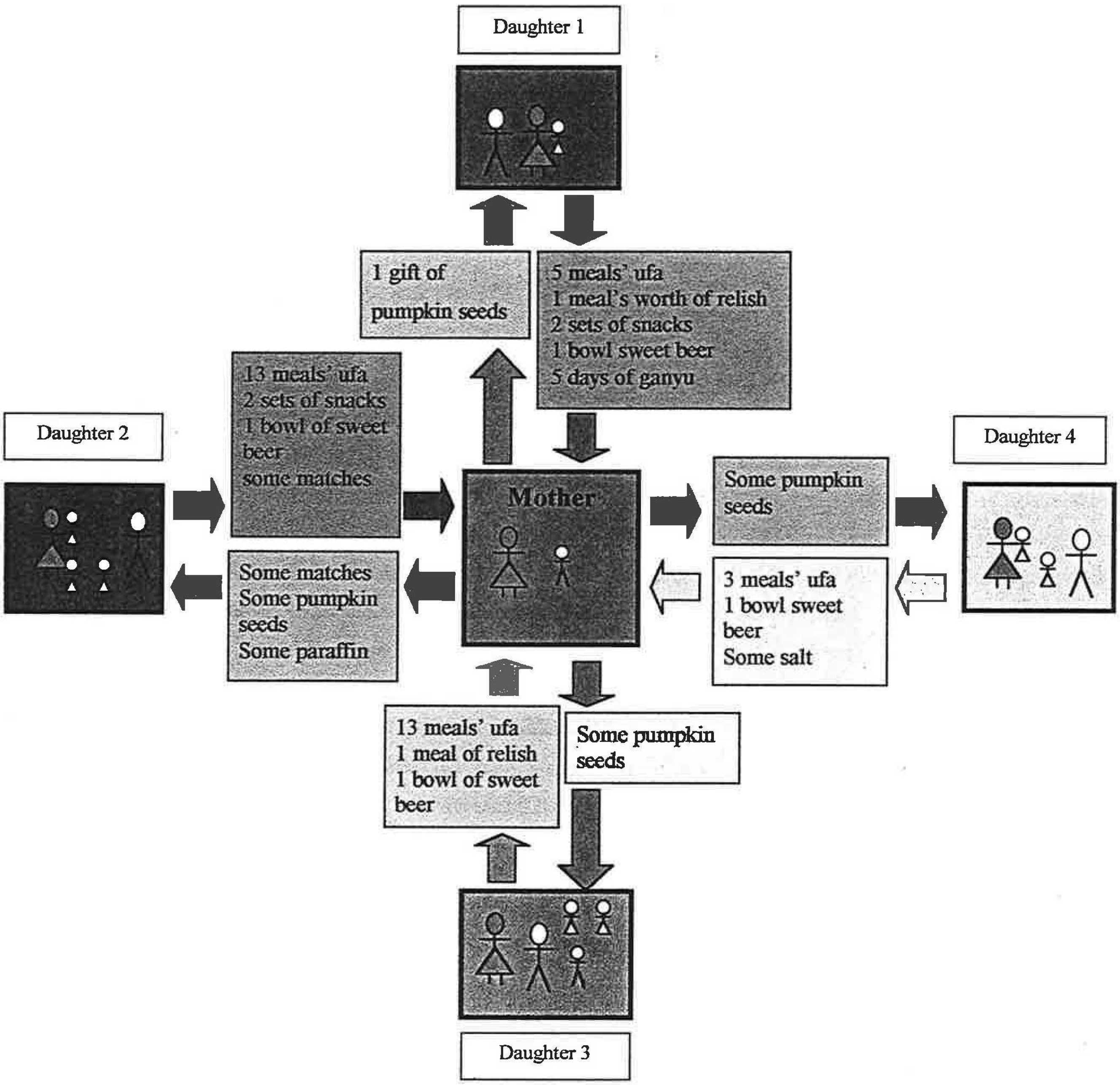
[11] Her fifth daughter, a schoolgirl mother, has gone to live with the father of her child in his village. If their relationship works out her husband will build her a house near to her mother and sisters.

[12] Mai Sukhali was beaten up by her husband when she objected to his polygamy.

Resource flows between closely related and co-resident households

November 1999 – January 2000

HAMLET NO 1: MOTHER AND DAUGHTERS



Flows between sisters

In Figure 3, we see that the three older sisters only give one another the 'normal' sharing gifts of 'snacks' (bananas, cassava, sweet potatoes, snacks), occasional relish and sweet beer. Mai Mukhumba did have 2 meals' worth of *ufa* from Mai Sukali when she had not had time to go to the mill but these two sisters are known to share very readily and the *ufa* would be reciprocated quickly enough. The youngest sister, Hilda Machinjiri, is still quite dependent on her family: she received 3 'meals for the baby' (the customary good meal – preferably with meat or fish – given by close relatives and friends to a woman who has just given birth) and 7 meals worth of flour (one meal a week) but was only able to give sweet beer in return.

Shame at receiving food

Cultural expectations of self-sufficiency in food provision appear to mean that recipients of support are ashamed to admit they receive help. Mai Mazinga initially denied being given food by her children, it was only because all members of the hamlet were being asked the same questions that the true level of support emerged[1]. Her daughters told us that, since their mother is too proud to ask for food, they either check her storage basket or watch to see if she is cooking a meal. If the basket is empty or she is sitting idle at mealtimes, they know that she has run out of maize. (This shows how easily other members of an extended family could know about a household where there is no food)[13]. Mai Mazinga later admitted that her daughters gave her food but stressed that she would never ask for help, they give willingly. She did not mention the support she receives from her elder son, we only know about this from her daughter-in-law in hamlet no.4. The youngest sister, Mai Machinjiri, did not tell us about the *ufa* she had been given, this information came from her sisters. (An alternative explanation, of course, might be that the respondent does not want to eliminate the possibility that the interviewers may be about to offer asssistance, but we suspect this is not a sufficient explanation).

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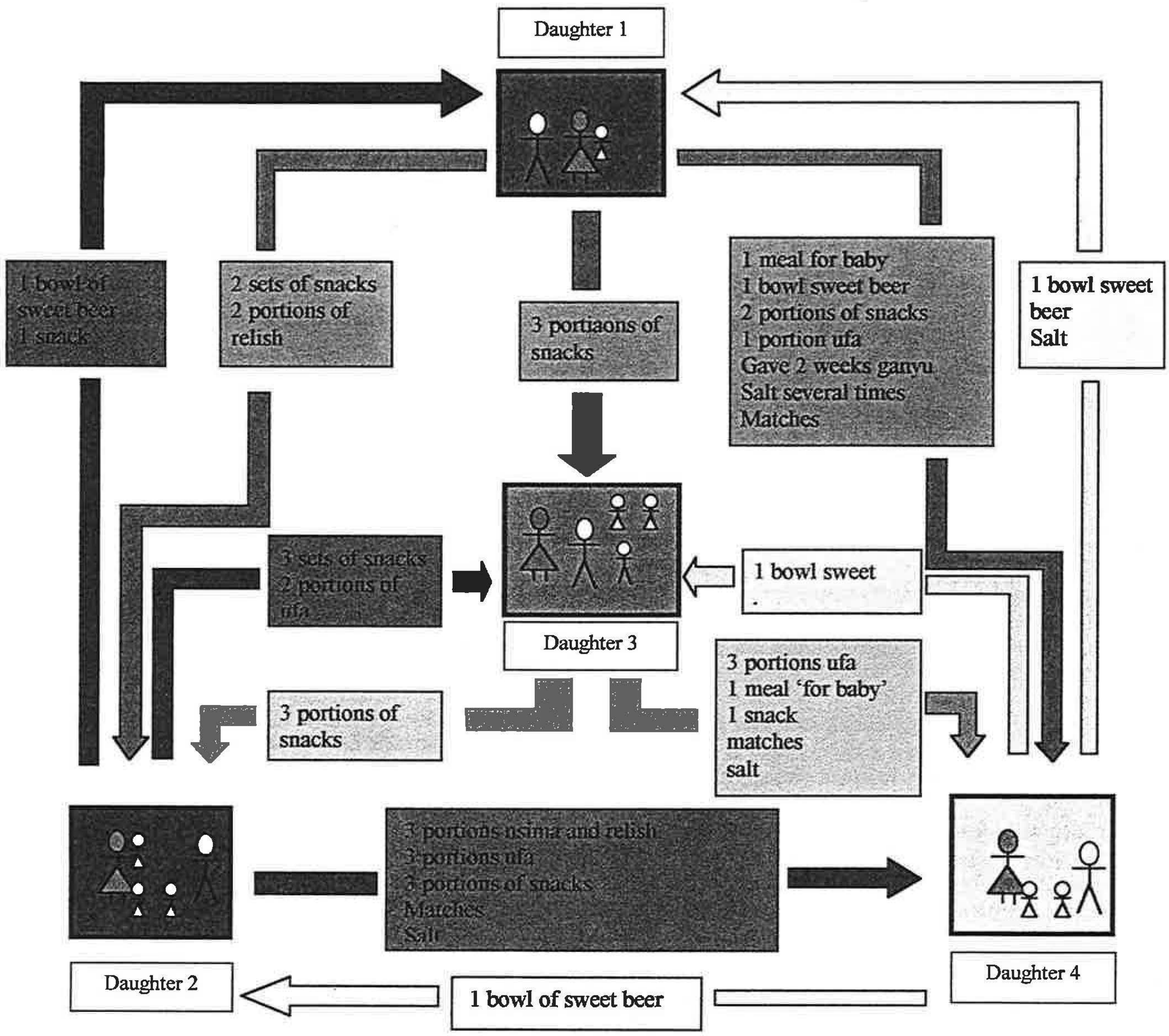
[13] It is also very likely that other members of a hamlet will either help harvest each others' fields or help with stripping cobs for storage. This means that they will form a good idea about how much maize each has in store.

Resource flows between closely related and co-resident households

November 1999 – January 2000

HAMLET NO 1: SISTERS



Hamlet 2: Muthowa

Limited flows and poor relations

There is not much sharing or support in this hamlet as Figure 3 reveals. The eldest sister gave her mother and brother enough *ufa* and *madeya* for six meals when her mother asked for help. On another occasion, when Mai Muthowa was short of food, Mai Naluso gave her mother some cooked relish. On a third occasion, Mai Naluso offered her brother 5 days *ganyu* labour paid with 50kg *madeya* flour. Mai January only gave her mother some sweet beer and a snack of sorghum. In return, Mai Muthowa gave her elder daughter a meal each of *ufa* and *madeya* when she ran short but nothing (or nothing worth recording) to her younger daughter.

Sisters not sharing

Mai Naluso gave nothing to her sister, Mai January, but Mai January gave Mai Naluso a bowl of sweet beer and a meal's worth of *ufa*. Mai Naluso gave nothing to Mai January during this period while Mai January appears to not to have given anything to Mai January's newborn first granddaughter. (Their youngest brother is not included in the diagram since no flows to or from his household were recorded).

The context

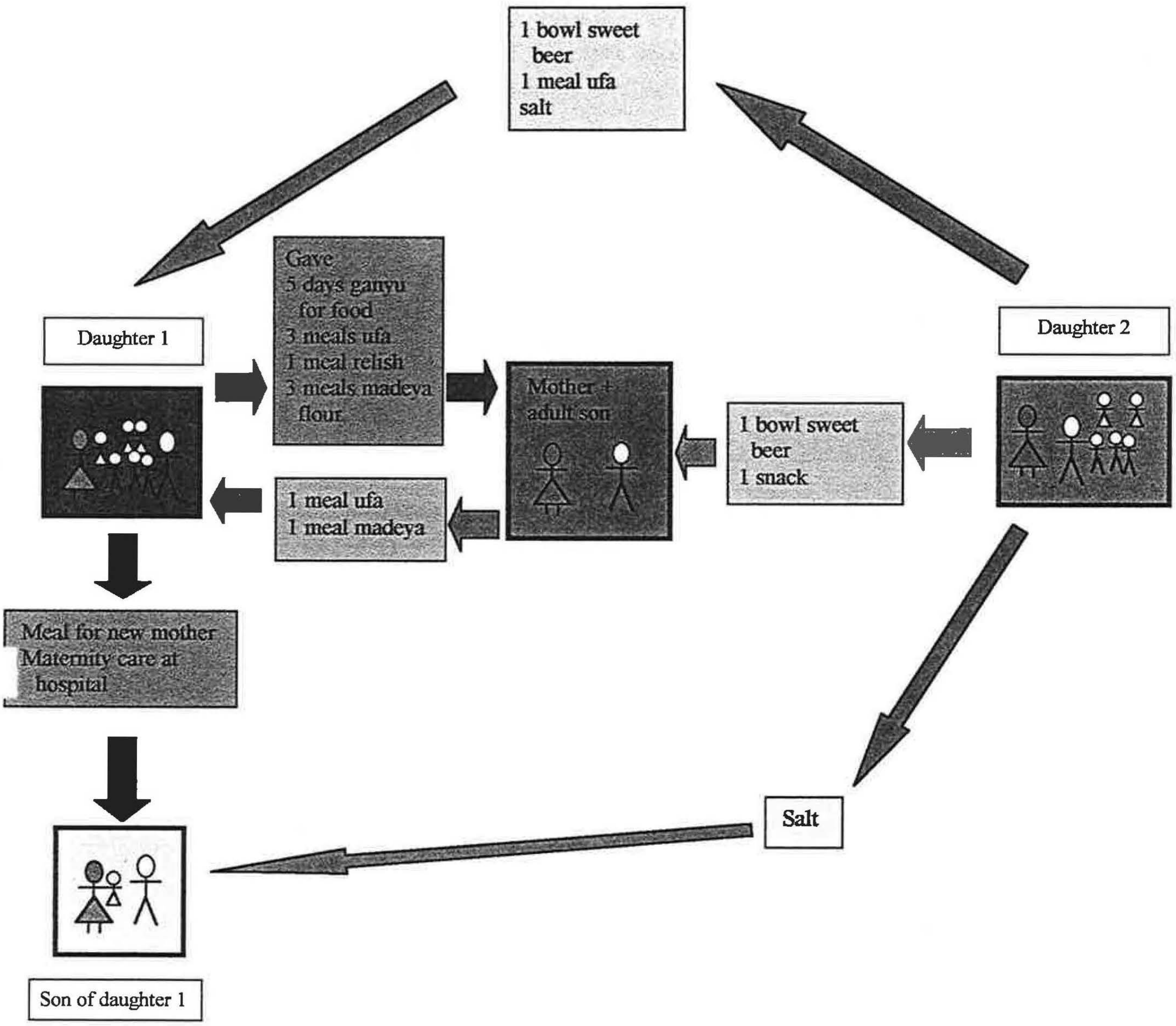
This hamlet has a history of conflict and strain. The two sisters do not have a warm or close relationship. The eldest daughter and her husband moved their house to some distance away from the other two households, even though building carried on into the rainy season and they neglected their fieldwork as a result.

Relations between mother and daughters appear also to have soured. Mai Muthowa gave most of her land to her daughters when she married a well-to-do farmer (her second marriage) with his own land in a neighbouring village. They resented giving the land back when she was widowed and returned home with two small sons from that marriage (under the matrilineal system, neither she nor her sons had any claim there). Mai Muthowa received land from her own mother in 1997 when the latter passed away. In 1997-98, Mai Muthowa had to put the trial on a different patch of land because her eldest daughter had demanded more land. Mai Muthowa is now in her early 60s and has an unstable relationship with Mr Muthowa, her 3rd husband, an elderly man who comes and goes. He particularly goes away when there is a lot of work and not much food (November to March) leaving his wife to struggle with the fieldwork and *ganyu* labour to earn money for food. In the 1999-2000 season, he appears to have left for good. Her daughters disliked this man (he is not their father) and resented the fact that helping their mother also meant feeding him.

For the first two years that we knew her, Mai Muthowa's situation was very precarious: she rarely had enough to eat, had few assets, could not afford inputs even though she was a hard working farmer, was frequently ill and was reduced to *ganyu* for *madeya*. However, she has always worked hard at maintaining her relationships with her extended family and friends and in 1997-98, we observed her making use of all her contacts to find enough to eat and seeds to plant. From 1998, on and off, she has had at least one of her sons around helping her which has much eased her situation. Currently, a son in his 40s has divorced and come back to live with his mother until he decides what to do next. He is supporting his mother with *ganyu* labour.

Resource flows between closely related and co-resident households
November 1999-January 2000

HAMLET 2: ALL HOUSEHOLDS



Hamlet no.3: Marichi

Exchange between sisters and support for a young pregnant niece.

In this hamlet, the main flows – shown in Figure 4 – are an exchange of childcare and meals for children with gifts of high quality foodstuffs from town between two sisters and a one way flow of food to from all other members of the hamlet to a young pregnant niece without any means of support.

There are four households in this hamlet. Two belong to sisters in their 40s while the remaining two belong to the children of their deceased sister. The younger sister, Mai Yasini has, for the last three years, since her husband has been in jail, supported her family by trading whatever she can. Over the last 18 months, she has managed to become successful as a *madeya* (maize bran) trader. This means that she has to spend a great deal of time in Limbe, waiting outside processors to collect the bran. While she is away, Mai Elizabeth, the older sister, or her daughter, Binette (a young married woman not yet in her own house) keep an eye on Mai Yasini's children. During this period, Mai Yasini was away for over two weeks. Her children quickly ran out of relish so Mai Elizabeth took over feeding them (the seven range in age from 3-16 years).

The context

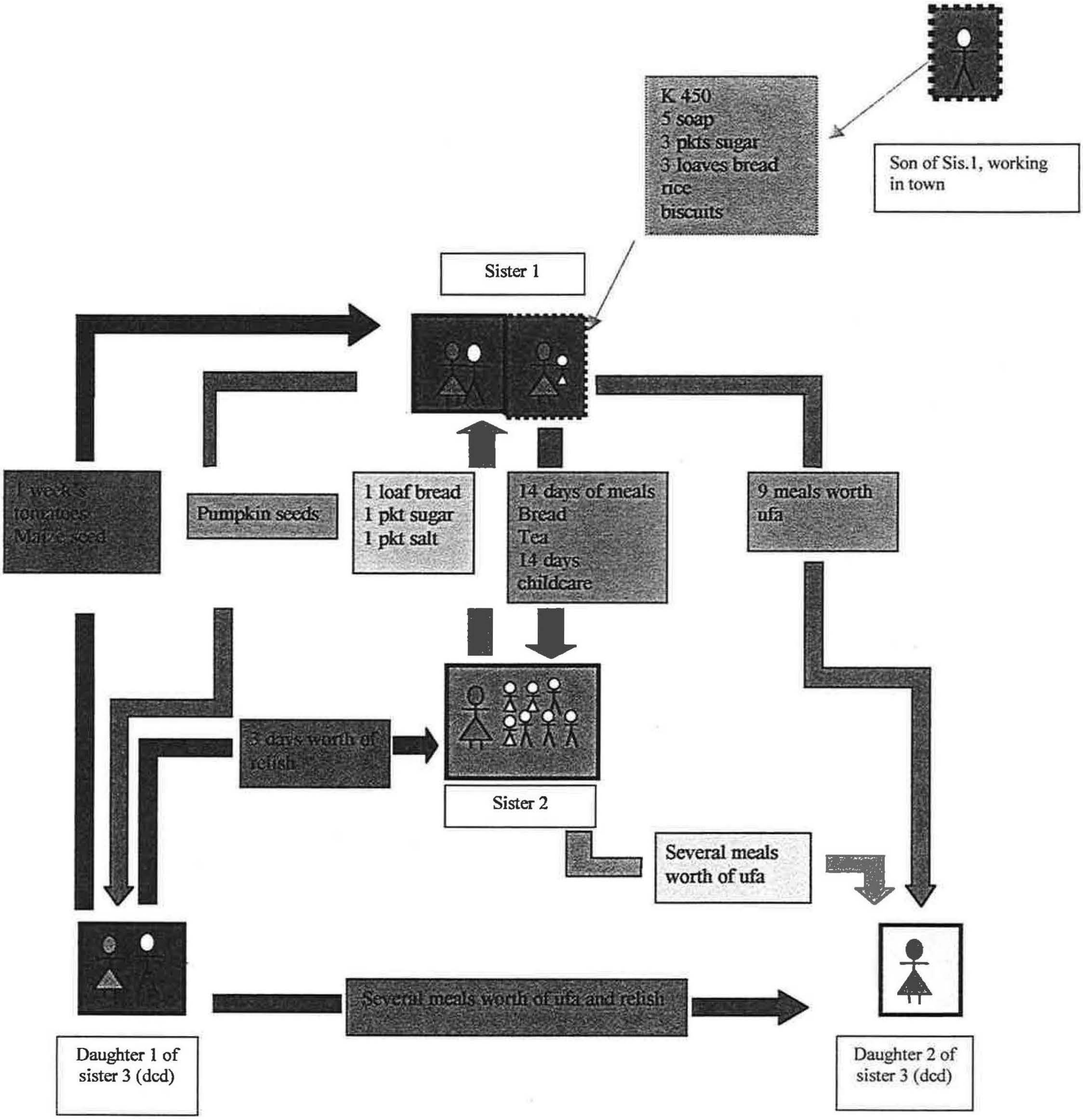
Mai Yasini is a woman who has fallen on hard times since her polygamous and well to do husband was imprisoned for stealing goats. The family lost an agricultural season through court attendance and Mai Yasini was unable to work for several months after the end of the court case due to the birth of her youngest daughter. Younger children in the household took themselves off to their paternal relatives in order to be fed. However, Mai Yasini then 'apprenticed' herself to her successfully trading older sister and has supported her children in this way ever since. The bulk of the fieldwork is done by her older children.

In the past, Mai Elizabeth used to complain that her sister deliberately abandoned the children without food thus forcing her to feed them or listen to her small nieces and nephews cry all day. At this time, Mai Elizabeth was struggling to keep her two children (both in their early 20s) in school and support her dying mother by trading vegetables, *madeya*, maize and root crops and resented her sister imposing upon her. These days, Mai Yasini is doing reasonably well with her business and brings her sister gifts from town on a regular basis. Mai Elizabeth is also better off than she was then since, firstly, she has a new (polygamous) husband with a job. Secondly, her son, Enoch, has found a job in town and is sending his mother money and gifts. Thirdly, her daughter has married but still lives with her mother and the son-in-law sends gifts to the household. These changes in circumstances mean that she finds looking after her sister's children much less of a strain.

The other two households in the hamlet are two nieces. Mai Anderson and Chrissie. The latter, a teenager, is expecting a baby but the father of her child (the cook where she was a 'housegirl' in Limbe) is already married and is not supporting her. Mai Elizabeth, Mai Yasini and Mai Anderson are all giving food to Chrissie since she was not farming last year and has neither food stocks nor savings. They know that she has run out of *ufa* when she does not cook at mealtimes.

Resource flows between four closely related and co-resident households November 1999 – January 2000

HAMLET NO 3: ALL HOUSEHOLDS



Hamlet no. 4 Mvula[14]

A case of virtual neglect

Figure 5 shows the flows to and from Mai Theresa, a woman in her late 60's who is nursing her dying son and whose husband is senile. During this period, she received only three meals' worth of maize flour and 15 meals' worth of relish. This is despite the fact that the households in her large hamlet are better off than those in Mai Mazinga's hamlet. During January, when food became very scarce, according to Mai Theresa, she was reduced to asking her son for *ganyu* labour. Her daughter-in-law, however, denied that the work was '*ganyu*' and insisted that Mai Theresa had just helped because she wanted to. Mai Theresa says that she gave all her land away to her daughters. All she has now is some hill land that she has illegally encroached.

Her granddaughter, Mai Mazinga (jr) appears to be the most active in supporting her grandmother and even gave her a mat since the older couple did not have anything to sleep on. She also gave her grandmother some money towards the care of her uncle.

Generous sharing

The flows between sisters and brothers and adult niece shown in Figure 6 constitute a normal pattern of sharing but the quantities involved both demonstrate the relative wealth of the cluster members and also that they all get on well together. These households share vegetables with one another when they harvest, pass on portions of particularly nice relish (fish and chicken) and give *ganyu* labour to each other's children.

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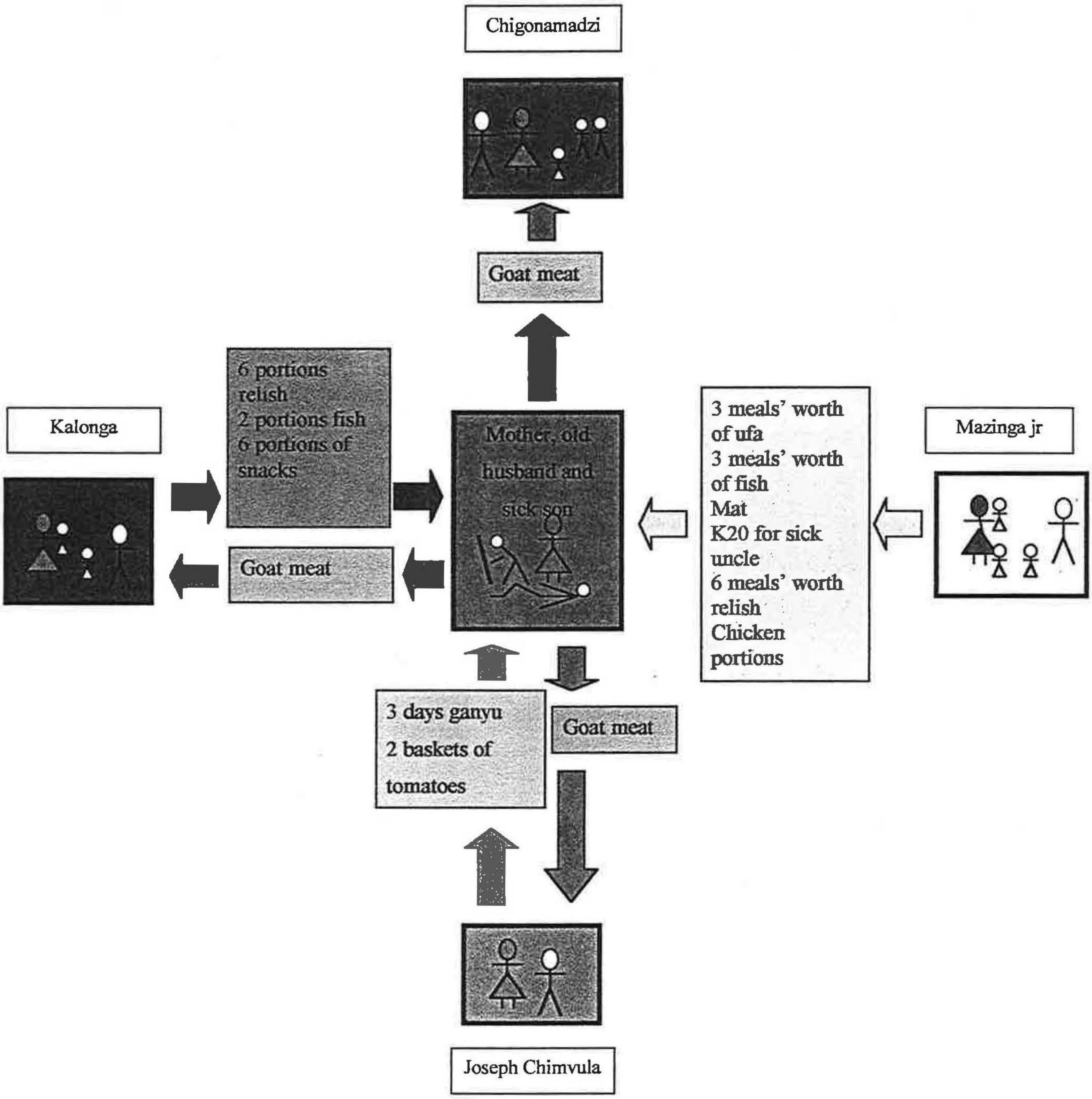
[14] For our purposes we consider six households in this cluster (no resource flows were recorded between the seventh household , a grandson and his young 'wife', and other members of the cluster)

Resource flows between closely related and coresident households
November 1999 – January 2000

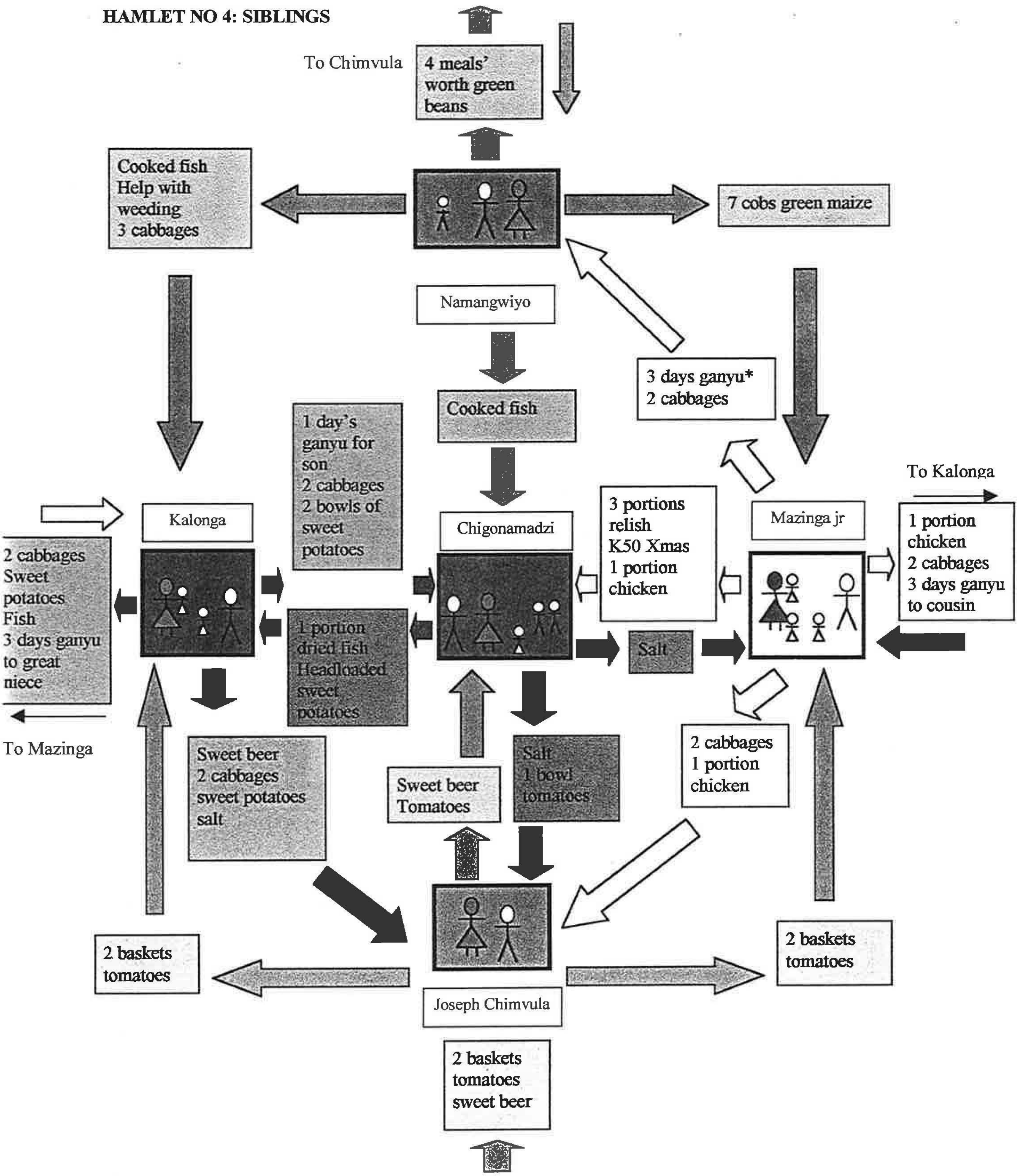
HAMLET NO 4: GRANDMOTHER AND OTHER HOUSEHOLDS



Resource flows between closely related and co-resident households.

November 1999 – January 2000

HAMLET NO 4: SIBLINGS



The context

The 3 children of Mai Theresa who live in the hamlet are all doing reasonably well. Her eldest daughter, Mai Chigonamadzi, in her late 40's is in a long-term stable marriage. Her husband works as a night guard on a nearby estate but who previously worked in South Africa and Zimbabwe. Their house is tin roofed and they are raising pigs thanks to a son living nearby who gave them a sow. When it is time to ridge or bank their fields, they are able to get all their adult children to come and help so that the job is done in a day.

Mai Theresa's second daughter, Mai Kalonga, in her late 30s, has recently married for the second time to Mr Nakatha, a successful vegetable grower from a nearby village who has some land of his own from his family. When not growing vegetables, Mr Nakatha travels widely to trade, for example, he recently went to Nsanje to buy sweet potatoes. Previously a widow, Mai Kalonga supported her two dependent daughters through vegetable trading. Mai Therea's son , Joseph Chimvula, also lives with his matrikin because his wife has no land of her own. With no claim to his own land, he rents land but has become a successful vegetable grower and employs his nephew all year round as a labourer. The couple have no children. Evidence of their wealth is displayed in their possession of pigs, a bicycle and a pesticide sprayer. Joseph once told project staff that he preferred to live in his natal hamlet so that he could support his elderly parents. There is little evidence of this here.

The two granddaughters who have set up home here are in very different positions. Mr Mazinga is the son of Mai Mazinga (Hamlet no 1) and has been married here for over 15 years to Mai Chigonamadzi's eldest daughter, Joyce. He is a prosperous vegetable grower and regularly gives baskets of vegetables to his mother and to his sisters; he will also sell more vegetables to his sisters at a reduced price. Although he has some dimba land from his mother, he also rents both a dimba field and a munda field. A younger brother of his wife is employed all year round as a labourer. They have limited their family to three deliberately.

Mai Namangwiyo, the eldest child of Mai Kalonga, has only been married for 4 years and has only lived apart from her mother for 2 years. They farmed together until the 1999-2000 season. Her husband was working in town but has now returned to the village where he makes a living from ganyu labour.

3.2 The households compared

We see two different patterns emerge between the households. The first is between households in approximately the same situation, usually sisters, occasionally brothers and adult nieces. Such households share a surplus as a matter of course. Whenever they harvest (or bring home for later marketing) vegetables, fruit, root crops or legumes, the other members of the hamlet, close friends and visitors will be given a gift. Thus, when Mr and Mrs Chimvula harvested their tomatoes, they gave two baskets of tomatoes to all the other members of the cluster.. 'Sharing' gifts defines a friendship or good relationship, however, and in another cluster, two sisters who do not get on gave each other very little.

The second pattern is that the poorer and more vulnerable households in the hamlets are partially supported by other members. We see an example of near maintenance of a widow in her early 60s by her children in the first hamlet. In the fourth hamlet, however, an older woman with a senile husband

and a dying son to support is virtually neglected. It is not possible to explain the difference by wealth of hamlet since the households in hamlet 4 are better off than those in hamlet 1.

Young women having their first child and setting up home receive assistance in this study. This is usually recognised to be a vulnerable time and also one where responsibility lies with the mother or older sisters to ease the transition with gifts of inputs, seed and other assistance. Where there is a husband and he is willing to support his wife, this eases the move but there will still be a lot of practical assistance from the immediate natal family. A girl's first move towards independent farming takes place as a form of apprenticeship while she is pregnant with and nursing her first child. She works alongside her mother for a year or two, while still living at home.

Certain types of gifts are routine. Several households here brewed sweet beer as part of the Christmas celebrations. This is the beer that is brewed for relatives, neighbours and friends helping with housebuilding during the dry season, the main form of communal labour remaining, and is a particularly social drink. It should be noted that women often borrow a plate of *ufa* from one another when they still have maize but have not had a chance to take it to the maize mill or to pound it. A few plates of *ufa* here or there is more likely to suggest a temporary shortfall than that the family has no food.

3.2 Social relations of *Ganyu* labour[15]

Devereux, (1999: 27) writes,

> "The relationship between hirers and providers of *ganyu* reflects a particular form of socio-economic stratification within rural Malawian communities: in general, field *ganyu* is demanded by the relatively wealthy, food-secure minority, and is supplied by the absolutely poor, food-insecure majority....It is not surprising then that going for field *ganyu* is asssociated with, and reinforces, chronic poverty and seasonal food insecurity."

Similarly, Whiteside (1999:3) argues that,

> "Low *ganyu* wage rates mean agricultural labourers do not earn sufficient to invest in sustainable agricultural development."

Our results suggest doing or hiring *ganyu* labour can fit into a range of livelihood strategies in a variety of ways and that while both of the above statements can be true, they are not so in every case. Whether a household hires *ganyu* labour regularly or for emergencies or to ease particular blockages is important. Similarly, if a household seeks *ganyu* labour for food and other necessities for large portions of the year it is likely to be poorer than a household where members occasionally accept work from relatives or friends. If adults do *ganyu*, this is likely to signify a poorer households than where adults do none and children do *ganyu* to have money to spend on themselves. It is also argued that different types of *ganyu* labour carry different economic and social value. Some activities are more highly regarded and better paid than others. Even the way payment is made has different significance for households or individuals.

During the 1998-99 and the months of October, November, December and early January, there were 89 instances of *ganyu* labour[16] being done by members of the households in these hamlets. There were also 57 instances of hiring *ganyu* labour over the 1998-99 season and between October 1999 and January 2000. Table x below shows the details of who in the household did *ganyu* labour and which households hired *ganyu* labour set against scores from an assets questionnaire administered in

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[15] It should be noted that I have collected information about communal work parties (*thandizi*) separately since the beer that is served is not to pay but refresh participants. Help is given either in the expectation of receiving help in turn or to assist someone who is elderly or infirm.

[16] It should be noted that I have recorded information about communal work parties (*thandizi*) separately since from other *ganyu* work. These activities are not part of any labour market since beer is not served as payment but to refresh participants. Help is given either in the expectation of receiving help in turn or to assist someone who is elderly or infirm.

November and December, 1999 (see Annex D). The scores from the asset strategy are a crude measure of wealth. They include recent expenditure and past expenditure as expressed in the purchase of assets such as hens, goats, bicycles, or brick houses. However, the asset scores are included because they support the broad classifications we can make about how doing or hiring *ganyu* labour fits into broader livelihood strategies of the households discussed here. Given what we know about why household members did *ganyu* or hired *ganyu*, the households have been divided into 4 groups: A, B, C and D. *Ganyu* labour contributes differently to the overall livelihoods of each group. This classification is not watertight. Several households could, arguably, be placed elsewhere. It should be noted that in all but 4 cases, individuals said that they themselves had decided to undertake *ganyu* labour. In the remaining 4, a husband and wife decided together that the wife should do *ganyu* labour.

In group A, we see 7 households where none of the adults have done *ganyu* labour in the last two years but where all have hired *ganyu* labourers. Three households use (often salaried) labourers in commercial vegetable growing while the fourth is an active trader. In some of these households, their children have worked but to spend money on themselves rather than contribute to the household budget. We hesitated, however, over placing three households in this category –January, Naluso and Chigonamadzi – since they had only hired labour because of medical emergencies (one had been ill and the other two households had to look after a daughter in law having a baby in hospital). They could be fitted into Category B or into a separate grouping. The average score of these households for assets is 517.

Group B contains 3 households which hired *ganyu* labour but where adults also relied on *ganyu* labour contracts to finance more profitable vegetable growing or marketing activities. Simeon took on six contracts for ridging and, later, weeding, mostly with relatives. This meant that he received some money in advance. The money earnt was mostly used to buy inputs for vegetable growing, his main source of income, and only once for immediate household needs. Once he took on a contract when he had no immediate need but to avoid money sent by an absent relative being paid to someone else. However, when his vegetables were ready to carry to market and when there was too much watering for his household to manage, Simeon had to hire labour. In January, 1999, Mai Yasini invited eight of her in-laws and 27 of their relatives, neighbours and friends to spend a morning banking all her fields. Yet, in October 1999, Mai Yasini and her eldest son and daughter ridged a field together over a week to earn K300 to finance her *madeya* bran trading after their capital had run low. (These examples also illustrate the significance of different types of contracts and will be discussed further below). The average score for these households in terms of assets is 276.

In the third category, C, are five households that do not often do *ganyu* but for whom it may either be important from time to time or too good a chance to turn down. This is what we find with Mai Mazinga and her two daughters, Sukhali and Mukhumba. Both Mukhumba and Sukhali had done *ganyu* in 1998-99 to earn money for soap, paraffin, matches and the other small items that require cash when on two occasions a family friend invited the whole hamlet to work for her and when they had seen a large group at work and decided to join in. Mai Mazinga would have little choice but to do *ganyu* if she were not so well suppported by her family but on two occasions took up opportunities close to home. Once when her great-niece was offering work and another time when one son-in-law, Machinjiri, failed to complete the work he was to do for another, Nangwale, and she offered to do the work instead. The assets average here is 230.

The households in category D match more closely with the situation described by Devereux and Whiteside. These households rely on *ganyu* for their cash income. One chronically food insecure household, Anderson, spends half a year with both husband and wife doing *ganyu* labour and the other half vegetable growing but so far has not succeeded in capitalising the more productive activity to break out of their cycle of poverty. In two other households, Muthowa and Mayenda, *ganyu* is the chief means to provide food and other necessities. At least for Muthowa, her son's return means she has given up the low paid *kuwerenga ganyu* for food and seed for planting that she was doing in the first two seasons that we knew her. In the Machinjiri and Namangwiyo households two young families rely on *ganyu* for food and cash for necessities although in each case, the husband was previously employed in town and may well return to work in town. As one would expect, the asset score is the lowest here, 161.

These findings match approximately, self perceptions by the households. Only three households said that they do not do *ganyu*. Of the remaining 15, 3 said that they do *ganyu* as part of their way of making a living while 11 said that it was an occasional activity to get food or money for salt, soap, paraffin and matches, clothes or snacks.

The four categories we have found here of employers of *ganyu* labour (A), those doing *ganyu* to invest in more productive enterprises (B), those doing *ganyu* occasionally and mostly when offered (C) and those reliant on *ganyu* to buy food and other necessities (D) can be further investigated by the type of work and the nature of the contract.

Table 1 Households doing *ganyu* or hiring *ganyu* Oct 1998- Jan 2000

HAM-LET	NAME	DID *GANYU**		HIRED *GANYU***		ASSET SCORE	STRATEGY
		ADULT	CHILD	YES	NO		
1	Nangwale	0	0	3	1	582	A
2	Naluso	0	4	2	2	423	A
3	Marichi	0	0	4	0	192	A
4	Chigonamadzi	0	4	1	3	546	A
4	Joseph Chimvula	0	0	3	1	543	A
4	Mazinga jr.	0	2	3	1	817	A
3	Yasini	1	2	1	3	172	B
4	Nakatha	1	2	1	3	235	B
5	Simeon	3	0	1	3	421	B
1	Mazinga sr.	2	1	0	4	169	C
1	Sukali	1	1	0	4	276	C
1	Mukhumba	1	0	0	4	278	C
2	January	0	4	1	3	197	C
1	Machinjiri	2	0	0	4	60	D
2	Muthowa	4	0	0	4	58	D
3	Anderson	4	0	0	4	287	D
4	Mayenda	3	0	0	4	286	D
4	Namangwiyo	2	0	0	4	116	D

*A total of 4 in each these column would mean that in the four time periods – the 1998-99 agricultural season, October-November 1999, November-December 1999 and December-January 1999, a member of the household had been involved in *ganyu* labour.

** A total of 4 in each these column would mean that in each of the four time periods the household had hired *ganyu* labour.

Out of the 91 cases of *ganyu* labour, boys (under 20 year olds) were the largest group (38%) involved followed by women (26%), men (18%) and girls (under 18 year olds) (16%). These figures, although for a small case study and not necessarily typical, suggest that *ganyu* labour for teenage boys and young men is more important than other literature has suggested. More men and boys (15/19) took on ridging work than women and girls. This is significant because ridging tends to be better paid and paid in the form of a contract where some money is given in advance. When we asked households which tasks paid best, they said heavier work such as ridging or looking after dimba vegetables paid by contract labour and mostly done by men was the highest paid. Fewer men in this group weeded than women and the younger members of the household. Weeding is more often paid by piecework. Only boys and girls helped head-load produce from fields or to market.

Table 2 Tasks performed by households doing *ganyu* by gender/age

	Ridging	Weeding	Banking	Head-Loading	Other	Total
Men	7	8	0	0	2	**17**
Women	3	17	3	0	1	**24**
Boys*	8	13	3	4	7	**35**
Girls**	1	6	2	6	0	**15**
Total	**19**	**44**	**8**	**10**	**10**	**91**

*(under 20)

**(under 18)

When we look more closely at the nature of the contract we see (Table x) that 24 men and boys took contract work against 10 women and girls. Only 5 men did piecework labour compared to 16 women, 15 boys and 6 girls. Male domination of the contract market is generally explained by men being stronger and able to commit themselves to larger pieces of land. (Though one female hirer of labour said she preferred women for contracts because they were cheaper). Anyone is able to join in *kuwerenga* weeding or banking. This view of what types of payment are appropriate for different types of work and different groups of people is reflected in the hiring process. Agreeing a contract with someone is a formal procedure: the field is measured and the price negotiated, often part of the money is paid in advance. By contrast, it seems that anyone passing[17] can ask to join in *kuwerenga* labour for weeding or banking. The category of 'day/job rate' covers occasional work like head-loading and help was given spontaneously without any agreement as to payment.

[17] We suspect that complete strangers would not be welcome but fellow villagers, particularly neighbours, could not be refused.

Table 3 Type of contract for households doing *ganyu* by gender/age

	Contract	Kuwerenga	Day/job rate	Salary ('ticket')	Total
Men	11	5	1	0	**17**
Women	7	16	2	0	**25**
Boys*	13	15	5	3	**36**
Girls**	3	6	4	0	**13**
Total	**34**	**42**	**12**	**3**	**91**

*(under 20)

**(under 18)

The results here for households doing *ganyu* make it clear that there is a preference for employing relatives although we only found one example of a preferential rate being paid[18] In 55% of cases, the person hired was related to the hirer as Table y shows. In 18% of cases, it was a neighbour or a friend. Clearly, in communities where cash or food are scarce resources, there is strong pressure to 'keep it in the family'. All those hiring *ganyu* labourers said that they employed relatives and neighbours and in 49 out of 57 instances, (86%) said that this was to help out because their relative needed the work. It should be noted that this is not the same as creating work specifically to help someone. Rather, it is a matter of giving relatives and friends the first refusal on any money earning opportunities that come up.

Table 4 Relationship between hirer and labourer

Nature of relationship	Doing *ganyu*	Hiring *ganyu*	Total
Own mudzi	18	8	26
Matrilineal kin	19	6	25
Patrilineal kin	7	10	17
In-law	5	6	11
Mixed relations	2	0	2
Neighbour	16	7	23
Friend	0	3	3
Acquaintance	3	1	4
Employer	4	5	9
Not related	17	11	28
Total	**91**	**57**	**148**

[18] When a cousin assisted in carrying tomatoes to market, she received K35 compared to 'friends' who got K30 and 'hired labourers' who received only K20. More information on contract work (i.e. comparing same work given to relatives and non-relatives) would be needed to be sure that preferential rates are not applied elsewhere.

When we investigated more closely the form of payment for *ganyu,* it was clear that cash dominated (79% of cases). Only in 14% of cases had the worker been paid with food. However, as Table j shows, men and boys nearly always received cash for their work whereas women occasionally received food.

Table 5 Payment by gender/age category for those doing *ganyu*

Type of payment	Men	Women	Boys	Girls	Total
Cash	16	18	30	9	**73**
Seed	1	0	0	0	**1**
Cash + meal	0	1	0	0	**1**
Food	0	5	4	0	**9**
Seed + cash	0	1	0	0	**1**
Cash + ufa	0	1	0	0	**1**
Don't know	0	0	2	2	**4**
Total	**17**	**26**	**36**	**11**	**91**

When we look more closely at why individuals wanted to do *ganyu,* it becomes clear that only on 19 occasions was this for the basic foodstuffs of ufa or *madeya.* Twelve instances were to get hold of either cash or inputs for more productive activities. On 22 occasions each, respectively, the labour was to buy either snacks or the household necessities of soap, salt, matches or paraffin. (t should be noted that soap is often an individual requirement since older boys and girls are expected to find their own soap for washing themselves and their clothes). Only 3 respondents said that it had been hard to find *ganyu* labour.

Table 6 Reasons for seeking *ganyu* by gender/age category

	Men	Women	Boys	Girls	TOTAL
Snacks	0	1	15	6	**22**
Soap, salt, matches, paraffin	4	11	5	2	**22**
Maize for food	4	5	4	1	**14**
Clothes and shoes	0	1	6	1	**8**
For business	2	4	1	1	**8**
Madeya for food	0	2	3	0	**5**
Seed to plant	3	1	0	0	**4**
No immediate need	1	1	0	0	**2**
Cash	2				**2**
School fees	1	0	0	0	**1**
Other	1	0	2	0	**3**
TOTAL	**18**	**25**	**36**	**11**	**91**

Looking at the issue from the other side, we asked those households where *ganyu* had been hired why they had done so, we received the following responses (Table d). In nearly all cases, extra labour was hired to ensure that crucial field or marketing operations were completed in good time. Those hiring were either working alongside or involved in other productive enterprises or ill.

Table 7 Reasons for hiring *ganyu*

	TOTAL
Illness	8
To speed up work	35
Doing other work	14
Total	**57**

One of the major issues in discussions of the role of *ganyu* in the livelihoods of the resource poor is the extent to which they neglect their own fieldwork because immediate needs drive them to work on others' fields. Out of 91 responses, only 36 said that they had neglected their own fields. This figure cannot stand alone, however, since a large proportion of the *ganyu* recorded here was done by younger members of the household without responsibility for feeding the family. When we analyse the results by gender/age category (Table g), we see that the crop most neglected was in the dimba (vegetables or early maturing maize) but that the majority of cases belonged to young men who normally grow vegetables on their own account. This means that negative implications for food security are limited.

However, more worrying is that weeding was being neglected in 26 cases. In 17 by men and women who are producing for the household at large.

Table 8 Tasks neglected while doing *ganyu*

Task	Men	Women	Boys	Girls	TOTAL
Ridging	0	0	2	0	**2**
Weeding	3	14	6	3	**26**
Banking	0	1	0	0	**1**
Dimba crops	5	6	17	2	**30**
Total	**8**	**21**	**25**	**5**	**59**

4. Conclusion

Within this small case study, the chief recipients and donors of substantial assistance were older people, the sick, and young women setting up home or having their first baby. It is clear that the poorest households described here would struggle to survive without assistance from their relatives. Nearly all assistance was given in the form of food or work. Only one case (Mai Marichi) received substantial remittances although not on a regular basis. The flows of resources between the other households in the hamlets, in similar economic circumstances, were normally reciprocated. This equality in flows to and from suggests that these gifts stem from good relations, what is considered normal practice and work to cement family or neighbourly feeling. These exchanges are thought provide a basis for social capital or the moral economy.

The larger part of the flows in resources mapped here are within the matrilineal kin group where women give help to other women. Women's control of resources, their relative autonomy, their obligation to be own account farmers or traders and contribute to the household income and residence in the matrilineal core unit make this easier than in many other societies.

However, we found much variation in the scale of assistance given: from the case of near maintainance to virtual neglect. It is not possible to explain the variation seen here by the wealth of the cluster since the wealthier cluster gave less support to a 'more-deserving' woman (Mai Theresa is older than Mai Mazinga, less fit, with a sick son and senile husband to care for). Nor do we know anything else about the members of the Mvula hamlet that might explain this neglect. However, in the Marichi hamlet where all members were better off than they had been a few years previously, the flow of gifts and assistance had become more reciprocal and we observed improved relations between the households.

Following Devereux,, (1999:10), calling on friends and relatives for assistance is an intensification of existing strategies rather than new or unusual behaviour. These findings suggests that commentators are correct in thinking that increased pressure on resources may well result in less support for poor and vulnerable households. After a certain point, how can people be more generous with less?

What do these resource transfers mean in terms of the recipients' broader livelihood strategies? Clearly, gifts of food do not enable the beneficiary to find more profitable ways of making a living. Yet without these gifts, the elderly women and younger women who received the food would have had to look for other means of finding food, probably through piecework ganyu labour, which is tiring in itself while only providing enough for the food needs of the day. The gift of several hundred Kwacha to Mai Marichi from her son in town would be enough to finance trading activities, pay for agricultural inputs or finance ganyu labour.

It is clear that older people are expected to be productive for as long as possible. One could hypothesise that old people do not get much help before they are entirely decrepit because sons and daughters try and put off taking responsibility for them or are waiting in the hope that another sibling may act first. There is not enough evidence here to test this suggestion.

Turning to ganyu labour, we observed how wherever possible, relatives, neighbours and friends were given the first chance to earn some money or food. Clearly, the opportunity to do ganyu labour is a valuable resource in a cash and food scarce situation. However, a point that is not widely explored in the literature concerns the nature of the help that is given when one person offers ganyu labour to another. Commentators note that there is a safety net aspect, that this is a crucial coping/adaptive strategy, that many poor households rely for more than a third of their income on ganyu. However, while in resource poor communities it is not to be expected that help can be offered beyond the opportunity to work and be paid, this type of help is self-limiting and not without recompense for the hirer. Ganyu labourers are self selecting and do not run the risk of becoming dependent by receiving something for nothing. Wage rates for piecework are at the bottom of any local labour market scale and whoever offers the labour gets something in return of value and the person needing money or food has to work hard for it. Ganyu functions as a food for work scheme at the local level.

It is also important to differentiate between who is doing ganyu labour, why they are doing it and what they are doing before generalising. We identified four forms of involvement with ganyu labour: those who hired but whose children might take part in ganyu labour, those who used ganyu to earn money to invest elsewhere, occasional ganyu labourers and those for whom it was a principal element in their overall livelihood strategy. It should be noted that ganyu provides cash not only for food but also for the necessities of life such as soap, paraffin, matches and salt.

There were more young people, especially boys, doing ganyu for their own income than the literature suggests. It is important to note that by working to buy snacks, clothes and soap, they relieve the burden on their parents or other relatives (who will, anyway, expect increasing self-sufficiency in this group). However, for the most part they can choose whether or not to hand over any of this money to their parents so other members of the household may have little direct benefit. (This may well be an idiosyncratic result of this study since other project work has found families in dire straits working and pooling resources to make sure that all had something to eat, see Orr et all, 1999).

It is also important to differentiate between different tasks and types of payment when seeking to understand the function of ganyu. Where men (and sometimes women) take on 'contracts' for large scale tasks like ridging or banking a field, they express satisfaction with the rate of return to their labour and this work may not be stigmatised. Piecework – being paid up to 5 tambala per planting station for weeding or banking in 1999-2000 – has a lower status but perhaps much less so for young people earning pocket money. Women and children seem to do more of this sort of work, although the numbers here are too small for certainty.

We would argue that methodologically this study demonstrates that an appropriate way to investigate informal resource transfers or ganyu working relationships is to take clusters of closely related people in rural areas as the object of study. This is the group between whom most resources flow. A cross-check is also built in to reduce the possibility that recipients downplay the help they have had from relatives. Visits need to be regular and should be timed to coincide with the deficit period in rural areas (although this does not then permit comparison with the remaining months). The particular conditions of the year may also influence flows. The work here is a snapshot but we have some idea of how in at least two hamlets the situation has changed quite dramatically over the last two years. This implies that a deficit season study of the same study over several seasons would reveal more of processes and trends. This methodology will not be appropriate to most urban situations.

Finally, what do the findings of this study imply for integrated crop or pest management with farmers? Firstly, we found little evidence in these groups of sharing inputs. However, we know from elsewhere that poor households lacking inputs do visit relatives and friends to beg for seeds (see Lawson-McDowall et al, 1998). However, the constant exchange of gifts of crops would expose all hamlet members to new varieties or new crops. New practices might spread more slowly since different households are involved in different enterprises. The proliferation of vegetable growing within two clusters may suggest that profitable activities are quickly emulated. Further research is needed to corroborate whether hamlets have shared economic characteristics. But it should be noted that villagers themselves believe that the households in different hamlets or mbumbas are often all poor or all doing well. They attribute this more to teaching children good habits or investing in their education than to just sharing resources. It seems likely then that technologies would spread first within these groups of related hamlets and would reach a range of different household types and situations as a result.

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ANNEX A: SOCIAL ORGANISATION IN SOUTHERN MALAWI

A 'village' (*mudzi*) in fact consists of a collection of hamlets, supposedly under the authority of one chief. Some, though not all, of these hamlets will be related, sharing a grandmother or great-grandmother who was usually the original founder of the village.

Mbumba

Since inheritance follows the female line, the most common residential pattern is a mother and her adult daughters, their spouses and young children, living independently in their own homes but clustered together in a hamlet. A single or collection of related hamlets constitute an *mbumba* or matri-lineage. Members of the same mbumba have close ties which are demonstrated at important moments such as housebuilding, births, initiation ceremonies, marriages, divorces, illness and death and in everyday sharing or exchanging of small amounts of food or assistance, with, for example, childcare.

Traditionally, the eldest brother of the sisters (the 'owner' of the lineage, *mwini mbumba*) has authority over the *mbumba*, although this may be shared with older women in the lineage, (for example, he should attend any traditional court case where a member of his mbumba is involved). Children then inherit moveable goods from their mother's brother rather than their father while women inherit land from older female relatives such as their mother, grandmother or aunts.

Banja

The household (*banja*) is made up of a woman, her husband and their children. After marriage a husband normally moves to his wife's village (*chikamwini* marriage). There he is expected to build a house for his wife and help with fieldwork (depending on what his other means of earning a living might be). Some men, often sons of the chief or the *mwini mbumba*, inherit land and bring wives home with them (*chitengwa* marriage). However, their daughters usually inherit this land while sons find wives elsewhere. It is also quite common for men to marry within their village of birth and to farm land owned by their parents. In the long run, their tenure is not secure as nieces and female cousins have a prior claim and land is in short supply.

Gender roles

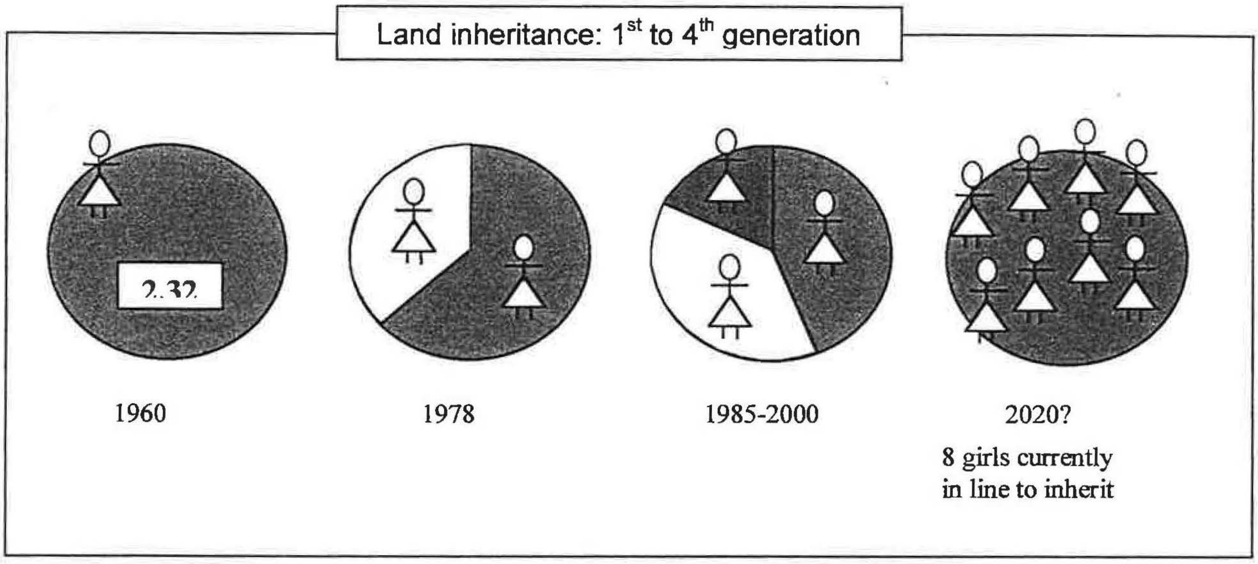
Women have substantial autonomy because they 'own' agricultural land, control much of their income and labour, and stay in the village of their birth surrounded by their own relatives. Consequently, much decision making within the household is shared between husband and wife, who are effectively joint heads of the household. Each spouse may pursue a different set of livelihood strategies (e.g. petty trading, marketing, cash cropping, formal employment) so that they have separate responsibilities in addition to the shared enterprise of farming. Divorce is surprisingly common. Women may fear divorce less because children 'belong' to the mother and the *mbumba.*

Coping and the moral economy

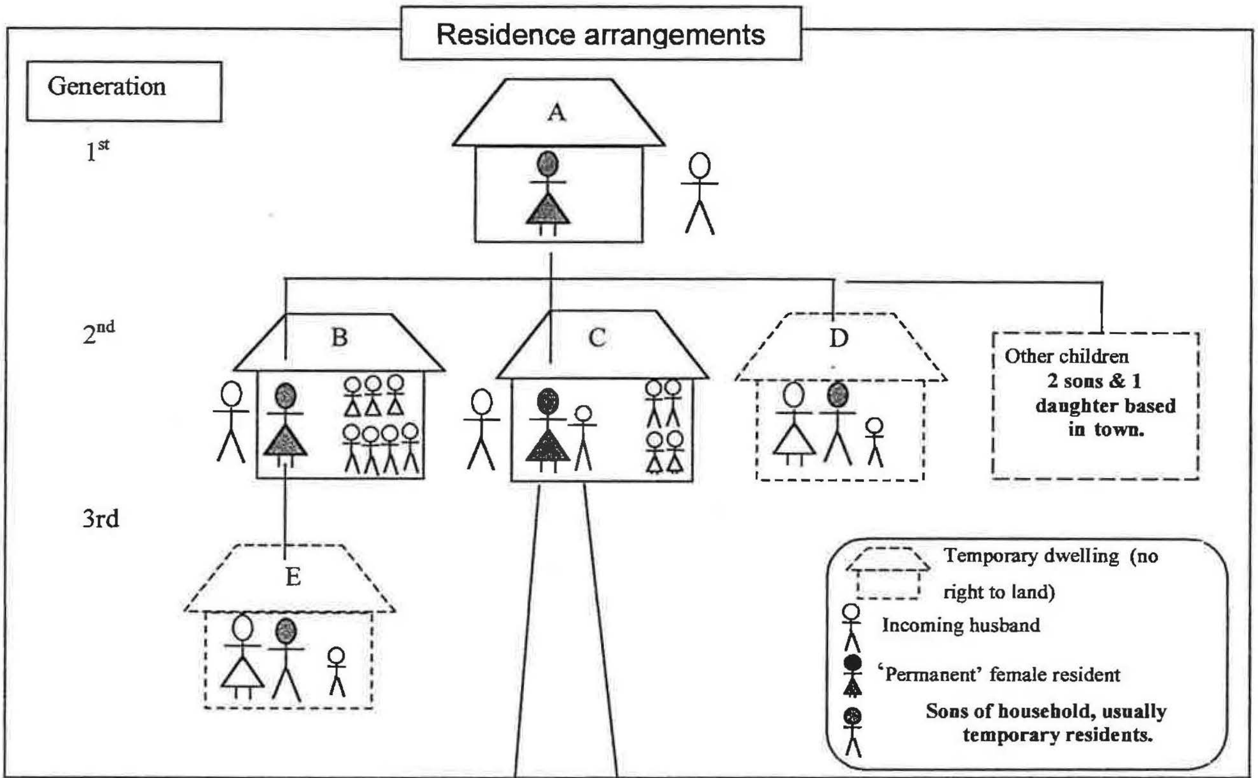
The open-ended nature of matrilineal systems may mean that an individual has more choices about who to turn to in hard times, e.g. an individual can turn not only to the natal family and members of the wider mbumba, but also to their father's families and in-laws. This is less easy in tightly organised patrilineal systems.

SOCIAL ORGANISATION: THE NKUTHO HAMLET

(i)



(ii)



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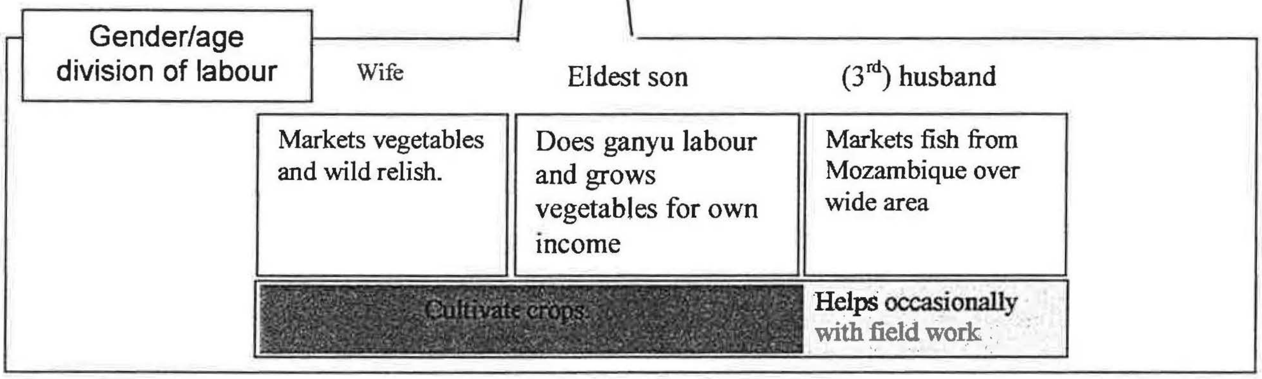

ANNEX B. GANYU LABOUR IN 1998-99 SEASON, QUESTIONNAIRE

	1 DOING GANYU	n.b. Specify each individual episode of ganyu employment for every family member	
1.01	Who in the household did ganyu labour?		
1.02	Task		
1.03	Type of contract		
1.04	Duration (days)		
1.05	Pay (specify if meal included)		
1.06	For whom was this done? What was the relationship		
1.07	If worked for this person before, how often?		
1.08	Why did s/he seek ganyu labour? If cash, for what?		
1.09	Who made the decision? Was it a decision?		
1.10	How was the ganyu labour found?		
1.11	Was there any fieldwork you could not do because you were doing ganyu?		
1.12	Was it hard to find ganyu on this occasion?		

2. HIRING GANYU 1998-99 n.b. Specify each episode of ganyu employment

2.01	**Who in the household hired ganyu labour?**			
2.02	**Whom did they hire? (Name)**			
2.03	**Age (approximate)**			
2.04	**Specify relationship of this person to the household member?**			
2.05	**Task**			
2.06	**Type of contract**			
2.07	**Duration (days)**			
2.08	**Pay (specify if meal included)**			
2.09	**Has this person worked for you before? If so, how often?**			
2.10	**Why was the decision made to hire ganyu labour? By whom?**			
2.11	**How did you come to hire this person?**			
2.12	**Do you employ relatives or neighbours? If so, why? If not, why not?**			
2.13	**Do you hire labourers so that you yourself can do other work, if so, what?**			

GENERAL QUESTIONS ON GANYU

3 **Do you do ganyu only when in need of money or food, or regularly as part of your way of making a living?**

4 **Is there any agricultural task that pays particularly well for ganyu labourers?**

5 **If children do ganyu, what do they use the money for? Do they contribute to the household income?**

6 **How is the amount of pay agreeed?**

7 **Is there any difference between men and women for the purposes of ganyu labour, especially for contract labour?**

ANNEX C. FLOWS OF RESOURCES BETWEEN HOUSEHOLDS 1999-2000, QUESTIONNAIRE

1. Ganyu OUT 1999-2000

	Who in the household has done ganyu labour in the last three weeks?	Task	Type of ganyu*	Duration (days)	Pay (specify if meal included)	For whom was this done? What was the relationship	Have s/he worked for this person before?	How often?	Was there any fieldwork s/he could not do because s/he was doing ganyu? What?
1.01									
1.02									
1.03									
1.04									
1.05									

2. Ganyu IN 1999-2000

	Who in the household hired ganyu labour?	Whom did they hire? (Name)	Age	What was the relationship of this person to the household member?	Task	Ganyu type*	Durat-ion (days)	Pay (specify if meal included)	Has this person worked for you before?	How often?
2.01										
2.02										
2.03										
2.04										
2.05										

* 1.Contract 2.Kuwerenga 3.Both

3. In the last month, have you or anyone in your household cooperated with anyone in any sort of work? (NOT ganyu)? Or have you helped anyone with any work for any reason?

	What type of work?	Who was the person and what is the relationship?	Why did s/he do this?
3.01			
3.02			
3.03			
3.04			

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FLOWS OF RESOURCES BETWEEN HOUSEHOLDS

4. In the last month, have you given any gift to anyone?

	What was the gift?	What was the source of the gift?	Who was the person and what is the relationship?	Why did you do this?
4.01				
4.02				
4.03				
4.04				

5. In the last month, have you received any gifts from anyone?

	What was the gift?	What was the source of the gift?	Who was the person and what is the relationship?	Why did this person do this?
5.01				
5.02				
5.03				
5.04				

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6. In the last month, have you given any food to anyone?

What sort of food and how much?	What was the source of the food?	Who was the person and what is the relationship?	Why did you do this?

7. In the last month, have you received any food from anyone?

What sort of food and how much?	What was the source of the food?	Who was the person and what is the relationship?	Why did this person do this?

ANNEX D: HIID/MAAP ASSETS QUESTIONNAIRE 1997

Hhd ID:|__|__|__| Date:|__|__|97 Respondent name: ________________ Enumerator:________________

Check the appropriate answer: YES/ NO SCORE | Number of each x pts.=SCORE

A. KODI PA CHAKA Munagulapo feteleza |__|__| 2 |__| |E.ZINTHU IZI Dengu/Chitundu |__| 1 |__|
MWAKOLOLACHI: Munalemberapo aganyu |__|__| 1 |__| | MULI NAZO Mphasa |__| 2 |__|
Munapangapo ganyu |__|__| -1 |__| | ZINGATI? Makasu |__| 5 |__|
|(write number in box)Mtondo |__| 5 |__|
B. KODI MWEZI WATHAWU, Mchere |__|__| 1 |__| | Mipando |__| 8 |__|
MUNAGULAPO: Maluwa |__|__| 1 |__| | Mabulangete |__| 18 |__|
Mafuta a nyali |__|__| 1 |__| | Nkhuku |__| 3 |__|
Sugar |__|__| 2 |__| | Mbuzi/Nkhosa |__| 15 |__|
Lifebuoy |__|__| 2 |__| | Ng'ombe |__| 100 |__|
Mafuta ophikira |__|__| 3 |__| | Mpando wa ndalem |__| 6 |__|
Mpando (wa tebulo) |__| 8 |__|
CURRENT WEALTH INDEX ----------> TOTAL | | | Kalulu |__| 3 |__|
(sum of Part A + Part B) |______| | Bakha |__| 4 |__|
| Nkhunda |__| 2 |__|
YES/ NO SCORE | Nkhukundembo |__| 15 |__|
D. KODI MULI NDI: Sefa |__|__| 3 |__| |
Chidebe |__|__| 3 |__| |F.CONDITION OF MAIN HOUSE YES/ NO SCORE
Nkhwangwa |__|__| 4 |__| | Does it have windows
Chidebe chothirira mbeu |__|__| 5 |__| | with glass panes? |__|__| 80 |__|
Tebulo |__|__| 10 |__| | Built w.fired brick? |__|__| 100 |__|
Galasi loyang'anirapo |__|__| 2 |__| | Has a tin roof? |__|__| 300 |__|
Watchi/koloko |__|__| 5 |__| | Has separate kitchen? |__|__| 20 |__|
Aironi |__|__| 20 |__| | Pali chimbudzi? |__|__| 20 |__|
Wailesi |__|__| 60 |__| |
Njinga |__|__| 180 |__| |ACCUMULATED WEALTH
Bedi |__|__| 30 |__| | INDEX --------> TOTAL |______|
(sum of Part D+Part E+Part F)

G. How many houses (buildings where people sleep) are there in the compound? Write the number: |__|

139

140

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

Identifying smallholder target groups for IPM in southern Malawi

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Abstract. IPM strategies for smallholders are more likely to be adopted when they form part of a recommendation domain with a clearly defined target group. Cluster analysis was used to construct a typology of smallholder households participating in IPM on-farm trials in the Shire Highlands. southern Malawi. Clusters were profiled in terms of land. labour. and cash resources using discriminant analysis. The implications of the cluster typology for the design and evaluation of IPM strategies are explored. By relating the cluster typology to farmers' existing pest management strategies. broad recommendation domains were identified for a menu of IPM strategies for maize. beans. and pigeonpea.

1. Introduction

A central feature of farming systems research and extension (FSRE) is the concept of a recommendation domain. Over time the term has acquired a variety of meanings (Wotowiec *et. al*., 1988). In this article, a recommendation domain is defined as 'a group of farmers with roughly similar circumstances for whom we can make more or less the same recommendation' (Byerlee *et. al*., 1980: 89). In sub-Saharan Africa, recommendation domains have been widely applied to evaluate the impact of integrated rural development projects (Kydd, 1982), to classify producers of the same commodity (Williams, 1994), and to differentiate smallholders within the same agro-ecological zone (Doorman, 1991; Jolly, 1988; Manyong *et al*., 1988).

The need for recommendation domains in Integrated Pest Management (IPM) is illustrated by the experience of crop protection projects which developed strategies which were technically efficient but which were not adopted because they did not fit farmers' circumstances. The Chikwawa Cotton Development Project (1968-73) in Malawi's Lower Shire Valley had only limited success because (1) returns to labour were lower for sprayed cotton than for maize (2) the timing of spraying conflicted with the harvest of maize and (3) cotton yields were variable with a high risk of zero yields. Consequently, " the attractiveness of sprayed cotton was not uniform for all households" (Coleman, 1988). Similarly, the Mali Millet Pests Project (1985-1991) perfected a custom-made ultra-low volume sprayer only to discover that the cost of spraying (US $12/hectare) was three times higher than the average cash investment in millet and that just one in ten farm households could afford the new technology (Lock, 1989; Jago *et. al*., 1993). IPM strategies are more likely to be adopted if they are combined with a clear identification of their target group. This applies particularly to strategies for staple foodcrops, where producers range from severely food-deficit households to those which regularly produce a marketable surplus.

This article describes the classification of target groups for the Farming Systems Integrated Pest Management (FSIPM) Project which is conducting on-farm trials (OFTs) to identify IPM strategies for pests of maize (*Zea mays*), beans (*Phaseolus* spp.), and pigeonpea (*Cajanus cajan*) for resource-poor smallholders in southern Malawi. The specific objectives are to: (1) classify smallholder households using cluster analysis, (2) profile the resulting clusters in terms of land, labour, and cash inputs; (3) relate the cluster typology to variations in existing pest management practices; and (4) identify appropriate IPM strategies for each cluster.

2. The Target Region

The FSIPM Project operates in two extension planning areas (EPAs) in the Shire Highlands Rural Development Project (RDP) in Blantyre Agricultural Development Division (ADD). The RDP has a land area of 450,000 hectares and is located in southern Malawi between latitudes 15 degrees 12' and 16 degrees 25' South, and longitudes 34 degrees 21' and 35 degrees 51'. The Shire Highlands form a plateau of rolling or flat upland plains 600-1200 metres above sea level. The climate is warm tropical with rainfall ranging from 600-1300 mm. depending on altitude. Rainfall distribution is unimodal with one continuous wet season between November-April, followed by sporadic showers (*chiperoni*) between May-July and a dry period between July-October. The growing season averages 165-195 in the north rising to 225 days further south. In terms of atitude, rainfall, and length of growing season the maize ecology is representative of 40 % of the area planted to maize in Malawi (Heisey and Smale, 1995). Soils are mostly deep, well drained and medium textured but low in soil carbon and organic matter.

Smallholder agriculture is characterised by small farm size, intensive maize cropping, and low productivity. In 1992, 61 % of the 336,000 smallholder households in the RDP cultivated 0.5 hectares or less. At current levels of productivity, farms of 0.5 hectares were self-sufficient in maize for only five months each year. A high proportion (38 %) of households in the RDP were female-headed (FHH), due partly to a matrilineal system of inheritance since men tend to return to their own village after divorce or separation. FHHs made up a disproportionate share of the poorest 20 % of the smallholder population (World Bank, 1996). Human development indicators for the RDP showed low adult literacy rates, limited access to safe drinking water, and widespread malnutrition evidenced by high rates of wasting among children under five (FEWS, 1996).

The farming system is maize-based with pigeonpea and beans as the main pulse and legume intercrops. Relay-planting of beans and fieldpeas (*Pisum sativum*) is also practised. Maize yields averaged 836 kg/ha for local varieties and 1765 kg/ha for hybrid semiflint varities between 1992-96. Low average yields reflected poor soil fertility and low rates of inorganic fertilizer. Burley tobacco and *dimba* vegetables[1] are the most important commercial crops. Up to one third of households in Matapwata EPA grow *dimba* vegetables compared with one in ten for Malawi as a whole (MEPD/WFP/FEWS, 1995). Infrastructure is favourable with close access to world markets (tobacco) and the urban markets of Blantyre and Limbe with a population of 500,000.

Target pests of foodcrops in the region were identified through extensive field surveys between 1990-92. These showed termites, whitegrubs and *Striga asiatica* as the major field pests of maize; bean stem maggot (*ophymia spp.*) and *ootheca* as major pests of beans, and *fusarium* wilt as the major pest of pigeonpea (Munthali *et. al.*, 1993; Hillocks *et. al.*, 1996a). These rankings were confirmed by a Stakeholder Workshop with Malawian crop protection professionals (Ritchie, 1996) and by diagnostic surveys in four villages in Mombezi and Matapwata EPAs (Orr *et. al.*, 1996). Major pests of vegetable crops were diamondback moth (*Plutella xylostella*) and clubroot (*Plasmodiophora brassicae*) for cabbage and red spider mite (*Tetranychus lambi*) for tomato. Pests of burley tobacco included nematodes and the bacterial disease wildfire (*Pseudomonas tabacum*).

3. Data and methods

The data derived from a baseline survey of 120 smallholder households conducted at FSIPM survey sites in four villages in Matapwata and Mombezi EPAs (Orr *et. al.*, 1997). The sample was stratified by EPA, by participation in OFTs, and by sex of household head. Thus, 30 sample FHHs participated in OFTs and 30 did not participate, with corresponding numbers for households headed by men. Using a structured questionnaire, information was collected for the 1996 crop year (1 September - 30 October) on household composition, labour participation rates, crops, input use, and farmers' pest management perceptions and practices.

Cluster analysis is a statistical procedure for grouping cases or variables according to common characteristics. Typically, analysis involves: (1) selection of variables to differentiate clusters, (2) determining the 'seed points' and optimal number of clusters, (3) determining the stability of the clusters, (4) 'fine-tuning' of cluster membership, and (5) profiling of clusters using variables not used in the original cluster analysis.

3.1 Selection of variables

Variables commonly used for targeting include labour, wealth, land, household demographics, crop and livestock production, and farm and family goals (Moore, 1995). Identifying variables for cluster analysis is a subjective excercise which requires prior knowledge of the socioeconomic and production variables which are relevant for the problem under investigation. The initial choice of variables was therefore not intended to characterise the farming system as a whole but determined by their potential relevance for IPM recommendation domains. Correlation analysis showed statistically significant relationships between variables which might bias the identification of clusters. Thus, the first stage of the cluster analysis was to identify variables with strong explanatory power and remove variables which were highly correlated with each other. While factor analysis may be used for this purpose (Gebauer, 1987; Jamtgaard, 1988) the same results may be obtained with a cluster analysis of the selected variables (SPSS, 1994). Variables were therefore selected by an agglomerative hierarchical cluster analysis using the complete linkage method with Pearson's correlation coefficient as the measure of distance. (These terms are explained below). The results identified BCLUB, FHH, FSIZE, MPA96, and VDIMBA as input variables (see Table 1 for variable definitions). Appendix 1 explains how these variables were selected.

3.2 *Seed points and number of clusters*

Identification of mean values for clusters and optimum number of clusters was made using agglomerative hierarchical clustering, in which all cases are considered as unique clusters and gradually combined until all cases are members of a single cluster. This method is superior to non-hierarchical clustering, in which averages of the cluster variables are assigned at random and where the number of clusters must be specified in advance. The analysis was made using the HIERARCHICAL CLUSTER command (SPSS, 1994). Trial runs using the within-groups linkage method (the SPSS default) produced several clusters with only one case even after removal of outliers. Ward's method was therefore used as the method for linking clusters since it tends to combine clusters with a small number of cases. Squared Euclidean distance was selected as the measure of distance between clusters. Because the input variables had different units of measurement they were standardised to Z scores with a mean of 1 and a standard deviation of 0. Examination of the solutions for 5-10 clusters showed that the agglomeration coefficient (the value of the distance between the two most dissimilar points of the clusters being combined) rose sharply after the fifth cluster solution (from 158.05 to 216.57). The five-cluster solution was therefore selected to avoid combining dissimilar clusters.

3.3 *'Fine-tuning' of cluster membership and stability of cluster solutions*

Hierarchical cluster analysis is susceptible to outliers, the distance measure used, mis-specification of variables, and the problem of 'chaining' whereby, once cases have been assigned to a particular cluster, they remain members of the same cluster throughout the analysis (Hair *et. al.*, 1994). Consequently, the hierachical five-cluster solution was 'fine-tuned' using non-hierarchical cluster analysis, where cases are grouped according to their distance from pre-specified 'seeds' or cluster centres. Analysis requires prior knowledge of both the optimum number of clusters and the average values of the input variables for each cluster. If both are known, classification is more accurate than with hierarchical clustering. Average standardised values of the input variables for the five cluster solution were therefore used as 'seed-points' for a non-hierarchical cluster analysis with the K-MEANS command (SPSS, 1995) using Ward's linkage method and with squared Euclidean distance as the measure of distance between clusters. Convergence was achieved after one iteration, indicating that the intial seed points were accurate measures of average values of the cluster variables. The analysis reclassified a total of three households, of which two were transferred from cluster 1 to cluster 3, and one from cluster 5 to cluster 2. To determine the stability of the cluster solutions, the 120 households were divided into two random samples of 60 then analysed separately to compare results.

3.4 *Profiling of clusters*

Cluster profiles were compared using discriminant analysis, which computes the linear combination of independent variables which accounts for the largest share of variation in the defined groups. With five (k) groups, discriminant analysis produces four (k-1) functions. The first function has the largest eigenvalue (ratio of between-groups to within-groups sums of squares) and explains the largest share of the variance between groups. The second function has the next largest eigenvalue and explains the largest share of the remaining variance, and so on. All functions are uncorrelated with each other. Because discriminant analysis allows estimation of the simultaneous effect of several independent variables it is commonly used to profile target groups (Jolly, 1988; Williams, 1994).

Eight variables not used in the original cluster analysis were used as profile variables, with cluster membership as the dependent variable. Discriminant functions were estimated with the DISCRIMINANT procedure using the direct entry method (SPSS, 1994). In order to validate the results, the sample was randomly split into two subsamples of 60, with membership of each sample drawn proportionately from the number of cases in the five clusters. The 'analysis' sample was used to compute the discriminant function while the 'holdout' sample was used to develop the classification matrix. The functions were validated by comparing the expected classification rate with the proportional chance criterion and with Press's Q-statistic (Hair *et. al.*, 1994). To simplify interpretation of results, the discriminant functions were rotated using the varimax method. The contribution of the independent variables was then assessed individually by examining their discriminant loadings, potency index, and F-ratios (Hair *et. al.*, 1994).

4. Results

Before discussing the results it is necessary to verify the stability of the five-cluster non-hierarchical solution by comparing the results for two random sub-samples (Table 2). In each case, convergence was achieved after two iterations, implying a close fit with the initial seed points. The Chi-square test showed no significant difference in the proportion of households in each cluster (Chi = 0.686 at $p < 0.9531$). The F-test showed that the means of the clusters for the two metric variables were significantly different at the 10 % level or above. Because of small sample size, it was not possible to test for differences in the proportions of the three binary variables, except in one case. Thus, the five-cluster solution appears robust in terms of the specified variables.

The results of the five-cluster non-hierarchical analysis for the complete sample are shown in Table 3. Tests of significance on the cluster means (F-test) or proportion of households in each cluster (Chi-square) were significant at $p < .0001$ in the case of four variables. The FSIZE variable was statistically significant at $p < .01$, suggesting it was a relatively weak indicator of differences between clusters.

Table 4 shows that on a univariate basis all the profile variables except HYBUY displayed significant differences between the group means. Of eight variables, six were statistically significant at $p < 0.05$ or above. The MZAREA variable was statistically significant at $p < 0.01$.

Two of the four discriminant functions were statistically significant ($P < 0.05$). The two functions had eigenvalues of 1.39 and 0.33 and explained 67% and 16 % respectively of the observed variation among the five groups. The classification accuracy for the discriminant analysis of the hioldout sample was 60 %, compared to 21.3 % for the proportional chance criterion for the five groups; thus, the model achieved a classification accuracy 2.5 times greater than chance.[2] Press's Q-statistic was 50.4 and 60.0 for the analysis and holdout samples, respectively. Both values were significantly higher than the Chi-square value at $p <.001$ with one degree of freedom (10.83). These results suggest that the profile variables were successful in discriminating between clusters. The value of Box's M was significant at the 5 % level, violating the assumption of equal covariance matrices between the five groups. This test is sensitive to large samples, however, and the small value of the F-ratio (1.72) suggested that the linear discriminant function performed well.

The relative importance of the profile variables in discrimininating between the five clusters can be determined using the rotated standardised coefficients and loadings (Table 5). Variables with loadings of +/- .30 or higher are considered significant (Hair *et. al.*, 1996). Function 1 is dominated by fertilizer use: the cost of fertilizer (FERTCOST), continuity of fertilizer use (FERT3YR), and the fertilizer rate on the area planted to maize (MZNRATE) explained 67 % of the variation in cluster membership. These three variables had the highest values in the potency index and FERTCOST and FERT3YR both displayed high F-ratios (Table 4). The group centroids suggest that function 1 distinguished cluster 4 from all others clusters. In function 2, purchase of hybrid seed (HYBUY) and share of household income from agriculture (OWNAG) showed the highest correlation with cluster membership. These variables had low values in the potency index, and the F-ratio was significant only for OWNAG (Table 4). The group centroids indicate that this function distinguished between clusters 4 and 3, and clusters 1, 2, and 5. Correlation coefficients for the variables FWORKER, MZAREA, and MWORKER were below + /- 0.30 and thus not significant.

5. Discussion

The results show that smallholders in the Blantyre Shire Highlands are not homogeneous but may be stratified into five broad groups:

- ***Dimba** households* (one third of which were FHHs) with access to land suitable for production of high-value vegetables (cluster 1);
- *Stable MHHs* producing neither vegetables or burley tobacco, but with sufficient resources to be relatively food-secure (cluster2);
- *Vulnerable households* [3] with low food-security, two-thirds of them FHHs which did not grow burley tobacco and lacked access to dimba (cluster 3);
- *Burley households* with a high level of food security (cluster 4); and
- *Stable FHHs* which produced neither burley nor *dimba* vegetables but which were reasonably food secure (cluster 5). This group formed the counterparts of *stable MHHs* in cluster 1.

Differences between households have important implications for the design and evaluation of IPM strategies. In this section we use the cluster profiles (Table 4) and information on existing pest management practices (Table 6) to suggest tentative recommendation domains for IPM strategies for the foodcrops of maize, beans, and pigeonpea grown by smallholders in the Shire Highlands.

5.1 Design of strategies

Although the area planted to maize (MZAREA) was somewhat lower among vulnerable households it was not an important discriminator between clusters (Table 5). Small average farm size among all clusters implies that IPM strategies for *Striga* such as trap crops and green manure crops are best grown as intercrops or relay crops rather than in rotation with maize or as part of an improved fallow. Examples include the trap crops soybean (*Glycine max*) and cowpea (*Vigna unguiculata*) intercropped with maize and the green manure crop *Tephrosia vogelii* undersown with maize. Most of these crops are not new to the farming system - *Tephrosia* was noted growing in the Shire Highlands in the 1880s (Buchanan, 1885). Green manure crops are more effective in increasing soil fertility when combined with inorganic fertilizers (Kumwenda *et. al.*, 1997). Since these strategies demand only small additional expenditures of cash or labour they are expected to be equally attractive for all clusters.

Labour constraints at seasonal peak periods limit the potential for labour-intensive IPM strategies (Goodell and Andrews, 1990). Labour shortages were evident in the area planted to maize left unweeded, despite high participation rates for this activity. Research has shown that farmers who weed twice at the critical period can obtain higher maize yields with half the amount of fertilizer than farmers who weed only once (Kabambe and Kumwenda, 1995). Yet weeding practices varied significantly between clusters (Table 6). For example, vulnerable households (cluster 3) weeded less thoroughly at first weeding and left a higher proportion of fields unweeded at first weeding (Table 6).[4] Variations in weeding practices are best explained in terms of labour availability. On the demand side, poorer households frequently work as hired labour for their better-off neighbours in order to buy maize, limiting the time available to weed their own fields (Pearce *et. al.*, 1996). On the supply side, tensions over land inheritance have also made FHHs more reluctant to exchange labour with their sisters (Davison, 1993) and work sharing (*chipere ganyu*) to overcome seasonal labour constraints has largely become a thing of the past (Trivedy, 1988).

Labour constraints are also experienced by *dimba* households. Among dimba households the peak period for labour fell between November-December, when labour requirements for vegetables competed with land preparation, planting, and weeding for maize. A separate survey of a random sample of 30 *dimba* growers in Matapwata EPA found that 60 % reported vegetable production delayed operations for fieldcrops, particularly land preparation. Over half those households which reported a labour constraint for land preparation hired labour for this activity. *Dimba* households may therefore face problems adopting IPM strategies which involve labour-intensive cultural practices during this period.

About half of vulnerable households were headed by women. By failing to target FHHs, agricultural research and extension have marginalised their access to inputs of hybrid seed and fertilizer (Gladwin, 1997). FHHs have smaller average farm size, higher dependency ratios, and less household labour than others (World Bank, 1996). However, FHHs are not homogeneous. Stable FHHs had similar levels of fertilizer use and food security as stable MHHs (Table 4). The sources of this stability may be linked to high earnings from off-farm employment, as indicated by the low share of cash income earned on-farm (31 %). One quarter of stable FHHs were married with absentee or polygamous husbands who may have assisted them financially. This suggests that stable FHHs and MHHs may be treated as a single target group for the design of IPM strategies.

Fertilizer use was the most important variable in discriminating between the five clusters. The cost of fertilizer (FERTCOST) and continuity of adoption (FERT3YR) were significantly lower among vulnerable households, with fewer than one in 10 using fertilizer continuously over three crop years (Table 4). The fertilizer rate applied to the area planted to maize (MZNRATE) was also lowest among vulnerable households (14 kg/N/ha). Since farmers are generally well aware of the need for increased soil fertility to raise average maize yields, high variation in fertilizer use between clusters reflects the high cost of this input to smallholders. The nitrogen: maize price ratio in Malawi between 1988-94 averaged 7.7, higher than most other countries in sub-Saharan Africa and three times higher than in Asia (Heisey and Mwangi, 1997). High expenditure on fertilizer among burley households (1251 MK) reflected access to credit through smallholder burley clubs where members receive credit for maize as well as tobacco. Without credit or a targeted fertilizer subsidy, fertilizer rates of 50 kg/N hectare as an IPM strategy for *Striga* appear inappropriate for vulnerable households and perhaps for others as well.

Cash constraints also limited adoption of hybrid maize. Purchase of hybrid maize seed (HYBUY) was a significant discriminant between clusters (Table 5). Yields of the semiflint maize hybrids grown in Malawi are higher and less variable than those of local maize varieties, even when grown without fertilizer (Smale and Heisey, 1997). Cash constraints were less important for pesticides, however. Although three-quarters of *dimba* households used pesticides for vegetables, almost none used pesticide for fieldcrops (Table 6). Low average yields reduce the economic incentive for the use of pesticides on staple foodcrops like maize, beans, and pigeonpea. Chemical control for foodcrops may be feasible in small doses, however, and three of five clusters reported seed-dressing maize against whitegrubs (Table 6).

Finally, the share of cash income from own agricultural production (OWNAG) differed significantly between clusters (Table 4) and was a significant profile variable in the discriminant function (Table 5). With the exception of *dimba* households where high-value vegetable production boosted own-agriculture income to 61 % of the total, a striking feature of other clusters was that own-agriculture accounted for half or less of total household income (Table 4).). Thus, off-farm income plays a major role in the smallholder economy. Unfortunately, the widespread perception of rural Africans as "farmers" has meant that the importance of off-farm income for smallholders has been largely ignored (von Braun, 1989). In Malawi, however, mapping of households according to food security status has shown that 35 % of smallholder households can be classified primarily by employment in off-farm, income-generating activities and that these households are concentrated in the southern region (Moriniere *et. al.*, 1996). Among poorer households, the need to earn cash to buy maize during food-deficit months has led to a portfolio of income-generation activities including handicrafts, petty-trade, and casual labour (Pearce *et. al.*, 1996). This limits the scope for IPM strategies which demand additional labour time, particularly among vulnerable households where 69 % of cash income has to be earned off-farm (Table 4).

Table 7 summarises tentative recommendation domains for 18 IPM strategies tested in OFTs in the 1996 and 1997 crop seasons. For the purpose of this analysis all strategies were assumed to be economically viable. Of 18 strategies, ten (56 %) were judged to be appropriate for all clusters. These included varietal resistance (five strategies), botanical seed dressing (one), green manure and trap crops (two), and two cultural practices (weeding without banking and planting pigeonpea on the side of the ridge). One strategy (earthing-up) was judged inappropriate for all clusters because of high labour requirements. Recommendation domains for the remaining seven strategies are summarised below:

- Inorganic fertilizer for *Striga* was considered appropriate for all households except vulnerable households (cluster 3);

- Handpulling *Striga* was judged inappropriate for *dimba* households (cluster 1) because of competion for labour with vegetables. More information is required on why so few stable MHHs were willing to handpull *Striga;*

- Extra weeding was reported to be a common strategy for *Striga*, except among burley households (cluster 4). But labour shortages may limit its appropriateness for *dimba* households (cluster 1) and vulnerable households (cluster 3);

- Chemical seed dressing for bean stem maggot was considered appropriate for all households but too expensive for vulnerable households (cluster 3);

- Chemical seed dressing for whitegrubs was considered appropriate for all households including vulnerable households (cluster 3). Vulnerable households cultivating land in the Chitera dambo where maize was severely damaged by whitegrubs pest had already experimented with chemical seed-dressing (Table 4); and

- Mulching and high density planting for bean stem maggot were considered inappropriate for vulnerable households (cluster 3) and doubtful for *dimba* households because of labour shortages.

Three limitations of the recommendation domain concept may be noted. First, half the IPM strategies involved little or no expenditure or actually reduced labour requirements, and were therefore appropriate for all smallholders. Examples include the pigeonpea variety ICP9145 which is resistant to *fusarium* wilt, biological control (under a separate project) of the larger grain borer (*Prostephanus truncatus*) by the predatory hister beetle *Teretriosoma negrescens,* and weeding maize without banking. Although a large number of potential IPM strategies for smallholder foodcrops have been identified (Hillocks *et. al.*, 1996b), in practice the most successful have been varietal resistance and biological control. Since both these strategies areappropriate for smallholders irrespective of socioeconomic circumstances, this simplifies the targeting of IPM strategies and reduces the need for recommendation domains. Nevertheless, the two clusters for which several IPM strategies were inappropriate constituted 38 % of smallholder households in the sample.

Second, several recommendation domains were difficult to identify because of gaps in knowledge about farmers' socioeconomic circumstances. In particular, more information is needed about labour availability. In rainfed maize-based farming systems with a single growing season, many farm operations - planting the main crop, planting intercrops, fertilizing, first and second weeding - must be concentrated in the first critical six weeks of the growing season to ensure optimum maize yields. The integration of IPM strategies with other farm operations during this 'six-week window' needs careful consideration, particularly when they require additional time and labour. This highlights the need for an integrated crop management (ICM) approach to identify the interactions between pest management strategies and crop production practices, and ensure that they are mutually supportive (Meerman *et. al.*, 1996).

Third, recommendation domains require continual refinement as more information becomes available (Moore, 1995). In the early stages of on-farm research the real value of the cluster typology is heuristic, serving as a framework for raising issues and setting priorities for analysis and action, rather than giving definite answers about IPM interventions. Further analysis is necessary to ensure more accurate recommendation domains.

5.2 Evaluation of strategies

Farmer evaluation of OFTs is common practice in FSRE. Farmers' opinions are sought through a mix of open-ended and closed questions in order to rank positive and negative features of new technologies (Ashby, 1990). Evaluation is normally made for all farmers involved in testing the technology or for a subsample, resulting in varied and uncoordinated responses (Jere, 1996). The objectivity of farmer evaluation may be enhanced by the use of the cluster typology as a sampling frame. For IPM strategies which are judged suitable for all producers, a representative sample may be ensured by selecting households from each of the five clusters. In the case of interventions which are considered appropriate for only one or two clusters, evaluations may be restricted to farmers from households in these particular groups. The cluster typology thus provides a bridge between qualitative and quantitative methods in FSRE.

The typology may also assist evaluation of IPM interventions on a whole-farm basis. Farm modeling can help identify the interactions between different components of the farming system. By introducing IPM interventions as enterprise vectors into an optimising model, the analyst can identify whether land, labour or cash resources are 'binding' constraints which limit the adoption of IPM strategies. Models are usually constructed for a 'typical' farm or series of farms in the target region. The cluster typology provides the basis for a set of five whole-farm models to evaluate IPM strategies for the Shire Highlands.

6. Conclusion

Smallholder households were classified to identify recommendation domains for IPM strategies for maize, beans, and pigeonpea. Five socioeconomic clusters were identified, differentiated by sex of household head, self-sufficiency in maize, cash crops, and farm size. Differences between households were determined largely by the use of inorganic fertilizer, hybrid seed, and the share of household income derived from agriculture. These findings confirm that low soil fertility and low maize productivity are major causes of food insecurity among smallholders in the Shire Highlands.

Of 18 IPM strategies tested so far in OFTs, only six required unique recommendation domains. Varietal resistance, biological control, and cultural practices which required no additional labour were judged equally appropriate for all smallholders. However, chemical control and cultural practices which required additional labour and cash expenditure were considered inappropriate or problematic for households cultivating *dimba* vegetables and for vulnerable households with low food security. These two clusters comprised four in ten smallholder households in the sample.

At this early stage of on-farm research, the cluster typology provides a framework for identifying likely contraints on adoption. Further refinement of recommendation domains for IPM strategies for weeds, *Striga*, and bean stem maggot will require a greater research focus on the 'six-week window' between the planting of maize and the end of second weeding. An integrated crop management approach is necessary to determine the optimum combination of pest and crop management practices during the critical first six weeks of the growing season.

Notes

1. A *dimba* is an area of agricultural land with impermeable soils, adjacent to a stream or lying above an underground watercourse, which can be cropped throughout the year using residual soil moisture, irrigation from streams or wells, or a combination of these.

2. The classification results for the holdout sample were: 54.5 % (cluster 1); 73.3 % (cluster 2); 41.7 % (cluster 3); 83.3 % (cluster 4); and 56.3 % (cluster 5). Thus the analysis was most successful in classifying clusters 2 and 4 (stable male-headed households and burley households).

3. We prefer the term vulnerable to food-insecure households since in the previous crop year (1995/96) households in this cluster had an average MPA of 6.5 months. High year-to-year variation in maize production among this cluster reflected (1) the large number of households with land in the Chitera dambo, an area of stiff black clay soils (vertisols) prone to severe floods, and (2) illness of the household head. Oxfam has also defined 'vulnerable' households in southern Malawi as those self-sufficient in maize for two or three months each year (Trivedy, 1988).

4. The comparison was slightly influenced by the high proportion of households in cluster 3 with land in the Chitera dambo, where floods in the 1996 crop year prevented weeding and banking. When households with land in Chitera were excluded, there was no significant difference in the proportion of maize not weeded at first weeding ($F = 0.33$, $p < .8539$). Other comparisons were unaffected.

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Table 1. Definitions of input and profile cluster variables.

1. *Rejected cluster input variables (Table A1)*

FSIZE	Total area cultivated in the 1996 crop year (ha)
HHSIZE	Persons in household (no.)
REVWORKER	Total workers in household (no.)
MVMZPER	Share of area planted to maize planted to hybrid varieties (%)
MZNRATE	Fertiliser rate on area planted to maize (kg/N/ha)
MZFPER	Share of area planted to maize which received fertilizer in the 1996 crop year (%)
OFT	Dummy variable for participation in IPM on-farm trials in 1996 crop year (1=Yes, 0 otherwise)
OWNAG	Share of household cash income derived from own agricultural production (%)

2. *Selected cluster input variables (Table 2)*

MPA96	Number of months household was self-sufficient in maize in 1996 crop year
BCLUB	Dummy variable for membership of a burley club (1= Yes, 0 otherwise)
FHH [a]	Dummy variable for female-headed household (1= Yes, 0 otherwise)
VDIMBA	Dummy variable for household growing *dimba* vegetables (1=Yes, 0 otherwise)

3. *Cluster profile variables (Table 4)*

MWORKER	Adult male workers in household (no) [b]
FWORKER	Adult female workers in household (no) [b]
HYBUY	Dummy variable for purchase of hybrid maize seed in 1996 crop year (1=Yes, 0 otherwise)
MZAREA	Area planted to maize in 1996 crop year (ha)
MZNRATE	Fertilizer rate on area planted to maize (kg/N/ha)
FERTCOST	Expenditure on fertilizer in 1996 crop year (Malawi Kwacha)[c]
FERT3YR	Dummy variable for households applying fertilizer in the 1994, 1995, and 1996 crop years (1 =Yes, 0 otherwise)
OWNAG	Share of household cash income derived from agriculture (%)

a FHHs included both *de jure* FHHs where the head was widowed, divorced, or separated and *de facto* FHHs where the head was male but absent for six months of the year or more.

b Adults were defined as aged 15 and over, and weighted as 1.0 for males and 0.8 for females.

c 15 MK = 1 US $ in 1996 crop year.

Table 2. Cluster means and significance levels for five-cluster non-hierarchical solution for two subsamples.

Subsample 1 (n = 60)

Variable [a]	Cluster					F-ratio/ Chi-square [b]	Probability[c]
	1 (n=11)	2 (n=16)	3 (n=11)	4 (n=6)	5 (n=16)		
MPA96	8.1	7.9	2.5	8.5	8.4	19.43	0.0000 ***
FSIZE	1.0	0.6	0.4	0.7	0.5	3.32	0.0166 **
BCLUB	-	-	-	6		[d]	
FHH	2	-	8	-	16	[d]	
VDIMBA	11	-	1	1	-	[d]	

Subsample 2 (n=60)

Variable [a]	Cluster					F-ratio/ Chi-square [b]	Probability[c]
	1 (n=11)	2 (n=13)	3 (n=13)	4 (n=5)	5 (n=18)		
MPA96	8.3	8.4	1.7	10.6	8.8	37.30	0.0000 ***
FSIZE	0.7	1.0	0.6	0.7	0.6	1.03	0.0291 **
BCLUB	-	-	-	5	-	[d]	
FHH	4	-	8	2	18	31.48	0.0000 ***
VDIMBA	11	-	-	-	-	[d]	

Source: FSIPM baseline survey data 1996/97

[a] for variable definitions see Table 1

[b] F-test for metric and Chi-square for categorical variables.

[c] ** = significant at 5 % level
*** = significant at 1 % level

[d] Chi-square test invalid because more than 3 cells with expected frequency < 5.

Table 3. Cluster means and significance levels for five-cluster non-hierarchical solution.

Variable [a]	Cluster					F-ratio/ Chi-square [b]	Probability [c]
	1 (n=22)	2 (n=29)	3 (n=24)	4 (n=11)	5 (n=34)		
MPA96	8.1	8.1	2.0	9.5	8.6	54.81	0.0000 ***
FSIZE	0.9	0.8	0.5	0.7	0.6	2.22	0.0716 *
BCLUB	-	-	-	11	-	120.00	0.0000 ***
FHH	8	-	16	2	34	71.76	0.0000 ***
VDIMBA	22	-	1	1	0	108.38	0.0000 ***

Source: FSIPM baseline survey data 1996/97

[a] for variable definitions see Table 1

[b] F-test for metric and Chi-square for categorical variables

[c] * = significant at 10 % level
*** = significant at 1 % level

Table 4. Profile variables for five-cluster non-hierarchical solution.

Variable [a]	Cluster					F-ratio/ Chi-square [b]	Probability [c]
	1 (n=22)	2 (n=29)	3 (n=24)	4 (n=11)	5 (n=34)		
MWORKER	1.45	1.72	1.67	2.09	0.97	2.53	0.0445 **
FWORKER	1.20	1.08	1.37	1.82	1.55	2.94	0.0235 **
MZAREA	0.86	0.78	0.53	0.46	0.56	2.62	0.0383 **
HYBUY	72.7	62.1	79.2	90.9	73.5	4.04	0.4004 ns.
MZNRATE	30.7	29.6	14.0	51.9	26.3	2.31	0.0619 *
FERTCOST	352	148	136	1251	277	26.47	0.0000 ***
FERT3YR	45.5	44.8	8.3	72.7	44.1	15.73	0.0034 **
OWNAG	63.1	38.6	44.2	51.8	31.2	2.50	0.0463 **

Source: FSIPM baseline survey data 1996/97

[a] for variable definitions see Table 1

[b] F-test for metric and Chi-square for categorical variables

[c]
* = significant at 10 % level
** = significant at 5 % level
*** = significant at 1 % level
ns. = not significant

Table 5. Discriminant coefficients, loadings, and group centroids for varimax rotated five-group discriminant analysis.

Variables [a]	Function 1	Function 2	
Rotated standardised coefficients (weights)			
MWORKER	-.13582	-.33032	
FWORKER	-.14950	.13147	
FERT3YR	.44183	1.25299	
HYBUY	-.29968	.56482	
MZNRATE	-.06078	-.57210	
OWNAG	-.13979	-.21500	
MZAREA	-.08522	-.23522	
FERTCOST	.82199	-.76124	
Correlations between rotated discriminant functions and independent variables (loadings) [b]			*Potency index* [c]
FERTCOST [d]	.86729 *	-.11546	.60642
FERT3YR	.79645 *	.45508	.51140
MZNRATE	.50092 *	-.03446	.25092
HYBUY	.03068	.42852 *	.00094
OWNAG	.00771	-.25642 *	.00005
FWORKER	-.01655	.12557	.00026
MZAREA	.01821	-.03644	.00033
MWORKER	.18410	.00011	.03389
Group means (centroids) of discriminant functions			
Cluster 1	.10165	-.47989	
Cluster 2	-.06039	.49833	
Cluster 3	-.93910	-.24502	
Cluster 4	2.46979	-1.97799	
Cluster 5	-.07513	.61846	

[a] for variable definitions see Table 1

[b] * denotes largest absolute correlation between each variable and any discriminant function

[c] potency index = sum of squared loadings times the relative eigenvalue, where the relative eigenvalue is the eigenvalue of the discriminant function divided by the sum of the eigenvalues for all significant functions (Hair *et. al.*, 1996).

[d] variables ordered by size of correlation within function

Table 6. Farmers' existing pest management practices, by cluster

Variable	Cluster					F-ratio/ Chi-square	Probability [a]
	1 (n=22)	2 (n=29)	3 (n=24)	4 (n=11)	5 (n=34)		
A. Maize							
1. *Weeds*							
First weeding (% area planted to maize) [b]							
- fully weeded	77	86	45	77	68	3.58	0.0086 **
- partly weeded	16	6	33	17	24	2.26	0.0674 *
- not weeded	8	8	28	6	8	2.93	0.0240 **
Second weeding (% area planted to maize) [b]							
- fully banked	31	53	37	41	43	0.83	0.5095 ns.
- partly banked	31	28	43	13	40	1.34	0.2582 ns.
- not banked	38	20	20	46	17	2.32	0.0609 *
2. ***Striga asiatica*** (% households) [c]							
- handpulling	29	8	44	80	59	[e]	
- extra weeding	57	58	67	20	71	4.34	0.3619 ns.
- removing from field	7	-	11	80	28	[e]	
3. *Termites* (% households) [b]							
- not banking [d]	32	28	17	18	35	3.13	0.5357 ns.
4. *Whitegrubs* (% households) [b]							
- seed dressing	5	17	21	-	3	[e]	
B. Pigeonpea							
1. ***Fusarium** wilt* (% households) [d]							
- planting ICP9145	15	7	21	27	16	2.93	0.5692 ns.
C. Pesticide use (% households)							
- field crops	0	0	4	0	3	[e]	
- *dimba* vegetables	73	0	4	0	3	[e]	

Source: FSIPM Baseline survey, 1996/97

[a] * = significant at 10 % level
** = significant at 5 % level
*** = significant at 1 % level
ns. = not significant
[b] = 120 households
[c] = 57 households
[d] = 108 households
[e] = Chi-square test invalid because more than 3 cells with expected frequency < 5.

Table 7. Suggested IPM recommendation domains, Blantyre Shire Highlands RDP

			Cluster number [a]				
			1 (n=22)	2 (n=29)	3 (n=24)	4 (n=11)	5 (n=34)
Crop	Pest	IPM strategies	Appropriateness [b]				
Maize	*Striga*	Inorganic fertilizer	Y	Y	N	Y	Y
		Trap crops	Y	Y	Y	Y	Y
		Green manure crops	Y	Y	Y	Y	Y
		Handpulling	N	N	Y	Y	Y
		Extra weeding	?	Y	N	Y	?
Maize	Termites	Varietal resistance	Y	Y	Y	Y	Y
		Weeding, no banking	Y	Y	Y	Y	Y
Maize	Whitegrubs	Seed dressing	Y	Y	Y	Y	Y
Pigeonpea	*Fusarium* wilt	Varietal resistance	Y	Y	Y	Y	Y
Pigeonpea	Termites	Varietal resistance	Y	Y	Y	Y	Y
Pigeonpea	Whitegrubs	Varietal resistance	Y	Y	Y	Y	Y
	Termites	Planting on side of ridge	Y	Y	Y	Y	Y
Beans	Bean stem maggot	Varietal resistance	Y	Y	Y	Y	Y
		Chemical seed dressing	Y	Y	N	Y	Y
		Botanical seed dressing	Y	Y	Y	Y	Y
		Earthing-up	N	N	N	N	N
		Mulching	?	Y	N	Y	Y
		High-density planting	?	Y	N	Y	Y

[a]
1 = *Dimba* households
2 = Stable male-headed households
3 = Vulnerable households
4 = Burley households
5 = Stable female-headed households

[b]
Y = Yes
N = No
? = Not known

APPENDIX 1. SELECTION OF INPUT CLUSTER VARIABLES

An agglomerative hierarchical cluster analysis was made of 10 socio-economic and production variables derived from baseline survey data. The agglomerative procedure treats each variable as a single cluster, gradually combining variables and clusters to provide nine possible cluster solutions.

The agglomeration schedule (Table A1) identifies the variables or clusters being considered at each stage of the analysis. Stage 1 represents the first stage, or the nine-cluster solution in which clusters six and ten are combined. The absolute value of Pearson's correlation coefficient is shown for each successive stage. The value of the coefficient is relatively high (above 0.2) until stage five of the analysis after which there appears to be little correlation between combined clusters.

Table A2 shows cluster membership among the variables for the complete range of cluster solutions. The row numbers indicate the number of the cluster to which each variable belongs. Studying the four-cluster solution, cluster one consists of three variables (BCLUB, MPA96 and MZNRATE), cluster two of three variables (FHH, OWNAG and VDIMBA), cluster three of three variables (FSIZE, HHSIZE, and REVWORKER), and cluster four consists of the single variable MVMZPER. Cluster four may be considered an outlier since it is incorporated into cluster 1 in the three cluster solution.

The dendogram (Table A3) illustrates the stage at which variables have been combined, and the values of the coefficients at each stage, standardised on the scale 0-25. It is clear from the dendogram that the variables fall into three major clusters with the cluster memership noted in Table A2. Once again the MVMZPER variable appears an outlier, only joining cluster 1 with MPA96, MZNRATE, and BCLUB in the penultimate stage of the analysis.

To reduce bias caused by correlation between variables, only one variable was selected from each cluster in the three-cluster solution. These were MPA96, FSIZE, and FHH. Two additional variables (BCLUB and VDIMBA) were also selected because households growing cash crops such as burley tobacco and vegetables were considered to face specific problems in the management of pests and diseases.

Table A1.Agglomeration Schedule using Average Linkage (Between Groups)

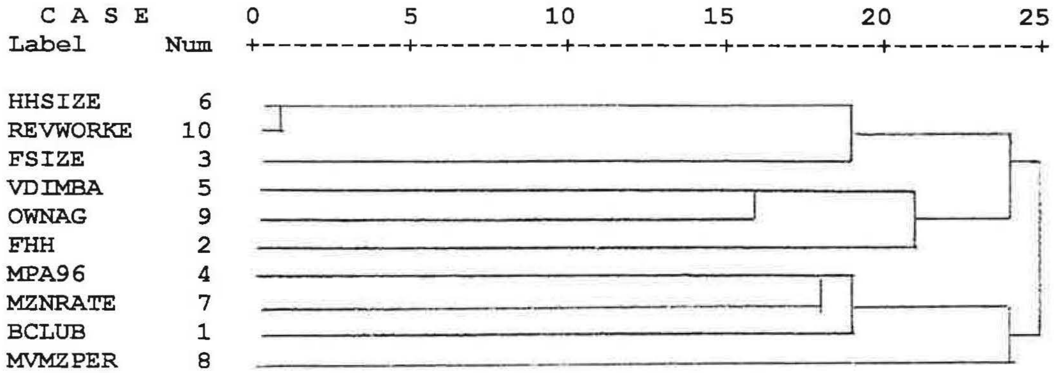
Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	6	10	.594814	0	0	5
2	5	9	.272782	0	0	6
3	4	7	.232453	0	0	4
4	1	4	.219263	0	3	7
5	3	6	.218407	0	1	8
6	2	5	.173561	0	2	8
7	1	8	.124259	4	0	9
8	2	3	.117930	6	5	9
9	1	2	.089157	7	8	0

Table A2. Cluster Membership of Cases using Average Linkage (Between Groups)

		Number of Clusters							
Label	Case	9	8	7	6	5	4	3	2
BCLUB	1	1	1	1	1	1	1	1	1
FHH	2	2	2	2	2	2	2	2	2
FSIZE	3	3	3	3	3	3	3	3	2
MPA96	4	4	4	4	1	1	1	1	1
VDIMBA	5	5	5	5	4	4	2	2	2
HHSIZE	6	6	6	6	5	3	3	3	2
MZNRATE	7	7	7	4	1	1	1	1	1
MVMZPER	8	8	8	7	6	5	4	1	1
OWNAG	9	9	5	5	4	4	2	2	2
REVWORKE	10	6	6	6	5	3	3	3	2

Table A3. Dendrogram using Average Linkage (Between Groups)

Rescaled Distance Cluster Combine



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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

IPM for smallholder farming systems in southern Malawi

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Abstract

Whole-farm models were developed to quantify the economic benefits of IPM strategies for maize, beans, and sweet potato on smallholder farms in southern Malawi. Major pests included witchweed (*Striga asiatica*), whitegrubs and termites on maize, wilting of beans and pigeonpeas caused by bean stem maggott (BSM) and *Fusarium* wilt respectively, and sweet potato weevil (*Cylas sp.*). Candidate IPM strategies included varietal resistance in beans and pigeonpea; cultural methods for sweet potato weevil; seed dressing for whitegrubs; and trap cropping with legumes, and green manures against witchweed. Modeling suggests that IPM interventions increased net benefits by 12 % over existing levels while the increase from soil fertility interventions was 34 %. Since low soil fertility, not pests, is the major constraint in the farming system IPM is best combined with a broader integrated crop management (ICM) approach to poverty alleviation. Farmers are now helping to refine the models by diagramming farm households and designing OFTs to test IPM interventions.

Introduction

What economic benefits (if any) can IPM offer resource-poor farmers in sub-Saharan Africa ? It is widely assumed that crop losses from pests are high and that IPM strategies are appropriate for smallholders because of the high cost of chemical control. However, while IPM has been successful against pest epidemics its effectiveness against endemic pests of staple foodcrops is problematic. On the supply side, although a wide range of potential interventions have been identified (Hillocks *et. al.*, 1996b) there is "a general lack of proven, effective control technologies" (Kiss and Meerman, 1991). On the demand side, smallholder adoption of IPM is limited because pests are not necessarily the most important constraint on maize yields. The smallholder farming system of southern Malawi is characterised by growing population pressure (> 290 km^{-2}), continuous maize cropping and limited access to fertiliser and hybrid seed. Consequently, "*the most important threat to sustainability of smallholder maize-based systems is the decline of soil fertility associated with falling levels of organic matter and soil nutrients as traditional farming practices become untenable under growing population pressure*" (Blackie, 1995).

Whole-farm modeling offers one method of estimating the benefits of IPM interventions for smallholders. Modeling is widely used for *ex ante* analysis of interventions (Barlow *et. al.*, 1979; Berdegue *et. al.*, 1989; Ghodake and Hardaker, 1981). Over-sophistication has limited the usefulness of farm modeling in farming systems research (FSR) since interactions between system omponents are harder to identify in complex models (Anderson *et. al.*, 1985). This paper describes a descriptive, non-optimising model which simplifies data-analysis and where outputs can facilitate farmer-researcher dialogue in evaluating interventions.

The objective of the paper is to measure the economic impact of IPM strategies for staple foodcrops grown by smallholders in southern Malawi. Specifically, we: (1) model the economic impact of IPM interventions for maize, beans, sweet potato, and vegetables; (2) compare net benefits from five IPM interventions; (3) compare the economic impact of IPM and soil fertility interventions; and (4) illustrate farmer participation in refining the models.

Malawi case study

The Farming Systems IPM (FSIPM) Project operates in the Blantyre Shire Highlands Rural Development Project (RDP) where the maize ecology is representative of 40 % of the area planted to maize in Malawi (Heisey and Smale, 1995). Sixty percent of holdings are under 0.5 hectares. Female-headed households (FHHs) comprise38 % of households in the RDP (GoM, 1996). The farming system is maize-based with pigeonpea and beans as the main pulse and legume intercrops. Relay-planting of beans and fieldpeas is also practised. Official crop statistics show maize yields averaged 836 kg/ha for local varieties and 1765 kg/ha for hybrid semiflint varities between 1992-96. Low average yields reflected poor soil fertility and low rates of inorganic fertilizer. Burley tobacco and *dimba* vegetables grown on residual moisture or with irrigation are the most valuable cash crops.

Termites, whitegrubs and *Striga asiatica* were identified as the major field pests of maize; BSM (*Ophiomyia spp.*) and *Ootheca* as major pests of beans; and *Fusarium* wilt as the major pest of pigeonpea (Hillocks *et. al.*, 1996a; Munthali *et. al.*, 1993). Major pests of vegetable crops were diamondback moth (*Plutella xylostella*) and clubroot (*Plasmodiophora brassicae*) for cabbage and red spider mite (*Tetranychus lambi*) for tomato (MOALD, 1994).

Data and methods

Cluster analysis was used to identify representative farm households for modeling (Orr and Jere, 1998). Data for the cluster analysis derive from a baseline survey of 120 smallholder households conducted at FSIPM survey sites in four villages in two Extension Planning Areas (EPAs) during the 1996/97 crop year (Orr *et. al.*, 1997). The sample was stratified by EPA, by participation in OFTs, and by sex of household head. Results showed that smallholders in the Project area could be stratified into five broad groups:

- ***Dimba** households* (one third of which were FHHs) producing maize and vegetables (cluster 1);
- *Stable male-headed households (MHHs)* producing neither vegetables nor burley tobacco, but enough maize to be reasonably food-secure (cluster2);
- *Vulnerable households* which produced neither vegetables nor burley tobacco, and without enough maize to be food-secure;
- *Burley households* which did not produce vegetables but enough maize to be reasonably food-secure; (cluster 4); and
- *Stable FHHs* which produced neither burley nor vegetables but enough maize to be reasonably food-secure.

Enterprise budgets were constructed for 17 existing agricultural activities, seven IPM interventions, and two soil fertility interventions (Table 1). Wherever possible, data on crop losses and crop loss reduction from IPM interventions was obtained from OFTs. Where this data was not yet available (whitegrubs, BSM, sweet potato weevil) conservative estimates were made by field researchers. (Assumptions for reductions in crop losses are provided in the footnote to Table 2). Enterprise budgets for soil fertility interventions were taken from the Malawi Agro-Forestry Project (Hayes, 1998). Areas under each enterprise were derived from field measurements, and yields from FSIPM OFTs.

IPM interventions included: soyabean as a trap crop for *Striga*; varietal resistance for BSM; and sealing cracks on sweet potato ridges to prevent entry by sweet potato weevil (*Cylas sp.*)[Pardales and Cerna, 1987]. Although vegetables are not included in the Project mandate, their importance in the Project area was sufficient to justify modeling the effect of reducing the current excessive rates of chemical control for cabbage and tomato. Varietal resistance to *Fusarium* wilt was not modeled because a resistant variety (ICP 9145) is already widely grown. Similarly, no suitable IPM intervention against termites has been identified. Soil fertility interventions included green manuring using *Tephrosia vogelii* undersown with maize and hedgerow intercropping using *Senna spectabilis*, which have been widely tested in Malawi and produce maximum benefits within three-five seasons (Bunderson *et. al.*, 1995; MAFE, 1998). Systematic tree interplanting with *Faidherbia albida* was not modeled because of the 10 or more years required for maximum benefits (Dewees, 1995). Soil conservation interventions were not modeled because research in Malawi has shown low economic returns (Bishop, 1995; Eaton, 1996).

Interventions were modeled using the software FARMACTION (Magor, 1992). Enterprise budgets were combined into farm plans with the mix of enterprises and level or area under each enterprise determined by baseline survey data for each of the five clusters. Three farm plans were modeled for each cluster: the existing system, changes with IPM interventions, and changes with soil fertility interventions. The method is purely descriptive, without optimisation subject to resource constraints. The results presented here are preliminary and subject to validation by farmers.

Results

Table 2 compares the relative impact of IPM and soil fertility interventions for each cluster of households. IPM interventions increased net benefits for all clusters, with a weighted average increase of 12 %. The greatest proportionate increases were found among vulnerable, stable male-headed, and stable female-headed households. Soil fertility interventions had a proportionately greater effect, raising existing household net benefits by an average of 34 %. The proportionate increase over existing returns was more evenly spread, with *dimba* households also sharing in the benefits. Changes in labour requirements resulting from IPM interventions were less than 15 days/year in all cases, but were higher with soil fertility interventions, reaching 25 and 28 days/year in the *dimba* and stable male-headed clusters. IPM interventions reduced material cash costs for *dimba* households but increased cash costs for other clusters. Soil fertility interventions increased material cash costs for all clusters.

Table 3 shows the net benefits (gross returns minus material and labour costs) associated with each IPM intervention. Net benefits varied from 300-500 MK/household. Crack sealing for sweet potato gave the highest net benefits despite high additional labour costs. Varietal resistance to BSM gave significant benefits, particularly for the main bean intercrop. Benefits from trap cropping for *Striga* were generally lower than for maincrop beans, at present rates of infestation. Finally, net benefits from reduced chemical pest control on cabbage and tomato were relatively low because of the small area planted to these crops.

Discussion

IPM and smallholder systems

The whole-farm models demonstrate 'the power of the budget' in evaluating new technology (Carruthers and Kydd, 1997). While interventions appear attractive expressed in terms of standardised per hectare budgets, the benefits are much smaller for the average farm family. Clearly, IPM strategies for major foodcrops have some potential to raise smallholder income in southern Malawi, particularly among resource-poor households which lack access to cash crops such as high-value vegetables or burley tobacco. Nevertheless, the total increase in returns from IPM interventions (12 %) is disappointingly small and support the view that many interventions proposed for resource-poor African farmers are unprofitable (Anderson, 1990).

Individual interventions show some potential for poverty reduction. National crop statistics show a nine-fold increase in sweet potato production between 1990-97; converted to maize equivalents, sweet potato now accounts for over 10 % of crop production compared to 2 % in 1990 (Simmons, 1998). The reasons for this increase include the release of Kenya, a high-yielding, palatable variety popular with commercial growers. In addition, high nitrogen-maize price ratios following the collapse of smallholder credit system in Malawi in 1993/94 have forced poorer households to search for alternatives to fertilised maize.Given the high losses from sweet potato weevil (30 %), an IPM strategy which uses cultural rather than chemical control offers poorer households an affordable method of improving food security. While crop losses from *Striga* are small at present, they will inevitably increase and are a particular threat to poorer households cultivating infertile soils and with limited access to inorganic fertiliser. Trap crops offer a low-input IPM strategy to counter this threat.

Economic incentives for IPM

The limited potential impact of IPM on smallholder gross returns reflects the almost complete absence of investment by smallholders in crop protection for staple foodcrops. In developing countries, IPM has enjoyed most success with commercial crops which have a high market value. Experience in Asia (rice) and in Latin America (maize) suggests that IPM for staple foodcrops has been successful where farmers already used large, frequently excessive amounts of pesticide and where IPM offered significant savings in cash costs. In Africa, too, "most IPM projects relate to these types of [high-input] systems because it is here that visible results are most easily achieved in the short term" (Kiss and Meerman, 1992). Since Malawian smallholders use few pesticides on foodcrops, cost savings from IPM adoption are minimal. In these circumstances, the most attractive IPM interventions are varietal resistance and classical biological control where the costs are borne by the publicly-funded agricultural research system and which require little or no increase in expenditure of cash or labour from the producer.

IPM and Soil fertility

Soil fertility interventions offer significant (> 30 %) increases in net benefits, suggesting that soil fertility is the major constraint on maize yields. In such circumstances, IPM is more effective as part of a broader strategy of integrated crop management or ICM to raise maize yields (Kiss and Meerman, 1991; Meerman *et al*., 1996). IPM for resource-poor farmers must therefore hit a double target. " A new technology will be more attractive if it solves not only a pest problem but a production problem as well" (Litsinger, 1993).

The complexity and heavy labour requirements of some agroforestry technologies have limited their adoption by Malawian smallholders (Dewees, 1995). Interventions must also compete with returns from off-farm employment (Becker, 1990). The whole-farm models suggest that undersowing *Tephrosia vogelii* and hedgerow intercropping with *Senna spectabilis* are labour intensive for some households, and need to be used in rotation to reduce yearly labour requirements. In rainfed maize-based farming systems with a single growing season, many farm operations - planting the main crop, planting intercrops, fertilizing, first and second weeding - must be concentrated in the first critical six weeks of the growing season to ensure optimum maize yields. Thus, the integration of agroforestry interventions with other farm operations during this 'six-week window' needs careful consideration.

Agroforestry technologies may require specific IPM strategies if they are to be successful. Two initially promising agroforestry interventions - *Leucaena* and *Sesbania sesban* - have experienced severe damage from psyllid and aphid pests. Similarly, *Tephrosia vogelii* supports root knot nematodes (*Meloidogyne incognita*) which may infect pigeonpea plants and lead to a breakdown of resistance to *Fusarium* wilt in resistant pigeonpea cultivars (Hillocks and Songa, 1993). IPM thus has an important role to play in developing viable soil fertility interventions.

Modeling and farmer participation

Farmers have been largely excluded from whole-farm modeling because of the complex and abstract nature of the methods favoured by researchers. Output from the FARMACTION software consists of simple yearly and monthly breakdowns of gross returns, net returns, and physical and cash inputs. Using PRA techniques - matrices, seasonality charts, chapatti diagrams - these ouputs can be converted into forms which are easily understood by farmers. Farmer participation can enhance researchers' understanding of the structure of the model, identify gaps in knowledge, and serve to fine-tune IPM interventions. During the 1998/9 crop season we will use the whole-farm models as a basis for farmer-researcher dialogue with households from each of the five clusters. Two examples from this on-going process are provided below:

1. Modeling of *dimba* households

Participatory modeling began with *dimba* households to coincide with winter vegetable production. Briefly, the method was to (1) work intensively with one farmer to understand his farming system; (2) ask this farmer to facilitate diagramming a 'typical' *dimba* household with other *dimba* farmers; and (3) produce a modified farm plan for discussion with the group which had produced the generalised farm diagramme. With the farmer case study we used field walks, farm diagrammes (resource flows, income), seasonality charts (vegetable production), and matrix ranking (labour use and pesticide expenditure). With the group approach we used only farm diagrammes. Diagramming was done separately with men and women in the household (s).

Table 3 shows the farm diagramme produced by the case study farm household. Important implications for modeling included: (1) the clear gender division of labour in *dimba* and dryland production; women were responsible only for marketing some *dimba* crops but provided most of the labour for upland crops; (2) expanding the variety of *dimba* enterprises to include rape, mustard and bananas; (3) the importance of off-farm enterprises (buying maize, maize bran) by women in the dry season; (4) a reduction in labour requirements for *dimba* in December-January to free household labour for weeding dryland maize; and (5) timing tomato harvesting to coincide with peak prices in December-January.

2. Farmer design of IPM interventions

The original model of the IPM strategy against sweet potato weevil was based on a researcher-designed OFTin the 1997/98 season. The crop was planted in January and harvested in May, with two crack-sealings in the third week of February and the first week of March to prevent entry of the adult *Cylas* weevil. Farmers produced a quite different design, however. They preferred to test crack-sealing after the rainy season, when damage from *Cylas* weevil was highest. More time was preferred between crack-sealings, with the first made10 weeks after planting (three weeks after second weeding) and second three months after planting. Farmers also preferred to seal cracks with their feet rather than with a hoe because this reduced labour requirements. Thus, the farmer-designed OFT for this IPM intervention, which will be tested in 1998/99, requires a major revision of the farm model.

Conclusion

Modeling suggests that IPM offers only limited scope for reducing poverty among smallholders in southern Malawi. Five interventions targeted at major pests of maize, beans, sweet potato and vegetables resulted in an average 12 % increase in net benefits over existing levels. IPM interventions for sweet potato and *Striga* have the potential, however, to benefit poorer households cultivating infertile soils and with limited access to fertiliser-hybrid seed technology. By contrast, green manuring and hedgerow intercropping increased net benefits by an average of 34 % over existing levels. Thus, combining IPM strategies with low-cost methods of enhancing soil fertility will both improve economic returns from crop protection and provide a sustainable basis for increased household food security. Working with farm families to develop and refine the models will allow farmers to participate more fully in establishing the feasibility of both sets of interventions.

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Table 1. IPM and soil fertility interventions modeled, FSIPM Project.

Existing enterprises	IPM Intervention	Soil Fertility Intervention
1. Unfertilised hybrid maize		Ditto + undersown *Tephrosia*
2. Unfertilised local maize		Ditto + undersown *Tephrosia*
3. Fertilised hybrid maize		Ditto + *Senna spectabilis*
4. Fertilised local maize		Ditto + *Senna spectabilis*
5. Local maize with *Striga*	Ditto + soybean trapcrop	
6. Dambo maize with whitegrubs	Ditto + seed dressing	
7. *Dimba* maize		
8. Beans, main intercrop	Resistant bean variety	
9. Relay beans	Resistant bean variety	
10. Field peas		
11. MV pigeonpea		
12. LV pigeonpea		
13. Sweet potato	Crack sealing	
14. Tomato	Reduced chemical control	
15. Cabbage	Reduced chemical control	
16. Burley		
17. Goat unit (4 does)		

Table 2. Gross returns, labour inputs, material and labour costs under existing system, IPM interventions, and soil fertility interventions.

(MK/household, 1996/97 prices)

Cluster Group	1 *Dimba* hh. (n=22)	2 Stable MHH (n=29)	3 Vulnerable hh. (n=24)	4 Burley hh. (n=11)	5 Stable FHH (n=34)
Gross returns (MK)					
Existing	5633	4208	3293	8543	2818
+ IPM	5879	4908	3758	9134	3272
+ Soil Fertility [a]	7368	5696	4092	9579	3877
Labour (days)					
Existing	400	174	151	227	122
+ IPM	410	189	158	238	132
+ Soil Fertility	428	199	159	243	139
Labour costs (MK)					
Existing	132	102	101	169	77
+ IPM	232	252	171	279	147
+ Soil fertility	412	352	181	329	247
Material costs (MK)					
Existing	2115	958	584	3641	623
+ IPM	2038	1063	638	3725	685
+ Soil fertility	2208	1074	627	3721	694
Net benefits (MK)					
Existing	3386	3148	2608	4733	2118
+IPM	3519	3593	2949	5130	2440
+ Soil fertility	4748	4270	3284	5529	2936
% change net benefits					
+ IPM	4	14	13	8	15
+ Soil fertility	40	36	26	17	39

Source: FARMACTION printouts, June 1998

Notes:

a Agroforestry inventions and proportionate yield increases from I. Hayes, MAFE Project [1998]) are:
(1) unfertilised local and hybrid maize with undersown *Tephrosia*;
(2) fertilised local and hybrid maize with *Senna spectabilis* and 65 kg/N/ha, which is farmers' existing rate on area planted to maize which is fertilised.
(1) local maize unfertilised: 600 kg/ha (FSIPM OFT, 1996), increasing by 63 % to 978 kg/ha after three years;
(2) hybrid maize unfertilised: 836 kg/ha (FSIPM OFT, 1996), increasing by 63 % % to 2198 kg/ha after three years;
(3) local maize fertilised: 1365 kg/ha (Crop estimates, Blantyre Shire Highlands, 1992-96) increasing by 120 % to 3003 kg/ha after five years;
(4) hybrid maize fertilised: 1765 kg/ha (crop estimates, Blantyre Shire Highlands, 1992-96), increasing by 120 % to 3883 kg/ha after five years.

Table 3. Estimated net benefits from IPM interventions, by cluster groupings.

(MK/household, 1996/97 prices)

Cluster Group	1 Dimba hh.	2 Stable MHH	3 Vulnerable hh.	4 Burley hh.	5 Stable FHH
IPM Interventions					
1. Sweet potato crack sealing [a]	-	356	235	356	235
2. Resistant bean variety (maincrop) [b]	104	132	138	113	78
3. Resistant bean variety (relaycrop) [b]	40	52	-	-	31
4. Soybean trap crop [c]	54	51	19	31	36
5. Maize seed dressing [d]	-	-	14	-	-
6. IPM tomato [e]	30	-	-	-	-
7. IPM cabbage [e]	70	-	-	-	-
Total	298	591	415	500	380

Source: FARMACTION printouts, June 1998

Notes:

a 30 % yield increase from crack-sealing, additional 33 days/ha labour, @ 10 MK/day;

b 20 % yield increase from improved bean variety from 314 kg/ha to 377 kg/ha;

c 10 % area planted to maize severely infested with *Striga* (information from village transects), with 60 % yield loss (Kroschel *et. al.*, 1996); additional 38 days/ha labour for planting soya @ 10 MK/day.yield increase from 240 kg/ha to 600 kg/ha;

d 15 % loss on area planted to maize in Chitera dambo, reduced to 3 % (T. Mzilahowa, *pers. comm*). Yield increase from 510 kg/ha to 582 kg/ha;

e Expenditure on chemical pest control reduced by half, to 375 MK/ha for tomato and 1167 MK/ha for cabbage.

Table 4. Farmer diagramme of *dimba* household farming system, southern Malawi

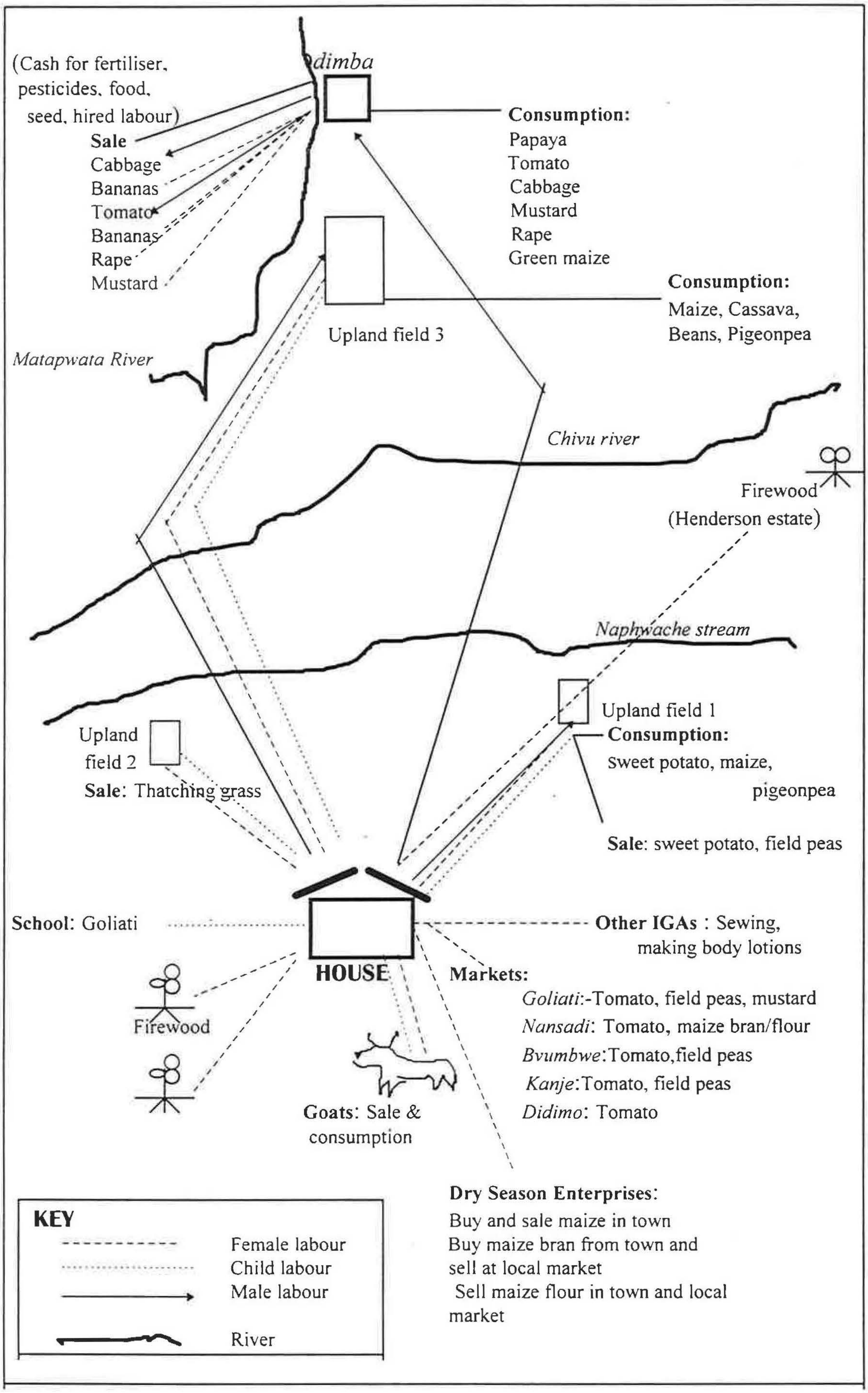

Table 5. Comparison of farmer and researcher design of OFT for crack-sealing against sweet potato weevil (*Cylas puncticollis*).

On-farm trial	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Researcher-design												
Farmer-design												

Key:
——— Sweet potato crop, ⟶ Crack-sealing, ········· Weeding

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

THE ECONOMIC POTENTIAL OF IPM FOR *DIMBA* CROPS

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Abbreviations

BLADD	Blantyre ADD
CYMMT	Centro Internacional de Mejoramiento de Maiz Y Trigo
DAR	Department of Agricultural Research
EPA	Extension Planning Area
FEWS	Famine Early Warning System
FHH	Female-headed household
FSIPM	Farming Systems Integrated Pest Management
GOM	Government of Malawi
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
IGA	Income generating activity
IPM	Integrated Pest Management
MGPPP	Malawi-German Plant Protection Project
MK	Malawi Kwacha
MOALD	Ministry of Agriculture and Livestock Development
NPK	Nitrogen, Phosphorus, Potassium
NSSA	National Sample Survey of Agriculture
OFT	On-farm trial
ODA	Overseas Development Administration
RDP	Rural Development Project
WHO	World Health Organisation

Abstract

A diagnostic survey of the economic potential of IPM for dimba *crops was conducted in 1997/98 with 30 households in Matapwata EPA, Blantyre Shire Highlands RDP. Food security among the sample averaged nine months self-sufficiency in maize during the 1996/97 season, two months above the average for farmers participating in FSIPM trials. Only two households were female-headed. Men did field operations for* dimba *crops except for irrigation, harvesting, and marketing. Almost all farmers applied pesticides to tomato and cabbage crops. Fourteen different brands of pesticide were in use, three of them highly toxic. Farmers' application rates were well above recommended rates. Expenditure on pesticides for* dimba *crops averaged 425 MK/household/year (US $ 10). Gross returns from* dimba *crops averaged 3186 MK/household/year (US $ 72) and the gross margin averaged 1419 MK/household/year (US $ 32). IPM to reduce pesticide rates to recommended levels would, if adopted, result in cash savings of US $ 5 yearly. While low in absolute terms, this represented a 100 % rate of return. The cash saving was equivalent to 12 % of average cash costs and 15 % of the average gross margin from* dimba *cultivation. Since farmers believe their current pesticide application rates are too low, reducing these rates will require investment in training farmers, retailers, and extension agents.*

1.0 Introduction

Smallholders in Malawi spend virtually nothing on chemical forms of crop protection. Of the US $ 16 million expended on pesticides in 1992, it is estimated that only US $ 0.8 million (5 %) is spent in the smallholder sub-sector. This is equivalent to just US $ 0.4 per hectare of customary land (von der Ohe and Kaske, 1997). Pesticides are rarely applied to field pests of low-value foodcrops (maize, beans, pigeonpea, sweet potato) grown in dryland conditions. By contrast, they are widely used on *dimbas* - cultivable land adjacent to a water source [a] - where high-value crops are grown under irrigation in the dry season. For smallholders, therefore, the potential scope for cost-savings from adoption of IPM interventions is far greater for irrigated crops grown in the dry season than for wet season foodcrops.

Roughly one-third of Malawian smallholders have access to *dimba* land (FEWS, 1996). A brief survey by BLADD in 1987/88 showed that 33 % of households in Blantyre Shire Highlands RDP grew *dimba* crops and of these 21 % used pesticides (BLADD, 1988). There is conflicting information on rates of pesticide use. A case study of six tomato growers near Bvumbwe in February 1991 showed excessive rates of pesticide use, as much as ten times above recommended levels (Braunworth Jnr., 1993). By contrast, a recent analysis of pesticide residues on cabbage and tomato sold in Ntcheu and Dedza in May 1995 showed residues of only 0.1 mg/kg, well below the maximum residue limit established by the WHO (Kern, 1995). It is difficult to draw general conclusions without larger samples of pesticide use on vegetable crops. Despite the importance of *dimba* crops as a source of cash, nutrition, and food security in smallholder agriculture, there is relatively little information about them. The NSSA, for example, focused exclusively on dryland agriculture (GOM, 1996). A detailed study of *dimba* cultivation exists for only one area in the central region (Dohnaleke-Droste, 1997). Consequently, the economic potential for IPM in *dimba* crops in the southern region is unknown.

While the mandate for research on IPM for vegetable crops lies with the Malawi-German Plant Protection Project (MGPPP), a recent review of the FSIPM Project recommended research on the potential for IPM on *dimba* crops in its Project area (Hansell *et. al.*, 1997). This information was intended to provide the necessary background for the demonstration of IPM for vegetable crops. Research on IPM for smallholder *dimbas* in the central region has identified clubroot (*Plasmodiphora brassicae*) as the major pest of cabbage and red spider mite (*Tetranychus lambi*) as the major pest of tomato (Thindwa, 1996). In the event, the MGPPP Project considered that IPM interventions for vegetables were not yet ready for demonstration and extension. The FSIPM Project has therefore continued with its original mandate to focus on IPM for dryland crops.

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[a] A *dimba* may be formally defined as an area of cultivable land adjacent to a water source which is cultivated in the dry season with irrigation from streams or wells.

This report analyses the results of a diagnostic survey on *dimba* crops carried out by the FSIPM Project. This information may prove useful to crop protection researchers when IPM interventions for *dimba* crops are eventually tested in OFTs and extended in the southern region. The diagnostic survey also illuminates an important, though neglected, aspect of the smallholder farming system. Already *dimba* crops play an important role in the smallholder economy in the Blantyre Shire Highlands. Their importance is likely to grow as the profitability of dryland agriculture declines due to the increasing cost of inorganic fertiliser and falling maize yields resulting from the progressive loss of soil fertility.

The specific objectives of this report are to: (1) determine the socioeconomic status of *dimba* growers in relation to the FSIPM target group; (2) explore the interactions between *dimba* and dryland agriculture; (3) determine household expenditure on pesticides in relation to average household income from *dimba* crops; and (4) estimate the potential cash saving from reduced pesticide rates.

2.0 Data and methods

The FSIPM Project operates in four villages in two EPAs located in Blantyre Shire Highlands RDP, southern Malawi. A baseline survey of 120 farm households in the FSIPM Project area showed that one-third of households in the sample had *dimba* gardens and that *dimba* production was concentrated in Matapwata EPA (Orr *et. al.*, 1997). A listing showed 57 households cultivating in three major *dimba*s (Mayera, Napwache, and Namikoko) in Magomero and Kambuwa villages, Nansadi section. A random sample of 30 households was selected for survey using a formal structured questionnaire. A sub-sample of these 30 households was interviewed to determine labour requirements for tomato (seven cases), cabbage (six cases), *dimba* maize (three cases), rape (four cases), and mustard (two cases). Information on crop budgets was collected for a specific plot which was measured using triangulation and pacing. Labour requirements for each plot were obtained by farmer recall. The survey was conducted in December 1997, after the start of the 1997/98 wet season.

In addition, one household was interviewed in depth about the issues discussed in this report. Several visits were made. On the first visit, we walked through his fields with the farmer. This helped him feel at ease and it helped us see what questions to ask. As we walked along, we asked the farmer the activities, enterprises, and the ecosystems we saw. During this field walk we were accompanied by one of his sons though not by his wife. A second visit was made to obtain more detailed information and make a diagrammatic representation of the farming system. With our guidance, the farmer drew a seasonality chart of his *dimba* crops and then a diagramme of his household's agro-ecosystem, showing labour divisions by gender and tasks. On a third visit, we refined the conceptual diagram with the help of his wife. Finally, on a fourth visit we invited two other *dimba* farmers and their wives to draw a similar farm diagramme and used this to obtain a more general picture of *dimba* production.

A visit was made to Bvumbwe local market to meet private pesticide traders in order to : (1) identify *dimba* crop pesticides that were on the market; and (2) measure the application rates recommended to farmers.

3.0 *Dimba* growers and the FSIPM target group

The FSPM Project is targeted at "smallholders with 1.0 hectares or less of whom at least half are female-headed households" (ODA/GOM, 1995). In fact, nine of ten households in Blantyre Shire Highlands RDP cultivate less than one hectare (GoM, 1996). A more appropriate criterion for targeting poorer smallholders is their degree of food security, measured as the number of months the household is self-sufficient in maize.

Food security and income

Food security among the sample averaged nine months for the crop year 1996/97 (Table 1). This reflects maize production from the crop harvested in March 1996. The 1996/97 crop year was a poor one for maize production because of heavy rainfall during the early stage of the growing season, which prevented timely weeding and increased leaching of inorganic fertiliser. Average maize production for BLADD fell by 40 % over the previous season (BLADD, 1997). The average level of maize self-sufficiency for households in the FSIPM Project area in 1996/97 was 7 months (Orr *et. al.*, 1997). The above-average level of food security among *dimba* households in a poor season suggests that they may be classed among the better-off smallholders. Averages are deceptive, however. While eight households (40 % of the sample) were self-sufficient in maize, four (20 %) had food security of less than 6 months.

Their above-average level of food security shows that *dimba* households are not specialised producers but have continued to cultivate dryland maize in order to reduce reliance on the market for their maize requirements. Of 30 households in the sample, only two specialised completely in *dimba* production and had no dryland fields. (A case study of one of these households is provided in Orr *et. al.*, 1997.) Relying on income from *dimba* crops for maize purchases is a high-risk strategy. *Dimba* production is vulnerable to losses from pests and disease, and market prices for high-value crops fluctuate considerably over short periods. The two households which specialised in *dimba* production grew high-value crops harvested at times when prices were high.

Gross income from *dimba* crops was relatively low, averaging 2850 MK/household/year. This figure underestimates gross income slightly, since some households could not give accurate figures for income from mustard and rape that are harvested piecemeal and earnings spent immediately on household necessities, including food. Again, income was variable. While three households reported income from *dimba* of over MK 7,000 one household had zero income due to waterlogging on their *dimba* garden. Access to *dimba*, therefore, is not necessarily an indicator of a high cash income from agriculture. On average, *dimba* provided three-quarters of household cash income. Thirteen households (43 %) reported income from *dimba* as their sole source of cash income while five households (17 %) reported that *dimba* crops accounted for half or less of their total cash income.

Female-headed households

Dimba households differ significantly from the FSIPM target group in that more are headed by men. While 38 % of smallholder households in Blantyre Shire Highlands RDP may be classified as FHHs (GOM, 1996), only two *dimba* households (9% of the sample) were headed by women. Of these, one was a divorcee who cultivated only maize and tomatoes and could not afford pesticides. The other, a widow, operated two *dimba* gardens and cultivated the full range of *dimba* crops. In both households, however, the household head was not involved in field cultivation which was done by children, including teenage sons.

Four reasons may be offered for the low proportion of female-headed households cultivating *dimba* gardens:

- Cultural controls on the acquisition of production skills necessary for *dimba* cultivation. There is nothing inherent in the techniques that prevent their acquisition by women. A clear gender division of labour exists in field operations, with female participation restricted to irrigation, harvesting, and marketing. Similar cultural controls are found in other crop enterprises; female burley-growers, for example, hire men to build their drying sheds because for women to do this is just "not done".

- Social pressure to allow brothers to lease or control *dimba* land when women become widowed, divorced, or separated. *Dimba* land is commercially valuable, with four households in the sample renting *dimba* gardens (Table 1). Newly divorced or widowed women with young families may wish 'protection' from brothers and one way to secure this is to allow them to cultivate the household's *dimba* garden. Similarly, while men usually move to their wife's village after marriage, they may ask their sisters to allow them to continue to cultivate their parents' *dimba* land. Other men may even choose to remain in their home village after marriage if their sisters will provide them with *dimba* land. One of the two households specialising in *dimba* production is a case in point (Orr *et. al.*, 1997).

- The existence of other culturally approved ways for women to earn cash income. An obvious example is trading in flour or bran, which may involve travel to Limbe or Blantyre. Trading in these commodities typically requires less start-up capital (MK 150-200) as cultivation of high-value *dimba* crops like cabbage. Women are also actively involved in wholesale purchase (*pikulitsa*) of *dimba* crops, selling from large market centres such as Bvumbwe. *Pikulitsa* offers high value-added with mark-ups of 50 % over farmgate prices (Braunworth Jnr., 1992).

- Trading may also be more remunerative than *dimba* production in terms of returns to labour. This may make it more attractive to female-headed households that on average have less labour available than male-headed households. Although *dimba* cultivation is labour-intensive, only 7 households (23 % of the sample) hired labour for *dimba* crops (Table 1). Asked why they did not hire labour for *dimba* production, farmers replied that high-value crops required their close personal attention. Average returns to labour from *dimba* were close to returns from *ganyu* labour on nearby estates (see section 6.0, Table 11), a common income generating activity among FHHs.

The absence of FHHs from *dimba* production is not sufficient reason for ignoring this enterprise on the grounds that it discriminates against women. It merely underlines the point that IPM interventions have different target groups. To benefit FHHs directly, IPM for *dimba* production may be pursued in tandem with other targeted IPM interventions such as improved pest management for kitchen gardens.

4.0 *Dimba* and the farming system

Dimbas

Dimba gardens vary widely according to their cropping potential, which depends on soiltype, land quality, and water supply. Table 2 summarises key features of the *dimba* gardens cultivated by the sample households. Of 49 *dimba* gardens in the sample, almost one-quarter (23 %) were rented. Rentals ranged from 180-240 MK/year, with single-season rentals of MK 40-60. Rented gardens are available only for short periods to avoid conflicts over cultivation rights; it was rare for the same *dimba* garden to be rented for more than two years. The range of crops grown was quite narrow (less than three per *dimba*, on average) with tomato (*Lycopersicon esculentum*), cabbage (*Brassica oleracea var capitata*), maize (*Zea mays*), rape (*Brassica napus*) and mustard (*Brassica carinata*) the five most popular crops. Irrigation came primarily from shared rivers or streams; only 13 households invested in ponds or wells. Presumably, this meant the shared water supply was adequate. Only five *dimba* gardens (10 % of the sample) experienced shortage of water during the growing season.

A generalised crop calendar with the months in which the five major *dimba* crops are generally is shown in Figure 1. There were two popular periods for growing each *dimba* crop. The exception was *dimba* maize that was usually grown only between October – January. Cultivation of *dimba* crops was not continuous but stopped at the end of November with the start of the rains. Some farmers continued to grow tomato in the wet season but competition for labour with dryland crops and high disease pressure during this period made this a risky venture.

Interactions between dimba and dryland agriculture

Only two households in the sample (7 %) were exclusively producers of *dimba* crops (Table 2). In general, *dimba* households are not specialists but attempt to combine irrigated with dryland production. The interactions between these two activities are important for an understanding of *dimba* agriculture. Among the sample, half reported that the main use of income from the sale of *dimba* crops was to purchase fertiliser for dryland agriculture (Table 3). The second most important use of cash from the sale of *dimba* crops was to buy maize during the 'hungry months' when household maize stocks were exhausted. This suggests that smallholders have used *dimba* cultivation as a strategy to maintain household food security in maize, namely to buy fertiliser in order to maximise household maize production in the face of rising real fertiliser prices or to increase cash reserves to cope with higher consumer prices.

The successful integration of irrigated and dryland agriculture requires a careful allocation of labour. Most households rely on their own labour for cultivation of *dimba* crops. The result is a shortage of labour between July - October when *dimba* crops require irrigation and when labour is also required to prepare land for dryland crops. Just as irrigation is the single most labour-intensive operation for dry season *dimba* crops, so land preparation for dryland crops is highly labour-intensive with clearing, incorporation of crop residues, and ridging done manually with a hoe. Eighteen households (60 %) reported that *dimba* cultivation created labour shortages for dryland agriculture, the bulk of this during the period for land preparation (Table 3). Relatively few households hired labour for these activities, however. This suggests that labour shortages may limit the area of *dimba* crops which households can cultivate where they are unable to hire labour and unwilling to risk their maize crop by delaying land preparation.

5.0 Input use: fertiliser, pesticides, and labour

The average area under each *dimba* crop was extremely small (Table 4). Although area estimates were based on a small sample for each crop, they agree closely with previous estimates of 0.03 ha for tomato (Braunworth, Jnr., 1992) and 0.054 ha for tomato and 0.085 for cabbage (Dohnalek-Droste, 1995).

Management practices for five major *dimba* crops showed:

- Most farmers purchased seed, fertiliser, and pesticides, resulting in a high level of cash expenditure. Rape and mustard were relatively low-input crops, however.

- The cost of fertiliser was highest for cabbage (MK 265), tomato (MK 172) and *dimba* maize (MK 164). Farmers applied unbalanced fertiliser rates: 160-60-0 NPK/ha for tomato (compared to the recommendation of 140-180-150 NPK/ha) and 253-180-00 NPK/ha for cabbage. No farmers used the 'S' compound recommended as basal fertiliser by DAR (MOALD, 1994).

- Mean pesticide costs were MK 124 for tomato and MK 120 for cabbage. Average expenditure for pesticides was lower than that for fertiliser.

- Pesticide sprays averaged 19 for tomato and 14 for cabbage whereas maize received less than two sprays. The greater number of sprays for tomato reflected a high proportion of preventative spraying for wilting (probably caused by late blight, *Phytophthora infestans*) and red spider mite. Spraying for *dimba* maize was usually curative after evidence of damage from stalkborers. se crops were frequently sprayed with whatever pesticide was left over from spraying tomato or cabbage.

- Irrigation was necessary for all five *dimba* crops. The exact frequency of irrigation depended on the month of planting, soil texture, the rainfall pattern, and the availability of labour. Four crops (tomato, cabbage, rape, and mustard) required 48 or more separate irrigations during the growing season. Irrigation was most frequent for cabbage, which required 72 separate waterings. *Dimba* maize required less frequent irrigation (40 times) because it is usually planted in October and matures during the wet season before harvesting in January.

Labour

Twenty-two households (73 %) reported that watering was the most labour-intensive activity in *dimba* cultivation. This is reflected in the participation rates for each farm operation (Table 5). While men participated evenly in all *dimba* activities, this was not true for women and children. The participation of women and children was highest in watering, harvesting, transporting, and selling *dimba* crops. Men were responsible for nursery management, land preparation, and application of pesticides. Female participation in irrigation reflects the labour-intensive nature of this activity, which is done by hand using buckets. Manual irrigation pumps (treadle and rower pumps) which have spread rapidly in parts of South Asia are completely absent. Although the potential for similar labour-saving irrigation devices in Malawi evidently exists, it remains unexplored. It seems likely that the high labour requirement for irrigation is a constraint on the area planted to *dimba* crops.

6.0 Pesticide use

Dimba households reported the use of 14 pesticides during the 1997/98 season (Table 6). Of these, 11 were insecticides and three were fungicides. In addition, seven cases of the application of chemical mixtures were found. Farmers who mixed chemicals told us that they believed two control agents were better than one. The large number of pesticides in use suggests that availability is not a serious problem although farmers may lack information about application rates and their effectiveness against specific pests. Of the 14 pesticides listed, three (Temik, Azodrin, and Lanate) fell into the extremely or highly hazardous category (Ia, Ib) established by the WHO. Temik is a Class Ia pesticide, extremely hazardous. In the US its use is restricted to tree and strawberry plantations and fruit from treated areas is not allowed to be used in the year of treatment. Lanate and Azodrin are Class Ib pesticides, highly hazardous. Use is restricted in the US. Six pesticides were classed as only moderately hazardous and four as slightly hazardous.

Cross-tabulation of pesticide by pest showed no discernible pattern, suggesting that farmers used whatever pesticide came to hand (Table 7). Less frequently grown crops such as rape and mustard were treated with whatever pesticide was left over after spraying cabbage and tomato. Temik, classed as extremely hazardous, was used on tomato, cabbage, maize, and mustard against a variety of pests. Temik was chiefly used against cutworms in tomato or cabbage, either as a basal dressing around the planting station or sprayed directly onto the plant. Fungicides such as Dithane were also applied as insecticides against red spider mite on tomato.

Farmers' application rates

An attempt was made to measure farmers' application rates for the common pesticides applied to cabbage and tomato (Table 8). Measurements are approximate because we used average figures for the weight or volume of the local units used by farmers. Table 8 shows that in 12 of 17 cases (48 %) the concentration used by farmers was above the recommended rate. The concentration of Dithane M45 averaged 3.6 g/l compared with the recommendation of 2 g/l. The concentration of Cypermethrin averaged 3.4 ml/l compared with the recommendation of 0.5-1.0 ml/l. And the concentration of Lanate averaged 2.1 g/l compared to a recommendation of 0.5-1.0 g/l.

The two most common methods of applying pesticides were with a knapsack sprayer (48 % of applications) and with a perforated plastic bottle (30 %). Average application rates were estimated by using the volume for perforated bottles used by our case study farmers and measuring the area they sprayed with one bottle. Unfortunately, the Guide to Agricultural Production does not provide recommended application rates in terms of kg/ml. active ingredient (a.i.) per hectare. In four out of five cases, however, farmers' application rate for Dithane M45 exceeded the recommended rate of 1.4-1.6 kg. a.i./ha. The average application rate for this pesticide was 4.5 kg. a.i/ha.

Similarly, field measurements for tomato at Bvumbwe in February 1991/2 showed application rates of 4 – 9.4 kg a.i/ha for Dithane M45, and rates of 1.8 – 13.7 l a.i./ha for Malathion compared to the DAR recommendation of 2.4 – 4.0 l a.i./ha (Braunworth Jnr., 1992).

Case study farmers believed that their pesticide application rates were too low. Convincing farmers to reduce pesticide rates will therefore require demonstration trials to compare farmers' and researchers' application rates, as well as field schools to train farmers and extension agents in correct levels of pesticide use. Successful IPM programmes to reduce farmers' pesticide rates (such as rice in Indonesia) have required more investment in farming training than in technology development.

Pesticide retailers at Bvumbwe market

Only one private trader selling pesticides was met that day in the market. This trader was selling liquid Actellic that he claimed was the most effective pesticide during that time of the year (December) for a variety of *dimba* crops. Other pesticides that the trader normally sells included Daconil, Dithane and Copper oxychloride. He reported that these pesticides were sold mainly during the rainy season. He said Dithane, Copper and Daconil are effective against *Chiwawu* (wilting), a common problem during the rainy season.

One farmer came to buy the Actellic in our presence and we had the opportunity to hear the advice the trader gave to the farmer. We took some measurements of the amount of Actellic he was selling based on his recommended application rates. The trader's knowledge was based on the experience acquired as a *dimba* farmer; he had no formal training on pesticide use and handling. For liquid Actellic he recommended mixing 12 ml in a full watering can, equivalent to 1.2 ml/l. The research recommendation is 1ml per litre of water. With Daconil and Dithane, he recommended mixing two and half teaspoons (25 gm) of powder in one watering can, or 2.5 gm/litre. The recommended application rate for these pesticides is 2gm/litre. Thus, this trader's rates were higher than the research recommendations. For Copper oxychloride, however, his recommendation was 1.5 gm/litre compared to the research recommendation of 4gm/litre. The trader also did not know correct frequency of application, recommending farmers to apply Copper oxychloride weekly instead of fortnightly.

Pesticide costs in relation to income from dimba

Average expenditure on pesticides for *dimba* crops is impressive when expressed on a per hectare basis. Crop budgets for the major *dimba* crops show average pesticide costs of MK 3100 (tomato), MK 4000 (cabbage), MK 64 (maize), MK 400 (rape), and MK 600 (mustard). These sums were equivalent to 37 % of total cash costs for tomato and 19 % for cabbage (Appendix 1, Tables A1-A5). Our estimates of farmer application rates suggest that these expenditures could be reduced by at least half with the adoption of recommended pesticide rates. This represents a considerable saving in cash costs.

To estimate the economic potential for IPM, however, it is preferable to measure cost savings on the basis of the average farm household.. This shows the actual impact of IPM interventions for *dimba* producers. On average, each household cultivating *dimba* crops spent just MK 425 (US $ 10) each year on pesticides (Table 9). Farmers' application rates were more than double the rate recommended by DAR researchers. Halving pesticide application rates would produce a 100 % return on working capital, or the 2:1 return considered the minimum acceptable for new technology (CYMMT, 1988). This would save MK 213 or about US $ 5 per year. The value of this saving is evident when expressed as a proportion of the average income received from *dimba* crops. Total gross returns from *dimba* crops were estimated at MK 3186 (US $ 72) for the average household in the sample. This figure is close to the MK 2850 reported by *dimba* households (Table 1). Our estimate seems reasonable, therefore, particularly in view of the uncertainty over yields and output price variations for *dimba* crops. Expenditure on pesticides (MK 425) represented about 13 % of gross returns from *dimba* crops. The total gross margin (gross returns-cash costs) from *dimba* crops averaged MK 1419 (US $ 32) for each household. Expenditure on pesticides (MK 425) accounted for 24 % of total cash costs (MK 425/ MK 3186-1419) or 30 % of the gross margin. While low in absolute terms, therefore, potential savings from the adoption of IPM are significant at the household level.

Another economic benefit from IPM is the possibility of extending cultivation of *dimba* crops such as tomato and cabbage into the wet season. Most households avoid cultivating *dimba* crops during the three wet months of December-February, partly because pest and disease pressure during the wet season requires high levels of pesticide use. IPM interventions that reduced pest pressure during this period would allow more frequent production of these crops and add significantly to household income. However, the slack period in the wet season also reflects the need for timely planting and weeding of dryland maize. Extending *dimba* cultivation into the wet season would divert labour devoted to maize and jeopardise household food security. This is not a realistic option for the majority of *dimba* households which are not specialist producers of *dimba* crops.

The total labour input to *dimba* crops averaged 251 days/year, measured using a six-hour working day. This is close to the figure of 260 working days estimated for the central region (Dohnaleke-Droste, 1995). Returns to labour were roughly similar for each crop, with the notable exception of *dimba* maize. On average, returns per labour-day were MK 5.7. This compares closely with the MK 6 day paid for a *gwazu* (task, usually 4-5 hours' duration) on the nearby Kamphonji estate.

7.0 Farmer perceptions

Farmers were questioned directly about problems with *dimba* cultivation and specifically about problems with the two most common and potentially lucrative crops, cabbage and tomato (Table 11). In general, farmers believed that the major problems with *dimba* cultivation were economic. Twenty-two farmers cited high input costs, three cited low prices, and one cited the high cost of transport to market. Five farmers cited pests as a problem; in three cases, this referred directly to wilting of tomato. The cause of wilting was not determined but may refer to late blight (*Phytophthora infestans*). Of the 12 farmers who did not grow cabbage, seven complained that they lacked sufficient working capital to buy inputs (seed, fertiliser, and pesticides). Two complained that their *dimba* was too small to make it worthwhile to plant cabbage. By contrast, none of the farmers who did not grow tomato cited high input costs as a constraint.

8.0 Case study

Farm diagramme

Figure 2 shows the conceptual diagramme of the household's agro-ecosystem produced by the farmer and his wife. The household has three dryland and two *dimba* fields. One *dimba* and one dryland field are at his parents' home near Goliati market. This is the *dimba* where he grows most of his *dimba* crops. Another small *dimba* and two other small dryland fields are at his wife's home in Kambuwa village. The big field is approximately 2 hectares in area and the other two fields together add up to about 0.5 hectares. One of the small fields was left fallow for the past two years. Apparently, the family has enough land (about 2.5 hectares) and they do not manage to cultivate it all with the labour and capital available to the family.

Farm enterprises

The major crops that the family grows at the *dimba* are cabbage, tomato, papaya and bananas. They also grow maize, usually intercropped with some vegetables like rape, pumpkins and mustard. At the time we visited the *dimba*, the mustard had already been harvested but some plants were kept as a source of seed for the next season. If the family harvest more than enough seed for themselves, they sell the surplus to other farmers.

Maize and sweet potato are the main crops in the dryland fields. Maize is usually intercropped with pigeonpea, beans, cowpea, field peas, and cassava. Bananas are also grown as boundary crops. The largest dryland field also has some guava and mango trees. Sweet potato is usually rotated with maize. The family also raises goats.

Seasonality

Figure 3 shows the cropping pattern, labour, and income flows for *dimba* production. The *dimba* produces one crop of rape and cabbage and two crops each of tomato, mustard and *dimba* maize. In addition, it produces a continuous crop of bananas. The farmer does not grow a second crop of cabbage because of lack of capital for buying seed. He manages to grow a second crop of tomato, however, because he obtains seed from friends.

Dimba activities run for a period ten months between April-January. Labour demand peaks in the dry months of September and October when the farmer spends most of his time irrigating. Cabbage and tomato require almost daily irrigation. During the same period, the farmer prepares a nursery, sows tomato seed, prepares the land, and plants a second crop of tomato. Labour is also required to spray pesticides for cabbage and tomato. In the months of June and July, there is also considerable pressure on his labour because of the need to water rape, mustard cabbage, and the first crop of *dimba* maize. Labour demand drops considerably in December and January since irrigation is not required during the wet season.

Income from *dimba* crops is highest between December-January thanks to high vegetable prices caused by short supply. Tomatoes sold in December fetch almost double the price they fetch in October. The average price of cabbage goes as high as 10 MK/head in January compared to 4 MK/head in September. Few farmers grow a second tomato or cabbage crop, however, because they are afraid of pest infestation which peaks after the start of the rains. In addition, many *dimba* farmers cannot afford to buy pesticides during this period of the year as the price also increases with high demand. However, this farmer still plants a cabbage crop in July-September even if it fetches a low price because it gives the family money for buying seed for dryland crops, fertiliser and other household needs. In October and November he gets the second highest income from the *dimba*. Cabbage is the main source of that income. Rape grown in April also brings a good income to the family. Rape sold in May fetches 50 tambala/3 leaves whereas during the dry season it is usually sold at 10 tambala/4 leaves.

Pesticide rates

Information about pesticide rates used by the case study farmer was obtained by measuring the quantity of pesticide applied and number of plants and area sprayed. Application rates for cabbage were: Cypermethrin at a concentration of 7.5 ml/l, sprayed at a rate of 7.3 l/ha; Lanate at a concentration of 1.7 gm/l sprayed at a rate of 2.7 g/ha; and Ripcord at a concentration of 2.6 g/l, sprayed at a rate of 4.1 g/ha. Application rates for tomato were: Lanate at a concentration of 1.7 g/l sprayed at a rate of 5.4 g/ha and Ripcord at a concentration of 2.6 g/l sprayed at a rate of 8.2 g/ha. Pesticide spraying rates were doubled for tomato grown in the wet season. Copper oxychloride was used only for tomato in the wet season at a concentration of 3.2 g/l. The farmer thought his application rates were too low but could not afford to spend more on pesticides.

Division of labour

Usually, the husband works alone in the *dimba*. His main tasks include tilling, planting/transplanting, watering, weeding, fertilising (usually with manure), and spraying pesticide on tomato and cabbage. He himself mainly sells cabbage because it involves travelling a long distance to the market and the crop is bulky. With respect to the *dimba*, the wife helps in selling bananas, rape, mustard and tomato on the local markets. The markets she usually visits (Goliati, Nansadi, Didima and Bvumbwe). The first three are within a five km radius from home. Sometimes she helps irrigate vegetables and with tilling when the husband is tied up with some other activities. One of the sons also assists in watering vegetables after coming from school. At times, the child brings food from home especially during those periods when his father has to stay at the *dimba* the whole day.

The wife does the lion's share of work in the dryland fields, including land preparation, planting, weeding, banking and harvesting. Her husband and son usually assist her with land preparation and weeding. Purchase of all seed for dryland fields is the wife's responsibility but if seed is not available locally her husband travels to the nearest market to buy some. Besides fieldwork, his wife is also responsible for collecting drinking water and firewood. Normally firewood is collected from around the homestead but during the rainy season it must be collected every second week from Henderson Estate, 5 km distant. She also looks after the children on day-to-day basis. During the dry season, she is engaged in trading maize bought from local markets and maize bran bought in town. At times she also sells flour made from the maize she buys on the local market.

Feeding of goats is mainly the responsibility of children. At times the wife helps to cut grass for the goats. When it comes to selling, then the husband is responsible. Currently, off-take is high. The family has to sell one or more goats every year either to buy food during times of food shortage or fertiliser for the upland fields.

Interactions between* dimba *and dryland agriculture

The *dimba* plays a key role in the household's needs: not only is it a source of nutrition for the family but it is also a source of cash for various households needs. The income from the *dimba* helps the family to purchase fertiliser for the upland fields and to hire labour to assist the wife finish land preparation and weeding in time. Part of the money is also used to buy chemical pesticides for the *dimba* crops, vegetable/maize seed and maize during months of food shortage.

Upland field crops that are sold for cash are sweet potato and field peas. Last season, the family had two harvests of sweet potato, one in October and the other in June. The money from sweet potato sales was used to buy clothes for the family.

The household was previously a member of a credit club and could get as many as ten bags of fertiliser. With this level of fertiliser input, the family used to harvest enough maize for the family for a full year and would sell the surplus. Since the collapse of the credit system in 1993/94 season, however, the family has no access to fertiliser credit. The household's focus on *dimba* production reflects the declining profitability of dryland agriculture in the face of the increased real costs of maize production.

Conclusions

Generally, *dimba* households match the FSIPM target group of poorer smallholders although few of them are headed by women and the cultivation of *dimba* crops is dominated by men. Moreover, *dimba* households with access to *dimba* are not specialist producers but also cultivate the dryland crops (maize, beans, pigeonpea, sweetpotato) which are the target crops for the FSIPM Project. A number of important interactions between *dimba* and dryland agriculture were identified. Income from *dimba* is typically used for purchase of inorganic fertiliser and seed for dryland crops as well as buying maize when household stocks are exhausted. Thus, access to *dimba* is an important element in household food security. The peak labour demand for dryland maize during the early months of the wet season makes it difficult for households to cultivate dryland and *dimba* crops simultaneously and most households stop *dimba* cultivation between January-February. Pesticides are almost universally used for *dimba* crops. Application rates are high, in most cases well above the recommended rates. This offers scope for cost-savings through IPM interventions that rationalise pesticide use or provide alternatives to chemical control. Expressed on a household basis, expenditure on pesticides is low in absolute terms (MK 425/year). The impact on incomes from reductions in pesticide use is significant, however. Expenditure on pesticide was equivalent to 13 % of average gross returns from *dimba* cultivation, and 24 % of average cash costs. Halving pesticide application rates would increase average gross returns from *dimba* by 7 % and increase the average gross margin from *dimba* crops by 15 %. Since farmers wish to apply more pesticides rather than less, reducing pesticide rates will require training in correct pesticide use for farmers, retailers, and extension agents.

Acknowledgements

The *dimba* survey was administered by P. Jere, A. Koloko, and D. Menyamenya. P. Jere helped design the survey questionnaires and process the data. We also thank P. Khonje and I. Hoeschle-Zeledon (GTZ) for information on recommended pesticide rates.

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Table 1. Socioeconomic indicators for *dimba* households, Matapwata EPA, 1997/98 season.

Indicator	Magomero (n= 12)	Kambuwa (n=18)	Total (n=30)
Sex of household head			
- male	11	17	28
- female	1	1	2
Maize provision ability (months, 1996-97)	8.9	9.2	9.1
Type of labour used in *dimba* cultivation			
- household	7	16	23
- household and hired	5	2	7
Number of *dimbas* cultivated			
- one	3	12	15
- two	7	6	13
- three	2	-	2
- mean	2.1	1.3	1.6
Households renting *dimba* (no.)	4	2	6
Share of cash income (%)			
- *Dimba*	75.8	77.8	77.0
- Dryland	10.8	17.8	15.0
- Livestock	11.7	4.4	7.3
- Other	1.7	-	0.7
Average cash income from *dimba* (MK/crop season)	3993	2043	2850

Source: FSIPM Survey, 1997/98.

Table 2. Characteristics of *dimbas*, Matapwata EPA, 1997/98 season.

Indicator	Magomero (n= 25)	Kambuwa (n=24)	Total (n=49)
Tenure of *dimba*			
- owned	18	22	40
- rented	7	2	9
Years cultivated	9.4	10.8	10.1
- owned	12.3	11.6	11.9
- rented	2.0	1.5	1.9
Number of crops grown	2.48	2.58	2.53
Number growing:			
- Tomato	14	19	33
- Cabbage	14	11	25
- *Dimba* maize	10	14	24
- Rape	6	5	11
- Mustard	4	7	11
- Chinese cabbage	3	0	3
- Onion	5	0	5
Main water source:			
- Shared stream/river	7	24	31
- Shared well/pond	5	-	5
- Owned well/pond	13	-	13
Months water available (%)			
- Jan	92	83	88
- Feb	92	83	88
- Mar	92	92	92
- Apr	96	92	94
- May	96	92	94
- Jun	96	92	92
- Jul	96	88	92
- Aug	96	83	90
- Sep	96	88	92
- Oct	100	92	96
- Nov	92	92	92
- Dec	92	88	90
Sufficient water ?			
- Yes	22	21	43
- No	3	2	5

Source: FSIPM Survey, 1997/98.

Table 3. Interactions between *dimba* and dryland agriculture, Matapwata EPA, 1997/98 season.

Households with dryland fields (n=30)	28
Main use of income from *dimba* crops (n=30)	
- Buy fertiliser for dryland gardens	15
- Buy seed for dryland gardens	2
- Buy maize for food	9
- Buy inputs for *dimba* gardens	1
- Other investment	3
Did *dimba* cultivation delay activities on dryland gardens ? (n=30)	
- Yes	18
- No	12 [a]
Which dryland activities were delayed ? (n= 18)	
- clearing	13
- ridging	17
- planting	2
- first weeding	4
- banking	3
- harvesting	1
For which dryland activities did you hire labour ? (n=18)	
- clearing	5
- ridging	6
- planting	1
- first weeding	3
- banking	2
- harvesting	1

Source: FSIPM Survey, 1997/98.

[a] Of these, two did not cultivate dryland fields.

Table 4. Management practices for major *dimba* crops, Matapwata EPA, 1997/98 season.

Variable	Tomato	Cabbage	Maize	Rape	Mustard
Sample size	26	18	18	11	9
Area (ha) [a]	0.04	0.03	0.11	0.03	0.02
Times grown/year:					
- once	13	11	14	7	8
- twice	8	6	4	4	1
- more than twice	5	1	0	0	0
- mean	1.7	1.4	1.2	1.4	1.1
- median	1.0	1.0	1.0	1.0	1.0
Buying seed (%)	96	100	94	100	100
Applying manure (%)	46	61	24	55	63
Applying fertiliser (%)	92	94	77	82	88
N (kg)	6.4	7.6	9.7	2.5	3.1
P (kg)	2.4	5.4	1.3	1.1	1.5
Mean fertiliser cost (MK)	172	265	164	57	71
Applying pesticide (%)	94	100	40	73	63
Average sprays (no.)					
- first pesticide	7.9	8.4	1.7	6.7	14.5
- second pesticide	10.9	6.0	0.0	0.0	0.0
- total	18.8	14.4	1.7	6.7	14.5
Type of spray (no.)					
- preventative	34	13	1	2	3
- curative	9	9	6	3	1
Mean pesticide cost (MK)	124	120	7	12	12
Frequency of irrigation:					
- daily	2	2	1	2	1
- weekly	4	6	5	6	6
- no. of months	3	3	2	2	2
- total frequency	48	72	40	48	48
- hours/day [b]	3	3	3	3	3
- total hours/crop	144	216	120	144	144

Source: FSIPM survey, 1997/98.

[a] average areas from crop budgets. Sample size = 8 (tomato); 6 (cabbage); 3 (maize); 4 (rape); 2 (mustard).

[b] labour inputs from crop-budgets (Tables A1-A5).

Table 5. Household labour for *dimba* crops, by activity, age and sex, Matapwata EPA, 1997/98 season

(n = 30 households)

Crop activity	Men	Women	Children
Nursery management	28	1	2
Land preparation	29	2	2
Transplanting	28	7	2
Weeding	29	5	4
Irrigation	29	18	7
Fertilising	29	8	2
Pesticide application	28	1	2
Harvesting	28	16	5
Transporting	28	13	4
Selling	27	16	4

Source: FSIPM Survey, 1997/98.

Table 6. Pesticides used on *dimba* crops, Matapwata EPA, 1997/98 season.

Trade Name	Active ingredient [a]	Type [b]	Hazard Class [c]	Farmers using (no.)[d]
Insecticides				
Temik	Aldicarb	OP	Ia	3
Azodrin	Monocrotophos	OP	Ib	6
Lanate	Fenthion	OP	Ib	7
Decis	Cypermethrin	SP	II	7
Ripcord	Cypermethrin	SP	II	6
Sherpa	Cypermethrin	SP	II	1
Cypermethrin	Cypermethrin	SP	II	7
Sevin	Carbaryl	C	II	2
Actellic	Pirimiphos-methyl	OP	III	6
Karate	Lambda-cyhalothrin	SP	II	1
Dursban	Chlorpyfiros	SP	III	1
Fungicides				
Dithane	Mancozeb	TC	III	6
Daconil	Chlorothalonil	na.	na.	1
Copper	Copper oxychloride	na.	III	1
Mixtures				
Copper + Actellic				1
Copper + Dithane				4
Copper + Cypermethrin				1
Dithane + Famage (?)				1
Lanate + Actellic				1
Lanate + Decis				1
Lanate + Ripcord				1

Sources:

[a] L. G. Copping, H. Kidd, and C. D. S. Tomlin (1995). *The Pesticide Index*. Third edn., (London: British Crop Protection Council/Royal Society of Chemistry).

[b,c] International Programme on Chemical Safety (1991). *The WHO recommended classification of pesticides by hazard and guidelines to classification, 1990-91*. (Geneva: UNDP/ILO/WHO).

[d] FSIPM Survey, 1997/98.

Notes:

[b]

OP	Organophosphate compound
SP	Synthetic pyrethroid
C	Carbamate
TC	Thiocarbamate

[c]

Ia	extremely hazardous
Ib	highly hazardous
II	moderately hazardous
III	slightly hazardous

[d] N = 28; 2 farmers did not use pesticides on *dimba* crops.

Table 7. Most common pesticides used by *dimba* farmers, Matapwata EPA, 1997/98 season.

Pesticide	Pest (s)	Crop (s)
Insecticides		
Temik	Stemborer, leafeater, aphids	Tomato (1) Cabbage (2) Maize (3) Mustard (1)
Azodrin	Grasshoppers, borers, cutworm, red spider mite	Tomato (6) Cabbage (3) Rape (2) Mustard (1)
Lanate	Aphids, stemborers, red spider mite, chamatowa	Tomato (3) Cabbage (4) Maize (1)
Decis	Aphids, cutworms	Tomato (1) Cabbage (4) Rape (1) Mustard (1)
Ripcord	Cutworms, borer,leafeaters, stemborers,chamatowa	Tomato (5) Cabbage (1) Maize (1) Rape (2) Mustard (1)
Sherpa	Aphids	Cabbage (1)
Sevin	Borers	Tomato (2)
Decis	Aphids, cutworms	Tomato (1) Cabbage (4) Rape (1) Mustard (1)
Actellic	Mites, leafeaters, stemborers, aphids	Tomato (1) Cabbage (2) Maize (3) Mustard (1)
Karate	Aphids, grasshoppers, chamatowa	Cabbage (1) Rape (1)
Dursban	Cutworms	Tomato (1)
Fungicides		
Dithane	Aphids, leafeaters, red spider mite, defoliation	Tomato (6) Cabbage (1)
Daconil	Wilting	Tomato (1)
Copper	Borers, defoliation	Tomato (2)
Mixtures		
Copper + Actellic	Leaf eaters	Tomato (1)
Copper + Dithane	Red spider mite, defoliation	Tomato (5) Cabbage (1)
Copper + Cypermethrin	Wilting, borers	Tomato (1)
Lanate + Dices	Aphids, *chamatowa*	Cabbage (2)
Lanate + Ripcord	Leaf eaters	Cabbage (1)
Dithane + Famage	Wilting, totox	Tomato (1)

Source: FSIPM Survey, 1997/98.

Table 8. Farmers' pesticide application rates for *dimba* crops, Matapwata EPA, 1997/98

Farmer	Trade Name	Local units Qty.	Local units Unit	Metric Units [a] Qty	Metric Units [a] Unit	Spray Volume [b]	Conc. (g/litre)[c]	Rate [de] (Kg/ha or l/ha)
	Tomato							
1	Dithane	3	tsp	24	gm	10	2.4 *	3.0 *
2	Copper	1	tsp	8	gm	10	0.8	1.0
2	Dithane	1	tbsp	40	gm	15	2.7 *	3.4 *
	Copper	1	tbsp	40	gm	15	2.7	3.4
4	Dithane	7	tsp	8	gm	10	0.8	1.0
5	Dithane	2	tbsp	80	gm	15	5.4 *	6.6 *
6	Copper	6	btop	102	gm	10	10.2 *	12.8
6	Cypermethrin	2	btop	34	ml	10	3.4 *	4.3
7	Cypermethrin	3	btop	51	ml	10	5.1 *	6.4
7	Dithane	4	btop	68	gm	10	6.8 *	8.5 *
8	Copper	4	btop	68	gm	10	6.8 *	8.3
8	Lanate	2	btop	34	gm	10	3.4 *	4.3
	Cabbage							
3	Karate	1.5	btop	25.5	gm	15	1.7 *	2.6
3	Lanate	1	tsp	8	ml	15	0.53	0.8
4	Lanate	1	tsp	8	ml	15	0.53	0.8
5	Lanate	1	tbsp	40	ml	10	4.0 *	6.2
5	Cypermethrin	1	btop	17	ml	10	1.7 *	2.6

Source: FSIPM Survey, 1997/98

Notes:

[a] Teaspoon (tsp) = 8 grams; tablespoon (tbsp)=40 grams; bottletop (btop)= 17 grams.
[b] watering can = 10 litres; knapsack sprayer = 15 litres;
[c] Recommended concentration: Dithane 2 g/l; Copper= 4 g/l, Karate= 1 ml/l; Lanate = 0.5-1. ml/l; Cypermethrin = 0.5-1 ml/l; Daconil = 2 g/l.
[d] Tomato 600-750 ml for 6 paces = 1250 ml/ha; cabbage, 1750 ml for 26 heads = 1548 l/ha
[e] Recommended application rates: Dithane M45 = 1.36-1.6 kg ai/ha. Other rates not available.
* above recommended concentration or application rate.

Table 9. Average total expenditure on pesticides by *dimba* growers, Matapwata EPA, 1997/98.

Crop	Area of crop (ha) [a]	Pesticide costs for each crop (MK)	Times grown (no.)	Total cost of pesticide (MK)
Tomato	0.040	124	1.73	214.5
Cabbage	0.025	120	1.44	172.8
Maize	0.106	7	1.22	8.5
Rape	0.026	12	1.35	16.2
Mustard	0.018	12	1.11	13.3
Subtotal				425.3

Total of 425 MK/year/household expenditure on pesticides (US $ 10).

Source: FSIPM survey, 1997/98.

[a] area obtained by field measurement.

Table 10. Average farm income from *dimba* crops, Matapwata EPA, 1997/98 season

Crops	Times grown (no)	Area (ha) [a]	Labour input (days)[b]	Cash costs (MK)[b]	Gross returns (MK)[b]	Gross margin (MK)	Returns labour/day (MK/day)
Tomato	1.73	0.040	78	585	845	260	3.3
Cabbage	1.44	0.025	52	751	1010	259	5.0
Maize	1.22	0.106	36	216	664	448	12.4
Rape	1.35	0.026	54	116	379	263	4.9
Mustard	1.11	0.018	31	99	288	189	6.1
Subtotals:			251	1767	3186	1419	5.7

Total gross margin from *dimba* of 1419 MK/year/household (US $ 32).

Source: FSIPM survey, 1997/98

[a] area obtained by field measurement

[b] converted from hectare basis (Appendix tables A1-A5). Converted to labour days at 6 hours/day.

Table 11. Farmers' perceptions of problems in *dimba* cultivation, Matapwata EPA, 1997/98 season.

Variable	Frequency (no)	Percent (%) [a]
1. *What is your main problem with dimba cultivation ?*		
- high input costs	22	65
- low prices	3	9
- tomato wilting	3	9
- tomato mites	1	3
- high transport costs	1	3
- pest resistance	1	3
- increase in new pests	1	3
- lack of extension advice	1	3
- seed not available	1	3
- none	1	3
Total	34 [b]	100
2. *If you do not cultivate cabbage, why not ?*		
- lack of money to buy inputs	7	58
- *dimba* too small	2	17
- lack of knowledge on cultivation	1	8
- water shortage	1	8
- no reason given	1	8
Total	12	100
3. *If you do not cultivate tomato, why not ?*		
- *dimba* too small	1	20
- wilting	1	20
- waterlogging	1	20
- seedlings damaged by rain	1	20
- pest damage	1	20
Total	5	100

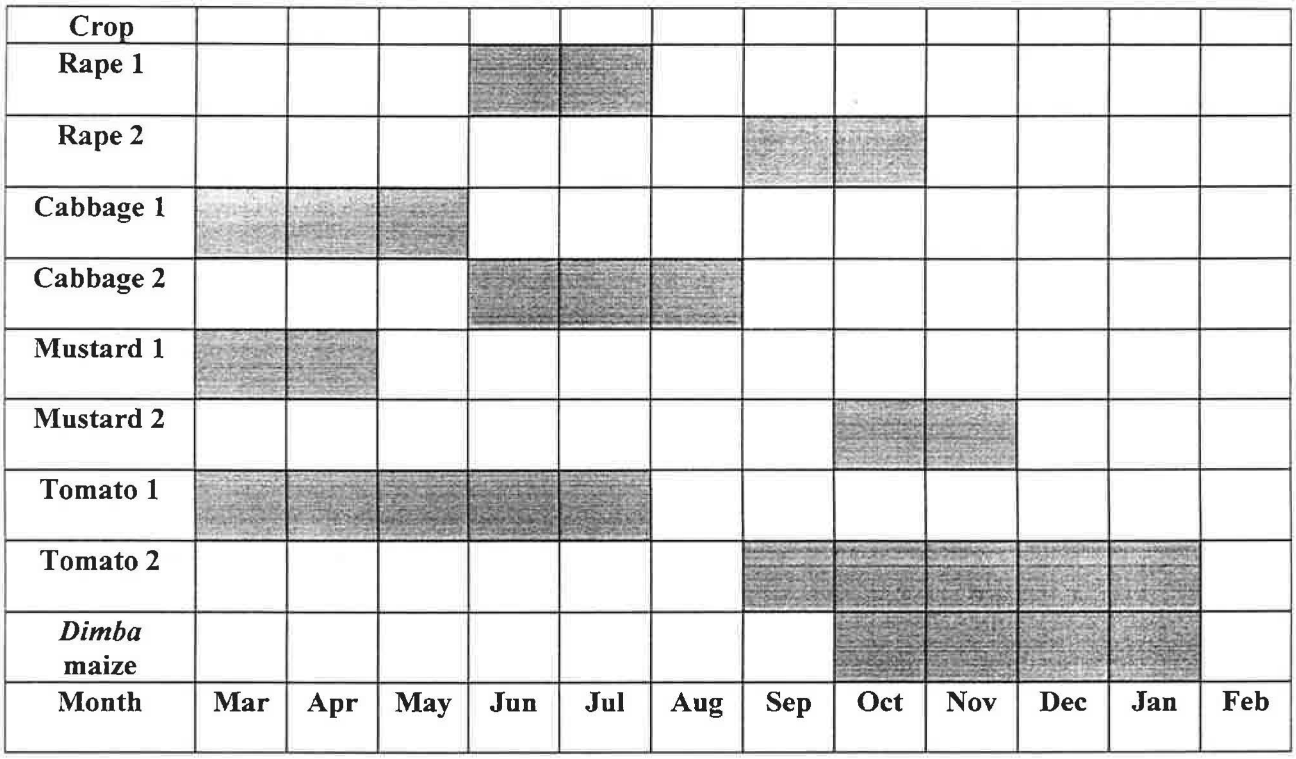
Source: FSIPM survey, 1997/98.

Notes:

[a] sums may not add to totals due to rounding error.

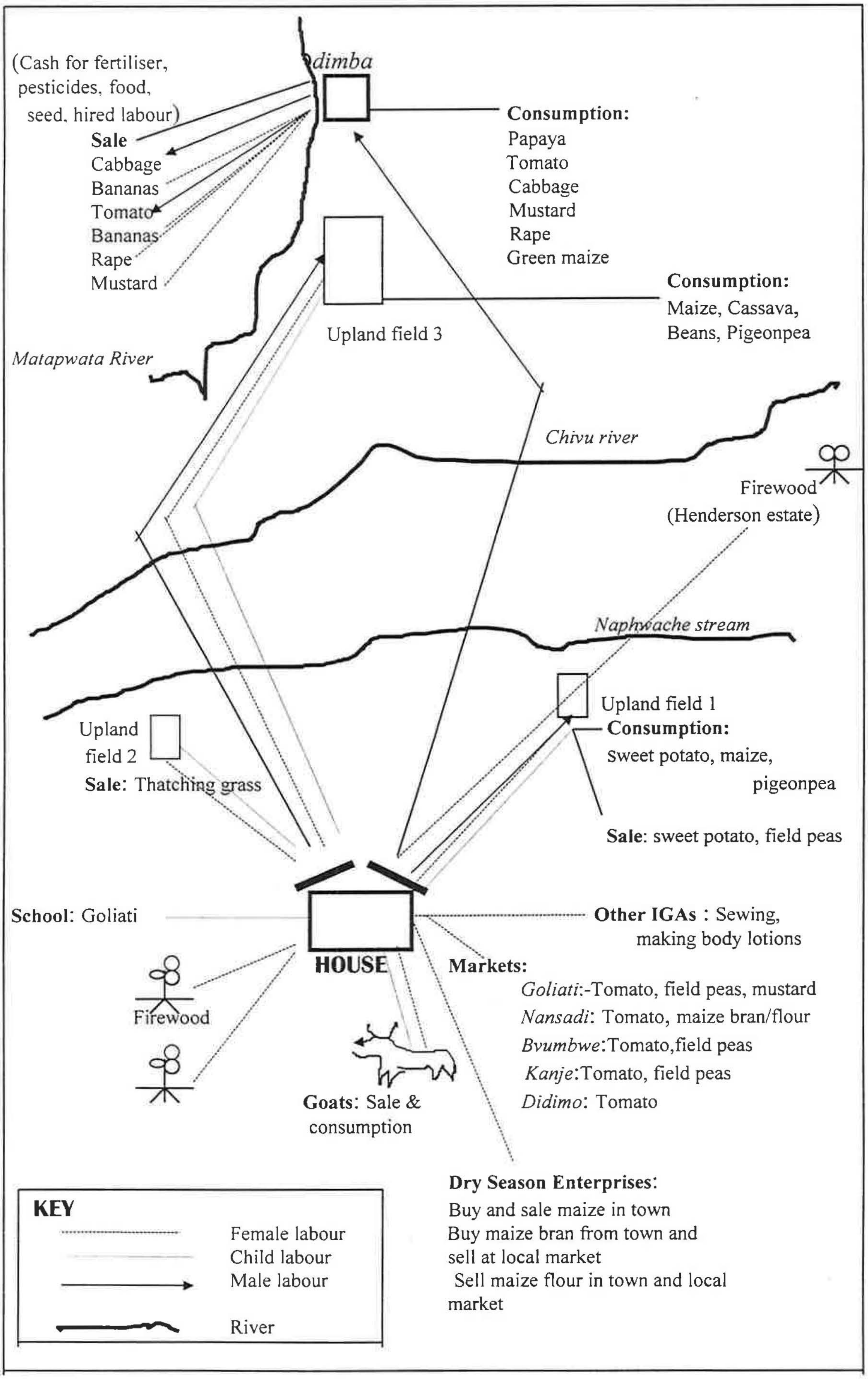
[b] some farmers gave more than one response.

Figure 1. *Dimba* crop calendar, Matapwata EPA, 1997/98 season.



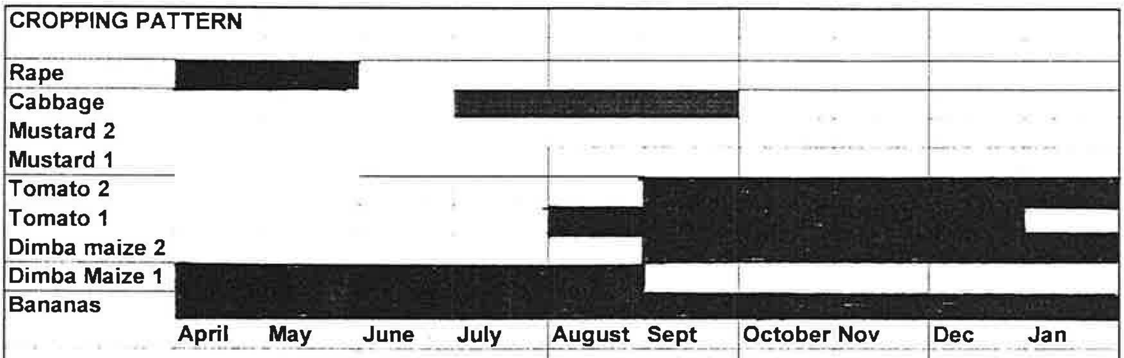
Source: FSIPM Field Survey, 1997/98.

Figure 2. Farm diagramme for case study farm.

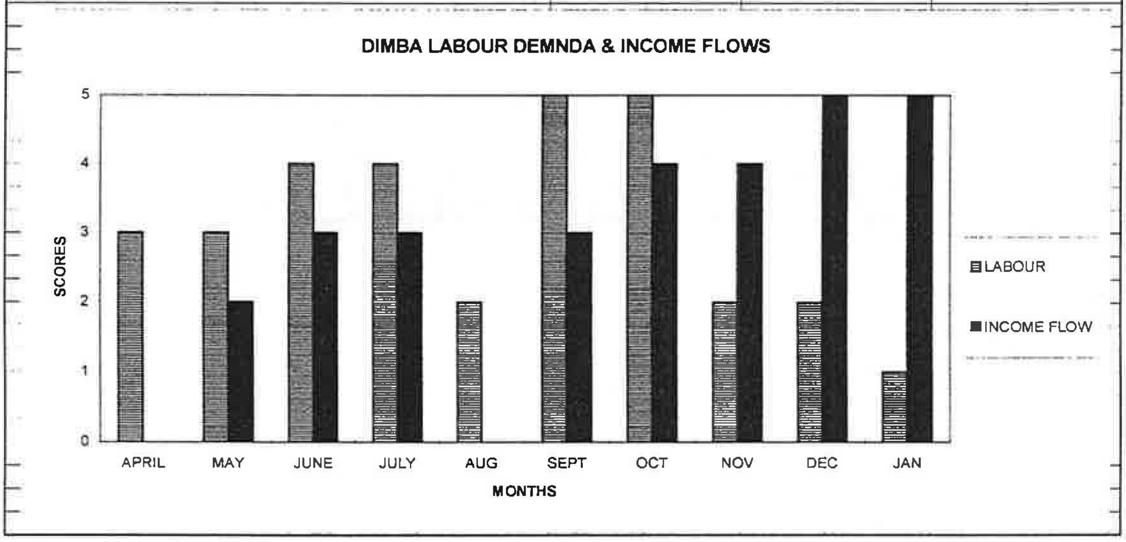


200

Figure 3. Seasonality chart for case study farm.



MONTH	LABOUR	INCOME FLOW	SCORING
APRIL	3	0	
MAY	3	2	
JUNE	4	3	
JULY	4	3	
AUG	2	0	
SEPT	5	3	
OCT	5	4	
NOV	2	4	
DEC	2	5	
JAN	1	5	



APPENDIX 1. Crop budgets

Table A1. Crop budget for tomato				
Area: 1 hectare.				
Month planted: March				
Variable	**Quantity**	**Unit**	**Cost/unit**	**Total**
Cash inputs [a]				
Seed		Kg		1050 MK
Fertiliser		Kg		4300 MK
Pesticide	18.8	Sprays		3100 MK
Total				8450 MK
Labour inputs [b]				
Seedbed	53	Person/hours	-	-
Nursery care	240	Person/hours	-	-
Land preparation	467	Person/hours	-	-
Planting	120	Person/hours	-	-
Fertilising	120	Person/hours	-	-
Weeding	100	Person/hours	-	-
Banking	-	Person/hours	-	-
Pest control [c]	244	Person/hours	-	-
Irrigation [d]	3600	Person/hours	-	-
Harvesting	800	Person/hours	-	-
Transport	600	Person/hours	-	-
Selling	400	Person/hours	-	-
Total	6744	Person/hours	-	
Gross returns				
Yield	**Unit**	**Price/unit**	**Total**	
5377 [e]	Kg	2.27 MK	12206	
Gross margin (total revenue-cash costs): 3,756 MK				

Source: FSIPM Field Survey, 1997/98.

Notes:

a fertiliser and pesticide input costs from Table 4; seed costs from crop budget sub-sample.

b labour inputs from crop budget sub-sample, weights: male (1.0), female (0.8), child (0.5). sample size = 7.

c 18.8 sprays at 13 person/hours/spray.

d 48 days at 3 person/hours/day (Table 4).

e 325 baskets/ha, at 1 basket = 16.5 kg. (Braunworth, Jnr.,1992) Cf. BLADD(1998) which gives 24,342 kg/ha for Blantyre Shire Highlands RDP.

Table A2. Crop budget for cabbage				
Area: 1 hectare.				
Month planted: March				
Variable	**Quantity**	**Unit**	**Cost/unit**	**Total**
Cash inputs [a]				
Seed		Kg		1050 MK
Fertiliser		Kg		8833 MK
Pesticide	14.4	Sprays		4000 MK
Transport [b]				6973 MK
Total				20856 MK
Labour inputs [c]				
Seedbed	50	Person/hours	-	-
Nursery care	120	Person/hours	-	-
Land preparation	400	Person/hours	-	-
Planting	158	Person/hours	-	-
Fertilising	120	Person/hours	-	-
Weeding	200	Person/hours	-	-
Banking	-	Person/hours	-	-
Pest control [d]	187	Person/hours	-	-
Irrigation [e]	7200	Person/hours	-	-
Harvesting	237	Person/hours	-	-
Transport	25	Person/hours	-	-
Selling	-	Person/hours	-	-
Total	8697	Person/hours	-	-
Gross returns				
Yield	**Unit**	**Price/unit**	**Total**	
23,000 [f]	Heads	1.22 MK	28,060 MK	
Gross margin (total revenue-cash costs): 7,204 MK				

Source: FSIPM Field Survey, 1997/98.

Notes:

a fertiliser and pesticide input costs from Table 4; seed costs from crop budget sub-sample.

b average cost MK 280 for hire of pickup for 0.03 ha garden.

c labour inputs from crop budget sub-sample; weights: male (1.0), female (0.8), child (0.5). (n = 6).

d 14.4 sprays at 13 person/hours/spray.

e 72 days at 3 person/hours/day (Table 4).

f Cf. BLADD (1998) which gives 24,813 kg/ha for Blantyre Shire Highlands RDP.

Table A3. Crop budget for *dimba* maize				
Area: 1 hectare.				
Month planted: October				
Variable	**Quantity**	**Unit**	**Cost/unit**	**Total**
Cash inputs [a]				
Seed		Kg		56 MK
Fertiliser		Kg		1491 MK
Pesticide	1.7	Sprays		64 MK
Total				1611 MK
Labour inputs [b]				
Seedbed	-	Person/hours	-	-
Nursery care	-	Person/hours	-	-
Land preparation	261	Person/hours	-	-
Planting	30	Person/hours	-	-
Fertilising	30	Person/hours	-	-
Weeding	56	Person/hours	-	-
Banking	-	Person/hours	-	-
Pest control [c]	22	Person/hours	-	-
Irrigation [d]	1091	Person/hours	-	-
Harvesting	33	Person/hours	-	-
Transport	42	Person/hours	-	-
Selling	46	Person/hours	-	-
Total	1611	Person/hours	-	-
Gross returns				
Yield	**Unit**	**Price/unit**	**Total**	
1980 kg	Kg	2.5 MK	4950 MK	
Gross margin (total revenue-cash costs): 3339 MK				

Source: FSIPM Field Survey, 1997/98.

Notes:

[a] fertiliser and pesticide input costs from Table 4; seed costs from crop budget sub-sample.

[b] labour inputs from crop budget sub-sample; weights: male (1.0), female (0.8), child (0.5).

[c] 1.7 sprays at 13 person/hours/spray.

[d] 40 days at 3 person/hours/day (Table 4).

Table A4. Crop budget for rape				
Area: 1 hectare.				
Month planted: September				
Variable	**Quantity**	**Unit**	**Cost/unit**	**Total**
Cash inputs [a]				
Seed		Kg		1000 MK
Fertiliser		Kg		1900 MK
Pesticide	6.7	Sprays		400 MK
Total				3300 MK
Labour inputs [b]				
Seedbed	29	Person/hours	-	-
Nursery care	268	Person/hours	-	-
Land preparation	975	Person/hours	-	-
Planting	250	Person/hours	-	-
Fertilising	95	Person/hours	-	-
Weeding	225	Person/hours	-	-
Banking	-	Person/hours	-	-
Pest control [c]	87	Person/hours	-	-
Irrigation [d]	4800	Person/hours	-	-
Harvesting	620	Person/hours	-	-
Transport	925	Person/hours	-	-
Selling	1253	Person/hours	-	-
Total	9527	Person/hours	-	-
Gross returns				
Yield	**Unit**	**Price/unit**	**Total**	
3,600 kg	Kg	3.0 MK	10800 MK	
Gross margin (total revenue-cash costs): 7500 MK				

Source: FSIPM Field Survey, 1997/98.

Notes:

[a] fertiliser and pesticide input costs from Table 4; seed costs from crop budget sub-sample.

[b] labour inputs from crop budget sub-sample; weights: male (1.0), female (0.8), child (0.5). (n = 6 for both rape and mustard).

[c] 6.7 sprays at 13 perrson/hours/spray.

[d] 48 days at 3 person/hours/day (Table 4).

Table A5. Crop budget for mustard				
Area: 1 hectare.				
Month planted: August				
Variable	**Quantity**	**Unit**	**Cost/unit**	**Total**
Cash inputs [a]				
Seed		Kg		812 MK
Fertiliser		Kg		3550 MK
Pesticide	14.5	Sprays		600 MK
Total				4962 MK
Labour inputs [b]				
Seedbed	29	Person/hours	-	-
Nursery care	-	Person/hours	-	-
Land preparation	975	Person/hours	-	-
Planting	250	Person/hours	-	-
Fertilising	95	Person/hours	-	-
Weeding	225	Person/hours	-	-
Banking	-	Person/hours	-	-
Pest control [c]	189	Person/hours	-	-
Irrigation [d]	4800	Person/hours	-	-
Harvesting	620	Person/hours	-	-
Transport	925	Person/hours	-	-
Selling	1253	Person/hours	-	-
Total	9361	Person/hours	-	-
Gross returns				
Yield	**Unit**	**Price/unit**	**Total**	
3,600 kg	Kg	4.0 MK	14,400 MK	
Gross margin (total revenue-cash costs): 9,438 MK				

Source: FSIPM Field Survey, 1997/98.

Notes:

[a] fertiliser and pesticide input costs from Table 4; seed costs from crop budget sub-sample.

[b] labour inputs from crop budget sub-sample; weights: male (1.0), female (0.8), child (0.5). (n= 6 for both rape and mustard).

[c] 14.5 sprays at 13 person/hours/spray.

[d] 48 days at 3 person/hours/day (Table 4).

FARMING SYSTEMS IPM PROJECT,
BVUMBWE RESEARCH STATION,
PO BOX 5748, LIMBE

DIMBA CROPS

Village		
Name of head of household		
Sex		
Marital status		
Name of respondent		
Sex of respondent		
Relation to household head		
Name of interviewer (s)		
Date interviewed		

CODES

SEX	MARITAL STATUS	RELATION TO HEAD
1 = male	1 = never married	1 = head
2 = female	2 = married	2 = spouse
	3 = polygamist	3 = son/daughter
	4 = wife of polygamist	4 = father/mother
	5 = widowed	5 = father/mother in-law
	6 = separated	
	7 = divorced	

Describe location of house

2. ACCESS TO DIMBA

2.1 How many dimba gardens do you have? __________(Number)

2.2 How many of these dimbas are you using this year?____________(Number)

2.3 If not using all, state the reasons:____

2.4 Dimba gardens

Dimba No.	Land tenure (give rent, if dimba is rented)	How many years have you used this dimba ?	What crops do you grow on this dimba ?	What is the source of water for this dimba ? *(enter code)*		Which months do you get water from this source ?		Is there enough water from this source ?	
				1st	2nd	1st	2nd	1st	2nd
1			1 2 3 4 5 6						
2			1 2 3 4 5 6						
3			1 2 3 4						

codes for source of water
1 = shared stream/river
2 = shared well/pond
3 = sole owned well/pond

2.5 If you do not cultivate tomato, why not ?

____

2.6 If you do not cultivate cabbage, why not ?

____

3- INPUT USE ON DIMBA CROPS

Variables	Tomato	Cabbage	Dimba maize		
How many times is this crop grown per year ? (March 1997- March 1998)					
Which months is it grown ?					
Crop 1 month transplanted: month harvested:					
Crop 2 month transplanted: month harvested:					
Crop 3 month transplanted: month harvested:					
Which variety did you grow ? Crop 1 Crop 2 Crop 3					
Where did you get the seed ? Crop 1 Crop 2 Crop 3					
Input use for FIRST crop grown					
Did you apply manure ?					
Type of manure					
Total cost of manure					
Did you apply fertiliser ?					
Type					
No of Bags					
Total cost					
Type 2					
No of bags					
Total cost					
How many times/day did you water this crop ?					
How many times/week did you water this crop ?					
How many months did you water this crop ?					

4. PESTICIDE USE ON DIMBA CROPS

Variables	Tomato (Harvested before rainy season)	Tomato (Harvested in rainy season)	Cabbage (Harvested before rainy season)	Cabbage (Harvested in rainy season)	Dimba maize
Months grown **month transplanted:** **month harvested:**					
Did you apply chemicals ?					
First chemical					
Quantity					
Unit					
Total cost (MK)					
Number of sprays/crop					
How did you apply the chemical ?					
Against which pest ?					
Did you spray before or after seeing the pest ?					
Second chemical					
Quantity					
Unit					
Total Cost (MK)					
Number of sprays/crop					
How did you apply the chemical ?					
Against which pest ?					
Did you spray before or after seeing the pest ?					
Third chemical					
Quantity					
Unit					
Total Cost (MK)					
Number of sprays/crop					
How did you apply the chemical ?					
Against which pest ?					
Did you spray before or after seeing the pest ?					

4. PESTICIDE USE ON DIMBA CROPS (continued)

CROP	Rape	Mustard			
Did you apply chemicals ?					
First chemical					
Quantity					
Unit					
Total cost (MK)					
Number of sprays/crop					
How did you apply the chemical ?					
Against which pest ?					
Did you spray before or after seeing the pest ?					
Second chemical					
Quantity					
Unit					
Total Cost (MK)					
Number of sprays/crop					
How did you apply the chemical ?					
Against which pest ?					
Did you spray before or after seeing the pest ?					
Third chemical					
Quantity					
Unit					
Total Cost (MK)					
Number of sprays/crop					
How did you apply the chemical ?					
Against which pest ?					
Did you spray before or after seeing the pest ?					

5. LABOUR

5.1 Who does these types of work on your dimba ? (TICK BOX FOR 'YES')

No.		Household labour			Hired labour		
	Activity	Men	Women	Children	Men	Women	Children
1	Nursery management						
2	Land preparation						
3	Transplanting						
4	Weeding						
5	Watering						
6	Applying fertiliser						
7	Applying pesticide						
8	Harvesting						
9	Transport						
10	Selling						

5.2 Which activity in your dimba garden requires most labour ?

(TICK ONE BOX ONLY)

Activity	Tick for 'Yes'
Land preparation	
Transplanting	
Weeding	
Watering	
Harvesting	
Transporting	
Selling	

5.3 Does labour for dimba delay work on your munda gardens ?

Yes	
No	

5.4 If yes, which activities are delayed ?

No.	Activity	Yes=1, 2=No	Do you hire additional labour ? (Yes=1, 2=No)
1	Clearing/burning		
2	Ridging		
3	Planting		
4	First weeding		
5	Banking		
6	Harvesting		

6. CASH FROM DIMBA

6.1 What are your household's main sources of cash income from agriculture ?

No.	Source of cash income	Share (out of 10)
1	Munda crops	
2	Dimba crops	
3	Livestock	

6.2 What was the **total cash income** from the last crop which you sold ?

(Period: March-December 1997).

No.	Crop	Month sold	Share sold	Where sold	Total cash income
1	Cabbage				
2	Tomato				
3	Dimba maize				
4	Mustard				
5	Rape				
6	Onions				
7					
8					

Codes for share of crop sold

1 = None
2 = Less than 1/4
3 = Between 1/4 and 1/2
4 = More than 1/2
5 = All.

Codes for where sold

1 = in the field
2 = in the village
3 = local markets
4 = other (specify)

6.3 What were the main uses of the cash income which you received from dimba crops this year ?

(Period: March-December 1997).

No.	Uses of dimba income	Yes=1, 2= No
1	Buy fertiliser for munda crops	
2	Buy seed for munda crops	
3	Hire labour for munda crops	
4	Buy maize for food	
5	Buy maize for trading	
6	Buy inputs for dimba crops	
7	Other (specify)	
8	Other (specify)	
9	Other (specify)	
10	Other (specify)	

7. PROBLEMS

7.1 What is the biggest problem you have with cultivation of dimba crops ?

____

____

7.2 When did your household run out of maize LAST year ?
(ie from maize harvested in March 1996)

____________(Month)

7.3 Which of these months did your household eat maize which was not from your own garden ?

(Circle number opposite each month)

1	March 1996	7	September 1996
2	April 1996	8	October 1996
3	May 1996	9	November 1996
4	June 1996	10	December 1996
5	July 1996	11	January 1997
6	August 1996	12	February 1997

AO/PJ/AK 3 Dec 1997

COSTS AND RETURNS FOR *DIMBA* VEGETABLES

Village		
Name of head of household		
Household member interviewed		
Name of interviewer (s)		
Date interviewed		

Describe location of dimba garden

1.1 Enter name of crop and month planted in dimba

Crop	**Variety grown**	**Month planted in dimba garden**

1.2 How much seed did you use for this crop ?

Quantity of seed used	Total cost

1.4 How much fertiliser did you use for this crop ?

First application

Type of fertiliser	Quantity	Unit	Total cost

Second application

Type of fertiliser	Quantity	Unit	Total cost

Codes for fertiliser:

0 = none used	4 = DAP	8 = MIXTURE OF TWO
1 = 20: 20: 04	5 = D. COMPOUND	9 = OTHER (Specify)
2 = Urea	6 = 14: 20: 0	
3 = CAN	7 = S. AMMONIA	

1.9 How much **household** labour and **hired** labour did you use on this plot ?

	Household labour					Hired labour					Wages for hired labour		
			Number of workers					Number of workers			Male	Female	Child
OPERATION	Days	Hours/ day	Male	Female	Child	Days	Hours/ day	Male	Female	Child	Total MK	Total MK	Total MK
Preparing seedbed													
Watering nursery													
Land preparation													
Planting													
Applying fertiliser													
Weeding													
Banking													
Staking (tomatoes)													
Applying pesticides													
Watering													
Harvesting													
Transport to market													
Other (specify)													

1.5 Did you apply manure or compost to this crop ?

Yes/No	Quantity	Units	Price/unit	Source of manure

1.6 How much pesticide did you apply to this crop ?

ASK TO SEE MEASURING CUP AND MEASURE VOLUME AND QUANTITY

Type	Quantity	Units	Total cost

1.7 (TOMATO CROP ONLY) How much did you spend on stakes for this field of tomato ?

Stakes (MK)	String (MK)

1.8 If crop was not sold direct from field, what was the cost of transport to market ?

Type of transport	**Own/hired**	**Total cost for hired (MK)**
Head-load		
Bicycle		
Pick-up		

1.8 What was **the total yield** from this crop on this plot ?

Plot yield	Units	Weight/unit	Price/unit

FARMING SYSTEMS INTEGRATED PEST
MANAGEMENT PROJECT

DISCUSSION PAPER

IPM for resource-poor African farmers: is the Emperor naked ?

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ABSTRACT

IPM has had limited success with foodcrops grown by resource-poor African farmers. Constraints to implementation include: quantifying economic benefits from IPM adoption; limited scope for cost-saving IPM interventions due to low pesticide use; limited farmer knowledge, reducing participation; and the secondary importance of pest management in farming systems faced with a crisis of sustainability. Similar constraints limit the potential impact of the Farming Systems Integrated Pest Management (FSIPM) Project, operating in the Blantyre Shire Highlands, southern Malawi. Mastering them will require broadening IPM interventions to include high-value horticultural crops, strengthening farmer participation in technology evaluation, and tackling soil fertility and soil erosion problems which farmers rightly perceive as the main constraints on foodcrop yields.

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INTRODUCTION

Integrated Pest Management (IPM) has been defined as "a pest management system that... utilises all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economically unacceptable damage or loss" (GTZ, 1992). *Integrated*, because new means of control (biological control, host plant resistance, the use of behaviour-modifying chemicals, cultural practices) are seen as component technologies rather than alternatives. *Management*, implying continuation of the pest within a balanced system whereas control suggests direct intervention with little concern for sustainability. First developed for commercial fruit cultivation in California, IPM was transferred to Asia as part of the Green Revolution during the 1970s (Andrews, 1985). IPM reached Africa in the late 1980s, and has been endorsed as a national pest management strategy for Sub-Saharan Africa by both scientists and major aid donors (World Bank, 1992; NRI, 1994).

Implementation of IPM has exposed numerous mistaken assumptions about pest management by resource-poor farmers. These include: readiness to adopt labour-intensive control strategies; knowledge of pests and diseases; ways in which knowledge is disseminated; and willingness to reject chemical control methods (Bentley, 1989 ; Goodell *et. al.*, 1990; Riches and Shaxson, 1994). Implementation has also revealed formidable technical constraints, including lack of scientific knowledge about certain pests (Bentley and Andrews, 1996) and "a general lack of proven, effective control technologies" (Kiss and Meerman, 1991: 9). Consequently, "IPM... has remained elusive at the operational level" (NRI, 1992: 2). In particular, there has been limited success with staple food crops like maize, sorghum, beans, and grain legumes.

The general objective of this paper is to explore the relevance of IPM for resource-poor African farmers. Section 2 analyses some key constraints in implementation. The next section explores implications for the FSIPM Project. Section 4 suggests some ways forward.

Like the child in the fairytale, this paper may seem to state the obvious. Its purpose is to provoke discussion in the FSIPM Project and the ODA. It lays no claim to completeness, but is based on the literature available to the author at time of writing and a limited understanding of Malawian farming systems.

2. KEY CONSTRAINTS

Four constraints to implementation of IPM are particularly relevant for resource-poor African farmers: (1) quantifying the economic benefits of IPM pest management strategies; (2) the limited scope for cost-saving IPM interventions on foodcrops due to low pesticide use; (3) limited farmer participation in technology design, evaluation, and extension, due partly to limited knowledge of pests; and (4) the secondary importance of pest management in farming systems faced with a crisis of sustainability.

The economic benefits of IPM

One argument frequently heard is that IPM is economically attractive to resource-poor Africa farmers because they cannot afford the cost of chemical control. This argument has an intuitive appeal but contains serious logical flaws.

It assumes, first, that *levels of crop losses for major food-crops constitute "economically unacceptable damage"*. This assumption is questionable for two reasons. First, standard experimental designs to measure crop losses from pests focus on the quantification of yield losses at each growth stage of the crop by successively omitting insecticide protection during each stage, while providing control in the others (Litsinger, 1987). This approach has been criticised because: (1) it ignores traditional techniques of pest management and is irrelevant for farmers who cannot afford insecticides; (2) it ignores competition between pests - controlling one pest may artificially increase the risk of crop losses from another; (3) farmers' economic thresholds involve more than simple profit-loss accounting; (4) farmer circumstances vary so widely that blanket economic thresholds are inappropriate (Altieri, 1984). Crop-loss assessment methods which attempt to take account of these factors are so complex as to almost constitute a project in their own right (Jago ed., 1995). By contrast, crop *storage* losses have proved easier to measure. Unfortunately, these show low levels of damage at the farm level (roughly 4 - 5 %) for major foodcrops such as rice and maize (Greeley, 1986).

Second, measurement of *economic thresholds* for IPM interventions has proved difficult for resource-poor farmers. IRRI's application of IPM in wet-rice cultivation began with quantitative economic thresholds for insecticide application, shifted to qualititative indicators, and finally abandoned these in favour of "eyeballing" the field once a week, which could be practised by farmers (Goodell *et. al.*, 1982).

Thus, *average annual* crop losses for major African foodcrops are not known with any precision and perhaps never will be. "In the absence of accepted procedures for assessing crop losses due to specific pests and diseases, it is difficult for Third World IPM programs to establish research priorities scientifically " (Goodell, 1989:253).

A second common assumption in IPM Projects has been that *farmers' time has a low opportunity cost.* Pest management strategies have frequently involved additional labour (eg. monitoring pest populations; cultural practices; denser planting). In much of Africa, however, pest management is done by women, who generally work much longer hours than men (Malena, 1994). Farmers may have other, off-farm activities offering higher marginal rates of return, which reduce the relative impact of IPM interventions on household income (Goodell *et. al.*, 1990). Resource-poor farmers favour chemical control not only for its effectiveness, but because it reduces labour requirements (Goodell *et. al.*, 1990; Bentley, 1994).

Low pesticide use on foodcrops

Another assumption has been that *resource-poor farmers are eager to adopt IPM methods for staple food crops.* In practice, IPM has enjoyed most success with commercial crops for the simple reason that these have a high market value and it pays farmers to protect them from pests. In developing countries, the bulk of pesticides are applied to plantation crops, smallholder cash crops, and horticultural crops grown in peri-urban areas. Returns from IPM pest management strategies are significantly lower on foodcrops. In Central America "... a farmer is able to generate enough income on one cabbage field to justify spraying 300 times [ie. revenue increment would cover the cost of 300 sprays ?], whereas by applying IPM principles in maize, for example, under normal pest conditions the revenue increment is about 10-20 %. Given the risk factor which IPM involves, this is unacceptable to the farmer" (Rueda and Bentley, 1994: 20). In Africa, "most IPM projects relate to these types of [high-input] systems because it is here that visible results are most easily achieved in the short term" (Kiss and Meerman, 1991: 16).

Table 1 summarises current IPM initiatives reported from the IPMWG Workshop for East/Central/Southern Africa in the early 1990s. Clearly, the major emphasis was on cash crops. Of nine countries listed, only two (Tanzania and Uganda) reported IPM programmes on maize, one (Madagascar) on rice, and three (Uganda, Burundi, and Mozambique) on cassava. Generally, the development of IPM strategies for foodcrops grown by resource-poor African farmers has proved costly and time-consuming. By contrast, IPM on commercial plantation crops builds on an existing body of knowledge and can adapt strategies developed elsewhere, short-cutting the research process.

Table 1 illustrates the limited IPM strategies available for maize, the staple East African foodcrop. Neither of the two strategies being tested involved farmer-developed methods of control. The first involved a storage pest, with a method of better pesticide management, while the second involved maize streak virus, with the method of host plant resistance. CIMMYT sees host plant resistance as the only realistic pest management strategy for farmers who cannot afford chemical control (Mihm, 1995). Breeding has focused so far on maize streak virus and stalkborers. Host plant resistance is not an ideal IPM intervention, however. IRRI's experience with IPM in the Philippines showed that farmers were unaware which varieties were resistant to which pests, and continued to spray for pests to which varieties were already resistant (Goodell *et. al.*, 1982). Also, most breeding has been for vertical resistance (resistance to one or a few races) rather than horizontal resistance (resistance to all races of a pest), and pathogenic variation means that resistance quickly breaks down. Finally, host plant resistance may prove technically impossible for certain pests. What varietal characteristics would make maize resistant to termites, for example ?

A notable exception has been cassava, where cassava mealy bug (*Phenacoccus manihoti)* introduced in the 1970s from South America, was successfully contained using the parasitoid *E. lopezi.* By 1991, biological control was effective in 26 African countries. Success was due to several factors, including : (1) political pressure to find solutions to a pest epidemic which threatened national food security; (2) the active role played by IITA in coordinating national research programmes; (3) the

Table 1: IPM experience in East/Central/Southern Africa, early 1990s.

No.	Country	Crop(s)	Pest (s)	IPM pest management strategies
1	Sudan	1. Tomato 2. Eggplant 3. Onion 4. Irish potato	1. Leaf curl virus 2. Various 3. Thrips 4. Tuber worm	Safer, more appropriate pesticide use; *neem* sprays.
2	Zimbabwe	1. Irish potato 2. Cotton	1. Tuber moth 2. Bollworms, sucking insects	Host plant resistance; cultural control; biological control; pesticide rotation; safer pesticide management.
3	Tanzania	Maize	Larger grain borer	Safer pesticide management
4	Uganda	1. Cassava 2. Cotton 3. Maize	1. African cassava mosaic virus 2. Bollworms, cotton stainers 3. Maize streak virus	Host plant resistance; roguing
5	French-speaking Sub-Saharan Africa	Cotton	Various	Host plant resistance; ultra-low-volume sprays; pheromones; trap crops
6	Burundi	1. Cassava 2. Tomato 3. Cabbage	1. African cassava mosaic virus 2. Thrips 3. Thrips	Host plant resistance; biological control
7	Kenya	Coffee	Leaf rust, berry disease	Safer, more appropriate pesticide use; cultural control
8	Mozambique	Cassava	Cassava mealybug	Biological control
9	Madagascar	Rice	Hispa, hoppers	Early warning systems

Source: NRI (1994)

quick-acting effects of the parasitoid, with full benefits obtained only two years after release; and (4) biological control operated independently from farmers or extension agents, avoiding the need for long, expensive training and extension (Neuenschwander, 1993). Biological control of the larger grain-borer (*Prostephanus truncatus*) introduced from South America also promises results following the release of the predator *Teretriosma nigrescens* in Togo in 1991 (Boeye *et. al.*, 1992). Scope for biological control of other pests of African foodcrops is more difficult since the major pests are indigenous, not recent introductions.

Where IPM has been successful with foodcrops, it has offered significant cost-savings compared to pesticides. This has often been precipitated by sudden pesticide price-hikes. Examples include IPM on rice in Indonesia and on maize in Nicaragua. In both cases, chemical control was already at unsustainably high levels. In Indonesia, IPM reduced pesticide applications on rice from an average of 4 per season in 1986 to 0.8 for IPM-trained farmers in 1991 (Waage, 1993). In Nicaragua, farmers used an average of seven pesticide applications on maize before adoption of IPM reduced this to an average of 1.5 for IPM-trained farmers (Hruska, 1994). In similar fashion, promotion of IPM in Bangladesh has focused on the irrigated winter rice crop, where pesticide use is highest and has prevented farmers realising additional economic benefits from rice-fish culture.

Since resource-poor African farmers use few pesticides on foodcrops, the economic incentive for adoption of IPM strategies must come not from cost-savings in pesticide use, but from yield increases through reduced crop losses. The primary constraint on foodcrop yields in African subsistence farming systems, however, is not pest management but low soil fertility, lack of appropriate crop varieties, and affordable fertiliser.

Farmer participation in IPM

Farmer participation is not a prerequisite for successful IPM. Biological control of the cassava mealy bug involved no farmer participation whatsoever. Farmers were completely unaware of the release of the parasitoid *E. lopezi*, attributing the reduction in yield losses from mealybug to divine intervention or better weather (Neuenschwander, 1993). Other IPM interventions, however, typically offer a 'menu' of pest management strategies from which farmers must choose to fit their individual circumstances, rather than a simplified 'package', and require a high level of farmer participation. This has proved difficult to achieve in practice, however.

Farmers' knowledge of pests and diseases has been one obstacle to effective participation. While farmers are experts on what they can readily observe (weeds, some insect and vertebrate pests) they are generally ignorant of pests which are difficult to observe (soil pests, nematodes, plant diseases, insect reproduction) and natural enemies (parisitoids, and entomopathogens). (Bentley, 1992, 1994). Even where farmers correctly identify a pest, as with *striga asiatica* in Malawi, they do not understand the causal mechanisms involved (Riches and Shaxson, 1993). Farmers cannot distinguish between the effects of the cassava green mite and cassava mosaic virus (Hammond *et. al.*, 1992). Farmers generally believe that all insects are harmful, and have no concept of natural enemies (Goodell *et al.*, 1982; Bentley, 1994). Finally, farmers see plant health as part of a broader spectrum of plant-soil-water relations, so that non-disease related causes of ill-health are not distinct from disease-related ones (Fairhead, 1991). Farmer participation in IPM has required education and changing traditional attitudes. The heaviest investment in the successful IPM programme against brown plant-hopper in Indonesia was in farmer training (Waage, 1993).

Finally, scientists' insistence on "rigorous" methods may prevent effective farmer participation. Examples include the complexity of calculating insecticide applications, and quantitative economic thresholds (Goodell *et al.*, 1982). Another example - common in FSR - is the use of conventional experimental methods (designed to measure biological responses on research stations) in on-farm trials. These require large amounts of trained manpower to collect data; high variability makes statistical testing difficult; and their complexity limits farmers' involvement to providing the land and a few cultural operations. An alternative approach is to superimpose treatments onto the farmers' own crop.

" *For example, to test the benefit of nitrogen top-dressing of maize, an area of healthy maize, that is a crop which farmers would be advised to top-dress, is identified on a participant's farm. The farmer is given the fertilizer with instructions to apply it over half the identified area demarcating the treatment and control plots after implementation. By contrast, a conventional experimenter would select the experimental area prior to land preparation, mark out the plots, and implement the treatment in the appropriate plots* " (Lightfoot and Barker, 1986: 451).

The simplicity of this experimental method permits farmer implementation and farmer evaluation.

Transferring IPM to African farming systems

Projects generally replicate ideas, models, or programmes developed elsewhere in quite different socio-economic contexts. Success with IPM in Asia reflected the stability of the wet-rice agro-ecosystem, the introduction of fertiliser-responsive crop varieties, and favourable fertiliser: rice price ratios. The resulting growth in Asian rice production - the Green Revolution - immediately enhanced the importance of pest control among farmers anxious to protect their investment in new seed and fertiliser, while the lack of genetic diversity among early MV releases increased the risk of widespread pest outbreaks. In this context, IPM made an important contribution to the profitability of new rice varieties and averted a breakdown in the sustainability of the rice ecosystem.

Contrast Africa today. Dryland farming systems are inherently unstable, with low soil fertility and extreme climatic fluctuations. Population pressure on fragile soils has resulted in soil erosion and declining fertility. Africa's "maize revolution" has been patchy, and slow to gain momentum. In East Africa, where maize is most widely grown, increases in total maize production between 1965-1988 were due almost as much to increases in area planted as to increases in yield (Gilbert, 1995: 28). The relatively high cost of hybrid seed and unfavourable fertiliser: maize price ratios has retarded adoption and prevented farmers capturing the potential yield increases from new varieties.

IPM in such situations has relatively little to offer resource-poor farmers. A recent review of IPM in Africa concluded that, in subsistence-level farming systems, "Pest control is relevant only if it can be shown that losses to pests represent an important production constraint relative to other factors" (Kiss and Meerman, 1991: 15). Goodell's comment that "... farmers may suffer such grave losses due to drought and declining soil fertility as to make even a 30 % yield increase hardly worthwhile (Goodell, 1989: 253) appears particularly relevant for African conditions.

Implementing IPM for resource-poor farmers has brought calls for revisions to earlier approaches in Asia and elsewhere. A farming systems perspective - which identifies the *interactions* between pest management and other components of the farming system - is helpful here. A farming systems approach to IPM focuses on ways to increase the plant's ability to *compensate* for pest damage, rather than focusing exclusively on improving farmers' pest management. In the rice-wheat system in Nepal, for example, the key to reducing pest build-up proved to be green manuring to improve soil fertility. Fertiliser-responsive varieties and shortages of manure had seriously depleted soil fertility, creating secondary pest problems which contributed to stagnating yield. Improving soil fertility was the "nugget" (a keystone technology that creates benefits in more than one component) which led to improved pest management (Litsinger, 1993). The lesson for IPM ? " A new technology will be more attractive if it solves not only a pest problem but a production problem as well" (Ibid. : 89).

In sum, the problems facing resource-poor farmers cannot be treated in isolation. In such unfavourable environments, technological change is likely to take the form of small, incremental changes rather than sudden breakthroughs. Improved pest management will form one part of this wider, cumulative improvement in farm productivity. In Africa, therefore, "most projects aimed at subsistence farmers are not IPM projects *per se*, but general agricultural development projects which come to have an IPM component" (Kiss and Meerman, 1991: 16).

3. IMPLICATIONS FOR THE FSIPM PROJECT

The constraints discussed echo concerns about scope, methods, and relevance in the FSIPM Project. The Project's objective is to improve local capacity to develop IPM pest management strategies for resource-poor smallholders in Malawi. It focuses on three foodcrops (maize, beans, and pigeonpea) widely grown in the southern region. Research sites are located at Matapwata and Chiradzulu North EPAs in Blantyre Shire Highlands RDP. The RDP is characterised by a high proportion resource-poor farmers (60 percent under 0.5 ha); high population density (285-290 persons/sq. km; low land productivity (average maize yields 1.3 t/ha); soil erosion and environmental degredation. In the 1996-97 crop season, the Project conducted 74 on-farm trials, testing seven IPM interventions for pests of maize (including four for the parasitic weed *Striga asiatica)*, five for beans, and two for pigeonpea.

Crop losses... Although the Project has no plans to directly measure crop losses caused by individual pests, its economic rationale (as stated in the Project document) is that IPM can increase maize yields by 5 % (ODA, 1995). Since successful farm innovations generally offer a minimum 25 % rate of return on investment, this is unlikely to be attractive to resource-poor farmers. Given average yields of 1,357 kg/ha for maize in Blantyre Shire Highlands (1992/93 season) , a 5 % increase translates into an average yield increase of 68 kg/ha. At the farm level (with an average of 0.24 ha planted to maize) the average yield increase is 16 kg, equivalent to 32 Kwacha. With the current wage rate for a *gwazu* (task) on local estates of 9 Kwacha/day, this is equivalent to roughly 3.5 days' *ganyu* labour.

Labour availability... Several of the strategies tested in the 1996-97 season involved additional labour inputs at planting, itself a period of peak labour requirements. Labour requirements for planting soyabean (as a trap crop for *Striga*) averaged 153 hours/hectare, while high-density planting of bean seed (a treatment for beanfly) required 88 hours/hectare. It seems likely that resource-poor households (particularly those headed by women) will find these labour requirements excessive. Total labour requirements for maize average approximately 1,000 hours/hectare.

Foodcrops and cash crops...A Stakeholder Workshop identified maize, beans, and pigeonpea as priority foodcrops for the FSIPM Project (Ritchie, 1996). High-value vegetable crops were already the subject of a separate IPM Project funded by GTZ, operating in the central region.

Diagnostic surveys revealed three intensification pathways in the farming system. Dry-season vegetables grown in streambeds (*dimba*) were a feature of Matapwata EPA, while burley tobacco was grown in Chiradzulu North EPA, and hybrid maize was common to both. Chemical control was confined almost exclusively to these three enterprises. High-value vegetables (cabbage, tomatoes, rape, mustard) attracted the highest level of pesticide use, followed by burley, followed by hybrid maize. Pesticide application to hybrid maize was confined to actellic on weevils during storage, particularly for denty hybrids. (The release in 1990 of the semi-flint hybrids, MH17 and MH18, which store as well as local varieties, is expected to reduce storage losses for untreated maize). Consequently, the scope for IPM interventions to save costs by reducing pesticide use on field cultivation of maize, beans, or pigeonpea, was nil.

Other IPM programmes in Malawi have focused on horticulture. Concern Universal, the NGO with most experience in IPM for resource-poor farmers, has promoted IPM through its kitchen garden programme. Training is supplied in a wide range of interventions for exotic vegetables, chiefly cabbage and tomato. These include the use of *Tephrosia* sprays, growing plants toxic to pests, hand-picking, and other interventions using materials which are readily available. Although scientific evaluation is lacking, results are said to compare favourably with neighbouring farmers using chemical control. Similarly, the Malawi-German Plant Protection Project (MGPPP) which targets commercial vegetable growers in the central region, is currently developing IPM interventions for clubroot and red spider mite (Thindwa, 1996). IPM offers significant economic incentives for vegetable growers: expenditure on pesticides accounted for 21 % of cash costs for tomato and 6 % for cabbage (Dohnalek-Droste, 1996).

Participation... Although farmers have participated in targeting crops for IPM interventions and in locating on-farm trials, the experimental design of the on-farm trials is extremely complex. Three features of the experimental design give concern:

(1) Since treatments are randomised, the number of treatments varies for each farmer. Because each farmer has a different combination of treatments, it is difficult for them to evaluate the effects of individual treatments or compare experiences with other participating farmers.

(2) 'Control plots' are not located adjacent to treatments, but randomised over the 74 trials. Thus, there is no simple 'demonstration effect' of the IPM technology being tested. At a recent field-day, NGOs and extensionists pointed out that this represented a missed opportunity to create awareness and promote discussion among farmers. With the exception of participating farmers, virtually no other farmers interviewed for the baseline survey understood the purpose or knew the location of the on-farm trials. In one village, a farmer with severe *Striga* infestation knew nothing about the *Striga* trial situated just 10 minutes' walk away.

(3) Both design and analysis of the on-farm trials require an external consultancy, raising doubts about appropriateness and sustainability for Malawi's cash-strapped national agricultural research system.

Africanising IPM... The issue has been stated succinctly by a recent FSIPM consultant:

"Is the project to develop IPM for a degraded environment (to what extent is impact possible?) or is it more feasible to look at a situation in which fertility can be maintained, ie. IPM for a sustainable system?" (Riches, 1997: 2).

The farming system in Blantyre Shire Highlands is clearly unsustainable. Average maize yields are low; few farmers apply fertiliser or organic materials; soil conservation practices (marker ridges, hedgerows) are rare, and soil erosion widespread; intensive cropping and the absence of fallows have led to low soil fertility. Although the FSIPM diagnostic survey showed that " soil erosion and low soil fertility are uppermost in farmers' minds" (Orr *et. al.*, 1996: 15), the Project addresses these constraints only through IPM interventions for *Striga,* which attempt to improve soil fertility through green manuring , nitrogen-fixation, and more effective fertiliser use.

4. WAYS FORWARD

Projects are like ships: built on land, launched in water. The shift from blueprint to process projects is designed to provide the necessary flexibility to cope with this transition. The ODA's position is that the Purpose of the Project, as defined in the logical framework, is sacrosanct but that Outputs can be renegotiated. Responsibility then lies with stakeholders to find sufficient room for manouevre to effect the necessary changes in the original design (Biggs, 1997). Many detailed suggestions on ways to improve Project relevance have already been made at the IPM Network Field Day (Orr and Jere eds., 1997). The list below is not exhaustive, therefore, but outlines three broad areas which require attention:

Crop losses... In addition to assessing pest incidence and yield losses in on-farm trials, the Project will conduct trials to directly measure *yield loss from weeds.*

Including *dimba* crops...*Better information* is needed about the importance of *dimba* crops in the household economy. The baseline survey provides information on the number of households with access to *dimba*, the crops grown, and their ranking as a source of cash income. Further work during the dry season will study a small sample of *dimba* farmers to collect crop budgets for the crops grown, and describe agronomic practices, including pest management.

Exploratory on-farm trials could be mounted for a small sample of *dimba* farmers using IPM interventions developed by NGOs such as Concern Universal. Since this technology has already been tested in the field, demonstration plots or simple trials super-imposed on farmers' existing practices seem appropriate. These could be coordinated by the FSIPM Project, but would require some assistance from Concern in planning and farmer training. This form of technology transfer would create linkages with the only NGO in Malawi with substantive experience of IPM, and overcome the problem of different working areas.

Participation...*On-farm trials* should be designed to enhance farmers' understanding of IPM technology, and promote adoption, in addition to quantifying biological relationships between pests and yields. At the very least, simple with-and-without demonstration trials could be run in parallel with complex field experiments.

Involving non-participating farmers in technology evaluation (eg. through field days) would strengthen the Project's impact and provide valuable feedback on adoption constraints. We cannot rely entirely on participating farmers to act as unpaid extension agents

Farming Systems Research...*Soil fertility and conservation issues should be addressed in tandem with IPM interventions to reduce crop losses.*

Hillslope agriculture could form one focus for activity. Mr. F. Gondwe, now doing M. Sc. (Ag. Econ) at Bunda College with Project funds, will focus his dissertation on hillslope agriculture and its associated problems. Mr. Msonkho, the Field Assistant at Nansadi, Matapwata EPA, plans to conduct trials with composting, marker ridges, and agro-forestry. A small sub-project to study these issues and conduct on-farm trials can be designed for next season. This activity would also foster links between FSIPM, agricultural extension, and Bunda College of Agriculture.

More information is needed about hillslope interventions from projects working on similar issues. These include PAPPA, operating in Blantyre Shire Highlands RDP, though not in our study EPAs: Bunda College research sites at Domasi, near Zomba; ICRAF's on-farm trials near Makoka; and the Maize Commodity Team's green-manuring trials. We intend to compile a shortlist of promising interventions from these projects.

In conclusion, the FSIPM Project must strike a balance between institutional support - developing local capacity in IPM - and making such support relevant to the needs of resource-poor farmers. This will require technical knowledge and skills (particularly in agronomy) which the Project does not have at present, but must acquire through networking and building alliances with orgainisations and other projects. Based on the discussion above, the following revisions to the revised Logical Framework are suggested (amendments in italics):

Narrative summary (NS)	Measurable indicators (OVI)	Means of Verification (MOV)	Important assumptions
Outputs: 2. IPM strategies suitable for *sustainable farming systems* and resource-poor farmers developed	2.1 At least one PMS per crop by end year 2 *2.2 PMS integrated with other sustainable interventions to improve crop yields*	2.1 Project reports	2.1 Stakeholders continue to develop and refine IPM strategies

Testing IPM interventions for *dimba* vegetables can be accommodated by amending Activity 2.7 to Output 2, and also form part of Activity 3.2, providing an opportunity to evaluate IPM interventions developed by Concern Universal and study informal extension mechanisms.

Narrative summary (NS)	Inputs/resources	Means of Verification (MOV)	Important assumptions
Activities: 2.7 Assess effectiveness and impact of PMS *developed by the Project and collaborating NGOs*		2.7 Project evaluation report	2.7 Farmers collaborate
3.2 Develop informal mechanisms in collaboration with NGOs		3.2 NGO's evaluations	3.2 NGOs willing to collaborate

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

What have we learned ?

1996/97 in review

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Abstract

This report discusses 10 important lessons learned during the FSIPM Project's first crop season (1996/97). Information has been derived both from written reports and discussions with other team members. The analysis compares the Project's expectations and assumptions about IPM strategies for resource-poor farmers in southern Malawi with experience from OFTs and data from socioeconomic surveys. Changes in Project activities in response to these lessons are outlined. While some lessons are specific to the Project, lessons of wider relevance include the role of IPM in unsustainable farming systems, economic incentives for IPM adoption, choice of appropriate interventions, and farmer participation in technology design and evaluation.

1.0 Introduction

During its first crop season in 1996/97 the FSIPM Project conducted a multi-disciplinary research programme. Following a Stakeholder Workshop in June 1996, the Project identified research sites in Mombezi and Matapwata EPAs in Blantyre Shire Highlands RDP for applied research on smallholder pest management of maize, beans, and pigeonpea. Diagnostic surveys were used to target priority pests of these three crops, and 74 smallholder households were purposively selected to participate in OFTs. Socio-economic data on the farming system was collected through diagnostic surveys, a formal structured survey of 120 households and case studies of household clusters. OFTs were evaluated by farmers, in addition to statistical analysis. Finally, the Project networked with NGOs involved with IPM, and with scientists conducting on-farm research in soil fertility and control of the parasitic weed *Striga asiatica*.

The objective of this review is not to attempt a rigourous accounting in terms of the Project logical framework, but to distil the lessons of experience. Specifically, we analyse strategic issues concerning the role of IPM in smallholder farming systems (lessons 1-3), and operational issues concerning choice of IPM strategies and on-farm research (lessons 4-10). Lessons are summarised in Appendix Table 1, which compares initial assumptions and expectations with outcomes ('new learning'). We focus chiefly on lessons which, by changing perceptions, have resulted in new Project activities.

The review synthesises material from formal Project reports, trip reports, short memoranda, and discussions at fortnightly Project meetings. Given the paucity of on-farm research in Malawi, the number of possible lessons is large, and this review is necessarily selective. It is also subjective, since no two individuals are at the same point on the learning curve. The perspective of this review reflects our training in agricultural economics.

2.0 Strategic lessons: IPM for resource-poor farmers

Lesson 1: The major constraint on maize yields is not crop losses from pests but low soil fertility

Crop losses

The assumption that farmers in southern Malawi experience severe crop losses from pests is undeniable, though the scale of such losses is difficult to quantify. Although estimates exist for physical crop losses due to pest outbreaks (Nyekanyeka, 1997), there are no accurate estimates of physical crop losses attributable to individual pests in farmers' fields. Since the effort required to measure such losses would require a Project in its own right they are, for all practical purposes, unknowable. Crop losses from weeds, however, can be measured by relatively simple, superimposed field trials. OFTs to measure crop losses from weeds will be made during 1997/98 by a weed science postgraduate from Bunda College of Agriculture.The baseline survey showed significant differences in weeding practices, with a higher proportion of the area planted to maize only partly weeded or not weeded at second weeding and partly banked or not banked in Matapwata EPA and among female-headed households (Orr *et. al.*, 1997b). This suggests that farmers' weeding decisions are determined by labour supply, soil fertility or fertiliser use, pest incidence, and climatic factors. An analysis of farmers' decision-making coupled with physical measurement of weeds on maize yields would assist the evaluation of alternative weed management strategies.

Soil fertility

The farming system in southern Malawi is characterised by high population density (> 290 km^2), continuous maize cropping, soil erosion aggravated by exposure of bare soil during the dry season and early rains, and a shortage of natural, organic sources of soil carbon and nitrogen. Consequently, while losses from pests are significant, "*the most important threat to sustainability of smallholder maize-based systems is the decline of soil fertility associated with falling levels of organic matter and soil nutrients as traditional farming practices become untenable under growing population pressure*" (Blackie, 1995: xiv).

Initially, the implications of low soil fertility for IPM were not fully appreciated by the Project. This led to the decision to leave maincrop OFTs unfertilised. Other contributory factors were the need to distance the Project from the bankrupt formal credit system which had 'politicised' access to fertiliser, and the lack of reliable information about fertiliser use on which to base decisions about affordable fertiliser rates for smallholders. The decision not to fertilise OFTs involved no economic loss for farmers, who were compensated with 20 kg maize (the difference between the median yield on the OFT and farmer's plot and the mean yield of hybrid maize in Blantyre Shire Highlands RDP). Nevertheless, the decision was not popular with farmers, who wondered why plots at Bvumbwe research station received fertiliser, but not theirs (Maulana and Daudi, 1997: 3).

The decision not to fertilise OFT plots has now been revised in the light of information on (a) area-specific fertiliser rates and (b) fertiliser use at FSIPM study sites.

(a) Yields and fertiliser rates

Table 1 shows results from the 1995/96 Fertiliser Verification Trials for FSIPM research sites, Blantyre Shire Highlands RDP, and Blantyre ADD. Average yields represent an 'agronomic optimum' (ie. trial yields adjusted downwards by 20 % to reflect small size of trial plots).This 'agronomic optimum' rate represents the lowest-cost fertiliser rate which provides the highest net benefit. Costs refer to the coming season (1997/98). Summarised:

- In Blantyre ADD, hybrid maize fertilised at the rate of 35 kg/N/ha increased yields by 809 kg/ha over unfertilised maize, an increase of 51 % . The corresponding yield increase for Shire Highlands RDP was 1169 kg/ha, an increase of 130 %.

- The agronomic optimum fertiliser rate was higher for households producing maize for home consumption, reflecting the higher consumer price of maize, the absence of marketing costs, and a lower opportunity cost of capital (Benson, 1997: 16).

- For Matapwata and Mombezi EPAs, the 'home consumption' fertiliser rates for hybrid maize were 69:21:0 and 92:21:0 NPK, respectively. At 1997/98 prices, these fertiliser rates imply a cost of 2,244 Mk/ha and 2,992 MK/ha, respectively.

Table 1. Average yields of MH18 maize at three fertiliser rates, 1995/96 (kg/ha).

Fertiliser rate (NPK)	Matapwata		Mombezi		BShH RDP	Blantyre ADD
	Nansadi	EPA	Lirangwe	EPA		EPA
No fertiliser	1170	1642	420	1126	1534	1581
35: 0: 0	2924	2703	2797	2255	2703	2390
96: 40: 0	3473	3618	3838	3267	3618	2979
Agronomic optimum for home consumption	-	69:21:0 + 4S	-	92:21:0 + 4S	-	-
Agronomic optimum for market sale	-	35:10:0 +2S	-	35:10:0 +2S	-	-

Source: GOM (1997), Vols I and II; Benson (1997).

Agronomic optimum yields may be compared with average yields on farmers' fields. Table 2 shows average maize yields for Blantyre Shire Highlands RDP and Blantyre ADD, derived from the national crop estimates. Summarised:

- Mean yields in the RDP were about 0.8 mt/ha for local maize and 1.8 mt/ha for 'hybrid' varieties which include recycled hybrid seed.
- Yields of local maize were determined largely by weather conditions. Drought (1994/95) and untimely rains (1996/97) led to sharp drops in average yields.
- Average yields of hybrid maize were less stable than local maize, making cultivation more risky. Over the past five seasons, the standard deviation of the yield of hybrid maize in Blantye ADD was twice that for local maize varieties (544 kg/ha vs. 283 kg/ha).

Low average maize yields seriously limit farmers' economic incentive for IPM, since the marginal return on crop protection (in terms of grain saved) is so low. At the same time, since smallholders use few pesticides on foodcrops, the incentives for adoption of IPM strategies must come from yield increases rather than savings in cash costs (see **Lesson 3,** below).

Table 2. Average maize yields, 1992-1996 (kg/ha).

Crop year	Blantyre Shire Highlands RDP		Blantyre ADD		Malawi	
	Local	Hybrid	Local	Hybrid	Local	Hybrid
1992/93	1516	1893	1252	1592	1632	2198
1993/94	925	2695	875	2542	580	772
1994/95	600	1439	614	1231	768	1829
1995/96	683	1265	691	1198	922	2406
1996/97	454	1534	545	1718	730	1801
Mean	836	1765	795	1656	926	1801
Standard deviation	416.94	568.09	283.43	543.90	412.78	629.14

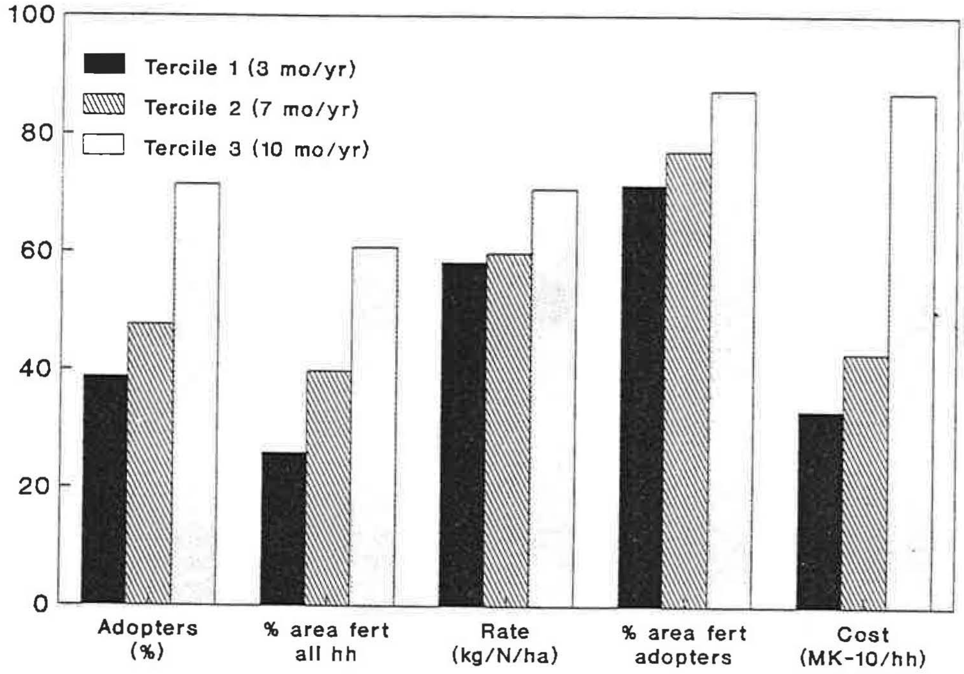
Source: 1992/93: GOM, 1996; 1993/4 - 96/97, BLADD, 1994-97.

(b) Fertiliser use and food security

The FSIPM baseline survey (1996/97) found that household food security was directly related to fertiliser use. Regression analysis demonstrated that the main determinants of maize provision ability (MPA) in 1996/97 were land quality, and whether the household had used fertiliser in the previous year (Orr *et. al.*, 1997b). In contrast to rainfed rice-based farming systems, where household food security is determined largely by the area cultivated, farm size was *not* a significant determinant of household food security among households at FSIPM research sites.

Fertiliser use in the *current* year, on the other hand, was strongly influenced by MPA in 1996/97 since households with higher food security could spare more cash to buy fertiliser. Among households with three months' MPA, 39 % used fertiliser in 1996/97 and only 26 % of the area planted to maize received fertiliser (Figure 1). Among households with 10 months' MPA, 71 % used fertiliser and 60 % of the area planted to maize was fertilised. Among households using fertiliser, there were no significant differences in the proportion of maize area fertilised or mean nitrogen rates. Households with 10 months MPA which used fertiliser spent an average of 812 MK/household on fertiliser during 1996/97. Households self-sufficient in maize for three months which used fertiliser could afford only 284 MK/household.

Figure 1. Fertiliser use by maize provision ability (MPA) at FSIPM research sites, 1996/97.



Source: FSIPM Baseline Survey (n=120)

Green manure crops

Poorer households which cannot afford the agronomic optimum fertiliser rate need alternative sources of nitrogen to raise maize yields and improve household food security. The Project's review of available technologies suggests that the most appropriate organic sources of nitrogen for poorer smallholders are green manure crops intercropped with maize (Ritchie *et. al.*, 1997a). They are not a complete substitute for chemical fertiliser, however. A 'target biomass' of 2,000 kg/ha from green manure crops is sufficient to provide 30 kg/N/ha (*Ibid*: 5), which is roughly half or one-third of the agronomic optimum rate for home consumption at FSIPM research sites. To achieve the agronomic optimum rate, therefore, green manure crops must be combined with applications of chemical fertiliser in the range of 40-50 kg/N/ha. Furthermore, the impact of green manure crops on soil fertility will only be felt in the second season after incorporation of biomass, and three or four seasons may be required to achieve substantial increases in average maize yields. In the first season, therefore, it is advisable to 'kick-start' improvement in soil fertility by applying the full agronomic optimum fertiliser rate.

The target biomass concept implies that the cost of producing biomass should not exceed the cost of 30 kg of urea (450 Mk/ha in 1996/97). Forthcoming Ph.D research at Wye College will provide economic analyses of improving soil fertility in Malawi using the agroforestry species *Leucena leucocephala* and

Acacia albida (Hayes, 1994). No economic evaluation of other green manure crops is presently available, however. Thus, the economic evaluation of FSIPM OFTs in 1997/98 will be of value to other DAR scientists.

Lesson 2: No ready-made menu of IPM strategies available for smallholders

Although the Project Proposal implied otherwise, there was no menu of IPM strategies arranged conveniently on the shelf awaiting adaptive research. Phase II of the Soil Pests Project tested six different cultivation practices and three maize intercrops as PMS for termites and whitegrubs over three crop seasons (1992-95). With the exception of the maize + cowpea intercrop which reduced weed density, weed biomass, and insect pest attack, the results were generally inconclusive (Khonga, 1997: 43-44). Similarly, the Stakeholder Workshop, which brought together 20 Malawian professionals with expertise in pest management, identified only 11 possible IPM strategies for field pests of eight priority foodcrops (Ritchie, 1996: 7). Consequently, the Project faced the need to assemble, screen, and field-test a large number of interventions in its first season.

Table 3. IPM strategies used in FSIPM Trials, 1996/97.

Crop	Pest	IPM strategies				
		Varietal resistance	**Chemical**	**Botanical**	**Cultural**	**Intercrops**
Maize	*Striga asiatica*		Fertiliser (dolloped) Fertiliser (banded)			Soya (trapcrop) *Tephrosia* (nitrogen)
Maize	Termites	MH18 MH17 NSCM41 CCC Synthetic C Local			Modified *kaselera* Weeding without banking	
Maize	Whitegrub	MH18 MH17 NSCM41 CCC Synthetic C Local	Seed dressing with Sevin			
Pigeonpea	*Fusarium* wilt	ICP9145			Side-planting	
Pigeonpea	Termites	ICP9145 QP38 Royes				
Pigeonpea	Whitegrubs	ICPL87105 ICPL86012 Local				
Beans	Bean stem maggot (*Ophiomyia* spp.)	Kaulesi	Seed dressing with Sevin, Gaucho	Seed dressing with Dema, *Tephrosia*, Neem	Earthing-up Mulching High density planting	
Total interventions		3	4	3	6	2

Table 3 shows that 18 interventions were tested in 1996/97. VR in maize and pigeonpea (termites and whitegrubs) was tested on-station at Thuchila. Six seed dressing treatments for beanfly were tested on-station at Bvumbwe, of which two (Sevin and Gaucho) were also tested on-farm. Thirteen interventions were tested in OFTs, on two different landtypes. Because of the large number of treatments, and because maize was grown with two intercrops of beans and pigeonpea, the OFTs required a factorial design. Despite the efficiency of the factorial method, this required 74 OFTs and the same number of participating farmers. Analysis was complicated by the large number of treatment combinations, and the frequency of missing observations, which led to an unbalanced experimental design. This in turn has required an interactive approach to analysis of experiments and the services of a professional statistician. A factorial design still remains the most efficient way of testing interventions in maize-based farming systems with several intercrops.

The hazards of testing these interventions on-farm are illustrated in Table 4, which identifies the main causes for missing yield observations for maize and beans in the *Striga*, maincrop, and relay bean OFTs. Of 296 total potential yield observations for these two crops, 243 valid observations were recorded and 18 % were lost. Of the missing 53 observations, 49 were due to human causes. Nine potential observations were lost through theft in the *Striga* trial, in one case due to the remoteness of the plot. The bulk of lost observations (38, or 73 % of the total) were due to early harvesting by OFT participating farmers, either to prevent theft, because they needed food, or were not convinced that the crop would be returned to them after harvesting and weighing. Climatic factors also took a heavy toll. In addition to the 53 observations lost through human and physical causes, 44 valid yield observations were recorded as zero.In the case of the main intercrop trial, this was caused by waterlogging on dambo fields, and in the case of the relay bean trial by Sevin seed dressing and pests and diseases other than bean stem maggot.

Lesson 3: Economic incentive for adoption of IPM is saving cash spent on pesticides

In retrospect, the assumption that the high cost of chemical control makes IPM economically attractive to smallholders seems flawed. Experience with foodcrops in Asia (rice) and Latin America (maize) suggests that IPM has been most successful where farmers already used pesticides at high levels, and where IPM offered significant savings in cash costs. Since smallholders in Malawi generally do not apply pesticides to foodcrops before harvest there is, therefore, little economic incentive to adopt IPM pest management strategies for field pests of maize, beans, or pigeonpea, except where pest outbreaks threaten severe crop losses (Orr, 1997).

In these circumstances, the most attractive IPM interventions are varietal resistance (VR) and biological control (BC). These require no increase in expenditure of cash or labour from the producer, since the costs are borne by the publicly-funded agricultural research system. Examples of VR include the pigeonpea variety ICP9145, a Kenyan landrace discovered through farmer selection, now multiplied and distributed in Malawi by ICRISAT. Examples of BC include introduction of the predatory hister beetle *Teretriosoma negrescens* to control the larger grain borer (*Prostephanus truncatus*) which threatens to become a major storage pest of maize in Malawi. VR strategies exist for *Fusarium* wilt in pigeonpea and for bean stem maggot (*Ophiomyia* spp.), though not yet for *Ootheca* spp., the second-most important pest of beans (Ross, 1997). BC also exists for bean stem maggot, which can be controlled by some parasitoids (*Opius phaseoli* Fischer and *Gronotoma* sp.) [Khonga, 1997: 46] and for sweet potato weevil, with males attracted to the pheromone released by female weevils (Ibid, 1997: 41-42).

Here it is appropriate to note the very different approaches adopted by the FSIPM and MGPP Projects. Whereas FSIPM has targeted specific *pests of foodcrops*, MGPPP has targeted *biocontrol interventions*, regardless of crop. These BC interventions are the focus of regional research programmes coordinated by international agricultural research centres (IITA, ICIPE). Examples include BC for cassava mealy bug (*Phenococcus manihoti*) and cassava green mite (*Mononychellus tanajoa*); the larger grain borer of maize (*Prostephanus truncatus*); diamondback moth (*Plutella xylostella*) and clubroot (*Plasmodiophora brassicae*), both pests of cabbage; and red spider mite (*Tetranychus lambi*), a pest of tomato. The MGPPP approach involves transfer of proven technologies and bypasses, to some extent, the shortage of plant protection scientists in DAR.

Table 4. Reasons for missing yield observations and zero yields in FSIPM OFT's, 1996/97

Variable		Striga trial			Main intercrop trial			Relay Bean trial
Crop		Maize		Beans	Maize		Beans	Beans
Plot type		Research	Farmer's	Research	Research	Farmer's	Research	Research
No of plots		40	10	40	64	64	48*	30
No of farmers		10	10	10	64	64	48	30
No of treatment factors		2	0	0	3	0	5	5
No of potential yield observations		40	10	40	64	64	48	30
No of valid yield observations		36	4	25	54	47	48	29**
No of lost observations		4	6	15	10	17	0	1
Reasons for lost observations:								
Human factors:	Theft	1	4	4	0	0	0	0
	Early harvest /field clearance	0	2	9***	10	16	0	1
	Data lost	1	0	0	0	1	0	0
Physical factors:	Erosion by water	2	0	2	0	0	0	0
	Waterlogging	0	0	0	0	0	0	0
Biological factors:	Goat damage	0	0	0	0	0	0	0
No of observed zero yields[1]		1	0	0	9	11	8	15

Notes

Data for main trial pigeonpea not available yet

* no beans in Chiradzulu N. dambo

** one yield value imputed from scaling gross yield from plot harvested by farmer

***two farmers harvested 4 plots and one harvested one plot

[1]Zero maize yields in the dambo are largely due to waterlogging;
zero bean yields were largely caused by the sevin treatment and pests and diseases other than beanfly

Unfortunately, VR and BC strategies are not presently available for the major fields pests of maize, including termites, whitegrubs, and the parasitic weed *Striga asiatica*. VR for maize against termites was tested in an on-station trial at Thuchila; the results showed no significant difference in average yields for six maize varieties (Abeyasekera, 1997a). VR for *Fusarium* wilt will be tested by including new long-duration varities (ICEAP 00040 and 00053) alongside ICP9145 in 1997/98. Varietal resistance to *Fusarium* may break down in the presence of root knot nematode, however (Khonga, 1997: 34).

3. Operational lessons: technology choice and on-farm research

Lesson 4: The Project has correctly identified the major pests of maize, beans, and pigeonpea

The major pests of maize, beans, and pigeonpea were identified by consulting expert opinion through the Stakeholder Workshop, and by participatory, diagnostic surveys in the FSIPM study area. Both approaches produced a similar ranking of pest problems for these three foodcrops. The exception was whitegrubs, not recognised as a major pest of maize by local experts at the Stakeholder Workshop, but identified as such by farmers and also by previous research in the southern region (Ritchie, 1996).

Results from OFTs in 1996/97 have confirmed this identification for maize and beans, but the incidence of *Fusarium* wilt on pigeonpea was lower than expected. In addition to *Fusarium*, pigeonpea was found to be damaged by a complex of other pests (podsucking bugs and podboring caterpillars). During diagnostic surveys farmers in Matapwata ranked podborers (*abongololo*) second to *Fusarium* as a pest of pigeonpea (Orr *et. al.*, 1996: 21). Surveillance of these pests will be increased in 1997/98.

Lesson 5: Expand the number of target crops to include others with promising IPM interventions

Six priority foodcrops for IPM were identified by the Stakeholder Workshop: maize, pigeonpea, beans, cowpea, cassava, and sweet potato (Ritchie, 1996: 7). As noted above, cassava IPM is already being handled by the MGPPP. It was agreed that research would focus initially on developing IPM strategies for three crops before tackling others (Ibid: 4). As noted in **Lesson 2** above, the number of viable IPM strategies for maize, beans, and pigeonpea was smaller than originally thought.

Sweet potato

Crack sealing of sweet potato ridges to prevent entry of the sweet potato weevil (*Cylas punctocillis*) was tested by the Soil Pests Project, which showed that both the number of weevils and damaged tubers was "generally" lower after crack sealing (Khonga, 1997: 27-28). Attempts to secure the raw data for formal statistical analysis have so far been unsuccessful. A field visit was made to Katuli EPA, Machinga ADD, where the Soil Pests Project conducted OFTs on crack sealing in 1992/93 and 1993/94 in order to interview farmers who participated in the original OFTs, and determine adoption rates. Of five farmers who had participated in OFTs, all had discontinued crack sealing, and there was no evidence of adoption by non-participating farmers. Farmers reported that sweet potato had declined in importance as a cash crop, and that crack sealing was regarded as labour-intensive, competing with other crops for labour (Jere *et. al.*, 1997).

Crack sealing seems more promising where there is high market demand for sweet potato. A diagnostic survey of Mangunda section in Matapwata EPA found evidence of widespread commercial cultivation of sweet potato, with larger smallholders cultivating 5 ha. One farmer with 1 ha of sweet potato practised crack sealing (Mkandawire *et. al.*, 1997). Farmers in this area grew the variety Kenya, whose high yields, short-duration, and poor storage make it an ideal commercial crop. (Recent research at Chitedze suggests that storage in pits with wet dambo sand rather than ash may allow storage for up to eight months, however [Jere, 1997]). This variety may also be susceptible to sweet potato weevil. Farmers reported that losses from weevils were due primarily to failure to harvest the crop on reaching maturity because of competing demands for labour, particularly maize harvesting during March-April. Sweet potato growing was also common in Chiwinja (one of two FSIPM villages in Mombezi EPA), where the crop was ranked as the second most important cash crop after field peas. Again, damage from weevils was linked with delayed harvesting due to competing demands for labour and also fluctuations in market demand (Jere *et. al.*, 1997).

In 1997/98 the Project will conduct OFTs in Mangunda section to test crack sealing. The socio-economic team will conduct farmer evaluations of the intervention and administer a costs-and-returns survey of sweet potato among a small sample of growers in the area to provide data for a formal economic evaluation.

Vegetables

The MGPPP has the mandate to develop IPM stategies for vegetable crops. Research so far has focused on diamondback moth (DBM) [*Plutella xylostella]* and clubroot *(Plasmodiophora brassicae),* both major pests of cabbage, and red spider mite (*Tetranychus lambi*), a major pest of tomato (Thindwa, 1996). Management problems resulted in the failure of OFTs in 1996/97. On-station trials at Bvumbwe for DBM have used biological control methods such as Neem and the microbial pesticide *Bacillus thuringiensis* (Bt) [Thindwa, 1997].

Vegetables form an important source of off-farm income at the FSIPM research sites in Matapwata EPA, where about one-third of households have access to *dimba* gardens. Although cabbage and tomato crops require working capital for pesticide and fertiliser, vegetable growing is not a monopoly of better-off smallholders. It may also be possible for farmers to 'graduate' from low-input horticulture (rape, mustard, Chinese cabbage) to more intensive, commercial systems (Lawson-McDowall and Chiumia, 1997).

The FSIPM Project may assist the MGPPP with socioeconomic data on vegetable production and farmers' perceptions of vegetable pests. We should also encourage MGPPP to conduct on-farm trials in Matapwata EPA.

Lesson 6: Collaboration with NGOs limited by low technical capacity

The FSIPM project is required to work with various NGOs as stated in the revised Logframe (Ritchie, 1996). The Output to Purpose review (October, 1996) recommended strengthening links with NGOs to foster collaboration in 1997/98 cropping season. To identify potential 'partner' NGOs, the Project hosted a field-day for the NGO IPM Network (Orr and Jere eds., 1997).

The expectation was that NGOs would collaborate in the development and extension of IPM strategies. For most NGOs, however, agriculture or food security formed one small component of their programmes which may include health, sanitation and water supply. As such, focus on IPM work is limited or absent. Most NGOs also have limited technical capacity for IPM work, with development of PMS proceeding on a trial-and-error basis. PMS are sourced from farmers and other organisations and are extended without scientific verification either on-station or on-farm. Furthermore, for NGOs interested in IPM the focus has been on horticultural crops for income generation rather than food crops. Lastly, the activities of the NGO most active in promoting IPM - CU - are concentrated in the central not the southern region.

It seems sensible, therefore, to consider NGOs as pathways for dissemination of strategies rather than as collaborators in development and testing of strategies. It is thus necessary to continue facilitating and strengthening contacts with NGOs so that they can help in dissemination of strategies which are being verified in OFTs. Meanwhile, scope exists for CU to field demonstration trials of IPM strategies for vegetable producers at FSIPM research sites.

Lesson 7: Farmer participation limited by design of OFTs and lack of scientific knowledge of pest biology

Involving farmers in assessment of PMS has been considered an important aspect of OFTs by the FSIPM Project. It was expected that farmer evaluation of the OFTs would assist in development and adoption of the various PMS. However, the complex nature of the experimental design meant that farmers had to evaluate more than one PMS at a time, without the benefit of direct comparable controls. The number of strategies tested affected farmers' understanding and ability to assess their effects. For example, farmers had difficulty evaluating the effects of individual strategies against bean stem maggot due to interactions on a single plot (Jere, 1997b). Thus, it is necessary to simplify the experimental design to facilitate farmer evaluation. In particular, treatments should include an explicit control plot so that farmers can clearly compare the effects of the PMS. The new design of OFTs for *Striga* now includes a control plot for every farmer participant.

Important lessons from farmer evaluation of OFTs included:

- Farmers' understanding and assessment of the PMS depended on whether the effects were direct or indirect. While it was easy for farmers to evaluate the effect of chemical seed dressing on white grubs in maize, only half the participants understood the rationale behind the use of *Tephrosia* and soya in reducing *Striga* (Jere, 1997: 4).

- Some farmers had little or no knowledge of some pests and their effects. It was difficult for these farmers to evaluate PMS against such pests. Most had little knowledge of bean stem maggot (*Ophiomyia* spp.) or how it attacks beans, and related wilting of beans to moisture stress or soil conditions. Similarly, others knew little about the biology of *Striga* as well as its effects on maize yield. This resulted in farmers doing little to control *Striga* if present in their fields apart from normal weeding.

- This problem of understanding can also reduce the farmers understanding and adoption of various interventions against *Striga*, especially those interventions with indirect effects, such as trap crops and green manure. It is thus necessary to train the farmers on the biology of *Striga* and how it reduces maize yields.

- Farmers' evaluations can also be influenced by their expectations and perceived benefits from their participation in the trials. Most farmers wanted immediate and direct benefits and the presence or absence of these can promote or bias their participation and evaluation. PMS which require several seasons to achieve results require time to train farmers in the scientific rationale for these interventions.

- Farmers evaluated new varieties of pigeonpea and beans using multiple criteria, not just resistance to pests. Early maturity, yield, cooking time, and taste were all important qualities from the farmers' point of view.

- Current prices make the cultivation of soya unattractive for farmers, and its use as a trap crop for *Striga* will be discontinued in next season's OFTs. Despite efforts by NGOs to promote soya as a means of improving household nutrition, farmers view it primarily as a cash crop (Orr and Jere, eds., 1997). Given the number of varieties available - 12 had been released by 1997 - the future of soya would seem to depend on increased demand from processing and export markets.

It is evident that on-farm research to develop PMS for *Striga* and bean stem maggot requires a different approach from that of conventional OFTs. Greater investment is necessary in training farmers about pest biology, and the rationale for interventions to improve soil fertility, if they are to fully participate in the design and evaluation of IPM strategies. It is also necessary to involve farmers at all stages of assessing OFTs so that they can have a better view of what is going on and how it affects them.

Lesson 8: Labour-intensive cultural IPM strategies were inappropriate

The FSIPM Project is not the first to assume that resource-poor farmers will favour labour-intensive pest management practices (Goodell *et. al.*, 1990). Several interventions tested in 1996/97 involved new cultural practices either at planting (high density planting of beans and soya), soon after planting (mulching, earthing-up beans) or later in the growing season (modified *kaselera*). (*Kaselera* is a farmer-developed cultural practice in which soil is removed from the ridge during weeding and used to make a new ridge in the furrow. Beans are relay-planted on this new ridge, which becomes the main ridge on which maize is planted in the next season).

Time and motion studies (Orr 1997a) showed that certain interventions had high labour requirements (Table 4). These figures may be compared with *total* labour requirements for maize of roughly 900-1060 hrs/ha, depending on soil type (Werner, 1987). High density planting of soya required a total of 183 hrs/ha, equivalent to 17 % of total labour requirements for maize on heavy-textured soils. High density planting of beans required 88 hrs/ha, over three times the labour required at farmers' normal planting density. Spreading fertiliser (banding) was also more labour-intensive than the normal farmers practice of dolloping (96 hrs/ha and 60 hrs/ha, respectively). The modified *kaselera* intervention required a total of 500 hrs/ha for scraping up weeds and making new ridges. This was similar to the time required for farmers' existing practice of *mbwera* (561 weighted hrs/ha), where the lower leaves of the maize plant are stripped, and soil removed from ridges to create a flat bed in the furrow for planting relay beans. Farmers commented unfavourably on labour requirements for high density planting, mulching, earthing up, and modified *kaselera* during OFT evaluations (Jere, 1997).

Table 5. Labour requirements for IPM interventions tested in OFTs, 1996/97.

No.	Operation	N	Manhours/ha [1]	Manhours/ha [2]
1	Plant beans	9	27	27
2	Plant high density beans	2	110	88
3	Plant low density beans	2	55	48
4	Open ridges for soya	8	30	30
5	Plant soya	13	200	153
6	Make holes for dollop fertiliser	5	27	27
7	Dollop fertiliser	11	33	33
8	Open ridges for spreading fertiliser	3	40	40
9	Spread fertiliser on ridges	11	60	56
10	Scraping off weeds (*kwonjeka*)	3	235	235
11	*Kaselera*	6	265	265
12	Stripping leaves for *mbwera*	3	94	47
13	Flattening ridges for *mbwera*	3	514	514

Notes to Table 5:

[1] Unweighted labour
[2] Labour weights: 1.0 (male); 0.8 (female); 0.33 (child) from MOAI, Agro-Economic surveys.
[3] All manhours calculated using median values for time taken and labour used on 5 or 10 sq. m. experimental plots, except for high and low density beans, where mean values were used.

When farmers were encouraged to carry out new cultural practices without supervision, the results were predictable. Of 30 farmers asked to mulch or earth up beans in the relay bean trial, 24 failed to carry out either intervention (Abeyasekera, 1997b). Social scientists were then called upon to determine the reasons for non-cooperation (Lawson-McDowall, 1997). The message from farmer evaluation of OFTs was that they were not convinced about the utility of these practices (Jere, 1997: 13).

Lesson 9: Farmer-developed PMS relatively few and localised

It was assumed that farmers' knowledge and practices as regards pests and crop protection were rich and diverse, because they have been practising a lot of PMS for a long time on their own. Such PMS were assumed to include use of indigenous botanical insecticides and cultural techniques. The baseline survey, however, revealed that less than 5 % of sample households in the study area used botanical insecticides. Farmer-developed PMS included Dema (either *Neorautanenia* sp. or *Dolichos kilimandscharicus*), Nadinji (*Mucuna* sp.), sprayed on vegetable nurseries against leaf-eating insects; sprinkling ash around maize planting stations to control termites and on cowpea leaves to control aphids; and Nkhadze or milk bush (*Euphorbia tirucalli),* planted in corners of the maize field to control termites. Knowledge of these methods seems to be localised and - in the case of Dema - may reflect availability of plant materials.

Cultural PMS included 'not banking maize' to control termites and planting pigeonpea on the side rather than on top of the ridge, supposedly against *Fusarium* wilt. A third PMS involved seed dressing with Sevin against whitegrubs, a practise learned from cotton-growers in the Shire Valley. Of these farmer-developed PMS, not banking against termites was used by one-third of sample households, drawn from both EPAs (Orr *et. al.*, 1997). Others were not widely used. Side-planting of pigeonpea was confined to Mombezi EPA. Sevin as a seed dressing against whitegrubs was confined to a small cluster of six households in Chiwinja, despite being practised for three to four years (Orr *et. al.*, 1996: 23-24).

Sevin seed dressing was found to be ineffective against whitegrubs and indeed reduced maize yields (Abeyasekera, 1997b). Results for side-planting of pigeonpea are not yet available, but visual inspection suggested no reduction in *Fusarium*. By contrast, not banking seems not have reduced attack by termites though the statistical analysis is not yet available. It is not known how farmers' decision to bank relates to their decision to do *mbwera* for relay-beans in Matapwata, and this interaction needs to be studied.

The limited use of farmer-developed PMS suggests the potential for technology transfer from other regions (Ritchie *et. al.*, 1997b). Promising strategies include *Tephrosia* sprays in vegetable growing and Dema for control of maize stem borers.

Lesson 10:* Striga asiatica *widely present but patchily distributed at field level

During the diagnostic surveys, farmers ranked *Striga* ranked as the second most important field pest of maize in Matapwata and the fourth most important field pest in Mombezi (Orr *et. al.*, 1996: 18). In the baseline survey, farmers also ranked *Striga* as the second most important pest of maize.

It was assumed from these findings that *Striga* was widely distributed in Blantyre Shire Highlands RDP. The baseline survey showed, however, that while *Striga* was widely present - affecting 37 % of the cultivated area - only 10 % of the area cultivated was reported to contain 'a lot' of *Striga*. This implies that farmers' perception of *Striga* as an important pest reflects high losses in maize yield on fields which are heavily infested. The relatively low incidence of *Striga* was illustrated by the difficulty experienced locating OFTs: of 10 fields, only one proved to be severely infested. In 1997/98 OFTs for *Striga* will be concentrated in Matapwata EPA, with badly infested fields having more than one trial.

Though severe infestation is reported to be low, it should be emphasised that *Striga* poses a threat which can only grow worse. Furthermore, the patchiness of *Striga* presents a research opportunity since strategies which farmers might be unwilling to adopt at the whole-farm level (hand-pulling, earlier fertiliser application) might be practical on small areas of particular fields (Ritchie *et. al.*, 1997c).

4.0 Conclusion

The first year of a new project is inevitably a period of 'new learning'. In the case of the FSIPM Project, most of the lessons identified in this review can be related to two broad themes.

Farming systems and IPM

First, there is the tension between IPM and farming systems research. The Project is neither a conventional farming systems Project with a crop protection component, nor is it a conventional IPM Project which focuses solely on crop protection. Instead it is a hybrid, with IPM as its technical core but with no predetermined boundaries between crop protection and its interactions with the farming system.

This review has identified two important interactions. The interaction between IPM and low soil fertility is fundamental for the maize-intercrop system. This can be adapted fairly easily within the Project's existing framework of target crops and on-farm research. But the interaction between IPM and high-value cash crops is less easy to integrate. From a systems perspective, the opportunities for cash crops offered by a fast-growing urban market represent the most dynamic feature of crop production in the Blantyre Shire Highlands. Cabbage, tomato, sweet potato, and Irish potato will play an increasingly important role in this peri-urban farming system. Such crops will also supply cash required to purchase inputs for other foodcrops. Compared to maize, beans, and pigeonpea, they may also offer greater potential for cost-saving IPM stategies. They form an obvious point of entry for farming systems research, but they are not part of our mandate in IPM. At best, the FSIPM Project can only play a supporting role.

Scientific and farmer knowledge

Second, it is necessary to reconcile the scientific need to test IPM strategies to meet requisite standards, and the socioeconomic need to ensure that such strategies are affordable and appropriate, which requires a high level of farmer participation in technology evaluation.

This poses two problems for the FSIPM Project. The large number of potential PMS and the complexity of the maize-intercrop system on two landtypes require a factorial experimental design to minimise the number of trials. This means that not all farmers will share the same treatments, and it may not be possible for each farmer to compare treatments and control on their own farm. The second problem is that of limited farmer knowledge of certain pests, namely bean stem maggot, *Striga,* and most plant diseases. Both problems limit the scope for farmer participation in the evaluation of IPM strategies. Overcoming these problems will require learning more about farmers' perceptions of pests, educating them in pest biology, and involving them more closely in routine monitoring of OFTs.

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ABBREVIATIONS

ADD	Agricultural Development Division
BC	Biological control
BLADD	Blantyre ADD
CU	Concern Universal
CIMMYT	International Maize and Wheat Improvement Center
DAR	Department of Agricultural Research
DBM	Diamondback moth
DO	Development Officer
EPA	Extension Planning Area
FA	Field Assistant
FSIPM	Farming Systems Integrated Pest Management
GOM	Government of Malawi
ICIPE	International Centre of Insect Physiology and Ecology
ICRISAT	International Centre for Research in Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
MGPPP	Malawi-German Plant Protection Project
MOAI	Ministry of Agriculture and Irrigation
NGO	Non-Government Organisation
NPK	Nitrogen, Phosphorus, Potassium
NSSA	National Sample Survey of Agriculture
OFT	On-farm trial
PMS	Pest management strategy
RDP	Rural Development Project
VR	Varietal resistance

Appendix Table 1. 'New learning' by the FSIPM Project, 1996/97 crop season.[a]

No.	Initial assumptions, expectations	New learning	Comments	Changes to Project
1	Crop losses from pests are a major constraint on foodcrop yields	No objective estimates available of crop losses from pests in farmers' fields	Direct physical measurement of crop losses attributable to individual insects and diseases would require major diversion of Project resources	OFTs to measure crop losses from weeds
		The key constraint on maize yields is low soil fertility	Fertiliser politicised through collapse of formal smallholder credit system	Combine IPM trials with green manure crops and inorganic fertiliser to raise average maize yields
2	Numerous IPM strategies for foodcrops available for adaptive research	Limited scientific knowledge about effectiveness of IPM strategies for maize, beans, or pigeonpea	OFTs on intercrops and cultural practices by Soil Pests Project, Phase II (1992-95) gave inconclusive results Experimental data not available for further analysis	Test broad spectrum of IPM strategies to identify 'best bet' interventions
3	Smallholders have an economic incentive to adopt IPM for foodcrops	Incentives for adoption higher on foodcrops where farmers already use pesticides and can use IPM strategies to reduce cash costs		None
		Varietal resistance (VR) and biological control (BC) are the most economic PMS for foodcrops	Limited VR and BC options for maize pests (termites, *Striga*, whitegrubs)	
			VR available for *Fusarium* wilt (pigeonpea) and bean stem maggot (*Ophiomyia* spp.)	Test additional resistant varieties of beans, pigeonpea
4	Project has correctly targeted priority pests of maize, beans, and pigeonpea	Lower than expected damage to maize from termites and whitegrubs, and to pigeonpea from *Fusarium* wilt	Weather conditions affect pest incidence between seasons	Increase surveillance of pigeonpea pests other than *Fusarium*
5	Research should target three crops (maize, beans, pigeonpea) to avoid overstretching resources	Promising IPM interventions exist for sweet potato and vegetables	Reflects small number of promising PMS for original target crops	Conduct OFTs on sweet potato Baseline data required on vegetable production in Matapwata EPA

Table 1 (cont.)

No.	Initial assumptions, expectations	New learning	Comments	Changes to Project
6	NGOs will collaborate in development and extension of IPM strategies	Agriculture only one component of NGO programmes: limited technical capacity and no formal testing of interventions NGOs have focused on horticulture rather than foodcrops	Conflict between scientific and 'trial-and-error' approaches	Facilitate contacts between NGOs and DAR plant protection scientists Evaluate NGO extension methods for IPM Request demonstration of *Tephrosia* sprays on cabbage and tomato in the Project area
7	Farmer evaluation of OFTs will assist development and adoption of IPM strategies	Experimental design prevented farmer comparisons of interventions and control Limited farmer knowledge of *Striga* and bean stem maggot reduced farmer evaluation of OFTs	Interventions to reduce *Striga* indirectly by improving soil fertility cannot be evaluated in first year	Simplify experimental design to facilitate farmer evaluation OFTs in IPM require investment in farmer training, including joint monitoring of trials by farmers and technical team
8	Cultural PMS are economically attractive to resource-poor farmers	Interventions were tedious (mulching, earthing up) or had high labour requirements at peak periods (eg. high density planting of beans, soya)	Participating farmers required repeated prompting from the technical team and many failed to carry out interventions	Discontinue interventions or modify to reduce labour requirements More emphasis on low-cost chemical control (eg. seed dressing)
9	Farmer-developed PMS use indigenous technical knowledge	Little use of botanical insecticides in Project area Both farmer-developed PMS tested in OFTs were found ineffective	Knowledge is localised, may reflect availability of plant materials PMS confined to one village or to related households	Transfer of farmer-developed PMS from other areas (eg. opportunistic use of *Tephrosia* sprays against pest outbreaks)
10	*Striga asiatica* is a widespread pest of maize in the study area	*Striga* reported present on one-third of cultivated area but only one-tenth had 'a lot' Of 10 *Striga* OFTs, only one was severely infested	Farmers' perception of *Striga* as a major pest reflects high losses on badly infested fields	Relocate OFTs in one EPA, and concentrate them on fields known to be badly infested

[a] format adapted from Goodell *et. al.*, (1990).

Preliminary assessment of 'New learning' by the FSIPM Project, 1997/98 crop season.[a]

A. Orr, M. Ritchie, C.S.M. Chanika, October 1998

No.	Initial assumptions, expectations	New learning	Comments	Changes to Project
1	A promising range of organic methods of improving soil fertility is available for smallholders	Few of the available technologies are currently appropriate for smallholders in southern Malawi	Organic methods of improving soil fertility appear site- and system-specific	Focus OFTs on green manure crops *Tephrosia vogelii* and *Crotalaria*
2	The economic benefits from IPM can be increased by combining IPM interventions with green manure crops to improve maize yields	There is a possibility that green manure crops may increase risk of pest attack on legume intercrops by nematodes, *Fusarium* and stem canker	*Tephrosia vogelii* supports root knot nematodes which may possibly infect nearby pigeonpea plants, which could lead to breakdown of resistance to *fusarium* wilt in resistant pigeonpea cultivars. In 1997/98 there has been some symptoms of a stem canker disease in *Tephrosia* which also may be the same disease as that which is attacking pigeonpea	Assess nematode/wilt and canker infestations in pigeonpea with and without *Tephrosia* present
3	Providing information to farmers will ensure understanding of OFTs and improve participation	Many farmers are still unaware of treatments on their plots (seed dressing, pigeonpea varieties)	Farmers were not fully involved at major field operations. However corrected action to encourge farmers and explain pigeonpes led to suxccessful farmer evaluation.	Review information flow to farmers Prioritise farming operations at which farmers are to be asked to participate
4	Maize, beans, and pigeonpea are the major smallholder foodcrops	Sweet potato is becoming more important as a commercial crop and as a fallback crop after failure of maize and beans	National crop figures show rapid growth in area planted to sweet potato. Relay beans are being progressively abandoned in Matapwata.	Move sweet potato up the research agenda to parity with maize, beans and pigeonpeas. Abandon bean relay-cropping: replace with field peas.
5	*Fusarium udum* is the only major disease of pigeonpea in Southern Malawi	There is a complex of diseases on this crop, including a group of symptoms referred to by FSIPM as "stem canker"	Little information on diagnosis and occurrence of pigeonpea diseases in Malawi	Count affected plants in OFTs Survey non-OFT fields
6	Cowpea and groundnut are suitable trap crops for *Striga asiatica*	*Alectra vogelii* is present in almost all fields of cowpea, groundnut, and beans and may cause severe yield losses to these crops.	See reports of *Striga* transect walks. These losses are unquantified and need to be estimated from the literature.	Screen cowpea and groundnut for sources of resistance Seek alternative trap crops, e.g. *Crotalaria*
7	Sealing cracks reduces pest attack by *Cylas punticollis* on sweet potato	Although sealing reduces pest damage, disturbance to vines causes yield losses	Tuber rots may be a comparable threat to some new varieties. Farmers need access to latest resistant varieties	Obtain best new disease-resistant varieties for trial by farmers. Reduce frequency of crack sealing to twice within six weeks of planting

Preliminary assessment of 'New learning' by the FSIPM Project, 1997/98 crop season.[a] Contd.

No.	Initial assumptions, expectations	New learning	Comments	Changes to Project
8	Weeding consists of handweeding (*kupalira*) and banking (*kubandira*)	Farmers have developed a wide range of weeding practices besides *kupalira* and *kubandira*	Lack of participatory on-farm research means that current research recommendations do not reflect the complexity of smallholder management practices	Ensure OFTs reflect farmers' weeding practices (eg. *kukwezera* for termites) Explore farmers' management practices and decision-making for land preparation and inorganic fertiliser
9	Fertiliser should be applied as soon as possible after planting	Farmers making a single application of fertilizer, apply it when the maize is above knee-height and before tasselling	See comment 8, above	OFTs to compare different timings of fertiliser application
10	IPM interventions can be incorporated into existing crop management practices	Labour constraints limit the scope for some IPM interventions, especially cultural control	In dryland maize-based farming systems, the optimal times for planting intercrops, basal fertiliser application, weeding, and banking all fall within six weeks of planting the main crop	Linear programming model of interactions between IPM interventions and other crop management practices during the 'six week window'.
11	Bean varieties released by research programmes will consistently out-yield local varieties.	In OFTs, less promising varieties (Kaulesi, Kalima) outperform new releases and are preferred by some farmers.	Short duration beans are a serious need for Blantyre Shire Highlands. Kaulesi demand exceeds supply.	Continue using kaulesi in trials. Continue search for better alternatives.
12	Farmers prefer to have much closer maize spacing than researchers.	Many farmers are spontaneously adopting or testing research recommendation on spacing (90 cms) as indicated by Farmer evaluation questionnaire responses.	Benefits for nutrient supply and intercropping options appear to be apreciated.	Continue to use 90 cm spacing on formal plots while permitting frmers to follow other spacing on their observation plots. Monitor farmer spacing.

[a] **2nd draft, October 1998**

Lessons3.doc

New Learning by the FSIPM Project, 1998/99 crop season.

No.	Initial assumptions, expectations	New learning	Comments	Changes to Project
1	A recommended PMS must be shown to be superior to others using statistical tests of significance	Three years of OFTs testing a farmers' PMS for termites failed to give consistently significant results	Variability at the field level makes statistical validation time-consuming and expensive	Redefine 'validation' of farmer-developed PMS.
2	PRA provides a quick and effective means of discovering farmers' PMS	Group discussions provided few farmers' PMS for termites and whitegrubs	Group dynamics suppress variations in farmers' PMS	Uncovering farmers' PMS requires patient case-studies of practices by individual farm households with experience of the target pest
3	PMS are pre-determined plans that can be tested by experimental methods in OFTs	Farmers may adjust the treatment factor according to seasonal conditions and whether or not the pest is actually present	Farmers management practices resemble 'performances' rather than plans	Redefine 'PMS' to allow for unplanned improvisation
4	Absence of cash investment in pesticides limits the potential for the adoption of IPM for food crops	IPM strategies for food crops are attractive to farmers if they promote a market opportunity	'Food crops' is a misnomer since most crops grown for consumption in the study area are also widely sold	Link PMS with market opportunities
5	Vegetables offer greater scope than food crops for IPM because growers invest heavily in chemical control	Vegetable growers spent only $ 20 per annum on pesticides	Low expenditure reflects cash constraints and the small area planted to vegetables because of high labour inputs for irrigation	None.
6	Farmers can effectively evaluate PMS being tested in OFTs	Farmers believed sealing cracks on sweet potato ridges was an effective PMS against *Cylas*, but statistical analysis showed the opposite	Farmers were confused by the design of the OFT, and were reluctant to reject the PMS after only one season	Simplify OFT design and restrict crack-sealing to within 6 weeks of planting

A. Orr. 4 January 2000

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

PROPOSED PROGRAMME OF ON-FARM RESEARCH

1996-97 SEASON

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Figure 2. FSIPM Project Stakeholder Workshop: proposed priorities for choice of crops and pests.

Figure 3. Farmers' ranking of pests in maize, Chiradzulu North and Matapwata EPA.

Figure 4. Farmer perceptions of major pests and control methods for *Phaseolus* beans and Pigeonpeas.

Figure 5. A social map as a tool for farmer selection for participation in on-farm IPM trials.

Figure 6. Proposed locations of on-farm pest management trials.

INTRODUCTION

The Farming Systems Integrated Pest Management (FSIPM) Project, financed by the UK Overseas Development Administration and the Government of Malawi, is intended to develop the capacity of the Department of Agricultural Research to undertake Farming Systems Integrated Pest Management Resarch and to provide government and NGO extension systems with pest management recommendations suitable for resource-poor farmers. The project has as its initial focus the Blantyre Shire Highlands Rural Development Project area.

The FSIPM Project held a Stakeholder Workshop in Limbe 4 - 6 June 1996, involving 29 participants from 11 agencies with a direct interest in the outcomes of the Project. The Workshop made several improvements to the Logical Framework of the Project (Figure 1).

GOAL AND PURPOSE OF THE FSIPM PROJECT

The overall Goal of the Project is the adoption by farmers of low-cost sustainable pest management strategies. The Purpose of the project is to improve national capability for carrying out IPM by strengthening capacity in farming systems IPM research, developing IPM strategies suitable for resource-poor farmers and preparing and disseminating extension materials incorporating such strategies (Figure 1).

CHOICE OF PRIORITY CROPS AND PESTS

The Stakeholder Workshop was asked to provide guidance on the priority crops and pests for which pest management strategies are needed for resource-poor farmers in Southern Malawi. Their recommendations are summarized in Figure 2. The clear message of this exercise was that the project should concentrate on the major pests of maize, pigeonpeas and common beans.

CRITERIA FOR SELECTION OF EPA:
Chiradzulu North And Matapwata EPAs

The Stakeholder Workshop endorsed the initial focus of the FSIPM Project within the Blantyre Shire Highlands RDP but did not provide guidance on the choice of EPAs within the RDP. The project team made the choice of Chiradzulu North and Matapwata EPAs on the basis of the following criteria:

- both EPAs are representative of the Blantyre-Shire Highlands RDP (topography, rainfall, and cropping pattern);
- they contain the highest population density of any EPA in Malawi (285-290 persons/sq. km in 1987);
- Chiradzulu was the site of BLADD's Adaptive Research Team on-farm trials, 1985-90;

- Matapwata was the site of Soil Pests Project surveys and trials, 1989-1992;
- RDP Extension officials recommended these two EPAs; and
- serious pest problems were identified through reconnaisance surveys (eg. whitegrubs in Chitera dambo).

CRITERIA FOR SELECTION OF VILLAGES:
Chiradzulu: Chiwinja, Lidala; Matapwata: Chaoni, Kambua.

Reconnaissance surveys were conducted throughout Matapwata and Chiradzulu North EPAs with the assistance of EPA staff. Criteria for selection of villages included:

- manageable size (100-150 households in each village);
- range of land types (dambo, upland, and hillslope);
- convenient, all-weather road access from Bvumbwe; and
- serious pest problems.

THE PARTICIPATORY RURAL APPRAISAL (PRA) PROCESS

PRA consists of a series of diagnostic exercises that provide 'approximate' information in a participatory fashion. These methods are highly visual in nature and enable a group of villagers to teach outsiders about their village. The following exercises were carried out in the target villages:

- **village meetings** - in order for the project to be introduced and to request the assistance of villagers; attended by DO and AO, chiefs and as many people as possible from village;

- **map of village,** showing main features (roads, rivers, wells, churches, schools, houses etc.);

- **resource map** (dambo, munda, soil types, firewood, crop distribution);

- **timelines** - main events in living memory;

- **seasonality charts** - rainfall, peak labour times, timing of health problems;

- **transects** - walk a cross-section of village with 2-3 informants;

- **crops grown and their importance** - ranking exercise by villagers: crops are listed and top ten most important ranked, these confirmed maize, pigeon peas and beans;

- **farmers perceptions of pests** - ranking exercise of pests and possible controls (Figures 3 and 4) and

- **social mapping for farmer selection** - since our remit is to target poorer households and poor female headed households, it has been necessary to identify these rapidly through a series of crude economic indicators: jobs, ownership of assets (bicycles, livestock), headship of house and household 'clusters' i.e. closely related households are also identified so that participation may therefore be spread between clusters. These indicators are represented by symbols on a chart known as a social map (Fig. 5), which functions as an approximate census of the lineages in the village.

Farmer perceptions of important pests of major crops in Matapwata and Chiradzulu North

Several meetings were held with separate groups of men and women farmers in the selected villages to discuss their perceptions of priority pests of their crops and possible control methods. The results of these meetings are summarized for maize in Figure 3 and for beans and pigeonpeas in Figure 4. Figure 3 shows farmers' ranking of pests which caused the most serious damage to maize at our two research sites. For the purpose of illustration, only the five most serious pests have been shown. Whitegrubs, termites, cobrot and striga asiatica were perceived as the most serious field pests of maize. With the exception of cobrot, all field pests were perceived as increasing in severity. Farmers also used a wide range of control methods, several of which (eg. the use of Sevin seed-dressing, or ash) were innovative farmer practices.

Figure 4 shows farmers' ranking of pests which caused the most serious damage to beans and pigeonpea. The Figure shows the five most important pests for each site. It is notable that for the three most important field pests of beans (wilting, sclerotium, and aphids), farmers reported no effective methods of control. In the case of pigeonpea, there was a dearth of reported control methods for insect pests. Farmers reported that planting on the side rather than the top of the ridge effectively controlled wilting, however.

The perceptions of farmers are consistent within and between Matapwata and Chiradzulu and also show similarity to the views of the group of professionals and experts assembled at the Stakeholder Workshop (Figure 2). However there is one major exception to this general agreement, whitegrubs, which were identified as the most important maize pest in both Chiradzulu and Matapwata, although not ranked as major pests by the Workshop. This perception by the farmers receives some support from the findings of the Chancellor College Soil Pest Project (1992) which rated whitegrubs as the second most important soil pest after termites in Southern Malawi. As discussed further below, wilting in beans is believed by scientists to be commonly caused by beanfly (*Ophiomyia* spp.) but farmers are not aware of the activities of this pest.

SOCIAL SCIENCE WORK PROGRAMME, 1996/97

Social Anthropology

The aim of socio-economic research with regard to this project is to investigate farmers' livelihoods in an holistic fashion in order to understand the opportunities and constraints in their farming systems and the influence these have on pest management. Farmers themselves will be providing evaluations of the on-farm trials; these evaluations need to be set in the wider social context.

By **'livelihoods'**, we mean all activities that farmers engage in to support themselves and their families

- subsistence farming;
- marketing produce;
- '*geni*' - micro-enterprises;
- off-farm employment/self employment;
- selling assets.

It is also important to understand

'inter-household relations':

- support between households (money, agricultural inputs, food, labour)
- patron-client networks; and

'intra-household relations':

- the gender division of labour (the different roles and responsibilities of men and women);
- control of and access to key resources (money, labour power);
- decision-making within the household.

Methodology

A variety of investigative techniques will be used:

- village stays;
- surveys and questionnaires/building on social map;
- semi-structured interviews;
- focus groups for particular issues;
- case study households;
- participant observation;
- diaries.

Farming Systems Economics

There is no universally agreed definition of Farming Systems Research (FSR). A farming systems approach, however, combines three distinctive elements: (1) it is holistic, and treats the farm as a system. It is concerned with the whole farm and the way in which component parts (crops, livestock, horticulture) interact; (2) it attempts to understand the rationality of existing farming systems and the way in which the household allocates resources to meet both its production and consumption objectives; (3) it has evolved primarily in response to the special problems facing agricultural research in unfavourable production environments, where farmers are generally poorer than average.

Objective: To assist Crop Protection scientists at Bvumbwe design and test appropriate and sustainable Pest Management Strategies (PMS) for three subsistence crops in the southern region of Malawi.

Methods:

(1) **Formal**

I) Baseline socio-economic survey at both research sites.

The baseline survey will consist of a simple random sample of approximately 200 households (100 from each of the two EPAs). Data to be collected includes: household labour supply; areas under crops; input use; incidence of pests,weeds, and diseases on maize, pigeonpea, and beans; and household income/expenditure (pre- and post-harvest); and

II) Economic evaluation of On-Farm Trials (OFTs) implemented during the 1996/97 season.

These include approximately 60 researcher-designed, farmer-managed OFTs, and approximately 30 farmer-designed, farmer-managed OFTs.

(2) **Informal**

I) Farmer evaluation of On-Farm Trials; and

II) Identification of farmer-innovators, and indigenous methods of pest control; case studies of farmer decision-making for pest-control.

PEST MANAGEMENT STRATEGIES FOR THE MAIZE/BEAN/PIGEONPEA INTERCROP

The main pests of this cropping system which which are being addressed by the FSIPM Project in the 1996/97 season are the parasitic weed, *Striga asiatica*, termites (Macrotermitinae), and whitegrubs (mainly larvae of scarabeid beetles) which affect maize; Fusarium wilt of pigeonpea; and beanfly (bean stem maggot) affecting common beans.

Management of *Striga* in maize

Striga. The major weed affecting maize is the witchweed (*Striga asiatica*) which is parasitic on the host root system. The weed produces up to 60,000 tiny seeds per plant which can remain viable for up to 20 years. Germination is triggered by proximity of host (and some non-host) roots. Only 10-30% of plants attacking the host emerge above ground. Hand pulled plants with green ovaries can set seeds. Attacked plants may show wilting and discoloration leading to stunting and failure to produce seed. In Southern Africa losses of 60-70% of the crop yield have been recorded.

Riches et al. (1993) working with the Soil Pest Project in Southern Malawi found that while farmers frequently listed Kaufiti as the most important weed of maize, they did not know that it was parasitic and were unaware that it produced large amounts of tiny seed which remains viable for many years. They point out that unless farmers have a basic grasp of pest biology they will not adopt practices such as hand pulling because the benefit is not seen at once. In recent discussions with farmers in Matapwata and Chiradzulu we have found the same lack of understanding of *Striga* biology.

Traditionally control was by avoiding infested land and long fallowing, hand pulling and use of local varieties. Increasing land pressure means that fallowing no longer occurs and *Striga* infestation is rapidly increasing. Since *Striga* performs especially well in well-drained soils with low nutrient status, it is being favoured by this process of land degradation.

Soil fertility trials have yielded conflicting results, possibly due to variation between *Striga* strains and variability of soil conditions in different trials. Addition of inorganic and organic nitrogen may reduce *Striga* severity and enhance the ability of the crop to produce a yield. However it does not reduce the seed bank in the soil. Incorporating fertilizer in the seed bed has been shown to give better crop growth than the standard recommendation of dolloping basal dressing 10 cms from the plant after emergence (Jones, 1993). This is partly because the greatest uptake of nitrogen by maize is in the first 20 days. Fertilizer incorporation in the seedbed should also reduce *Striga* by reducing the production of stimulant chemicals by the maize as well as promoting more vigorous crop growth. Initial results reported by Shaxson and Riches (1995) from a study involving six farmers in Katuli EPA indicated that the addition of 30 Kg of nitrogen as 23:21:0+4S fertilizer incorporated in the ridge at sowing gave the best revenue/cost ratio. This practice will be tested by the FSIPM Project in the coming season in both EPAs.

Hand-pulling is laborious if used frequently and may not increase crop yield in the current season. Its value lies in reducing the seed bank for future years and the next year's harvest may be expected to improve. The weeding needs to be late enough for the *Striga* stem to remain intact and pull up the roots, but not too late to save the crop or to prevent *Striga* seed setting. Early flowering is the best time if labour is available but removal needs to continue up to and beyond harvest. Frequent hoeing might be a less time-consuming alternative (Riches, pers. comm.).

Catch cropping involves planting a crop which is infected by germinating *Striga* and is then ploughed in. This technique is not attractive for smallholders without spare land particularly since it needs to be repeated for several years to be really effective. Trap cropping involves the use of a crop which causes germination but cannot be infected and therefore need not be destroyed. Suitable trap crops for subsistence farmers must be food crops. These include pigeonpea, sunflower, cowpea, groundnut, field pea, pearl millet and various bean species. It is important in trap cropping to suppress grass weed hosts such as *Rottboelia cochinchinensis* which might permit *Striga* to reproduce. Again three years are needed for significant benefit.

Rotation with legumes and trap crops has been found beneficial especially with incorporation of fallowing in the rotation. In Southern Malawi where much more than half the smallholder's land is usually planted to maize annually this appears impracticable. However intercropping maize with soybean or sorghum with groundnut, especially in the same row, has been found to increase yields and reduce *Striga* counts.

In the proposed FSIPM trials two methods of applying a minimal quantity of inorganic fertilizer will be compared, together with the use of a trap intercrop (soya) and a green manure (Tephrosia). Weeding practices will be standardized across the plots. Because farmers with serious *Striga* problems will generally be a relatively small subgroup, the *Striga* trial is organized separately from other trials. However in the long run it will be necessary to integrate Striga control treatments with other IPM activities in maize.

Management of whitegrubs and termites in maize

The Soil Pest Project conducted surveys of soil insect pests in farmers' fields in 1990-91 and 199192 seasons. Termites were the major insect pests of maize in all EPAs surveyed (Logan et al., in press). Most damage took place near to harvesting with a mean of 23.7% of plants attacked, of which 73.5% were severely damaged. During the vegetative stage 12.9% of plants were attacked, and 60.6% of them severely damaged. The Maize Productivity Task Force identified termites as the main national priority for pest management. Surveys by ICRISAT in the 1986-87 growing season found white grubs to be the major pest of groundnuts in areas receiving more than 1000 mm of rain annually, while termites were the most serious pests in areas with lower rainfall (Wightman & Wightman, 1994). The Soil Pest Project recorded whitegrubs as the second most damaging soil insect pest of maize (after termites) in 1990-91, while *Schizonycha* sp. was the most prevalent pest of vegetative groundnuts. Between 29 and 38 species of Scarabeid beetles are involved in crop damage in Malawi. For most of these the identity of adults and juvenile stages of individual species are not established.

Technical options for IPM include cultural control, crop resistance, biological control and selective use of pesticides. Recent PRA in Chiwinja village (Chiradzulu North EPA) elicited the information that a small group of innovative farmers had adopted the practice of treating maize seed with Sevin (Carbaryl) WP formulation (85%) against whitegrubs. Respondents indicated that the technique, which involved soaking seed, draining and mixing it with the insecticide, had been highly effective in killing beetles and reducing damage. This technique will be tested by the FSIPM with farmers in the coming season.

Many farmers believe that the second weeding and re-ridging conventionally carried out in maize causes increased termite damage because the decomposing organic material brought into contact with the maize plants attracts termites. This may cause them to neglect weeding. In Katuli EPA maize is grown on the previous winter season's bean crop ridges. After several weeks the ridge is partly demolished and dragged into the interrow to form a new ridge. Later more soil is pulled away from the maize plants to augment the new ridge. This practice, known as the chisalanga/kaselera system, has been proposed by the soil pest project to reduce lodging due to termite attack. In the initial season of on-farm trials, we will investigate the effect on termite damage of two cultural practices: modified kaselera system (in Matapwata) and weeding without banking at second weeding (in Chiradzulu).

A follow-up project to the Soil Pest Project, funded by ODA is due to begin work in collaboration with DAR in the 1996-97 season. This will evaluate cultural control practices and potential resistant cultivars of maize and groundnuts against termites and white grubs. A series of experiments are envisaged on station and on farm involving maize/groundnut and maize cowpea intercrops and cultural practices including crop residue management, soil management (e.g. ridging), crop varieties and planting densities. The FSIPM Project is seen as a major conduit by which management strategies developed by this project would be made available to smallholders. There is clearly scope for coordinated surveys and trials with farmers between the two projects.

Management of *Fusarium* wilt in pigeonpea

The main strategy for controlling wilt in pigeonpea has been the development of resistant varieties. Currently ICP9145 is the only released resistant variety available to farmers though others are under development. Farmers in Chiwinja (Chiradzulu North EPA) informed the FSIPM Team that pigeonpea is sometimes planted on the side of the ridge to reduce wilting. The Project will conduct trials of this practice with ICP9145 and local pigeonpea.

Management of bean stem maggot (*Ophiomyia* spp.)

Infestation of beans (*Phaseolus vulgaris*) by this pest in southern Malawi is common and frequently severe, especially in the rainy season when beans are intercropped with maize. Infected plants often die soon after germination or are greatly weakened as a result of stem damage by bean fly larvae and the associated invasion by fungal infections especially *Fusarium* wilts (Letourneau, 1991; Ampofo, 1993). This synergistic association makes BSM possibly the most serious pest of common beans.

It appears that farmers are unaware of BSM as the causative agent of dead bean plants in their plots and view the wilting and death of plants as a form of blight (Letourneau, 1991). However the experience of the FSIPM Project has been that farmers are ready to listen to this new explanation for the early wilting which they know so well, and are keen to participate in trials of management practices. IPM for smallholders could involve one or more of the following management strategies which have been summarised by members of the SADC/CIAT Regional Programme on Beans:

- *Foliar Insecticide sprays.* In practice this approach seems unlikely to be appropriate for resource-poor farmers since they have no access to chemical or application equipment. The safety implications are also of concern.

- *Seed dressings.* Endosulfan has been successfully used in several countries in Africa (including the Soil Pest Project at Chancellor College) as a seed dressing but is now classified as moderately hazardous (WHO, 1990) and its use is not regarded as acceptable. Yields have been increased by 17-21% with endosulfan alone and in combination with fungicides such as thiram and benomyl yield increases ranged from 14-63%. A safer insecticide with some persistence and some systemic action in the germinating beans is needed. One economic analysis of the combined insecticide/fungicide seed treatment in Rwanda quoted a cost per hectare of $4 - 6 with a benefit: cost ratio of 5.0 - 22.2 for bush and climbing beans respectively (quoted in Trutmann et al., 1992). Isofenphos (Oftanol) has been recommended by one study (Kabungo et al., 1994). In the FSIPM trials Sevin wettable powder will be assessed. It is widely available and relatively cheap (MK 23.5 for 100gms). It is known to have slight systemic action and soil treatments can reduce both nematode and aphid attack. It is expected to produce a more marked reduction of beanfly damage than non-insecticidal approaches.

- *Varietal resistance.* Bean resistance to BSM is believed to be largely based on the ability to tolerate the damage. It is not clear whether varieties with proven resistance are available for distribution to farmers. In any event farmers use mixtures and selection of resistant varieties might erode genetic diversity (Trutmann et al., 1992). The variety Kalima was extensively tested by Bunda College for its agronomic qualities and acceptability to farmers before release in 1993 and is known to be tolerant of beanfly attack. An older variety, Kaulesi, was reported by Kapeya (1995) as being the most tolerant of the local varieties which he assessed in his studies of beanfly. One or other of these varieties will be compared with the most widely grown local variety, Chimbamba, in the FSIPM intercrop trial in Matapwata and Chiradzulu and in a follow-up relay crop trial in Matapwata only.

- *Mulching.* Use of various plant residues (dry banana leaves, rice straw, dry bracken) as mulch has been investigated and found to reduce and stabilise soil temperature while conserving moisture. This causes enhanced growth of adventitious (but not lateral) roots which aids survival after BSM stem damage (Ampofo & Massomo, 1996).

- *Early planting.* Where practicable early planting is known to reduce BSM attack at the vulnerable seedling stage (Davies, 1990; Abate, 1990) though occasionally later planting may miss the peak of the pest population.

- *Earthing up.* In Tanzania earthing up plants to encourage adventitoious roots has been claimed to be effective (Kabungo, 1994) in reducing mortality due to BSM infestation. Yield improvements are not great.

- *Increased plant population.* This may reduce infestation levels and increase yields at densities up to 300,000 plants per hectare (Abate, 1990). In the proposed trials a planting density equivalent to usual farmer practice (one planting station between each maize and pigeonpea station) and a density three times higher will be used.

- *Natural enemies.* Despite high rates of parasitism (up to 93%) by a wide range of parasitic wasps, the parasitoids do not appear to regulate pest populations and only kill the BSM when it has already inflicted damage (Abate, 1990; Davies, 1990). Management strategies should seek to avoid disrupting existing control by natural enemies. The use of a short-lived seed treatment rather than foliar spraying of chemicals may be expected to cause less damage to natural enemy populations.

- *Botanical pesticides.* Data presented by Ampofo (1993), showing improved yield and apparent reduction in feeding and pupation of BSM on plants treated with Neem and Tephrosia extracts, offer some interest. It is hoped to set up an on-station trial to assess the effectiveness of these methods.

- *Multiple interventions.* There is agreement between different studies that the use of several different approaches simultaneously is likely to give the greatest reduction in losses caused by BSM (and associated infections) (Ampofo & Massomo, 1994; Kabungo, 1994; Abate, 1990). In the proposed

FSIPM on-farm trials seed dressing, varietal tolerance, earthing up, mulching and increased plant density will be combined.

PROPOSED PROGRAMME OF ON-FARM PEST MANAGEMENT TRIALS

The proposed on-farm trials are set within one of the common cropping systems found in both Matapwata and Chiradzulu EPAs in which maize is intercropped with pigeonpea and beans planted in November - December. In Matapwata a relay crop of beans or other legumes is planted in February - March. A summary of the proposed on-farm trials is shown in Figure 6.

Trial 1. Striga management on upland (munda) farmland (Table 1)

Standard plot size: 4.5m x 4.5m gross, 3.6m x 3.6m nett (See figure 7 for plot layout).

Ten farmers, with five in each EPA. Three plots per farmer. 20 experimental plots and 10 farmer practice plots.

Cropping pattern: Maize (MH18) + pigeonpea (local) + beans (Chimbamba) intercropped on ridge

Treatments:

1. Fertilizer: 30 Kg N (23: 21: 0 + 4S) per hectare spread in ridge at sowing, no top dressing (see Shaxson & Riches, 1995).
2. Fertilizer 30 Kg N (23: 21: 0 + 4 S) dolloped to one side of maize plant
3. Control: no fertilizer
4. *Tephrosia* broadcast in furrow at first weeding and and incorporated at second weeding.
5. Soya beans sown in furrow.
6. No *Tephrosia* or soya beans.

Experimental Design: 3x3 Factorial (Table 1).

Responses:

1. Count all emerged Striga stems weekly in three quadrats (0.9 m x 0.9m) each formed by enclosing area between four maize stems in nett plot. Quadrats placed diagonally from top left to bottom right of plot.
2. Determine yield from treatment nett plots.

Trial 2. Pest management for maize/pigeopea/bean intercrop (Table 2).

Cropping pattern: Maize (MH18) + pigeonpea (local/ICP9145) + beans (Kalima [or Kaulesi] /local: Chimbamba) intercropped on ridge

Standard plot size: 4.5m x 6.3m gross (28.35m^2), 3.6m x 3.6m nett (12.96m^2) (See Figure 8 for plot layout).

Experimental Design: See Table 2. Fractional replicate of a 2^8 factorial experiment in four blocks each having 16 plots, i.e. 64 experimental plots in total. Each farmer has a second plot with his own methodology applied.

Maize

Whitegrubs (seedling attack) - dambo only (Chiradzulu and Matapwata)

1. Seed dressing with Sevin (Carbaryl) (85% WP formulation) (level 1)
2. Seed dressing with Sevin (Carbaryl) (85% WP formulation) (level 2)
3. Control: no seed dressing.

Termites (lodging mature plant) - upland only

Chiradzulu (no relay bean crop):

1. Hand weed without banking maize at second weeding.
2. Control: weed and bank at second weeding.

Matapwata (followed by relay bean crop- see Trial 3)

1. Use modified "kaselera"system: hand weed without banking at second weeding around time of cob formation (Feb), leave weeds to dry in furrow, form new ridge (Feb/March) and plant short duration beans on new ridge.

2. Control: weed and bank at second weeding. Form new ridge for beans when maize is drying (Feb/March) and plant short duration beans on new ridge (Trial 3).

Responses:
1. Score whitegrub damage (0-4) weekly for all plants at 5 planting stations, initially 15 plants (see fig.).
2. Score termite damage (0-4) weekly for all plants at 5 planting stations, initially 15 plants (see fig.).
3. Determine maize yield from treatment nett plots.

Pigeonpea:

Fusarium wilt.

1. Resistant variety, ICP 9145 planted in row.
2. Resistant variety, ICP 9145 planted on ridge side.
3. Local planted on ridge side.
4. Control: Local planted in row.

Responses:
1. Score wilting (0-4) weekly for all plants at 5 planting stations (initially 15 plants).
2. Uproot dead plants and record disease symtoms.
2. Determine pigeonpea yield for nett plot.

Beans :

Beanfly (bean stem maggot): Chiradzulu: Upland only (because beans get waterlogged in dambo). Matapwata: Dambo and upland. First crop (Nov/Dec)

1. Seed dressing with sevin.

2. Control, no seed dressing.

3. Earthing up plants (to allow adventitious root formation).

4. Control, no earthing up.

5. Mulching with available materials (dry banana leaves, grass).

6. Control, no mulching.

7. Varietal resistance/tolerance (Kaulesi or Kalima)

8. Control, local check: Chimbamba.

9. Plant density high (three bean stations between each maize and pigeonpea station)

10. Plant density low (one bean station between each maize and pigeonpea station)

Responses:
1. Score beanfly damage (0-4) weekly at 12 planting stations (see Fig. 8) (two plants in each station).
2. Remove dead plants weekly and count puparia in stems. Rear adults + parasitoids in laboratory.

Trial 3. Relay beans (March/April) - Matapwata only

Same farmers as for Trial 2. Standard plot size as for Trial 2. Beans grown on new ridge formed in old furrow.

Treatments:

1. Seed dressing with sevin.

2. Control, no seed dressing.

3. Earthing up plants (to allow adventitious root formation).

4. Control, no earthing up.

5. Mulching with available materials (dry banana leaves, grass).

6. Control, no mulching.

7. Varietal resistance/tolerance (Kaulesi or Kalima)

8. Control, local check: Chimbamba.

9. Plant density high (10 cms between planting stations)

10. Control: Plant density low (15 cms between planting stations)

Responses: As for first crop.

Trial 4. Locally available botanical pesticides for seed dressing

Seed dressing of maize with locally available botanical pesticides (neem and *Tephrosia*) to control whitegrubs. This experiment will be conducted if possible in a dambo area on farmers fields. The aim would be to perform an initial exploratory trial to determine whether these substances have any value in this context. There is also a need to conduct on station trials of botanical pesticides for protection of beans against beanfly.

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Table 1. *Striga* management trial for maize/pigeopea/bean intercrop.

EPA	Farmer	Plot 1	Plot 2	Plot 3 (farmers own method)
1	1	f_0t_0	f_2t_2	
1	2	f_1t_0	f_1t	
1	3	f_2t_0	f_0t_2	
1	4	f_0t_1	f_2t_1	
1	5	f_1t_1	f_0t_1	
2	6	f_2t_1	f_1t_1	
2	7	f_0t_2	f_1t_0	
2	8	f_1t_2	f_2t_0	
2	9	f_2t_2	f_0t_0	
2	10	f_2t_1	f_1t_2	

Notation: f_0 represents no fertilizer,
f_1 represents dolloped fertilizer
f_2 represents spread fertilizer

t_0 represents no Tephrosia or soya beans
t_1 represents Tephrosia
t_2 represents soya bean in furrow

Table 2. Pest management trial for maize/pigeopea/bean intercrop.

Block 1 - Dambo in Matapwata							
irg	sbirg	smig	bmig	spirg	bpirg	mpiw	sbmpiw
svrw	bvrw	mvw	sbmvw	pvr	sbpvr	smpv	bmpv
Block 2 - Upland in Matapwata							
sirt	birt	mit	sbmit	pirt	sbpirt	smpit	bmpit
vt	sbvt	smvrt	bmvrt	spv	bpv	mpvr	sbmpvr
Block 3 - Upland in Chiradzulu							
s	b	mr	sbmr	p	sbp	smpr	bmpr
vi	sbvi	smvir	bmvir	spvit	bpvit	mpvirt	sbmpvirt
Block 4 - Dambo in Chiradzulu (no beans here so no bean treatments)							
g	ig	rw	irw	g	ig	rg	irg
w	iw	rw	irw	i	i	r	ir

Notation for factors included in trial:

G - Seed dressing maize with Sevin (85% WP formulation) (level 1).
absence of letter G represents control, i.e. no seed dressing.

W - Seed dressing maize with Sevin (85% WP formulation) (level 2).
absence of letter W represents control, i.e.no seed dressing.

T - presence of letter T indicates maize termite treatment (different in two locations).
absence of letter T represents control, i.e. weed and bank at second weeding.

I - presence of letter I indicates use of wilt-resistant pigeonpea variety, ICP 9145.
absence of letter I represents control, i.e. local pigeonpea variety.

R - presence of letter R indicates pigeonpea planted on ridge side.
absence of letter R represents control, i.e. planting in row.

S - presence of letter S indicates bean seed dressing with Sevin for beanfly.
absence of letter S represents control, i.e. no bean seed dressing.

B - presence of letter B indicates earthing up bean plants.
absence of letter B represents control, i.e. no earthing up.

M - presence of letter M indicates mulching of beans.
absence of letter M represents control, i.e. no mulching.

V - presence of letter V indicates tolerant bean variety (Kaulesi or Kalima).
absence of letter V represents control, i.e Chimbamba.

P - presence of letter P indicates planting density is high .
absence of letter P represents control, i.e. planting density is low.

Fig. 1. Proposed revision of Farming Systems IPM Project Logical Framework.

Narrative summary (NS)	Measurable indicators (OVI)	Means of Verification (MOV)	Important assumptions
Supergoal: 1. Improved incomes for resource-poor farmers.			
Goal: 1. Farmers adopt low cost sustainable integrated pest management strategies.	1.1 'X' percent of farmers in zone adopt by year 'y'.	1.1 ADD Monitoring and Evaluation Surveys.	**(Goal to Supergoal)** 1.1 Economic environment remains favourable.
Purpose: 1. Local capacity for IPM improved.	1.1 Commodity Teams incorporate IPM PMS for maize and two other major foodcrops.	1.1 DAR annual reports and CT reports.	**(Purpose to Goal)** 1.1 Extension system continues to function effectively.
Outputs: 1. Research capacity for farming systems IPM research strengthened.	1.1 At least 6 Malawian postgraduate scientists trained in IPM by end of project. 1.2 Three seasons on-farm IPM research experience for staff attached to project by end of project. 1.3 Two seasons on-farm IPM research experience for returned graduates by end of project. 1.4 Buildings completed according to contract date.	1.1 Project reports. 1.2 Project reports. 1.3 Project reports. 1.4 Quantity surveyor's reports.	**(Output to purpose)** 1.1 Suitable staff are identified, assigned to the project, and retained by DAR 1.2 Adequate budget. 1.3 Returned graduates remain attached to project. 1.4 Building costs remain stable.
2. IPM strategies suitable for resource-poor farmers developed.	2.1 At least one PMS per crop by end year 2.	2.1 Project reports.	2.1 Stakeholders continue to develop and refine IPM strategies.
3. Improved extension materials prepared and disseminated by both formal and informal extension networks.	3.1 Three packages of extension materials (one per crop for verified PMS) developed by end year 3.	3.1 Project reports and extension materials.	3.1 Informal and formal networks willing and able to cooperate. 3.2 Timely approval of IPM strategies by Technology Clearing House.
4. Project management systems implemented.	4.1 List of management responsibilities. 4.2 Schedule of activities. 4.3 Accounting systems.	4.1 Project document (Annex), job descriptions. 4.2 Work plans, GANTT charts. 4.3 Accounting records.	4.3 Timely financial information available to management

Narrative summary	Inputs/resources	Means of verification	Important Assumptions
Activities			**(Activity to output)**
1.1 Prepare plans and issue contracts for buildings.	See budget and staffing schedule.	1.1 Site manager's report.	1.1 MoW cooperate.
1.2 Construction of buildings.		1.2 Site manager's evaluation, visit by BDDCA.	1.2 Contractor completes work on timely basis.
1.3 Furnish and equip buildings.		1.3 Project reports.	1.3 Equipment ordered and delivered on time.
1.4 Train research and extension staff in farming systems and participatory research methods.		1.4 Numbers trained and trainees course evaluation.	1.4 Research staff assigned to and remain with the project.
1.5 Train 6 M.Sc. students at University of Malawi.		1.5 Numbers registered and supervisors' reports.	1.5 Suitable candidates identified.
1.6 Train 3 MoA staff on M.Sc. courses in UK.		1.6 Numbers registered and supervisors' reports.	1.6 Suitable candidates identified.
1.7 Use consultancies for specialist inputs (local where possible; co-consultants if otherwise).		1.7 Project reports.	1.7 Good consultants available on timely basis.
1.8 Procurement of vehicles and equipment.		1.8 Procurement agents reports.	1.8 Vehicles available in price range.
2.1 Select agro-ecological zones (one per year; total three).		2.1 Project reports.	2.1 Background information available.
2.2 Review existing data on crop protection.		2.2 Review document.	2.2 Literature available.
2.3 Conduct baseline surveys on crop losses and PMS of farmers in the selected zones.		2.3 Project reports.	2.3 Farmers collaborate.
2.4 Determine reasons for crop losses at farm level.		2.4 Project reports.	2.4 Farmers assist with data collection.
2.5 Identify and select participating farmers.		2.5 Project reports.	2.5 Farmers keen to participate.
2.6 Develop PMS with farmers to reduce crop losses.		2.6 Project reports and collaborators' evaluations.	2.6 Farmers actively involved.
2.7 Assess effectiveness and impact of PMS.		2.7 Project evaluation report.	2.7 Farmers collaborate.
2.8 Prepare recommendations.		2.8 Project reports.	2.8 Appropriate PMS identified.
3.1 Identify formal and informal communication networks in the three project areas.		3.1 Project reports.	Socio-economic conditions in the three areas do not change enough to alter communications networks significantly.
3.2 Develop informal extension mechanisms in collaboration with NGOs.		3.2 NGOs' evaluations.	3.2 NGOs willing to collaborate.
3.3 Prepare training and extension materials for extension workers.		3.3 Project reports, reports from collaborating agencies.	3.3 Appropriate PMS identified.
3.4 Train extension workers.		3.4 Numbers trained and collaborators' reports.	3.4 Links with ADDSs allow training.
3.5 Prepare extension materials for smallholder farmers.		3.5 As above.	3.5 Appropriate PMS identified.
4.1 Develop and maintain project management reponsibilities chart (PMS).		4.1 PMS document, job descriptions.	4.1 Secure electronic and hardcopy storage of records.
4.2 Prepare job plans.		4.2 Project documents and reports.	
4.3 Set up and maintain financial accounting systems.		4.3 Monthly imprest account summaries and cash book audits.	
4.4 Set up and maintain assets register.		4.4 Assets register.	

Figure 2. FSIPM Project Stakeholder Workshop: proposed priorities for choice of crops and pests.

Variable	Maize	Beans	Pigeon-pea	Cowpea	Cassava	Sweet Potato	Sorghum	Millet	Soyabean	Chickpea	Groundnut
Major pest(s)	1- *Striga* 2- termites 3- stemborers 4- head smut	1- beanfly 2- angular leaf spot 3-*Ootheca*	1-*Fusarium* wilt	1- blight	1- mosaic virus 2- mealy bug 3-green mite	1- S P weevil 2- S P mosaic virus	1- stem borers 2- *Striga*	1- stem borers 2- *Striga*	1- bacterial blight	1- Fusarium wilt	1- rosette virus 2-foliar diseases
Candidate PMS available ?	1-3 cultural	1 cultural, seed dressing	1 resistant varieties	1 varietal mixtures?	2-3 biocontrol	1 filling soil cracks	?	?	N/A	N/A	1- resistant vars, cultural, chemicals
Area planted in RDP (approx.)	50%	13%	17%	4%	4%	2%	4%	<1%	<1%	<1%	4%
Food security	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓		✓
Cash income	✓	✓✓	✓✓	✓	✓✓	✓	✓	✓	✓✓	✓✓✓	✓✓
NGO linkages	✓	✓	✓		✓✓✓	✓✓✓	✓	✓	✓		✓
Research linkages (eg. IARCs)	✓	✓	✓		✓	✓	✓	✓	✓		✓
Male/female decision-maker ?	M/F	F	F	F	M/F	M/F	F	F	M	M	F
Overall priority for FSIPM	1	3	2	5	4	6	7				

Fig. 5. A social map as a tool for farmer selection for participation in on-farm IPM trials.

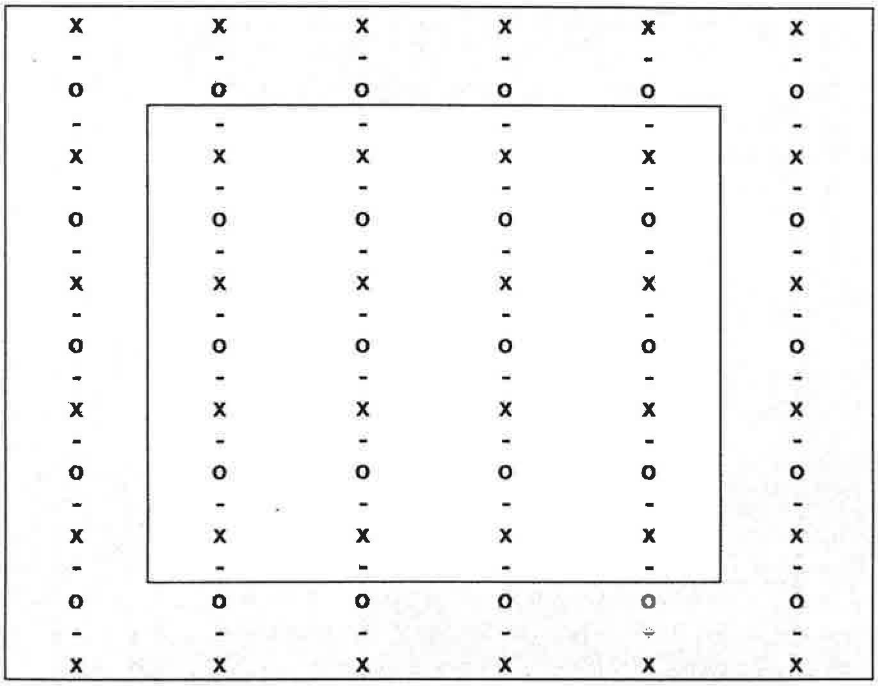
SOCIAL MAP OF CHIWINJA LINEAGE, CHIWINJA VILLAGE 4/9/96

KEY man woman boy girl head of household		proper job (i.e. with salary) 'big' business (i.e. more than just 'gain')		cow goat bicycle owner burley club member			
33. Duniya Majede	34. Egneti Majede	35. Alice Ndale	36. Enifa Ndale	37. Rose Mdala	38. Ruwiza Mdala	39. Katherine Kachere	40. Anne Mandota
25. Daina Chilinkhonde	26. Edesi Chilinkhonde	27. Sabastione Chilinkhonde	28. Richard Chilinkhonde	29. Witness Joni	30. Alice Joni	31. Nasiyani	32. Austine Joni
17. Mary Kapitawo	18. Dorika Kapitawo	19. Levison Kapitawo	20. Eva Jumbe	21. Nelly Phalombe	22. Mercy Phalombe	23. Isaac Chilinkhonde	24. Redson Chilinkhonde
9. Linily Mateseke	10. Elina Walala	11. Lucy Magreen	12. Klyson Belo	13. Dickson Chimseu	14. Giant Chimseu	15. Florence Chimseu	16. Margaret Chimseu
1. Marita Sapuwe	2. Dora Makwiti	3. Levison Makwiti	4.Emily Muchera	5. Alice Muchera	6. Tenson Sapuwa	7. Agnes Mandevu	8. Rhoda Kaisa

Fig. 6. Farming Systems IPM Project: Proposed locations of on-farm pest management trials

Trial	Crop	Pest	PMS	Matapwata EPA				Chiradzulu North EPA			
				Magomero section (Chaoni village)		Kambuwa village		Chiwinja village		Lidala village	
				Dambo	Upland	Dambo	Upland	Dambo	Upland	Dambo	Upland
1. Striga	Maize	Striga	Fertilizer (spread)	-	+	-	+	-	+	-	+
	Maize	Striga	Fertilizer (dollop)	-	+	-	+	-	+	-	+
	Maize	Striga	Tephrosia	-	+	-	+	-	+	-	+
	Maize	Striga	Soya	-	+	-	+	-	+	-	+
2. Intercrop	Maize	Whitegrub	Seed dressing (Sevin)	+	-	+	-	+	-	+	-
	Maize	Termites	Weed without banking	-	-	-	-	-	+	-	+
	Maize	Termites	Modified "kaselera"	-	+	-	+	-	-	-	-
	Pigeonpea	Fusarium wilt	ICP9145	+	+	+	+	+	+	+	+
	Pigeonpea	Fusarium wilt	Planting position	+	+	+	+	+	+	+	+
	Beans	Beanfly	seed dressing	+	+	+	+	-	+	-	+
	Beans	Beanfly	earthing up	+	+	+	+	-	+	-	+
	Beans	Beanfly	mulching	+	+	+	+	-	+	-	+
	Beans	Beanfly	plant density	+	+	+	+	-	+	-	+
	Beans	Beanfly	varietal tolerance	+	+	+	+	-	+	-	+
3. Relay	Beans	Beanfly	seed dressing	+	+	+	+	-	-	-	-
	Beans	Beanfly	earthing up	+	+	+	+	-	-	-	-
	Beans	Beanfly	mulching	+	+	+	+	-	-	-	-
	Beans	Beanfly	plant density	+	+	+	+	-	-	-	-
	Beans	Beanfly	varietal tolerance	+	+	+	+	-	-	-	-

Fig. 7. Proposed *Striga* management plot layout for on-farm trials 1996-97.



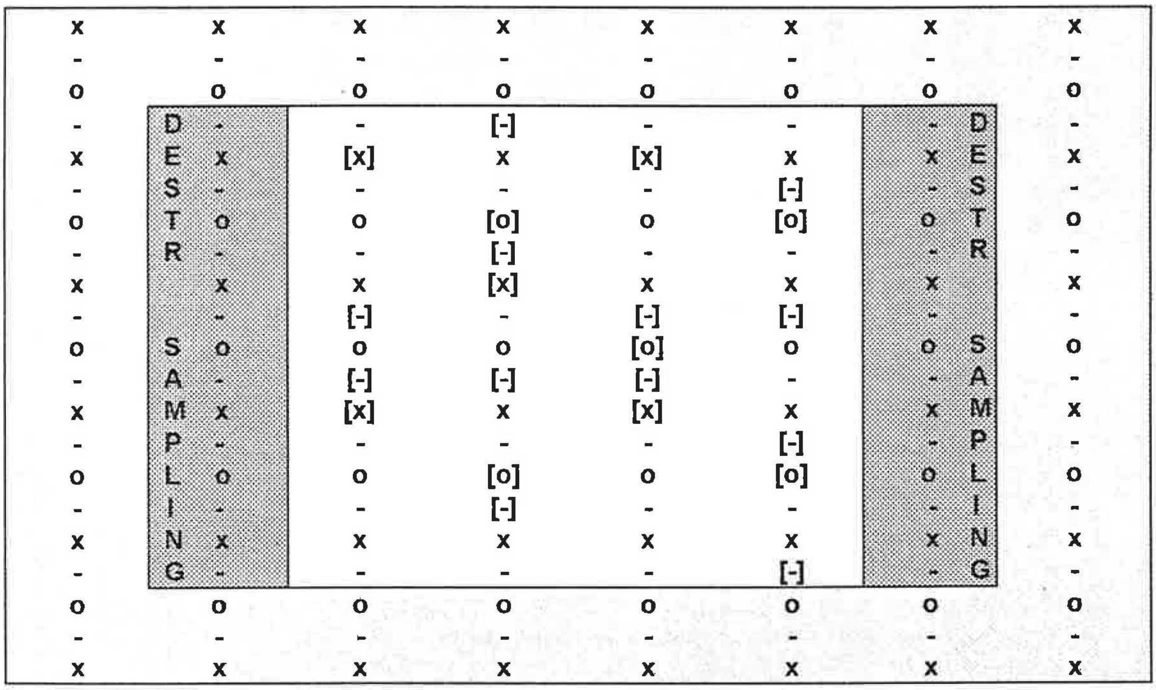
Outer box = Gross plot area with guard rows (4.5m x 4.5m, 36 maize planting stations)

Inner box = Nett plot (3.6m x 3.6m, 16 maize planting stations)

Gross plot area = $20.25m^2$
Nett plot area = $12.96m^2$

LAYOUT:	x	maize (3 plants per station)
	o	pigeonpea (3 plants per station)
	-	beans (2 plants per station)

Fig. 8. Main trial plot layout for on-farm intercrop trials 1996-97.



Outer box = Gross plot area with guard rows (4.5m along rows x 6.3m across 8 rows, 48 maize planting stations)

Inner box = Nett plot (3.6m x 3.6m, 16 maize planting stations)

Gross plot area = 28.35m^2
Nett plot area = 12.96m^2

LAYOUT:	x	maize (3 plants per station)
	o	pigeonpea (3 plants per station)
	-	beans (2 plants per station)*
	[ ]	sampling station (all plants in station sampled)

* In planting density treatment, alternative levels are one bean station between each maize and pigeonpea station and three bean stations between each maize and pigeonpea station

Sampling: all plants at each sampling station except for high density level of bean density treatment where only one (central) station of each triplet is sampled.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

PROPOSALS FOR ON-FARM PEST MANAGEMENT FIELD TRIALS

1997-98 SEASON

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Proposals for main intercrop IPM trial 1997/98

Background

The 1996/97 main intercrop trial was conducted with 64 farmers in four villages in 2 EPAs. This trial was set within the maize/pigeopea/bean intercropping system with relay cropping of beans or field peas which is the commonest cropping system within the Blantyre Shire Highlands. The objectives and design of the experiment have been detailed by Ritchie et al. (1997). Analysis of results is proceeding in a series of reports (Abeyasekera 1997). There were four IPM objectives relating to each of the three crops:

- Evaluation of modified Kaselera to reduce lodging of maize by termites.
- Evaluation of seed dressing for reduction of damage to maize by whitegrubs.
- Evaluation of planting position and varietal resistance to reduce wilting due to *Fusarium udum* in pigeonpea.
- Evaluation of seed dressing, planting density, varietal tolerance, mulching and earthing up to control damage by bean stem maggot (*Ophiomyia* spp.) in common bean.

The advantages of combining trials of pest management strategies (PMS) for the different crops within one on-farm experiment were listed by Ritchie et al. (1997). These include the fact that the approach mirrors the actual farming system; interactions between different PMS and resource competition can be detected and obviated; logistics are simplified by dealing with a limited area and farmer group; a factorial design cuts replication and reduces plot numbers and associated labour and expense.

Analysis of results is still incomplete (especially for pigeonpea for which harvest has only just been completed). Biometric analyses of part of the data have been reported by Abeyasekera (1997). Farmer evaluation of IPM strategies was carried out by Jere (1997) although this process was hampered by the difficulties caused by a complex design and the fact that farmers could not observe the full range of treatments on their fields. In some cases farmers were unsure of the intended effect of a strategy. The design of experiments proposed below is intended to ensure that most of the proposed combinations of management practices are visible to each farmer on one or more of the four experimental plots on his or her farm. In addition there has been a radical reduction in the number of combinations involved, focussing attention on those interventions most likely to have a significant effect which can be evaluated by farmers.

Management of termite damage to maize

Termite attack can be heavy in some fields, especially when crops are banked. In general however termite damage was more marked in on-station monocrop trials in the hotter drier area of Thuchila than in on-farm intercrop trials in Chiradzulu and Matapwata. Khonga (1996) found that intercropping with pigeonpea significantly reduced termite attack compared to monocropped maize. On-farm termite damage appears to be site specific. The trial followed up the Soil Pest Project technique of using modified kaselera tillage to discourage termites by removing soil from around maize plants and forming a new ridge in the furrow on which a relay crop of beans could be planted.

Modified kaselera was found to differ little in reality from the local practice of Mbwera which is normally undertaken slightly later when maize plants are starting to dry out. This technique produces a flat planting area which is also used to support a relay crop of beans planted in a regular spacing at high densities. At present it is not clear what the relative labour requirements of the two techniques are, taking into account the labour saved owing to the fact that a new ridge has been formed which will later be used for the following maize crop. However there is objective evidence from the trial that beans planted on the kaselera ridge performed significantly less well than those planted on the flat. In a major bean growing area this would seem to militate against the technique.

The approaches available would seem to be Mbwera vs no Mbwera (in Matapwata) and weeding with banking or weeding without banking (in Chiradzulu North), as last year. For the coming year it is proposed to continue banking versus not banking, with both techniques visible on each farmer's field.
In Matapwata the proposed treatments of Mbwera and no mbwera must include a decision on banking or not banking at second weeding. There is some evidence that banking encourages termite damage to maize. The simplest comparison therefore would be between plots which have been weeded and banked at second weeding and then left without Mbwera, and those which are weeded without banking at second weeding and then have mbwera carried out in order to grow beans or field peas. The social science team will provide backup in the area of farmers' decision-making in cultural practices.

Management of whitegrubs in maize

In 1996/97 the effect of seed dressing on whitegrubs was masked by the low fertility of the plots and the effects of waterlogging which led to many fields being abandoned. There is clearly a need to repeat seed dressing trials using either Sevin (carbaryl) or the more expensive but less toxic alternative, Gaucho (Imidacloprid) which is sold elsewhere in Africa specifically for whitegrub control. It is proposed that the seed dressing will be used both in dambo fields (as last year) and in upland fields because it is known that some whitegrub attack occurs throughout the area and also because there is known to be an anti-feedant effect on termites which may be detectable on upland farmers' trial plots.

Mr Themba Mzilahowa, Msc student at Bunda College is preparing to conduct a study of the biology and management of scarabeid beetles in the maize-based cropping system in Blantyre Shire Highlands RDP. He will be supervised by Dr G.K.C. Nyirenda at Bunda College and Dr J.M. Ritchie at Bvumbwe and will interact with all members of the Project team in the course of his study. Much of his work will centre around the Project's on-farm trials in Mombezi and Matapwata. His study will seek to identify the main species of scarabeids affecting farmers' crops, assess the nature and extent of damage and evaluate some potential control measures. A full proposal for his study is in preparation.

Management of beanfly in beans

Results from the 1996/97 trials have only been partially analysed. In particular detailed data on beanfly infestations from the main season on-farm trial are not yet complete and the same data for the relay trial have not yet been input into excel and analysed. However from the analyses so far available and from team observation and farmer evaluation some conclusions can be drawn. In the main crop bean variety performance was affected by heavy rain and disease. Beanfly attack was relatively light.

In the relay crop Kaulesi performed better than Chimbamba in terms of proportion of plant stand at mid pod fill ($P=0.003$) and numbers of plants dead at harvest ($P=0.009$). Kaselera ridges had a significant negative effect on bean yields ($P=0.043$) which increases if zero yields are omitted from the analysis ($P=0.015$). There were no discernible effects due to earthing up or mulching the relay crop nor due to increased plant density. There is an increased labour and seed cost associated with increased plant density. Farmers were generally unwilling either to mulch or to earth up the beans. In the rainy season mulching to preserve moisture appears unnecessary due to the surplus of moisture. Mulch was displaced by heavy rain and was in general too thinly applied to be useful.

Seed dressing with Sevin proved to be toxic to beans based on experience on-farm and in a separate experiment on-station at Bvumbwe and Chitedze. In the relay bean trial Gaucho proved to have a significant beneficial effect on plant stand with deaths between the first two sampling occasions reduced to 5% rather than 18% in the control ($p=0.037$). Seed yield was also increased significantly ($P=0.043$).

In 1997/98 it is proposed that earthing up, mulching and increased plant density are abandoned. This should make farmer understanding easier. Seed dressing with Gaucho will be reassessed on station, given the poor results last season and the expense of this approach. It may be used again in the relay crop. The CIAT bean programme has offered the project two varieties from the Andean gene pool, newly released in November 1995: Napilira (CAL 143) and Nagaga (A197). These varieties are believed to have some resistance or tolerance to bean stem maggot (BSM) since they have been exposed to it over several seasons in the CIAT project trials. They have been found to have good agronomic characteristics and disease resistance and have a potential yield of more than 2 tons/ ha (CIAT BEAN Programme Annual Report 1996).

The variety Kalima, which was extensively tested before its recent release by Bunda College will also be used in trials. This variety is similar in appearance to Napilira and is a member of the Calima group of varieties, but with different characteristics from CAL 143 (R. Chirwa, pers. comm.). It has a thick stem and erect habit and performed well in trials in Matapwata over several years, which suggests that it must have some tolerance of BSM. It perfomed well under poor conditions in 1996/97 *Striga* trials and at least one farmer in Lidala village has stated (7 Nov 1997) that she is planting her saved seed in 1997/98. These varieties will be tested against Kaulesi as local control because of its shorter duration in view of an expected season with low rainfall.

Last year beans were not supplied to farmers with dambo fields in Chiwinja and Lidala since in initial discussion meetings villagers had said that the dambo was unsuitable for beans. At a later stage farmers expressed the view that beans would have been appropriate in the dambo intercrop. In 1997 in response to this and discussions with farmers in Mombezi at village meetings on 7 November 1997, the project will supply beans for all fields, though it is expected that some of the more extreme dambo fields will not achieve a good crop. An excess of seed will be supplied to allow some to be planted elsewhere by the farmer at will.

Once again data on pigeonpea yields from the 1996/97 trials are not yet available for analysis because of the extended harvest period in this crop. *Fusarium* wilt is certainly the main cause of plant mortality though yields are affected also by sucking bugs and pod borers. Of the two strategies tested on-farm, side-planting does not appear to have had a discernible advantage over ridgetop planting. However the use of ICP9145 has clear advantages in reducing wilt incidence and severity. For the coming year, use of resistant cultivars offers the only viable technology for management of this disease. ICRISAT's technology transfer specialist, Dr Richard Jones, has offered the project planting material of two new long-season cultivars, ICEAP 00040 and ICEAP 00053, to test on-farm. Both are wilt-resistant Kenyan landraces which are being multiplied for release to farmers. It is therefore proposed that these should be grown alongside ICP 9145 and a local check on farmer's plots. This change may require slight modification of the design in Table 1 to capture potential interactions.

Experimental design:

The trial is designed as a factorial experiment in incomplete blocks, so as to ensure that all important two-factor interactions can be estimated in the analysis. The design cannot estimate the i by v interaction. However, because these two factors refer to pigeonpea and bean varieties, it is assumed that their interaction does not exist. The proposed layout of the plots in the eight blocks (corresponding to upland and dambo in four villages) is shown in Table 1. The size of blocks is dictated by the number of available farmers in each category. Some dambo fields were found unsatisfactory last year due to waterlogging and farmers were asked to provide alternatives. The treatments and locations are summarized in Table 2. Information to be supplied to participating farmers at village meetings is shown in Annex 1.

Table 1. Pest management trial for maize/pigeopea/bean intercrop

Block 1 - Dambo in Chiradzulu North, Chiwinja
8 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0\ v_3\ g_1$	$i_1\ v_2\ g_0$	$i_2\ v_1\ g_1$	$i_3\ v_0\ g_0$
2	$i_0\ v_0\ g_0$	$i_1\ v_3\ g_1$	$i_2\ v_2\ g_0$	$i_3\ v_1\ g_1$
3	$i_0\ v_1\ g_1$	$i_1\ v_0\ g_0$	$i_2\ v_3\ g_1$	$i_3\ v_2\ g_0$
4	$i_0\ v_2\ g_1$	$i_1\ v_1\ g_0$	$i_2\ v_0\ g_0$	$i_3\ v_3\ g_0$
5	$i_0\ v_3\ g_0$	$i_1\ v_2\ g_0$	$i_2\ v_1\ g_0$	$i_3\ v_0\ g_1$
6	$i_0\ v_0\ g_1$	$i_1\ v_3\ g_1$	$i_2\ v_2\ g_1$	$i_3\ v_1\ g_0$
7	$i_0\ v_1\ g_0$	$i_1\ v_0\ g_1$	$i_2\ v_3\ g_0$	$i_3\ v_2\ g_1$
8	$i_0\ v_2\ g_1$	$i_1\ v_1\ g_1$	$i_2\ v_0\ g_1$	$i_3\ v_3\ g_0$

Block 2 - Dambo in Chiradzulu North, Lidala
7 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0 v_3 g_1$	$i_1 v_2 g_0$	$i_2 v_1 g_1$	$i_3 v_0 g_0$
2	$i_0 v_0 g_0$	$i_1 v_3 g_1$	$i_2 v_2 g_0$	$i_3 v_1 g_1$
3	$i_0 v_1 g_1$	$i_1 v_0 g_0$	$i_2 v_3 g_1$	$i_3 v_2 g_0$
4	$i_0 v_2 g_1$	$i_1 v_1 g_0$	$i_2 v_0 g_0$	$i_3 v_3 g_1$
5	$i_0 v_3 g_0$	$i_1 v_2 g_1$	$i_2 v_1 g_1$	$i_3 v_0 g_1$
6	$i_0 v_0 g_1$	$i_1 v_3 g_0$	$i_2 v_2 g_1$	$i_3 v_1 g_0$
7	$i_0 v_1 g_0$	$i_1 v_0 g_1$	$i_2 v_3 g_0$	$i_3 v_2 g_1$

Block 3 - Upland in Chiradzulu North, Chiwinja
8 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0 t_0 v_3 g_0$	$i_1 t_1 v_2 g_1$	$i_2 t_0 v_1 g_0$	$i_3 t_1 v_0 g_1$
2	$i_0 t_1 v_0 g_1$	$i_1 t_0 v_3 g_0$	$i_2 t_1 v_2 g_1$	$i_3 t_0 v_1 g_0$
3	$i_0 t_0 v_1 g_1$	$i_1 t_1 v_0 g_0$	$i_2 t_0 v_3 g_1$	$i_3 t_1 v_2 g_0$
4	$i_0 t_1 v_2 g_0$	$i_1 t_0 v_1 g_1$	$i_2 t_1 v_0 g_0$	$i_3 t_0 v_3 g_1$
5	$i_0 t_1 v_3 g_1$	$i_1 t_0 v_2 g_0$	$i_2 t_1 v_1 g_1$	$i_3 t_0 v_0 g_0$
6	$i_0 t_0 v_0 g_0$	$i_1 t_1 v_3 g_1$	$i_2 t_0 v_2 g_0$	$i_3 t_1 v_1 g_1$
7	$i_0 t_1 v_1 g_0$	$i_1 t_0 v_0 g_1$	$i_2 t_1 v_3 g_0$	$i_3 t_0 v_2 g_1$
8	$i_0 t_0 v_2 g_1$	$i_1 t_1 v_1 g_0$	$i_2 t_0 v_0 g_1$	$i_3 t_1 v_3 g_0$

Block 4 - Upland in Chiradzulu North, Lidala
12 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0 t_1 v_3 g_0$	$i_1 t_0 v_2 g_1$	$i_2 t_1 v_1 g_0$	$i_3 t_0 v_0 g_1$
2	$i_0 t_0 v_0 g_1$	$i_1 t_1 v_3 g_0$	$i_2 t_0 v_2 g_1$	$i_3 t_1 v_1 g_0$
3	$i_0 t_1 v_1 g_1$	$i_1 t_0 v_0 g_0$	$i_2 t_1 v_3 g_1$	$i_3 t_0 v_2 g_0$
4	$i_0 t_0 v_2 g_0$	$i_1 t_1 v_1 g_1$	$i_2 t_0 v_0 g_0$	$i_3 t_1 v_3 g_1$
5	$i_0 t_0 v_3 g_1$	$i_1 t_1 v_2 g_0$	$i_2 t_0 v_1 g_1$	$i_3 t_1 v_0 g_0$
6	$i_0 t_1 v_0 g_0$	$i_1 t_0 v_3 g_1$	$i_2 t_1 v_2 g_0$	$i_3 t_0 v_1 g_1$
7	$i_0 t_0 v_1 g_0$	$i_1 t_1 v_0 g_1$	$i_2 t_0 v_3 g_0$	$i_3 t_1 v_2 g_1$
8	$i_0 t_1 v_2 g_1$	$i_1 t_0 v_1 g_0$	$i_2 t_1 v_0 g_1$	$i_3 t_0 v_3 g_0$
9	$i_0 t_0 v_3 g_0$	$i_1 t_1 v_2 g_1$	$i_2 t_0 v_1 g_0$	$i_3 t_1 v_0 g_1$
10	$i_0 t_1 v_0 g_1$	$i_1 t_0 v_3 g_0$	$i_2 t_1 v_2 g_1$	$i_3 t_0 v_1 g_0$
11	$i_0 t_0 v_1 g_1$	$i_1 t_1 v_0 g_0$	$i_2 t_0 v_3 g_1$	$i_3 t_1 v_2 g_0$
12	$i_0 t_1 v_2 g_0$	$i_1 t_0 v_1 g_1$	$i_2 t_1 v_0 g_0$	$i_3 t_0 v_3 g_1$

Block 5 - Dambo in Matapwata, Magomero
5 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0\ g_1\ v_3$	$i_1\ g_0\ v_2$	$i_2\ g_1\ v_1$	$i_3\ g_0\ v_0$
2	$i_0\ g_0\ v_0$	$i_1\ g_1\ v_3$	$i_2\ g_0\ v_2$	$i_3\ g_1\ v_1$
3	$i_0\ g_1\ v_1$	$i_1\ g_0\ v_0$	$i_2\ g_1\ v_3$	$i_3\ g_0\ v_2$
4	$i_0\ g_0\ v_2$	$i_1\ g_1\ v_1$	$i_2\ g_0\ v_0$	$i_3\ g_1\ v_3$
5	$i_0\ g_0\ v_3$	$i_1\ g_1\ v_2$	$i_2\ g_0\ v_1$	$i_3\ g_1\ v_0$

Block 6 - Dambo in Matapwata, Kambuwa
8 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0\ g_1\ v_0$	$i_1\ g_0\ v_3$	$i_2\ g_1\ v_2$	$i_3\ g_0\ v_1$
2	$i_0\ g_0\ v_1$	$i_1\ g_1\ v_0$	$i_2\ g_0\ v_3$	$i_3\ g_1\ v_2$
3	$i_0\ g_1\ v_2$	$i_1\ g_0\ v_1$	$i_2\ g_1\ v_0$	$i_3\ g_0\ v_3$
4	$i_0\ g_0\ v_3$	$i_1\ g_1\ v_2$	$i_2\ g_0\ v_1$	$i_3\ g_1\ v_0$
5	$i_0\ g_0\ v_0$	$i_1\ g_1\ v_3$	$i_2\ g_0\ v_2$	$i_3\ g_1\ v_1$
6	$i_0\ g_1\ v_1$	$i_1\ g_0\ v_0$	$i_2\ g_1\ v_3$	$i_3\ g_0\ v_2$
7	$i_0\ g_0\ v_2$	$i_1\ g_1\ v_1$	$i_2\ g_0\ v_0$	$i_3\ g_1\ v_3$
8	$i_0\ g_1\ v_3$	$i_1\ g_0\ v_2$	$i_2\ g_1\ v_1$	$i_3\ g_0\ v_0$

Block 7 - Upland in Matapwata, Kambuwa
7 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0\ t_2\ v_2\ g_1$	$i_1\ t_0\ v_1\ g_0$	$i_2\ t_2\ v_0\ g_1$	$i_3\ t_0\ v_3\ g_0$
2	$i_0\ t_0\ v_3\ g_0$	$i_1\ t_2\ v_2\ g_1$	$i_2\ t_0\ v_1\ g_0$	$i_3\ t_2\ v_0\ g_1$
3	$i_0\ t_2\ v_0\ g_1$	$i_1\ t_0\ v_3\ g_0$	$i_2\ t_2\ v_2\ g_1$	$i_3\ t_0\ v_1\ g_0$
4	$i_0\ t_0\ v_1\ g_1$	$i_1\ t_2\ v_0\ g_0$	$i_2\ t_0\ v_3\ g_1$	$i_3\ t_2\ v_2\ g_0$
5	$i_0\ t_2\ v_2\ g_0$	$i_1\ t_0\ v_1\ g_1$	$i_2\ t_2\ v_0\ g_0$	$i_3\ t_0\ v_3\ g_1$
6	$i_0\ t_2\ v_3\ g_1$	$i_1\ t_0\ v_2\ g_0$	$i_2\ t_2\ v_1\ g_1$	$i_3\ t_0\ v_0\ g_0$
7	$i_0\ t_0\ v_0\ g_0$	$i_1\ t_2\ v_3\ g_1$	$i_2\ t_0\ v_2\ g_0$	$i_3\ t_2\ v_1\ g_1$

Block 8 - Upland in Matapwata, Magomero
7 farms available

Farmer	Plot 1	Plot 2	Plot 3	Plot 4
1	$i_0\ t_2\ v_3\ g_0$	$i_1\ t_0\ v_2\ g_1$	$i_2\ t_2\ v_1\ g_0$	$i_3\ t_0\ v_0\ g_1$
2	$i_0\ t_0\ v_0\ g_1$	$i_1\ t_2\ v_3\ g_0$	$i_2\ t_0\ v_2\ g_1$	$i_3\ t_2\ v_1\ g_0$
3	$i_0\ t_2\ v_1\ g_1$	$i_1\ t_0\ v_0\ g_0$	$i_2\ t_2\ v_3\ g_1$	$i_3\ t_0\ v_2\ g_0$
4	$i_0\ t_0\ v_2\ g_0$	$i_1\ t_2\ v_1\ g_1$	$i_2\ t_0\ v_0\ g_0$	$i_3\ t_2\ v_3\ g_1$
5	$i_0\ t_0\ v_3\ g_1$	$i_1\ t_2\ v_2\ g_0$	$i_2\ t_0\ v_1\ g_1$	$i_3\ t_2\ v_0\ g_0$
6	$i_0\ t_2\ v_0\ g_0$	$i_1\ t_0\ v_3\ g_1$	$i_2\ t_2\ v_2\ g_0$	$i_3\ t_0\ v_1\ g_1$
7	$i_0\ t_0\ v_1\ g_0$	$i_1\ t_2\ v_0\ g_1$	$i_2\ t_0\ v_3\ g_0$	$i_3\ t_2\ v_2\ g_1$

Notation for factors included in trial:

g - **Seed dressing maize**

g_1 Seed dressing maize with gaucho (70 WS formulation).

g_0 Control, i.e. no seed dressing.

t - **Maize termite treatment (Upland only, different in two locations).**

t_2 Mbwera tillage in Matapwata (+ weeding without banking)

t_1 Weeding without banking in Chiradzulu North.

t_0 Control, i.e. , no mbwera in Matapwata (+ weed and bank), weed and bank at second weeding in Chiradzulu North.

i - **Wilt-resistant pigeonpea**

i_3 Variety, ICP 9145.

i_2 Variety, ICEAP 00040

i_1 Variety, ICEAP 00053

i_0 Control, local pigeonpea

v - **Tolerant bean variety**

v_3 Tolerant variety: Kalima

v_2 Tolerant variety: Napilira

v_1 Tolerant variety: Nagaga

v_0 Control, local check, Kaulesi.

Table 2. Farming Systems IPM Project: Summary of interventions and locations for on-farm pest management trials 97/98

				Matapwata EPA				Chiradzulu North EPA			
Trial	**Crop**	**Pest**	**PMS**	Magomero section (Chaoni village)		Kambuwa village		Chiwinja village		Lidala village	
				Dambo	Upland	Dambo	Upland	Dambo	Upland	Dambo	Upland
1. Striga	Maize	Striga	Fertilizer (dollop)	-	+	-	+	-	-	-	-
	Maize	Striga	Tephrosia	-	+	-	+	-	-	-	-
	Maize	Striga	Cowpea	-	+	-	+	-	-	-	-
2. Intercrop	Maize	Whitegrub	Seed dressing (Gaucho)	+	+	+	+	+	-	+	-
	Maize	Termites	Weed without banking	-	-	-	-	-	+	-	+
	Maize	Termites	Mbwera	-	+	-	+	-	-	-	-
	Pigeonpea	Fusarium wilt	Varietal tolerance: ICP9145 ICEAP 00040 ICEAP 00053	+	+	+	+	+	+	+	+
	Beans	Beanfly (bean stem maggot)	Varietal tolerance: Kalima Napilira (CAL 143) Nagaga (A197)	+	+	+	+	+	+	+	+

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Proposed modifications to design for follow-up on-farm *Striga* trial, 1997/98

Background

The 1997 trial involved 10 farmers in 4 villages with treatment involving dolloped and spread fertilizer and presence of soya beans or *Tephrosia* as trap crop and green manure respectively. The plots were planted with an intercrop of Maize (MH18), beans (Kalima) and pigeonpea (local). The partly analysed results of this experiment were discussed by Ritchie (1997) and a report of some statistical analyses has been produced (Abeyasekera, 1997).

Preliminary Results of 1996/97 trial

This experiment is ongoing with pigeonpea and *Tephrosia* harvest data yet to be analysed. Only five farmers had emerged *Striga* on their plots and only one of these had a severe infestation. In general, occurrence of *Striga* was patchy. Plot yields were extremely variable (110 to 3063 Kg ha^{-1}). Table 3 gives a summary of results and farmer reactions together with some tentative conclusions. It must be emphasized that the sample size was small due to unavailability of some yield figures due to thefts and farmers harvesting themselves. Few definite conclusions can therefore be drawn from these data. In the absence of substantial *Striga* infestations, it will not be possible to relate *Striga* incidence and severity to yields.

Discussion

The effect of fertilizer was visually striking though the effect on maize yield was not significant. Soil analyses for the main intercrop trials in Chiradzulu and Matapwata showed that phosphorus levels were about four times as high in Matapwata as in Chiradzulu (77.41 ppm compared to 16.94 ppm on average). The implication of this would be that nitrogen could be added as Urea rather than as the much more expensive 23: 21: 0 + 4 S (assuming the additional sulphur is not critical).

Soya grew well on the ridge side but *Tephrosia* suffered from being waterlogged in the furrow due to heavy rain and being weeded out and trampled during farming operations. Reseeding (four seeds per station) was undertaken to fill gaps. In future the side of the ridge may be a better location for planting *Tephrosia*. In some plots where fertilizer was used there is now a good stand of well-grown *Tephrosia* with a large amount of biomass for incorporation. These plots could be used in the coming season under farmer management to compare maize yields between *Tephrosia* incorporation and no *Tephrosia* incorporation.

There is need to simplify experimental design to allow farmers to participate more fully. The "farmer's plot" serves no clear purpose and should be used for contrasting treatments or another trial. Farmers need to be able to make visual comparisons between treatments with separate effects where possible. They can use their own crops in some cases for this. In the interests of simplifying trials, weeding may best be handled as a separate trial which could be designed when *Striga* is visible in fields. Since this is a strategy which is known to be effective it could be applied to patches of *Striga* as a demonstration for farmers. Only the infested areas need to be weeded.

Table 3. Farming systems IPM project: summary of interventions for Striga management trials 96/97 and candidate technologies for 1997/98 trials

PMS	RESULT	COMMENTS ON RESULT	FARMER PERCEPTION (Jere, 1997)	CONCLUSIONS
Fertilizer (30Kg/ha banded)	Maize yield (Kg/ha) not significantly increased (p=0.373) but maize plant height slightly increased (p=0.048)* Bean yield (Kg/ha) higher than no fertilizer, but N.S. (p=0.08); pod weight increase marginally significant (p=0.051)*	Previous research has shown crucial importance of early application of fertilizer to maize yield (Jones et al.). The fertilizer application here was largely leached out by heavy rain. Banding appears not to benefit maize but does benefit beans due to broad spread. Pigeonpea data are not available yet for comparison. Soya benefited from the banding.	Farmers were ambivalent in their response to use of fertilizer, valuing its effects but objected to early application of fertilizer on grounds of labour need, promotion of weeds and danger of wastage through run-off. There may be an unexpressed farmer perception of risk of crop failure through poor germination etc which encourages delay in application of fertilizer. Banding was seen as wasteful, encouraging weeds but potentially beneficial to intercrops.	1. Give up banding - no apparent advantage. 2. Farmers would benefit by seeing a comparison of fertilizer timing (apply at sowing vs germination?).
Fertilizer (30 Kg/ha dolloped)	Maize yield not significantly increased (p=0.373) but maize plant height increased (p=0.017)** Bean yield and pod weight not significantly affected	Maize plant growth improved by closer placement, but yield benefit not significant here, perhaps due to leaching. Dolloping does not appear to benefit beans because targeted closer to maize plant (i.e. not wasted)	Some farmers perceived dolloping as more targetted to the maize and less wasteful.	3. Continue dolloping at 30Kg/ha basal dressing.
Tephrosia	Maize yield reduction present but not significant (p=0.106)	*Tephrosia* did not compete significantly with maize and slight yield loss may be made up by yield gain in future years after incorporation. Planting in furrow leads to trampling and waterlogging. Ridge side better but what about pigeonpea?	Most farmers were concerned with the poor germination and survival (waterlogging /trampling) of the *Tephrosia* in the furrow and associated weeding problems. Some felt labour needs were increased. Others perceived future fertility benefit.	4. Plant *Tephrosia* at 4 seeds per station on one side of ridge midway betwen maize stations.
Soya	Maize yield significantly reduced by soya (p=0.011)** Also reduction in bean yield (but NS)	Soya competes strongly with the maize and also probably with beans at this density. However when value of current soya crop is counted and future maize yield gain from soya residues incorporated into the plot then maize losses might be offset.	Farmers felt narrow spacing increased labour in planting and weeding. Some perceived competition but others valued inclusion of an extra intercrop. Low prices and low yields were a concern.	5. Soya could be planted at reduced density on one side of ridge to reduce labour and competition with maize. 6. Try other *Striga* trap crops, e.g. groundnut (CG7?) or cowpea.
Weeding	***Not used in 1996 /97***	Hoeing or handpulling before flowering is an essential part of a viable *Striga* control strategy. It was not assessed in 1996/97.	Farmer attitudes to weeding *Striga* have not yet been assessed.	7. Possibly incorporate hand-pulling or hoeing into trial.

Proposals for 1997/98 trial

In the coming year different fields which were observed last season to have heavy *Striga* populations will be used for trials. These fields are all in Matapwata which simplifies logistics of working on *Striga* and also will enable the use of cheaper fertilizer (see above). Increasing plot size may also ensure that significant numbers of *Striga* plants are sampled. The bean intercrop is to be omitted to simplify the experiment and reduce data recording needs.

A seminar at Bvumbwe on 6 October (Ritchie, Orr & Jere, 1997b) explored the main options for further on-farm experiment, endorsing continued use of *Tephrosia* and proposing the use of cowpeas as an alternative trap crop to soya. The baseline survey (Orr et al., 1997a), conducted in villages where FSIPM Project is working with farmers, indicates that farmers who use fertilizer on their maize use it at rates approaching 60 Kg of N per hectare. However the economic analysis of the national fertilizer verification trials (Benson, 1997), suggests that at the current fertilizer: maize price-ratio the optimum application rate would be 35 Kg N per ha for light-textured uplands. This figure is sensitive to changes in the ratio such that a fall of 20% leads to an increase in the optimum application rate to 55 Kg N per ha. For this experiment a figure of 50 Kg N per ha has therefore been selected. Soil sample analyses for farmers' fields in Chiradzulu North and Matapwata have shown that phosphorous is relatively plentiful in Matapwata (mean 77.41 ppm) (Abeyasekera, 1997). It is therefore proposed that CAN should be used instead of 23: 21: 0 + 4S.

A plot size of 10.8 m (12 planting stations) by 5.4 m (6 ridges) will be used. Fields will have maize (MH 18) and pigeonpea (ICP 9145). *Tephrosia* will be planted at 4 seeds per station on one side of the ridge at 45 cm intervals alternating with maize and pigeonpea plants. The pigeonpea will be planted on the oposite ridgeside to use the available space effectively. Cowpea will be planted between maize and pigeonpea at a spacing of one station (3 seeds) between each adjoining maize and pigeonpea plant.

Proposed treatments:

1. Fertilizer: 50 Kg N (CAN) per hectare dolloped to both sides of maize plant at sowing, no top dressing.
2. Control: no fertilizer.
3. *Tephrosia* (3 seeds per station) planted at 45 cm spacing on one side of ridge between maize and pigeonpea, and incorporated at maturity.
4. Cowpeas (nseula) (2 seeds per station) planted at 45 cm spacing on top of ridge.
5. No *Tephrosia* or Cowpeas.

Experimental Design:

2x3 Factorial experiment with split plots in 6 blocks with unequal replication (Table 4). Each farmer is one block. Three farmers have fields which can only support one replicate of the trial layout. Two control half plots are used with each farmer to increase the chances of observing good *Striga* emergence in the absence of any inhibiting treatments. Two farmers (5 and 6) have fields with enough space to include a second replicate and one (7) can accommodate three replicates. In these fields half-plots are included with each of the legume treatments (cowpeas, Tephrosia) occurring once with fertilizer and once without fertilizer. Two half plots have the control legume treatments with and without fertilizer. This arrangement is designed to allow extra opportunity to detect patchy *Striga* emergence in the absence of treatments. It is proposed that the treatment combinations should be assigned at random to the plots of any farmer which themselves may be arranged in varying layouts within a field in order to avoid disruptive features such as paths, termite hills, trees and gulleys. The design has an increased requirement for monitoring effort compared to last year's design but is more likely to detect *Striga*. In addition each farmer has the same combinations and can therefore compare his/her own fields with those of other farmers.

Management

The plots will need to be researcher managed to ensure that weeding is carried out at the same time on all plots. This is essential if *Striga* emergence is to be comparable between plots. At flowering the heads of *Tephrosia* will be removed and thrown into the furrow to prevent nitrogen being concentrated in seed production. Information to be supplied to participating farmers at village meetings is shown in Annex 2.

Responses:

1. Time of first observed emergence of Striga.
2. Number of emerged *Striga* stems fortnightly.
3. Number of *Striga* plants found dead without flowering.
4. Number of *Striga* plants flowered.
5. Fortnightly stand counts of maize, pigeonpeas, *Tephrosia* and cowpea; cause of death.
6. Yields of maize, pigeonpea, cowpeas and *Tephrosia* seed and biomass of cowpea and *Tephrosia* from treatment nett plots.

Striga emergence may be measured in quadrats of 0.9 m x 0.9m, formed by enclosing area between four maize stations with quadrats placed between non-contiguous groups of maize plants within nett plot. However it may be necessary to use a larger area to obtain satisfactory figures.

Table 4 ***Striga*** **management trial for maize/pigeopea intercrop. Modified split-plot design proposed by Dr Abeyasekara**

Farmer	Block No	Plot 1	Plot 2	Plot 3	Plot 4
1	1	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
2	2	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
3	3	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
4A	5	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
4B	5	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
5A	6	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
5B	6	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
6A	7	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
6B	7	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$
6C	4	$f_1 t_0$ $f_0 t_0$	$f_1 t_1$ $f_0 t_1$	$f_1 t_2$ $f_0 t_2$	$f_1 t_0$ $f_0 t_0$

Notation:
f_0 represents no fertilizer,
f_1 represents 50Kg N/ha dolloped fertilizer

t_0 represents no *Tephrosia* or cowpeas
t_1 represents *Tephrosia*
t_2 represents cowpeas

NOTES

1. Plot 4 can be omitted if resources in data collection do not allow this. But notice that it has some extra checks, i.e. the $\mathbf{f_0 t_0}$ combination.

2. The randomisation should occur at two levels:
   * First randomise the legume treatments to the main plots (3 or 4) within each farm.
   * Then randomise the allocation of fertiliser to one of the two sub-plots within each main plot.

3. The above design uses much the same amount of land area as previously suggested. There will however be an increase in the amount of measurement effort.

4. In each farm there are 4, 8 or 12 large sized main plots (approx 10.8 m by 5.4 m), with each divided into two to form the sub-plots. One sub-plot would form the control as far as the fertiliser treatment is concerned.

Tephrosia green manure demonstration and observation plots: Follow-up of 1996/97 *Striga* plots

Background

Two farmers in Kambuwa village (Mai Golden and Luka Dinala) who participated in the 1996/97 *Striga* trial had good stands of *Tephrosia* at the end of September 1997. Mai Golden had *Tephrosia* with spread fertilizer in plot 1 whereas both plot 4 (farmer's plot) and plot 5 had no inputs. Luka Dinala had *Tephrosia* with dolloped fertilizer (plot 3) and with spread fertilizer (plot 4). Plots 2 and 5 (farmer's) had no inputs. The aim of the proposed follow-up experiment is to assess the benefit to a following maize crop from the incorporation of a good stand of *Tephrosia*. The plot with *Tephrosia* is to be compared with one of the untreated adjoining plots. Remark the plots and re-ridge over the furrows with one additional ridge on the down slope side of the original plot.

Preparation of plots

Before the plots were prepared one of them was used to demonstrate to Mai Golden and Luka Dinala and to our new *Striga* farmers the appearance of mature *Tephrosia* and how to incorporate it and to describe why it is being grown and the benefit that is expected next year on this plot. Five farmers attended and there was much interest in the idea that its use could save expenditure on manure or fertilizer.

The *Tephrosia* stand was counted for the whole plot (gross). Five plants randomly selected were measured for height and dug up and examined for nematodes and whitegrubs. The leaves of the plants were stripped off by hand and also the tender ends of stems. These were weighed and then placed in the furrows evenly distributed including the furrow downslope of the last old ridge. The team then demonstrated ridging over them to make new 90 cm ridges. Weighed samples of 0.5 Kg of leaves were retained in a plastic bag and dried at Bvumbwe for estimating dry weight of biomass. The woody parts of the plant were also gathered and weighed in tied bundles and given to the farmer. Two samples of five plants were counted for seed pods and a sample of ten pods for seeds per pod. Any ripe seed was removed and given to the farmer but the rest was incorporated.

Results of 1996/97 biomass

Results for the biomass incorporated from 1996/97 growth are shown in Table 5. It is clear that *Tephrosia* with 30 Kg of N applied has the capacity to yield 1-2 tons per hectare given the mortality in this experiment due to waterlogging caused by placement in the furrow which reduced the stand count from 110 plants per plot to about half that number.

Table 5. Measurements from plots with *Tephrosia* planted in 1996

Date: 15 October 1997

Farmer	Plot	Stand Count	Plant ht (5 random)	Weight of Wood (Kg/ha)	Dry Biomass of leaves (Kg/ha)	Seeds/ ten pods	Pods/ plant for 5 plants	Nematode score (5 plants)
Mai Golden	A	53	146.6	5761.32	971.64			2
Luka Dinala	A	68	175.8	10493.83	2023.26	118	112.6	6
Luka Dinala	B (plot 4)	46	140	10059.44	1890.15	107	66	

Note: In each case 500g of leaves was removed for drying and weighing and not returned to the plot.
Results from Luka Dinala plot B scaled from 6 furrows to five.
All plots received 30 Kg N/ha at planting

Management of 1997/98 observation plots

All plots will receive fertilizer (30 Kg N per ha) as for last year. This will be dolloped on both the test and control plots by the researchers. We will provide MH18 maize and local pigeonpea for both plots. Apart from the fertilizer addition we ask the farmer to manage the plots until harvest and to apply the same weeding to both of them. We will harvest with him/her.

Responses and evaluation

Responses to be measured are yields of maize and pigeonpea (and time of weeding by the farmer). The experiment is otherwise evaluated by the farmer using semi-structured interviews. The main concern in use of *Tephrosia* with pigeonpea or followed by pigeonpea is that it clearly can permit the build-up of high populations of the root-knot nematode *Meloidogyne incognita* which also attacks pigeonpea and may have the potential to cause breakdown in *Fusarium* wilt resistance of ICP 9145. In the coming season the *Striga* plots will be scored consistently for nematode attack on both *Tephrosia* and pigeonpea at maturity.

Outline for proposed MSc research project on weeding and weeds

Purpose of study

Mr Albert Chamango, an Msc student on the Agronomy Msc programme at Bunda College is scheduled to undertake an on-farm study of weed management supervised by Dr H. Mloza Banda at Bunda College and Dr M. Ritchie at Bvumbwe, with advisory inputs from Dr C.R. Riches, weed science consultant at NRI/LARS, UK.

This project is a component of FSIPM socio-economic research focusing on farmers' weed management decisions. It is suggested that the student could contribute to the teams understanding of the impact of weeds in the farming system by undertaking a project which involves characterisation of weeding issues. While the student will use empirical methods to assess the impact of different levels of weeding on crop yield and weed populations, farmers may also use a range of other criteria. A further objective of this MSc. project could be to attempt to understand how farmers perceive weediness and weeding timeliness - do they for example consider crop growth stage, size and density of weeds, the time from planting or the weather? It is hoped that the student will investigate farmer criteria for assessing the need to weed from discussion with participating farmers. This aspect of the work will be developed in collaboration with the socio-economics staff of FSIPM.

Key questions to study are:

- What is the extent of yield loss that may be attributed to weeds under current weeding regimes?
- Is timely weeding relatively more or less important at different levels of fertility?

Background

This study should build on the findings of the baseline survey (Orr et al., 1997) which reported:

- an important factor in farmers' choice of pest management strategy is the available supply of household labour;
- both male and female headed households have difficulty in meeting extension recommendations that farmers should complete first weeding within 3 weeks of planting, and second weeding/banking within 6 weeks;
- IPM strategies which require additional labour and weeding will pose problems for smallholders.

The survey reported high participation rates of household labour in weeding; as this is one of the greatest pre-harvest labour costs it is important to fully understand the issues which influence weediness and the farmers perception of this. Characterisation of existing weed control practices and crop loss due to weeds would assist the project to identify situations in which improved weed control is appropriate and would provide the greatest returns and will also contribute to assessment of any gaps in farmer knowledge of weeding issues.

This raises the following questions:

- Why are some fields well weeded why others are full of weeds?
- Why do farmers begin to weed apparently stressed stunted maize which is not likely to produce much of a yield?
- Does weediness vary with soil type and aspect?
- Is timely weeding more or less important under different levels of fertility?
- How do farmers perceive weediness and what is their concept of weeding timeliness, eg. is this crop stage or weed size?

Field trials

One component of the study would involve the student monitoring plots at a range of on-farm sites. There would be four plots at each site. One pair would be weeded by the farmer according to his/her usual decisions while the second pair would receive additional weeding from the project to ensure timely weeding as per recommendations. Any resulting yield difference could be evaluated by paired 'T' test. The rationale and design for such as study have been fully discussed by Moody (1987). Sites should be chosen to represent households with different resources, access to labour and at different positions on the catena ie upland and dambo. It is expected that a maximum of 20 households will be involved divided into four categories:

- dambo / female-headed household ;
- upland / female-headed household;
- dambo / male-headed household;
- upland / male headed household;

It is suggested that four plots are established at each site covering a total of 100 m^2. The entire area will be planted with MH18 maize variety, intercropped with pigeon pea (ICP 9145) and beans (Kaulesi?). Fertiliser will be applied to half the entire area at planting at a rate of 35 kg ha^{-1}. Following emergence the fertilised and non-fertilised portion will be split in half to provide four plots. The farmer will be asked to weed and bank two of the plots according to his/her normal practice. The student will ensure that weeds are controlled on two research plots, one fertilised and one with out fertiliser, for the first 8 weeks following planting by weeding at 2, 4, and 6 weeks and depending on the rains also at 8 weeks. If the farmer uses banking, he/she will be asked to bank the research plots at the same time as the farmer plots. Information to be supplied to participating farmers at village meetings is shown in Annex 3.

The plots will therefore appear as:

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Farmer weeding No fertiliser	Farmer weeding Fertiliser
Research weeding Fertiliser	Research weeding No fertiliser

Date to be recorded will be:

- Routine soil analysis;
- Date of operations carried out by farmer and identification of who is involved ie household or hired;
- Weed assessments on research and farmer plots at 2, 4 and 6 weeks after harvest and at planting;
- Collection and identification of weed species found on each site;
- Crop yields;

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Annex 1. Main intercrop pest management trial. Information for participating farmers.

Plots

Last year each farmer had two plots. One was a "research" plot and the researchers provided the inputs for it. The other plot was the "farmer's" plot planted with the farmer's seeds.

This year we want to use the same sized plot area but divided in half to give four smaller plots. We will provide all the necessary seeds for all four plots. Because each farmer has four plots the farmer will be able to compare a different variety on each plot, and each farmer will be able to see all the different things being tested side by side. The researchers will tell the farmer which of the four plots should have each variety or treatment. The plots will have labels to tell everyone what is in the plot. We will ask farmers during the season to compare and comment on the different plots.

Fertilizer

Last year no fertilizer was provided for the plots. This year we will provide some fertilizer. The amount has been set to match the latest recommendations from experts and will be carefully measured and dolloped on both sides of the maize plants.

Maize

Last year we used MH18 hybrid maize. This is a good variety but the farmer cannot use seed from their own field next season without losing yield. We have been advised to use "Masika" (Synthetic C) a composite variety which can be used for several years without losing yield.

Maize pests and treatments

Last year we looked at ways of reducing losses caused by termites and whitegrubs because farmers said there was a serious problem with these pests. We tried comparing weeding with banking and weeding without banking in Mombezi because farmers say that banking increases termite lodging of maize. We found that this was sometimes true and we want to compare the two methods on plots on each farm to check this more thoroughly. This means that some plots in each farm will be banked and others not.

In Matapwata we tried "kaselera" as an alternative to Mbwera, taking soil from around the maize on the ridge to make new ridges when the maize was maturing. In Mbwera farmers also broke down the ridge, but a bit later, and created a flat area for growing beans. We found that there was not much difference between Kaselera and Mbwera but growing the relay bean crop on Kaselera ridges meant that the crop had less moisture and did less well. This year we want to compare Mbwera with leaving the old ridge in position to see how this affects the maize and the termite damage on nearby plots.

Some farmers have been using Sevin as a seed dressing against whitegrubs. Last year we used Sevin as a treatment for whitegrubs in the dambo fields but the fields were so waterlogged that we could not get a good yield in any case. This year we want to try another insecticide (gaucho) which is often used in other places against white grubs. We want to try it in some of the upland plots as well as the dambo ones.

Pigeonpea pests and treatments

Last year we were trying out ways of reducing the amount of wilting in pigeonpeas which is caused by a disease called Fusarium wilt. Some farmers said that planting on the ridge side instead of the top helped stop wilting so we tested that. So far we think it made no difference but results are not fully worked out yet. The other treatment we used was ICP 9145 pigeonpea variety compared to local. This was very effective against wilt. This year we want to try some new research varieties from Kenya which are called ICEAP 00040 and ICEAP 00053. We want to see whether they have less wilt than the local variety and we want you to tell us what you think of them in terms of growth and yield.

Bean pests and treatments

Last year we were trying out several ways of protecting beans against wilting due to bean stem maggot. The methods we used were ones used in other places. They were high density planting, mulching, earthing up, seed dressing. One problem with these was that some farmers only saw some methods and could not compare all the different treatments. Another was that these methods were costly in labour and mulch was hard to find. Farmers were doubtful about how worthwhile the treatments were and not everyone was sure which treatment they were supposed to be doing and exactly how to do it. Seed dressing (with Sevin) caused damage to the beans and we will not use it again. The other methods we feel need more trials on station to see whether they really help before we try them on farm again.

The other technique we used last year was comparing varieties to see which resist bean stem maggot best. However last year there was a lot of rain which reduced bean stem maggot attack in the main crop, and the results were not very clear. We want to try four varieties this year. One of these is Kalima which we used on Striga trials last year. This variety has a thick stem and yields well in southern Malawi. We are using Kaulesi (also used last year) as a check because we think that there may be less rain this year than last year so it may do better than Chimbamba because it has a short season. Finally we have obtained two newly released varieties (Napilira and Nagaga) which are said to cope well with bean stem maggot and yield well. Again each variety will be seen on every farmer's field so we want to see which variety has the least bean stem maggot attack and we want you to tell us what you think of them in terms of growth and yield. Researchers will harvest with the farmer and weigh the yield. All the yield is for the farmer. Until the researchers have harvested with you, please do not remove cobs or pods or plants from the field without the research team being there. Compensation cannot be paid if the research team cannot calculate the yield.

Annex 2. Striga (Kaufiti) intercrop trial (Matapwata). Information for participating farmers

The purpose of last year's trial was to try to see if we could reduce the amount of kaufiti in farmers' fields because we were told that kaufiti is a big problem for some farmers in their maize fields.

We put our trial plots in farmers' fields last year in places where we were told there was plenty of kaufiti. Out of ten fields we only had kaufiti present in three and only one of those was badly infested. Some farmers had Alectra (with yellow flowers) which grew on the beans.

There are some things about kaufiti which farmers need to know if they are stop it growing in their fields:

- Fistly Kaufiti seeds are so small that you cannot see them and they stay alive in the soil for many years. In an infested field there are thousands of seeds waiting to attack the maize.
- The seeds only germinate when they are close to the roots of a maize, sorghum, millet or other grass-like plant. Their roots produce a substance which affects the kaufiti to make it germinate.
- When that happens the kaufiti seedling attaches to the root of the young maize plant and starts to feed on it.
- Roots of some other plants (cowpeas, beans, groundnuts, soya) make kaufiti germinate but it cannot attach to them and feed so it dies. Crops which do this are called "**trap crops**".
- Only some of the kaufiti seedlings emerge above ground but the others still weaken the maize plants even though they are below the soil.
- Kaufiti prefers eroded soils with few nutrients. **Fertilizer** or **green manure** discourages kaufiti.
- Kaufiti plants must be removed from the field and burnt before they set seed if they have flowered. Plants that have flowered can set seed even when pulled up. Younger plants can be hoed or weeded and left if they have not flowered.

We mean to come and talk to farmers about this problem later in the year when it can be seen flowering in the fields (with red flowers).

The methods we tested last year were to apply fertilizer (banded in the ridge or dolloped), or to plant a green manure crop (Nthuthu) or or a trap crop (soya). Our main problem was the lack of Kaufiti on the plots.

The soya was planted densely and reduced the yield of the maize. Farmers do not find it easy to sell soya or to use it at home. This year we want to test cowpeas (nseula)as a trap crop because we know farmers in Matapwata intercrop it with maize.

As for last year we want to plant Tephrosia (nthuthu) on some of the plots to make a large amount of green manure which can be incorporated into the new ridge ready for the next season. If enough green leaves are incorporated they will have the same effect as fertilizer in increasing maize yields but for much less cost.

Some plots from last year in Kambuwa had a good stand of nthuthu by October (Mai Golden and Bambo Luka Dinala). This has been incorporated as a demonstration and maize and pigeonpeas will be grown on the plots alongside plots without green manure, to show the effect. Other farmers participating in the kaufiti trial will be invited to inspect the crop as it is growing.

Last year the placing of fertilizer in bands was regarded as wasteful by farmers and results showed that dolloping is just as effective as long as it is done early. This year we propose to dollop fertilizer on half of each plot at planting. Farmers will be compensated for the difference between the average yield from fertilized half plots and the average yield from unfertilized half plots.

There will be no beans in this experiment but all the plots will have ICP 9145 pigeonpea and MH 18 maize provided for them. Some half plots will be left untreated so that researchers can see the difference in the number of kaufiti emerging with and without each of the treatments.

The researchers will tell the farmer which of the four plots should have each variety or treatment. The plots will have labels to tell everyone what is in the plot. We will ask farmers during the season to compare and comment on the different plots. Researchers will harvest with the farmer and weigh the yield. All the yield is for the farmer. Until the researchers have harvested with you, please do not remove cobs or pods or plants from the field without the research team being there. Compensation cannot be paid if the research team cannot calculate the yield.

Annex 3. Weed management Trial (Matapwata). Information for participating farmers.

Purpose of trial

Farmers sometimes find it difficult to weed their crop on time. This trial is being set up to see what effect different amounts of weeding and high or low fertility have on the numbers and kinds of weeds and what effect the weeds have on the maize yield. There will be up to 20 farmers in the trial. Each farmer has four plots. Each plot is 5.4 metres by 5.4 metres and the four plots can be arranged in a square if possible but this is not essential.

Inputs

The project will supply fertilizer, maize seed (MH18) and pigeonpea (ICP9145) for the plots. Two of the plots on each farm will receive dolloped fertilizer at planting. Researchers will carry out planting and placement of fertilizer with the farmers. Two of the plots will receive no fertilizer so that weeds can be studied where there is no fertilizer as well as where fertilizer has been used. Farmers will be compensated for the difference between the average yield from fertilized plots and the average yield from unfertilized plots.

Management

The farmer will be asked to weed two of the four plots just the same way they weed the rest of the field. The aim is for the plots to have whatever weeding is normal for that farmer at the time. The other two plots will be weeded by the researchers to keep them free of weeds for the first eight weeks. If the farmer uses banking he or she will be asked to bank all four of the plots at about the same time so that all the plots are treated the same way. The plots will look something like this:

Farmer weeding Fertilizer	Researcher weeding No Fertilizer
Researcher weeding Fertilizer	Farmer weeding No Fertilizer

Measurements

The researchers will come and take measurements of the weed numbers and count how many kinds are present. Researchers will want to ask the farmer questions from time to time about the weeding that has been done and also to ask for their opinions on aspects of the trial. They will harvest with the farmer and weigh the yield. All the yield is for the farmer. Until the researchers have harvested with you, please do not remove cobs or pods or plants from the field without the research team being there. Compensation cannot be paid if the research team cannot calculate the yield.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

PROPOSALS FOR ON-FARM PEST MANAGEMENT FIELD TRIALS

1998-99 SEASON

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FSIPM PROJECT BEAN AND PIGEONPEA VARIETY TRIAL 1998/99

Background

Management of bean stem maggot in beans

As in 1996/97 the purpose of the 1997/98 trial and the proposed 1998/99 trial is to develop an appropriate pest management strategy for bean stem maggot (*Ophiomyia* spp.) while at the same time assessing the relative effects of other pest and diseases under farmer management (notably striped bean weevil (*Alcidodes* sp.). with the aim of increasing smallholder bean yields.

As a result of experiences in 1996/97 season. earthing up. mulching and increased plant density were abandoned in 1997/98. Seed dressing with Gaucho for beans was also dropped. given the poor results in an on-station trial in 1996/97 and the expense of this approach. In the face of high cost and environmental concerns associated with pesticides used for BSM control. the preferred strategy in 1997/98 has been the evaluation of varieties of beans for resistance or tolerance to BSM.

The CIAT bean programme provided the project with two varieties from the Andean gene pool. newly released in November 1995: Napilira (CAL 143) and Nagaga (A197). These varieties are believed to have some resistance or tolerance to bean stem maggot (BSM) since they have been exposed to it over several seasons in the CIAT project trials. They have been found to have good agronomic characteristics and disease resistance and have a potential yield of more than 2 tons/ha (CIAT BEAN Programme Annual Report 1996). The variety Kalima. which was extensively tested before its recent release by Bunda College was also used in trials. This variety is similar in appearance to Napilira and is a member of the Calima group of varieties. but with different characteristics from CAL 143 (R. Chirwa. pers. comm.). It has a thick stem and erect habit and performed well in trials in Matapwata over several years. which suggests that it must have some tolerance of BSM. It performed well under poor conditions in 1996/97 *Striga* trials and at least one farmer in Lidala village planted her saved seed in 1997/98. These varieties were tested against Kaulesi as local control because of its shorter duration. In 1997/98 and in 1998/99. at the request of farmers. the project supplied beans for all fields. though it was expected that some of the more extreme dambo fields would not achieve a good crop.

In the 1997/98 on-farm trials. overall differences in Kg/ha seed yield between varieties were highly significant ($p=0.001$). with Kaulesi as best performing variety. folowed by Kalima and Nagaga. Napilira had the lowest yield. closely followed by Nagaga. This relationship held good across both EPAs.

In the 1997/98 on-station summer bean variety trial. seven varieties (Mlama 127. PAD3. G22501. Kaulesi. Kalima. Napilira. Nagaga) were compared for yield and pest damage. The first three were supplied for testing by CIAT because they had performed well in their own multi-locational trials over several seasons. Overall differences in Kg/ha seed yield were highly significant ($p=0.002$). with G22501 as best performing variety. folowed by PAD3 and Napilira. Mlama 127 had the lowest yield. closely followed by Kaulesi. The variation in number of plants with pods was also highly significant. ($p<0.001$). with Napilira as the clear best performer in this category. With the exception of Mlama 127. all the released and experimental varieties used in FSIPM trials performed well on-station.

Overall it was clear from the 1997/98 season that the newly released varieties Napilira and Nagaga performed well under monocropping conditions in on-station trials. However. under the exacting conditions of the farmer's intercropped maize field or the winter relay with maize. yields are much lower and are exceeded by the older varieties. Kaulesi and Kalima. In evaluation interviews with farmers. Kaulesi was strongly preferred to any other variety. largely because of its fast development period.

Management of *Fusarium* wilt in pigeonpea

Use of resistant cultivars appears to offer the only viable technology for management of this disease. Some other varieties may still have a role if they offer faster maturation and high yield. In 1997/98. ICRISAT's technology transfer specialist. Dr Richard Jones. provided the project with planting material of two new long-season cultivars. ICEAP 00040 and ICEAP 00053. to test on-farm. Both are wilt-resistant Kenyan landraces which are being multiplied for release to farmers. These were therefore grown alongside ICP 9145 and a local check on farmer's plots.

In on-farm trials in Matapwata and Chiradzulu. the new varieties all performed well. though detailed analysis of results is still in progress. Farmers consistently evaluated the improved varieties as better than the local variety for most characteristics. including yield.

An additional trial with five farmers in Mangunda Section of Matapwata EPA was established in 1997/98 to assess the relative performance against *Fusarium* wilt and other pests of six varieties (ICP 9145. ICEAP 00020. ICEAP 00040. ICEAP 00053. QP38. Royes and the local check). Once again the ICEAP varieties were supplied by ICRISAT. Nairobi. The Mangunda farmers scored the pigeonpea varieties for yield and other characteristics and were later asked which varieties should be used in the new season. Royes and QP 38 were rejected. along with the local variety. All the other varieties were retained. although ICEAP 00053 was found to be less resistant to wilting than the other improved varieties.

Proposals for 1998/99 trials

A series of meetings were held with farmers in each of the four villages to establish the preferred content of trials for the 1998/99 season. Farmers were very definite that they wished to continue experimenting with the new CIAT bean varieties. despite mixed performance in 1997/98. They also wished to retain Kalima and Kaulesi. In relation to ICRISAT pigeonpea varieties farmers also wished to try the same varieties for a second season. Accordingly the trial varieties of both beans and pigeonpeas were kept the same as for 1997/98 and the same plot layout was used as before. Farmers in Matapwata indicated that they no longer wished to plant a relay crop of beans after *mbwera*. since the rains no longer continue long enough to guarantee a reasonable crop. Accordingly no winter relay crop experiment is planned for 1998/99.

The only difference between the new season's trials and the preceding season was that those farmers participating in the 1998/99 termite and whitegrub trials were omitted from the bean and pigeonpea trial. This left a total of 42 farmers in the bean and pigeonpea variety trial. All fields were fertilized at 50 Kg of N/hectare and farmers were requested to weed once and bank all the plots according to the usual practice. The treatment structure for the trial is shown in Table 1.

Data collection

The formal data collection from this experiment is now concentrated for 1998/99 on the bean and pigeonpea plants only. Causes of death of plants are assessed at 10 day intervals through the growing season and yields are determined at harvest. If specific diseases become widespread. then disease scoring will be undertaken across all plots to provide a co-variate for use in the analysis of yield and pest damage. Dead plants are examined in the laboratory to confirm BSM infestation.

FSIPM PROJECT MAIN INTERCROP TRIAL 1998/99 (BEAN AND PIGEONPEA VARIETY TRIAL). TREATMENT STRUCTURE

Village	Zone	EPA	New Farmer No	Name	Plot No.	Pigeon -pea variety	Bean Variety	Bank Plot
Chiwinja	Dambo	Chiradzulu	1	Stenley Kainga	1	0	1	1
Chiwinja	Dambo	Chiradzulu	1	Stenley Kainga	2	1	0	1
Chiwinja	Dambo	Chiradzulu	1	Stenley Kainga	3	3	2	1
Chiwinja	Dambo	Chiradzulu	1	Stenley Kainga	4	2	3	1
Chiwinja	Dambo	Chiradzulu	2	Isaac CHILINKHONDE	1	1	3	1
Chiwinja	Dambo	Chiradzulu	2	Isaac CHILINKHONDE	2	0	0	1
Chiwinja	Dambo	Chiradzulu	2	Isaac CHILINKHONDE	3	2	2	1
Chiwinja	Dambo	Chiradzulu	2	Isaac CHILINKHONDE	4	3	1	1
Chiwinja	Dambo	Chiradzulu	3	Daina CHILINKHONDE	1	0	3	1
Chiwinja	Dambo	Chiradzulu	3	Daina CHILINKHONDE	2	1	2	1
Chiwinja	Dambo	Chiradzulu	3	Daina CHILINKHONDE	3	3	0	1
Chiwinja	Dambo	Chiradzulu	3	Daina CHILINKHONDE	4	2	1	1
Chiwinja	Dambo	Chiradzulu	4	Lozalio LIMANI	1	3	2	1
Chiwinja	Dambo	Chiradzulu	4	Lozalio LIMANI	2	1	0	1
Chiwinja	Dambo	Chiradzulu	4	Lozalio LIMANI	3	2	3	1
Chiwinja	Dambo	Chiradzulu	4	Lozalio LIMANI	4	0	1	1
Chiwinja	Dambo	Chiradzulu	5	Elina Walala	1	2	1	1
Chiwinja	Dambo	Chiradzulu	5	Elina Walala	2	1	2	1
Chiwinja	Dambo	Chiradzulu	5	Elina Walala	3	3	0	1
Chiwinja	Dambo	Chiradzulu	5	Elina Walala	4	0	3	1
Chiwinja	Dambo	Chiradzulu	6	Yelesia Kundala	1	2	2	1
Chiwinja	Dambo	Chiradzulu	6	Yelesia Kundala	2	3	1	1
Chiwinja	Dambo	Chiradzulu	6	Yelesia Kundala	3	0	0	1
Chiwinja	Dambo	Chiradzulu	6	Yelesia Kundala	4	1	3	1
Chiwinja	Dambo	Chiradzulu	7	Mai Kainga	1	0	3	1
Chiwinja	Dambo	Chiradzulu	7	Mai Kainga	2	3	0	1
Chiwinja	Dambo	Chiradzulu	7	Mai Kainga	3	2	1	1
Chiwinja	Dambo	Chiradzulu	7	Mai Kainga	4	1	2	1
Chiwinja	Dambo	Chiradzulu	8	Beatrice Maduka (=Chilewani)	1	0	3	1
Chiwinja	Dambo	Chiradzulu	8	Beatrice Maduka (=Chilewani)	2	2	1	1
Chiwinja	Dambo	Chiradzulu	8	Beatrice Maduka (=Chilewani)	3	3	0	1
Chiwinja	Dambo	Chiradzulu	8	Beatrice Maduka (=Chilewani)	4	1	2	1
Lidala	Dambo	Chiradzulu	9	Dorothy PIANO	1	2	2	1
Lidala	Dambo	Chiradzulu	9	Dorothy PIANO	2	0	0	1
Lidala	Dambo	Chiradzulu	9	Dorothy PIANO	3	1	3	1
Lidala	Dambo	Chiradzulu	9	Dorothy PIANO	4	3	1	1
Lidala	Dambo	Chiradzulu	10	Tereza LUWERO	1	2	1	1
Lidala	Dambo	Chiradzulu	10	Tereza LUWERO	2	0	3	1
Lidala	Dambo	Chiradzulu	10	Tereza LUWERO	3	1	2	1
Lidala	Dambo	Chiradzulu	10	Tereza LUWERO	4	3	0	1
Lidala	Dambo	Chiradzulu	11	Linny MPENDA	1	1	1	1
Lidala	Dambo	Chiradzulu	11	Linny MPENDA	2	0	2	1
Lidala	Dambo	Chiradzulu	11	Linny MPENDA	3	3	3	1
Lidala	Dambo	Chiradzulu	11	Linny MPENDA	4	2	0	1
Lidala	Dambo	Chiradzulu	12	Emily MUSTAFA	1	0	0	1
Lidala	Dambo	Chiradzulu	12	Emily MUSTAFA	2	1	3	1
Lidala	Dambo	Chiradzulu	12	Emily MUSTAFA	3	2	2	1
Lidala	Dambo	Chiradzulu	12	Emily MUSTAFA	4	3	1	1
Lidala	Dambo	Chiradzulu	13	Dyson CHIMWAZA	1	0	3	1
Lidala	Dambo	Chiradzulu	13	Dyson CHIMWAZA	2	1	2	1
Lidala	Dambo	Chiradzulu	13	Dyson CHIMWAZA	3	2	1	1
Lidala	Dambo	Chiradzulu	13	Dyson CHIMWAZA	4	3	0	1

TABLE 1. FSIPM PROJECT MAIN INTERCROP TRIAL 1998/99 (BEAN AND PIGEONPEA VARIETY TRIAL). TREATMENT STRUCTURE (Continued)

Village	Zone	EPA	New Farmer No	Name	Plot No.	Pigeon -pea variety	Bean Variety	Bank Plot
Lidala	Dambo	Chiradzulu	14	Felia Matchado	1	0	1	1
Lidala	Dambo	Chiradzulu	14	Felia Matchado	2	1	0	1
Lidala	Dambo	Chiradzulu	14	Felia Matchado	3	3	2	1
Lidala	Dambo	Chiradzulu	14	Felia Matchado	4	2	3	1
Chiwinja	Upland	Chiradzulu	15	Enelesi Kaminyu	1	2	3	1
Chiwinja	Upland	Chiradzulu	15	Enelesi Kaminyu	2	3	2	1
Chiwinja	Upland	Chiradzulu	15	Enelesi Kaminyu	3	1	0	1
Chiwinja	Upland	Chiradzulu	15	Enelesi Kaminyu	4	0	1	1
Chiwinja	Upland	Chiradzulu	16	Mai Mpoya	1	0	0	1
Chiwinja	Upland	Chiradzulu	16	Mai Mpoya	2	3	1	1
Chiwinja	Upland	Chiradzulu	16	Mai Mpoya	3	1	3	1
Chiwinja	Upland	Chiradzulu	16	Mai Mpoya	4	2	2	1
Lidala	Upland	Chiradzulu	17	Elube Nankhonya	1	2	0	1
Lidala	Upland	Chiradzulu	17	Elube Nankhonya	2	3	3	1
Lidala	Upland	Chiradzulu	17	Elube Nankhonya	3	1	1	1
Lidala	Upland	Chiradzulu	17	Elube Nankhonya	4	0	2	1
Lidala	Upland	Chiradzulu	18	Dorothy Ayimu	1	0	2	1
Lidala	Upland	Chiradzulu	18	Dorothy Ayimu	2	1	1	1
Lidala	Upland	Chiradzulu	18	Dorothy Ayimu	3	3	3	1
Lidala	Upland	Chiradzulu	18	Dorothy Ayimu	4	2	0	1
Lidala	Upland	Chiradzulu	19	Luckness Muhemwe	1	1	2	1
Lidala	Upland	Chiradzulu	19	Luckness Muhemwe	2	0	3	1
Lidala	Upland	Chiradzulu	19	Luckness Muhemwe	3	2	1	1
Lidala	Upland	Chiradzulu	19	Luckness Muhemwe	4	3	0	1
Lidala	Upland	Chiradzulu	20	Yelesi Ayidi	1	2	2	1
Lidala	Upland	Chiradzulu	20	Yelesi Ayidi	2	0	0	1
Lidala	Upland	Chiradzulu	20	Yelesi Ayidi	3	1	3	1
Lidala	Upland	Chiradzulu	20	Yelesi Ayidi	4	3	1	1
Lidala	Upland	Chiradzulu	21	Enifa Mwadala	1	3	1	1
Lidala	Upland	Chiradzulu	21	Enifa Mwadala	2	2	2	1
Lidala	Upland	Chiradzulu	21	Enifa Mwadala	3	0	0	1
Lidala	Upland	Chiradzulu	21	Enifa Mwadala	4	1	3	1
Lidala	Upland	Chiradzulu	22	Saina Kadango	1	0	1	1
Lidala	Upland	Chiradzulu	22	Saina Kadango	2	3	0	1
Lidala	Upland	Chiradzulu	22	Saina Kadango	3	1	2	1
Lidala	Upland	Chiradzulu	22	Saina Kadango	4	2	3	1
Lidala	Upland	Chiradzulu	23	Howard Taimu	1	3	2	1
Lidala	Upland	Chiradzulu	23	Howard Taimu	2	0	1	1
Lidala	Upland	Chiradzulu	23	Howard Taimu	3	1	0	1
Lidala	Upland	Chiradzulu	23	Howard Taimu	4	2	3	1
Lidala	Upland	Chiradzulu	24	Esther Thom	1	2	0	1
Lidala	Upland	Chiradzulu	24	Esther Thom	2	0	2	1
Lidala	Upland	Chiradzulu	24	Esther Thom	3	1	1	1
Lidala	Upland	Chiradzulu	24	Esther Thom	4	3	3	1

TABLE 1. FSIPM PROJECT MAIN INTERCROP TRIAL 1998/99 (BEAN AND PIGEONPEA VARIETY TRIAL). TREATMENT STRUCTURE (Continued)

Village	Zone	EPA	New Farmer No	Name	Plot No.	Pigeon -pea variety	Bean Variety	Bank Plot
Magomero	Dambo	Matapwata	25	Chief Magomero	1	1	3	1
Magomero	Dambo	Matapwata	25	Chief Magomero	2	2	2	1
Magomero	Dambo	Matapwata	25	Chief Magomero	3	0	0	1
Magomero	Dambo	Matapwata	25	Chief Magomero	4	3	1	1
Magomero	Dambo	Matapwata	26	Bambo Julius (2)	1	2	3	1
Magomero	Dambo	Matapwata	26	Bambo Julius (2)	2	1	0	1
Magomero	Dambo	Matapwata	26	Bambo Julius (2)	3	0	1	1
Magomero	Dambo	Matapwata	26	Bambo Julius (2)	4	3	2	1
Magomero	Dambo	Matapwata	27	Bambo Julius	1	3	0	1
Magomero	Dambo	Matapwata	27	Bambo Julius	2	2	1	1
Magomero	Dambo	Matapwata	27	Bambo Julius	3	0	3	1
Magomero	Dambo	Matapwata	27	Bambo Julius	4	1	2	1
Magomero	Dambo	Matapwata	28	Mai Mazinga	1	0	2	1
Magomero	Dambo	Matapwata	28	Mai Mazinga	2	3	3	1
Magomero	Dambo	Matapwata	28	Mai Mazinga	3	1	1	1
Magomero	Dambo	Matapwata	28	Mai Mazinga	4	2	0	1
Magomero	Dambo	Matapwata	29	Bambo Chigomire	1	0	3	1
Magomero	Dambo	Matapwata	29	Bambo Chigomire	2	2	1	1
Magomero	Dambo	Matapwata	29	Bambo Chigomire	3	1	2	1
Magomero	Dambo	Matapwata	29	Bambo Chigomire	4	3	0	1
Kambuwa	Dambo	Matapwata	30	Bambo Chimombo	1	3	1	1
Kambuwa	Dambo	Matapwata	30	Bambo Chimombo	2	1	3	1
Kambuwa	Dambo	Matapwata	30	Bambo Chimombo	3	2	2	1
Kambuwa	Dambo	Matapwata	30	Bambo Chimombo	4	0	0	1
Kambuwa	Dambo	Matapwata	31	Mai Baluti	1	1	1	1
Kambuwa	Dambo	Matapwata	31	Mai Baluti	2	0	2	1
Kambuwa	Dambo	Matapwata	31	Mai Baluti	3	3	3	1
Kambuwa	Dambo	Matapwata	31	Mai Baluti	4	2	0	1
Kambuwa	Dambo	Matapwata	32	Mai Butao	1	3	2	1
Kambuwa	Dambo	Matapwata	32	Mai Butao	2	0	1	1
Kambuwa	Dambo	Matapwata	32	Mai Butao	3	1	0	1
Kambuwa	Dambo	Matapwata	32	Mai Butao	4	2	3	1
Kambuwa	Dambo	Matapwata	33	Mai Chelewani	1	1	2	1
Kambuwa	Dambo	Matapwata	33	Mai Chelewani	2	0	3	1
Kambuwa	Dambo	Matapwata	33	Mai Chelewani	3	2	1	1
Kambuwa	Dambo	Matapwata	33	Mai Chelewani	4	3	0	1
Magomero	Upland	Matapwata	34	Frazer Mazinga	1	0	2	1
Magomero	Upland	Matapwata	34	Frazer Mazinga	2	3	3	1
Magomero	Upland	Matapwata	34	Frazer Mazinga	3	2	0	1
Magomero	Upland	Matapwata	34	Frazer Mazinga	4	1	1	1
Magomero	Upland	Matapwata	35	Bambo Sitima	1	0	0	1
Magomero	Upland	Matapwata	35	Bambo Sitima	2	3	1	1
Magomero	Upland	Matapwata	35	Bambo Sitima	3	1	3	1
Magomero	Upland	Matapwata	35	Bambo Sitima	4	2	2	1
Magomero	Upland	Matapwata	36	Mai Muthowa	1	3	0	1
Magomero	Upland	Matapwata	36	Mai Muthowa	2	0	3	1
Magomero	Upland	Matapwata	36	Mai Muthowa	3	2	1	1
Magomero	Upland	Matapwata	36	Mai Muthowa	4	1	2	1

TABLE 1. FSIPM PROJECT MAIN INTERCROP TRIAL 1998/99 (BEAN AND PIGEONPEA VARIETY TRIAL). TREATMENT STRUCTURE (Continued)

Village	Zone	EPA	New Farmer No	Name	Plot No.	Pigeon -pea variety	Bean Variety	Bank Plot
Magomero	Upland	Matapwata	37	Mai Lombola	1	1	3	1
Magomero	Upland	Matapwata	37	Mai Lombola	2	0	0	1
Magomero	Upland	Matapwata	37	Mai Lombola	3	2	2	1
Magomero	Upland	Matapwata	37	Mai Lombola	4	3	1	1
Kambuwa	Upland	Matapwata	38	Mai Vakala	1	2	2	1
Kambuwa	Upland	Matapwata	38	Mai Vakala	2	3	1	1
Kambuwa	Upland	Matapwata	38	Mai Vakala	3	1	3	1
Kambuwa	Upland	Matapwata	38	Mai Vakala	4	0	0	1
Kambuwa	Upland	Matapwata	39	Mai Katchotsa	1	3	3	1
Kambuwa	Upland	Matapwata	39	Mai Katchotsa	2	0	2	1
Kambuwa	Upland	Matapwata	39	Mai Katchotsa	3	2	0	1
Kambuwa	Upland	Matapwata	39	Mai Katchotsa	4	1	1	1
Kambuwa	Upland	Matapwata	40	John Pahuwa	1	0	3	1
Kambuwa	Upland	Matapwata	40	John Pahuwa	2	1	2	1
Kambuwa	Upland	Matapwata	40	John Pahuwa	3	3	0	1
Kambuwa	Upland	Matapwata	40	John Pahuwa	4	2	1	1

Bean code

KAULESI	0
NAGAGA	1
NAPILIRA	2
KALIMA	3

Pigeonpea code

Local	0
ICEAP 00053	1
ICEAP 00040	2
ICP 9145	3

Farmer observation plots 1998/99 - pigeonpea and bean varieties

At the village meetings, farmers expressed the desire to be given seed of suitable crop cultivars to test under their own management, including the varieties already used in on-farm trials and new varieties.
The DFID Output to Purpose Review (Nov 1997) indicated the need to move in third year trials from purely researcher-designed trials to greater farmer participation in trial design, implementation and assessment. This was seen as a necessary step in the generation of IPM recommendations for extension workers. However there is a need to continue concurrently (for a second season) the existing trials to verify the technical results obtained in 1997/98 for the benefit of both researchers and farmers. Accordingly farmers were given seeds of promising bean and pigeonpea varieties to grow on their own observation plots.

Purpose of farmer observation trials

1. To enable farmers to assess the suitability of bean and pigeonpea cultivars under their own management on-farm (including resistance to wilt).

2. To enable the FSIPM Project to assess the suitability of cultivars for wider promotion among farm households with differing levels of resources.

3. To observe the process of farmer adoption and adaptation of technologies.

Methods

Farmers will be given standard quantities of each of the seeds used on the main trial and seed of other promising varieties.

Crop varieties supplied to participating farmers for observation under farmer management 1998/99

Bean varieties	Comments	**Pigeonpea varieties**	Comments
Kaulesi		ICEAP 00053	
Nagaga		ICEAP 00040	
Napilira		ICP 9145	
Kalima		ICEAP 00020	
PAD3		Chilinga	
G22501		ICEAP 00068	Mombezi only (medium duration)
Mkhalira		ICEAP 00073	Mombezi only (medium duration)
Kambidzi		ICP 6927	Mombezi only (medium duration)
Soya	Matapwata only (requested by farmers)		

Each bag will contain a written label to place on the plot. Plot size, position and component crops are at farmers discretion but test varieties should be side by side and plot size should be small enough to allow for this within the available field. It will be explained that no compensation will be given for any failed plots. Farmers are to be encouraged to place a small plot of their favourite bean(s) (if available and different) alongside the test varieties for evaluation. They need to know that our varieties are bush varieties, not climbers. Spatial arrangement and management are at farmers' discretion and no pressure is to be applied to influence farmers' management decisions (e.g. weeding, fertilizer) by the team. However timely planting is to be encouraged .

Monitoring Visits

Monitoring visits will only be made to 42 farmers in the main trial. This will ensure adequate time for visits and data collection within project staff work plans. All other farmers (whitegrubs, termites) will be involved via their own end of season evaluation group meetings but could be invited to attend any "open day" activities where farmer managed plots with the bean or pigeonpea varieties are displayed and discussed.

Visit 1. After germination and emergence (2-3 weeks after planting).

1. Check position of varieties with farmers and map plots, noting spatial arrangement and combination of crops on form provided.

2. Ask farmer to score the establishment of each variety on a 1 (very poor) to 5 (very good) scale. Probe for farmer comment on any differences and possible reasons for them. Record.
3. Ask farmer what s/he hopes to learn from the plots. Probe. Do not prompt with menu of choices (e.g. yield, taste, marketability).

Associated activities related to main plot:

1. Explain fertilizer visit and ask about availability.
2. Do post-germination stand count and mortality.
3. Elicit comments from farmer on the four plots. Probe for farmer comment on similarities and differences between the four varieties as seen on research plots and their own plots.
4. Explain researcher's data collection methods (for future visits by research team).

Outputs from visit 1

1. Description of how farmers plant beans/pigeonpeas under their own management.
2. Semi-quantitative assessment of farmer opinion of establishment by variety, problems, and reasons for them.
3. Description of what farmers felt they might learn from these plots.

Visit 2. Around time of Kaulesi pod maturity.

1. Ask whether plots were fertilized or not.
2. When was first weeding?
3. When was banking?
4. Score farmers' perceptions of strengths and weaknesses of each variety.
   - Yield
   - Early maturity
   - Vigour
   - Wilting
   - Other characteristics nominated by farmer

6. Specifically ask farmers if they have seen any *Alectra* (*Kaufiti Wamkulu*) on any bean variety.
7. Check plots with farmer and if *Alectra* is present, record for each plot on a scale of:
0, 1-5, 6-10, >10 plants seen. Ask farmers what they think the effect of the *Alectra* has been, before commenting on this ourselves.

Associated activities related to main plot:

8. Probe for farmer comment on similarities and differences between the four varieties as seen on research plots and their own plots.
9. Harvest Research plot Kaulesi with farmer.

Visit 3. In August for Pigeonpea when medium duration varieties are reaching pod maturity.

1. Score expected yield.
2. Score farmers' perceptions of other strengths and weaknesses of each variety.

Early maturity
Vigour
Wilting
Pests
Other characteristics nominated by farmer

Outputs from visit 2 3

1. Basic information on management practices for subsequent interpretation of how farmers managed these varieties.
2. Semi-quantitative analysis of farmer assessment of variety performance.
3. Descriptive analysis of variety characteristics under farmer management.
4. Description of *Alectra* incidence and effect on beans tested under farmer management.

Final Group Evaluations

To take place as soon as possible after completion of Bean and pigeonpea harvest, having given farmers an opportunity to cook their produce.

This can use the group assessment methodology worked out for last year's trials with A. Sutherland. Individual scoring is not necessary at this stage. So meeting can concentrate on revisiting criteria (in case of season-induced changes) and developing an overview of varieties including farmers' perceptions of taste and marketability etc.

Researchers should present a summary of individual scores from individual farmer visits 2 and 3 and discuss them.

Probe what farmers learnt from the observation plots. Were their expectations met? In what ways?

Final test of acceptance. (December 1999)

Visit all farmers and ask which of the varieties they saved and planted, if any.

FSIPM PROJECT ON-FARM WHITEGRUB MANAGEMENT TRIAL 1998/99

Background

Farmers in Chiwinja village (Chiradzulu N EPA) were interviewed in 1996 about their pest management strategies for whitegrubs and indicated that they had been using Sevin (Carbaryl) in a wettable powder formulation to treat maize seed against adult whitegrubs (Matono) in dambo fields. In 1996/97 the effect of seed dressing maize with Sevin on whitegrubs was assessed in a multi-factorial experiment across dambo fields in four villages in 2 EPAs.

In 1996/97 the effect of the treatment on whitegrubs was masked by the low fertility of the plots and the effects of waterlogging which led to many fields being abandoned. As a result, no significant beneficial effect of seed dressing was observed, while at the higher dose rate, there was a significant negative effect on both maize yield ($p=0.051$) and on maize plant height ($p=0.022$).

The experiment was repeated in 1997/98 on 62 farms in four villages in 2 EPAs, using the more expensive but less toxic alternative seed dressing, Gaucho (Imidacloprid), which is sold elsewhere in Africa specifically for whitegrub control. The experiment was conducted both in dambo fields (as for 1996/97) and in upland fields because it had been established in 1996/97 that larval whitegrub attack occurs throughout the area and also because there is known to be an anti-feedant effect of Gaucho on termites which it was hoped would be detectable on upland farmers' trial plots.

Results of 1997/98 trial

Preliminary examination of damage and yield data from the 1997/98 trial indicates that the incidence of whitegrubs at harvest was reduced by about 13% by seed dressing. Seed dressing reduces whitegrub damage incidence and severity but levels overall are very low and the effect may not be significant. On the basis of raw data, seed dressing appears to increase usable grain yield by about 10%.

Proposal for 1998/99 trial

Hypotheses

1. Farmers who experienced high whitegrub populations and damage in previous years are likely to do so again.

2. Seed dressing will show an effect in reducing whitegrub populations and damage on badly affected fields.

3. The previous season's treatment will have no residual effect on current whitegrub populations and damage.

4. Incorporation of *Tephrosia vogellii* green manure will show an effect in reducing whitegrub populations and damage on badly affected fields.

Farmer selection

Damage by whitegrubs (and termites) is extremely patchy as between farms. All damage data were therefore searched to develop a list of nine farmers who had higher levels of either visible damage (maize plant deaths) or whitegrub population in 1996/97 and 1997/98 (Table 2).

Treatments

Seed dressing using Gaucho (Imidacloprid). as in 1997/98. is again being tested. though on a reduced group of farmers with more severe history of whitegrub attack. A minor modification has been proposed by the suppliers. however. A 125g packet of Gaucho 70 WS currently costs $US 41.50 (T. Katalama. pers. comm.). The manufacturers (Bayer) are experimenting with a new formulation (Gaucho-T) which includes Gaucho 70 WS plus the fungicide Thiram which is already used on its own as a standard treatment for most hybrid seeds in Malawi. Gaucho-T is expected to be made available at approximately one third lower cost than Gaucho and there appears to be little justification for continuing to test the more expensive Gaucho 70WS. As in 1997/98. the treatment will be at the level of 5 g of Gaucho/Kg of maize seed.

A second treatment factor. the addition of incorporated *Tephrosia* leaves in the ridge at a rate of 2 tons of dry matter per hectare. is also proposed for this experiment. *Tephrosia* is already being used within the FSIPM project as a green manure and as a trap crop for *Striga* management. *Tephrosia* is known to contain insecticidal compounds (principally Rotenone and Tephrosin) which are highly toxic to insects. It was therefore included in this experiment to determine whether there is any additional benefit to farmers in terms of whitegrub suppression.

Treatments are therefore:

1. Gaucho in 1997/98. no gaucho 1998/99. no Tephrosia incorporated
2. Gaucho in 1997/98. gaucho 1998/99. no Tephrosia incorporated
3. Gaucho in 1997/98. no gaucho 1998/99. Tephrosia incorporated
4. Gaucho in 1997/98. gaucho 1998/99. Tephrosia incorporated
5. No gaucho in 1997/98. no gaucho 1998/99. no Tephrosia incorporated
6. No gaucho in 1997/98. no gaucho 1998/99. Tephrosia incorporated
7. No gaucho in 1997/98. gaucho 1998/99. no Tephrosia incorporated
8. No gaucho in 1997/98. gaucho 1998/99. Tephrosia incorporated

Experimental design

Factorial design (2 x 2 x 2). with four plots per farmer. divided into a total of eight subplots using the seed treatment randomization from the 1997/98 trial (Table 2). Maize is intercropped with beans and pigeonpea varieties preferred by farmers in each EPA. *Tephrosia* is applied randomly to one pair of previously (1997/98) gaucho-treated and one pair of untreated plots. Gaucho treatment is assigned randomly to one subplot of each of the plots to give one of each of the eight combinations shown above.

Management

The planting of these plots will need to be carefully supervised to ensure that seed dressing is applied in the correct subplots and 36 new labels will be required to mark the subplots. The words *Mankhwala* and *Wombwe* or *Nthuthu* should be written on the labels for the appropriate subplots. Farmers should be encouraged to put a plastic bag over their hand to hold the treated seed while planting (or use the gloves provided) and reminded to wash their hands afterwards before touching their eyes or mouth. or eating or smoking.

The plots will be laid out with maize and pigeonpea stations (3 seeds) alternated at 90 cm spacing and with one station (2 seeds) of beans between each pair of maize and pigeonpea plants. Management will be carried out by the farmer. including first weeding followed by normal banking (kubandira).

Technical response data collection (Maize only)

The quantitative data to be collected on this experiment relates <u>only</u> to maize stand and pest damage and maize yield on the research plots. Qualitative data on pests and diseases or other factors affecting other intercrops will only be noted if unusual. Note that quantitative data on these intercrops are available from other trials.

Visits: 2-3 weeks (with farmer). 4-5 weeks. 8 weeks. 12 weeks. 16 weeks. 20 weeks. harvest (with farmer).

Responses: Net sub-plot stand count (Live). Net sub-plot total dead maize plants. deaths due to individual causes (termites. whitegrubs. stem borers. others). Damage to living maize plants (early visits only). Plants with cobs lodged by termites (post 16 weeks)

Harvest data: Net sub-plot stand count. plants with cobs. Plant height (sample). whitegrubs (sample). net sub-plot plant deaths (total and individual causes). live plant stem borer scoring. Termite lodged plants.

Farmer observation plots

Purpose

1. To enable farmers to test the technique of seed dressing against soil pests under their own management.

2. To enable FSIPM Project to assess the suitability of the technique for farmer use and observe any adaptation by farmers.

Methods

It is proposed that a packet containing enough Gaucho-T to treat about 0.3 Kg of maize seed (1.5 g) should be given to each of the nine participating farmers. together with a volume measure (tin or plastic cup) to hold about 300g of maize seed. a plastic bag to mix the seed in. and instructions to add a small quantity of water to the seed and powder in the bag before planting. Farmers will observe the method being used by researchers while planting the main plots (see above) and should be encouraged to keep back some of their seed for planting after observing this demonstration.

Since the farmers participating in this trial have been withdrawn from the main intercrop trial group. they are being supplied with labelled packets of pigeonpea and bean varieties identical to those given to the 42 farmers in the bean and pigeonpea variety trial. They will be encouraged to grow these separately in small plots but monitoring will only be done with the 42 bean and pigeonpea variety trial farmers. The whitegrub trial farmers may be asked questions about which varieties seemed most useful when their own trial is evaluated.

Monitoring

Visit 1. At time of first weeding (2-3 weeks after planting):

Individual farm visits

1. Map treated maize plot location. noting spatial arrangement and combination of intercrops on the form provided.
2. Ask farmer to score the establishment of the maize with and without seed dressing on a 1 (poor) -5 (good) scale on the farmer's own observation plot (if any) and on each of the trial plots (see below). Ask the farmer how they found the seed treating. Was there any problem?
3. Ask farmer what s/he hopes to learn from the treated plot. Probe but do not prompt.

Associated activities related to main plot

1. Explain fertilizer visit (to take place at around 4 weeks) and ask about household availability (as for main bean/pigeonpea trial).
2. Do post-germination stand count and mortaility.
3. Ask the farmer to score the maize establishment (1-5) on the eight subplots. Afterwards (not before) ensure that the farmer knows which sub-plots are treated (with gaucho or Tephrosia or both) and write on the labels if not done at planting.
4. Explain researchers' data collection methods related to the maize (for future visits by the research team).

Visit 2. At time of maize harvest

Individual farm visits

1. Ask farmer to score the maize plant stand and yield (of cobs) with and without seed dressing on a 1 (poor) -5 (good) scale on the farmer's own observation plot (if any) and on each of the trial plots (see below).

Associated activities related to main plot:

2. Assess stand count. maize height. plants with cobs. yield etc.
3. Ask farmer to score the maize plant stand and yield (of cobs) on each subplot on a 1 (poor) -5 (good) scale.
4. Afterwards (not before) ensure that the farmer knows which sub-plots are treated with Gaucho or Tephrosia (or both) and ask them if they think there are any differences overall between treatments.

Final group evaluation meeting

To take place after maize harvest. Ask farmers their overall opinion of treatments and dicuss the benefits and costs of seed dressing or Tephrosia incorporation with them.

Researchers should present a summary of individual scores from individual farmer visits 1 and 2 and elicit reactions to them.

Probe what farmers learnt from the seed dressing observation plot. Were their expectations met? In what ways? Which of the bean and pigeonpea varieties did they like best? Why was that?

Table 2. FSIPM PROJECT WHITEGRUB TRIAL 1998/99. TREATMENT STRUCTURE.
FARMERS WITH CONSISTENT OR EXTREME WHITEGRUB PROBLEM 1996/97 to 1997/98

Village	EPA	ZONE	Farmer no.	Name	Plot no	Sub-plot no	Pigeon-pea variety	Bean variety	Gaucho treated (1997 /98)	Tephrosia incor-porated	Gaucho treated (1998 /99)	Banking
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	1	1	00040	Nagaga	1	0	0	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	1	2	00040	Nagaga	1	0	1	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	2	1	00040	Nagaga	1	1	0	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	2	2	00040	Nagaga	1	1	1	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	3	1	00040	Nagaga	0	1	0	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	3	2	00040	Nagaga	0	1	1	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	4	1	00040	Nagaga	0	0	1	1
Chiwinja	CHIRA	DAMBO	1	Mai Malonda	4	2	00040	Nagaga	0	0	0	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	1	1	00040	Nagaga	0	1	1	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	1	2	00040	Nagaga	0	1	0	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	2	1	00040	Nagaga	1	1	1	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	2	2	00040	Nagaga	1	1	0	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	3	1	00040	Nagaga	1	0	1	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	3	2	00040	Nagaga	1	0	0	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	4	1	00040	Nagaga	0	0	1	1
Chiwinja	CHIRA	DAMBO	2	Bambo Chilewe	4	2	00040	Nagaga	0	0	0	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	1	1	00040	Nagaga	1	0	0	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	1	2	00040	Nagaga	1	0	1	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	2	1	00040	Nagaga	0	1	1	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	2	2	00040	Nagaga	0	1	0	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	3	1	00040	Nagaga	0	0	0	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	3	2	00040	Nagaga	0	0	1	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	4	1	00040	Nagaga	1	1	0	1
Chiwinja	CHIRA	UPLA	3	Emily Muchera	4	2	00040	Nagaga	1	1	1	1

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Table 2. FSIPM PROJECT WHITEGRUB TRIAL 1998/99. TREATMENT STRUCTURE (Contd).
FARMERS WITH CONSISTENT OR EXTREME WHITEGRUB PROBLEM 1996/97 to 1997/98

Village	EPA	ZONE	Farmer no.	Name	Plot no	Sub-plot no	Pigeon-pea variety	Bean variety	Gaucho treated (1997 /98)	Tephrosia incor-porated	Gaucho treated (1998 /99)	Banking
Lidala	CHIRA	UPLAND	4	Charles Sapanga	1	1	00040	Nagaga	0	1	0	1
Lidala	CHIRA	UPLAND	4	Charles Sapanga	1	2	00040	Nagaga	0	1	1	1
Lidala	CHIRA	UPLA	4	Charles Sapanga	2	1	00040	Nagaga	1	0	0	1
Lidala	CHIRA	UPLA	4	Charles Sapanga	2	2	00040	Nagaga	1	0	1	1
Lidala	CHIRA	UPLA	4	Charles Sapanga	3	1	00040	Nagaga	0	0	1	1
Lidala	CHIRA	UPLA	4	Charles Sapanga	3	2	00040	Nagaga	0	0	0	1
Lidala	CHIRA	UPLA	4	Charles Sapanga	4	1	00040	Nagaga	1	1	1	1
Lidala	CHIRA	UPLA	4	Charles Sapanga	4	2	00040	Nagaga	1	1	0	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	1	1	00040	Nagaga	0	0	1	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	1	2	00040	Nagaga	0	0	0	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	2	1	00040	Nagaga	0	1	0	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	2	2	00040	Nagaga	0	1	1	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	3	1	00040	Nagaga	1	0	1	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	3	2	00040	Nagaga	1	0	0	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	4	1	00040	Nagaga	1	1	0	1
Lidala	CHIRA	UPLA	5	Daina Chipakula	4	2	00040	Nagaga	1	1	1	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	1	1	00040	Nagaga	0	1	1	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	1	2	00040	Nagaga	0	1	0	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	2	1	00040	Nagaga	1	1	0	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	2	2	00040	Nagaga	1	1	1	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	3	1	00040	Nagaga	1	0	0	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	3	2	00040	Nagaga	1	0	1	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	4	1	00040	Nagaga	0	0	0	1
Lidala	CHIRA	UPLA	6	Nelia Kassimu	4	2	00040	Nagaga	0	0	1	1

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Table 2. FSIPM PROJECT WHITEGRUB TRIAL 1998/99. TREATMENT STRUCTURE (Contd).
FARMERS WITH CONSISTENT OR EXTREME WHITEGRUB PROBLEM 1996/97 to 1997/98

Village	EPA	ZONE	Farmer no.	Name	Plot no	Sub-plot no	Pigeon-pea variety	Bean variety	Gaucho treated (1997 /98)	Tephrosia incor-porated	Gaucho treated (1998 /99)	Banking
Kambuwa	MATA	UPLA	7	Bambo Tomato	1	1	ICP9145	Kaulesi	1	0	1	1
Kambuwa	MATA	UPLA	7	Bambo Tomato	1	2	ICP9145	Kaulesi	1	0	0	1
Kambuwa	MATA	UPLA	7	Bambo Tomato.	2	1	ICP9145	Kaulesi	0	1	0	1
Kambuwa	MATA	UPLA	7	Bambo Tomato	2	2	ICP9145	Kaulesi	0	1	1	1
Kambuwa	MATA	UPLA	7	Bambo Tomato	3	1	ICP9145	Kaulesi	1	1	1	1
Kambuwa	MATA	UPLA	7	Bambo Tomato	3	2	ICP9145	Kaulesi	1	1	0	1
Kambuwa	MATA	UPLA	7	Bambo Tomato	4	1	ICP9145	Kaulesi	0	0	0	1
Kambuwa	MATA	UPLA	7	Bambo Tomato	4	2	ICP9145	Kaulesi	0	0	1	1
Magomero	MATA	UPLA	8	Bambo Gomani	1	1	ICP9145	Kaulesi	1	1	1	1
Magomero	MATA	UPLA	8	Bambo Gomani	1	2	ICP9145	Kaulesi	1	1	0	1
Magomero	MATA	UPLA	8	Bambo Gomani	2	1	ICP9145	Kaulesi	1	0	1	1
Magomero	MATA	UPLA	8	Bambo Gomani	2	2	ICP9145	Kaulesi	1	0	0	1
Magomero	MATA	UPLA	8	Bambo Gomani	3	1	ICP9145	Kaulesi	0	0	1	1
Magomero	MATA	UPLA	8	Bambo Gomani	3	2	ICP9145	Kaulesi	0	0	0	1
Magomero	MATA	UPLA	8	Bambo Gomani	4	1	ICP9145	Kaulesi	0	1	0	1
Magomero	MATA	UPLA	8	Bambo Gomani	4	2	ICP9145	Kaulesi	0	1	1	1
Magomero	MATA	UPLA	9	Mai Marichi	1	1	ICP9145	Kaulesi	0	0	1	1
Magomero	MATA	UPLA	9	Mai Marichi	1	2	ICP9145	Kaulesi	0	0	0	1
Magomero	MATA	UPLA	9	Mai Marichi	2	1	ICP9145	Kaulesi	0	1	0	1
Magomero	MATA	UPLA	9	Mai Marichi	2	2	ICP9145	Kaulesi	0	1	1	1
Magomero	MATA	UPLA	9	Mai Marichi	3	1	ICP9145	Kaulesi	1	0	1	1
Magomero	MATA	UPLA	9	Mai Marichi	3	2	ICP9145	Kaulesi	1	0	0	1
Magomero	MATA	UPLA	9	Mai Marichi	4	1	ICP9145	Kaulesi	1	1	0	1
Magomero	MATA	UPLA	9	Mai Marichi	4	1	ICP9145	Kaulesi	1	1	1	1

FSIPM PROJECT ON-FARM TERMITE MANAGEMENT TRIAL 1998/99

Background

The approaches used in 1997/98 were Mbwera vs no Mbwera (in Matapwata) and weeding with banking or weeding without banking (in Chiradzulu North), as in 1996/97, but with both techniques visible on each farmer's field. In Matapwata the treatments of Mbwera and no mbwera included a decision on banking or not banking at second weeding. There was already some evidence that banking encourages termite damage to maize. The simplest comparison therefore was between plots which have been weeded and banked at second weeding and then left without Mbwera, and those which are weeded without banking at second weeding and then have mbwera carried out in order to grow beans or field peas. However farmers prefered to bank before carrying out mbwera and often did so. Actual farmers decisions on banking and mbwera have been used in the treatment structure for analysis of the trial.

Results of 1997/98 trial

Masika produced consistently good yields in the upland at around 2.5 tons/ha (Chiradzulu) and 1.1 tons /ha in the dambo. Banking apparently increases yield by 20% while mbwera has no effect. Not banking reduces incidence of termite damage to plots by 13.2 %, and reduces deaths of plants due to termites by 21%. Mbwera reduces plot incidence of termites by 45% but attack level appears to be increased by 11.5%. These effects may not all be real because sources of variation have not been removed from the analysis. Termite damage varied from 57.5% of plots and 8.6% of plants attacked in upland fields in Chiradzulu North EPA to 44.6% of plots and 4.7% of plants attacked in Matapwata upland. However, only a minority of farmers experienced these attacks which suggested that work related to termites should be concentrated in upland fields with a history of damage in 1988/89. On the basis of raw data, termite damage at harvest was reduced by 22% by seed dressing, suggesting that there is a residual effect, possibly antifeedant in nature.

Proposal for 1998/99 trial

Hypotheses

1. Farmers who experienced high termite damage in previous years are likely to do so again.
2. In cases of severe termite attack, using kukwezera instead of banking may reduce loss of yield due to termite damage without unacceptable loss of maize yield due to not banking fully.
3. Seed priming (soaking seed overnight in water) will speed up germination and result in earlier harvest, reducing damage by termites and other pests.

Farmer selection

Damage by termites is extremely patchy as between farms. All damage data were therefore searched to develop a list of 12 farmers who had higher levels of visible termite damage (maize plant deaths) in 1996/97 and 1997/98 (Table 2).

Treatments

The social science team made a study of farmers' decision-making in tillage practices (Orr et al.. 1998) which indicated that farmers use a specific weeding practice (*kukwezera*) instead of banking (*kubandira*) when termite damage is detected before banking or is anticipated from previous experience.

The exclusion of other treatments related to beans and pigeonpea allows us to incorporate one additional treatment which is actually not termite related but may increase yields for little cost - seed priming of maize - which was recommended to us by the independent review in June 1998. It speeds up crop development (by up to 10 days) and may be a great advantage where farmers are anxious to harvest early due to hunger or fear of termite damage. Each farmer will have four plots as usual:

1. banked. seed primed
2. banked. not seed primed
3. not banked. seed primed
4. not banked. not seed primed

Experimental design

Factorial design (2 x 2) with four plots per farmer (Table 3). For the purposes of this experiment it is assumed that there is no detectable effect of last year's banking or seed dressing which would affect termite attack in the new season. It is assumed that termite foraging patterns will be realigned to exploit the new ridges and any organic matter which will be made available by the new banking operation. Hence this year's treatments will be overlaid on last year's randomizations without using the previous pattern as a treatment in its own right (as seed dressing is being used in the whitegrub trial). Maize is intercropped with beans and pigeonpea varieties preferred by farmers in each EPA.

Management

The plots will be laid out with maize and pigeonpea stations (3 seeds) alternated at 90 cm spacing and with one station (2 seeds) of beans between each pair of maize and pigeonpea plants. Management will be carried out by the farmer. including first weeding followed by normal banking (kubandira) or kukwezera. Plots are to be labelled to indicate which practice is to be done on which plot.

Table 3. FSIPM PROJECT TERMITE MANAGEMENT TRIAL 1998/99. TREATMENT STRUCTURE

Village	New farmer no.	Name	Plot No.	Maize seed dressed (1997/98)	Intended plot banking 1997/98	Actual farmer banking 1997/98	Banking 1998/99	Seed priming 1998/99
Chiwinja	1	Malita Sapuwa	1	0	0	1	1	1
Chiwinja	1	Malita Sapuwa	2	0	0	1	0	1
Chiwinja	1	Malita Sapuwa	3	1	1	1	1	0
Chiwinja	1	Malita Sapuwa	4	1	1	1	0	0
Chiwinja	2	Linily Matekesa	1	0	0	1	1	1
Chiwinja	2	Linily Matekesa	2	1	1	1	0	0
Chiwinja	2	Linily Matekesa	3	1	1	1	1	0
Chiwinja	2	Linily Matekesa	4	0	0	1	0	1
Chiwinja	3	Lucy Magreen	1	1	0	1	1	0
Chiwinja	3	Lucy Magreen	2	0	1	0	0	1
Chiwinja	3	Lucy Magreen	3	0	1	0	1	1
Chiwinja	3	Lucy Magreen	4	1	0	1	0	0
Lidala	4	Kasimu Sapanga	1	1	0	0	1	0
Lidala	4	Kasimu Sapanga	2	0	1	1	0	1
Lidala	4	Kasimu Sapanga	3	1	0	0	0	0
Lidala	4	Kasimu Sapanga	4	0	1	1	1	1
Kambuwa	5	Mai Jana	1	0	0	1	0	1
Kambuwa	5	Mai Jana	2	0	0	1	1	1
Kambuwa	5	Mai Jana	3	1	1	1	0	0
Kambuwa	5	Mai Jana	4	1	1	1	1	0
Kambuwa	6	Mai Kwizombe	1	0	0	1	1	1
Kambuwa	6	Mai Kwizombe	2	1	1	1	1	0
Kambuwa	6	Mai Kwizombe	3	1	1	1	0	0
Kambuwa	6	Mai Kwizombe	4	0	0	1	0	1
Kambuwa	7	Bambo Basikolo	1	1	1	1	0	0
Kambuwa	7	Bambo Basikolo	2	0	0	1	0	1
Kambuwa	7	Bambo Basikolo	3	0	0	1	1	1
Kambuwa	7	Bambo Basikolo	4	1	1	1	1	0
Kambuwa	8	Bambo Chikoti	1	0	0	1	0	1
Kambuwa	8	Bambo Chikoti	2	1	1	0	0	0
Kambuwa	8	Bambo Chikoti	3	1	1	1	1	0
Kambuwa	8	Bambo Chikoti	4	0	0	0	1	1
Kambuwa	9	Bambo Kawerenga	1	0	0	0	1	1
Kambuwa	9	Bambo Kawerenga	2	1	1	1	1	0
Kambuwa	9	Bambo Kawerenga	3	1	1	1	0	0
Kambuwa	9	Bambo Kawerenga	4	0	0	0	0	1
Kambuwa	10	Bambo Kamoto	1	0	1	1	1	1
Kambuwa	10	Bambo Kamoto	2	1	0	1	1	0
Kambuwa	10	Bambo Kamoto	3	1	0	1	0	0
Kambuwa	10	Bambo Kamoto	4	0	1	1	0	1
Kambuwa	11	Bambo Mafaiti	1	1	1	1	1	0
Kambuwa	11	Bambo Mafaiti	2	1	1	1	0	0
Kambuwa	11	Bambo Mafaiti	3	0	0	1	0	1
Kambuwa	11	Bambo Mafaiti	4	0	0	1	1	1
Magomero	12	Mai Kusala	1	1	1	1	1	0
Magomero	12	Mai Kusala	2	0	0	1	0	1
Magomero	12	Mai Kusala	3	1	1	1	0	0
Magomero	12	Mai Kusala	4	0	0	1	1	1

Technical response data collection (Maize only)

The quantitative data to be collected on this experiment relates only to maize stand and pest damage and maize yield on the research plots. Qualitative data on pests and diseases or other factors affecting other intercrops will only be noted if unusual. Note that quantitative data on these intercrops are available from other trials.

Visits: 2-3 weeks (with farmer). 4-5 weeks. 8 weeks (post-banking). 12 weeks. 16 weeks. 20 weeks. harvest (with farmer).

Responses: Net plot stand count (Live). Net plot total dead maize plants. deaths due to individual causes (termites. whitegrubs. stem borers. others). Damage to living maize plants (early visits only). Plants with cobs lodged by termites (post 16 weeks)

4-5 weeks. Remind farmer of need to bank/kukwezera plots and identify which plots.

Post-banking (8 weeks). Check that the appropriate plots have been banked and record what actual banking or kukwezera has been done. Do not ask the farmer to do these operations if not already done at this stage.

Harvest data: Net plot stand count. plants with cobs. Plant height (sample). whitegrubs (sample). net plot plant deaths (total and individual causes). live plant stem borer scoring. Termite lodged plants.

Farmer observation plots

Kukwezera is already a farmer practice so there is no advantage in having an additional farmer-designed plot for this.

Since the farmers participating in this trial have been withdrawn from the main intercrop trial group. they are being supplied with labelled packets of pigeonpea and bean varieties identical to those given to the 42 farmers in the bean and pigeonpea variety trial. They will be encouraged to grow these separately in small plots but monitoring will only be done with the 42 bean and pigeonpea variety trial farmers. The termite trial farmers may be asked questions about which varieties seemed most useful when their own trial is evaluated.

Monitoring

Visit 1. At time of first weeding (2-3 weeks after planting):

Individual farm visits

Activities related to main plot:

1. Explain fertilizer visit (to take place at around 4 weeks) and ask about household availability (as for main bean/pigeonpea trial).
2. Do post-germination maize stand count and mortality.
3. Ask the farmer to score the maize establishment (1-5) on the four plots. Afterwards (not before) ensure that the farmer knows which plots are to be banked and which are to undergo kukwezera and write on the plot labels if not done at planting.
4. Explain researchers' data collection methods related to the maize (for future visits by the research team).
5. Ask the farmer what (if anything) they expect to learn from this experiment. Why is that?.

Visit 2. At time of maize harvest

Individual farm visits

Associated activities related to main plot:

1. Assess stand count. maize height. plants with cobs. yield etc.
2. Ask farmer to score the maize plant stand and yield (of cobs) on each plot on a 1 (poor) -5 (good) scale.
3. Afterwards confirm with them which plots were banked or not banked and ask them if they think there are any differences overall between treatments. What caused those differences?

Final group evaluation meeting

To take place after maize harvest. Ask farmers their overall opinion of treatments and dicuss the benefits and costs of banking and kukwezera in relation to termites with them.

Researchers should present a summary of individual scores from individual farmer visits 1 and 2 and elicit reactions to them.

Probe what farmers learnt from the banking experiment. Were their expectations met? In what ways? Which of the bean and pigeonpea varieties did they like best? Why was that?

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT PROPOSED ON-FARM *STRIGA* TRIAL, 1998/99

Background

The 1997 trial involved 10 farmers in 4 villages with treatment involving dolloped and spread fertilizer and presence of soya beans or *Tephrosia* as trap crop and green manure respectively. The plots were planted with an intercrop of Maize (MH18), beans (Kalima) and pigeonpea (local). The partly analysed results of this experiment were discussed by Ritchie (1997) and a full report of statistical analyses has now been produced (Abeyasekera, 1998).

Results and conclusions from 1996/97 *Striga* trial

Only five farmers had emerged *Striga* on their plots and only one of these had a severe infestation. In general, occurrence of *Striga* was patchy. Plot yields were extremely variable (110 to 3063 Kg ha^{-1}). It must be emphasized that the sample size was small due to unavailability of some yield figures due to thefts and farmers harvesting themselves. Few definite conclusions can therefore be drawn from these data. In the absence of substantial *Striga* infestations, it was not possible to relate *Striga* incidence and severity to yields. Dolloped fertilizer produced an increase in maize height over no fertilizer ($p=0.017$) but maize yields did not differ significantly with or without fertilizer. The bean intercrop benefited from the banded fertilizer ($p=0.02$) whereas dolloping had no benefit for beans. The soya planted at high density depressed maize grain yield by 350 Kg/ha compared to no legume ($p=0.030$), whereas *Tephrosia* had no significant effect on maize yield ($p=0.186$). Bean yileds were unaffected by the other legume intercrops.

The effect of fertilizer was visually striking though the effect on maize yield was not significant. Soil analyses for the main intercrop trials in Chiradzulu and Matapwata showed that phosphorus levels were about four times as high in Matapwata as in Chiradzulu (77.41 ppm compared to 16.94 ppm on average). The implication of this would be that nitrogen could be added as Urea rather than as the much more expensive 23: 21: 0 + 4 S (assuming the additional sulphur is not critical).

Soya grew well on the ridge side but *Tephrosia* suffered from being waterlogged in the furrow due to heavy rain and being weeded out and trampled during farming operations. Reseeding (four seeds per station) was undertaken to fill gaps. In future the side of the ridge may be a better location for planting *Tephrosia*. In some plots where fertilizer was used, a good stand of *Tephrosia* developed with up to two tons of biomass for incorporation. Mai Golden's plot in Kambuwa was used for a demonstration in the 1997/98 season under farmer management to compare maize yields between *Tephrosia* incorporation and no *Tephrosia* incorporation. The result was a striking increase in yield which impressed farmers who participated in the harvesting during a field school on Striga (Chanika and Ritchie, 1998).

Modifications for 1997/98 trial

Design

The experimental design was simplified to allow farmers to participate more fully. The "farmer's plot" serves no clear purpose and instead four plots were used to enable the farmer to make visual comparisons between treatments with separate effects where possible. They can use their own crops in some cases for other comparisons. In the interests of simplifying trials, weeding was excluded as a treatment. Since this is a strategy which is known to be effective it could be applied to patches of *Striga* as a demonstration for farmers. Only the infested areas need to be weeded.

In the 1997/98 season only fields which were observed in the previous season to have heavy *Striga* populations have been used for trials. These fields are all in Matapwata which simplifies logistics of working on *Striga* and also will enable the use of cheaper fertilizer (see above). The bean intercrop was omitted to simplify the experiment and reduce data recording needs.

A seminar at Bvumbwe on 6 October 1997 (Ritchie, Orr & Jere, 1997b) explored the main options for further on-farm experiment, endorsing continued use of *Tephrosia* and proposing the use of cowpeas as an alternative trap crop to soya. The baseline survey (Orr et al., 1997a), conducted in villages where FSIPM Project is working with farmers, indicates that farmers who use fertilizer on their maize use it at rates approaching 60 Kg of N per hectare. However the economic analysis of the national fertilizer verification trials (Benson, 1997), suggests that at the current fertilizer: maize price-ratio the optimum application rate would be 35 Kg N per ha for light-textured uplands. This figure is sensitive to changes in the ratio such that a fall of 20% leads to an increase in the optimum application rate to 55 Kg N per ha. For this experiment a figure of 50 Kg N per ha has therefore been selected. Soil sample analyses for farmers' fields in Chiradzulu North and Matapwata have shown that phosphorous is relatively plentiful in Matapwata (mean 77.41 ppm) (Abeyasekera. 1997). CAN was therefore used instead of the more expensive 23: 21: 0 + 4S.

The experiment was designed as a 2x3 Factorial experiment with split plots in 6 blocks with unequal replication. Each farmer was one block. Three farmers have fields which can only support one replicate of the trial layout. Two control half plots were used with each farmer to increase the chances of observing good *Striga* emergence in the absence of any inhibiting treatments. Two farmers (5 and 6) had fields with enough space to include a second replicate and one (7) could accommodate three replicates. In these fields half-plots are included with each of the legume treatments (cowpeas. Tephrosia) occurring once with fertilizer and once without fertilizer. Two half plots have the control legume treatments with and without fertilizer. This arrangement was designed to allow extra opportunity to detect patchy *Striga* emergence in the absence of treatments. The treatment combinations were assigned at random to the plots of any farmer which themselves were arranged in varying layouts within a field in order to avoid disruptive features such as paths. termite hills. trees and gulleys. The design had an increased requirement for monitoring effort compared to the 1996/97 design but was more successful in detecting *Striga*. In addition each farmer had the same combinations and could therefore compare his/her own fields with those of other farmers.

Experimental design for 1997/98 Striga experiment

At the 1997 DAR annual research meetings the problem of capturing data from patchy infestations of pests such as Striga was discussed. Subsequently after discussions between the team and Dr Abeyasekera and Dr Riches. a split-plot design was adopted. A plot size of 10.8 m (12 planting stations) by 5.4 m (6 ridges) was used. split into fertilized and unfertilized portions. Fields had maize (MH 18) and pigeonpea (ICP 9145). *Tephrosia* was planted at 4 seeds per station on one side of the ridge at 45 cm intervals alternating with maize and pigeonpea plants. The pigeonpea was planted on the ridge to use the available space effectively. Cowpea were planted between maize and pigeonpea at a spacing of one station (3 seeds) between each adjoining maize and pigeonpea plant.

1997/98 Treatments:

1. Fertilizer: 50 Kg N (CAN) per hectare dolloped to both sides of maize plant at sowing. no top dressing.
2. Control: no fertilizer.
3. *Tephrosia* (3 seeds per station) planted at 45 cm spacing on one side of ridge between maize and pigeonpea. and incorporated at maturity.
4. Cowpeas (nseula) (2 seeds per station) planted at 45 cm spacing on top of ridge.
5. No *Tephrosia* or Cowpeas.

Management

The plots were researcher managed to ensure that weeding was carried out at the same time on all plots. This is essential if *Striga* emergence is to be comparable between plots. Owing to poor development of *Tephrosia*. the plants were incorporated before flowering because it was perceived that many plants might otherwise die before full development.

Responses:

1. Time of first observed emergence of Striga.
2. Number of emerged *Striga* stems fortnightly.
3. Number of *Striga* plants found dead without flowering.
4. Number of *Striga* plants flowered.
5. Fortnightly stand counts of maize. pigeonpeas. *Tephrosia* and cowpea: cause of death.
6. Yields of maize. pigeonpea. cowpeas and *Tephrosia* seed and biomass of cowpea and *Tephrosia* from treatment nett plots.

Striga emergence was measured in three quadrats of 0.9 m x 0.9m. formed by enclosing area between four maize stations with quadrats placed between non-contiguous groups of maize plants within nett plot.

Preliminary results of 1997/98 trial

Striga emergence

Emergence of Striga on the plots. as shown by maximum counts. was good. Kambuwa plots had more *Striga* than Magomero plots. A striking feature of the data is the increased incidence of emerged Striga in the presence of fertilizer. This conflicts with results of previous work in Malawi but has been recorded elsewhere. There is some indication that *Striga* emergence in the presence of fertilizer is inhibited by Tephrosia, which appears to be acting as a trap crop. However other analysis suggests this effect may not be significant.

Maize harvest data
Grain yields were approximately doubled in the presence of fertilizer. Presence of legumes probably has no significant effect on maize yield without fertilizer, but cowpea appears to depress maize yields without fertilizer. Very little pest damage of any kind was recorded to maize.

Discussion
In contrast to 1996/97, the effort invested in locating *Striga*-infested plots in 1997/98 paid off. However in 1997/98 *Tephrosia* did less well and was incorporated early in case of further deterioration. It appeared to be suffering from the same or a similar pest problem to the pigeonpea (stem canker). Data on biomass and on nematode attack on *Tephrosia* and pigeonpea are still awaiting analysis. Yield data for pigeonpea are not yet summarized.

Proposed changes for 1998/99 season
The farmers who participated in 1997/998 were willing to repeat the experiment. The *Crotalaria ochroleuca* demonstration plots set up in 1997/98 were found to produce 2 tons of biomass per hectare and *Crotalaria* was therefore incorporated into the experiment, occupying one of the plots previously used as a control.

The treatments are therefore:

1. Fertilizer: 50 Kg N (CAN) per hectare dolloped to both sides of maize plant at sowing; no top dressing.
2. Control: no fertilizer.
3. *Tephrosia* (3 seeds per station) planted at 45 cm spacing on one side of ridge between maize and pigeonpea, and incorporated at maturity.
4. Cowpeas (nseula) (3 seeds per station) planted at 45 cm spacing on top of ridge.
5. *Crotalaria ochroleuca* seed scattered along a drill on one side of the ridge only.
6. No *Tephrosia* or Cowpeas.

Experimental Design:

The design is as for 1997/98, a 2x3 Factorial experiment with 6 blocks and unequal replication. Four farmers had fields which can only support one replicate of the trial layout. Three farmers have fields with enough space to include a second replicate. The treatment combinations (Table 4) are assigned at random to the plots of any farmer which may be arranged in varying layouts within a field in order to avoid disruptive features such as paths, termite hills, trees and gulleys.

Management and response data collection: as for 1997/98 (see above).

Table 4. FSIPM PROJECT STRIGA TRIAL 1998/99. PARTICIPATING FARMERS AND PLOT TREATMENTS.

Village	Farmer No	Block	Name	Plot No.	Sub plot	Legume (1997/98)	Legume (1998/99)	Fertilizer (1998/99)	Fertilizer (1997/98)
Magomero	1	1	Mai Kazembe	1	1	Tephrosia	Tephrosia	No!	No!
Magomero	1	1	Mai Kazembe	1	2	Tephrosia	Tephrosia	Yes!	Yes!
Magomero	1	1	Mai Kazembe	2	1	None	Crotalaria	Yes!	Yes!
Magomero	1	1	Mai Kazembe	2	2	None	Crotalaria	No!	No!
Magomero	1	1	Mai Kazembe	3	1	Cowpea	Cowpea	No!	No!
Magomero	1	1	Mai Kazembe	3	2	Cowpea	Cowpea	Yes!	Yes!
Magomero	1	1	Mai Kazembe	4	1	None	None	No!	No!
Magomero	1	1	Mai Kazembe	4	2	None	None	Yes!	Yes!
Magomero	2	2	Simeon Magomero	1	1	Cowpea	Cowpea	Yes!	Yes!
Magomero	2	2	Simeon Magomero	1	2	Cowpea	Cowpea	No!	No!
Magomero	2	2	Simeon Magomero	2	1	None	None	No!	No!
Magomero	2	2	Simeon Magomero	2	2	None	None	Yes!	Yes!
Magomero	2	2	Simeon Magomero	3	1	Tephrosia	Tephrosia	No!	No!
Magomero	2	2	Simeon Magomero	3	2	Tephrosia	Tephrosia	Yes!	Yes!
Magomero	2	2	Simeon Magomero	4	1	None	Crotalaria	No!	No!
Magomero	2	2	Simeon Magomero	4	2	None	Crotalaria	Yes!	Yes!
Magomero	3	3A	Mai Kalonga	1	1	None	Crotalaria	No!	No!
Magomero	3	3A	Mai Kalonga	1	2	None	Crotalaria	Yes!	Yes!
Magomero	3	3A	Mai Kalonga	2	1	Cowpea	Cowpea	Yes!	Yes!
Magomero	3	3A	Mai Kalonga	2	2	Cowpea	Cowpea	No!	No!
Magomero	3	3A	Mai Kalonga	3	1	Tephrosia	Tephrosia	No!	No!
Magomero	3	3A	Mai Kalonga	3	2	Tephrosia	Tephrosia	Yes!	Yes!
Magomero	3	3A	Mai Kalonga	4	1	None	None	No!	No!
Magomero	3	3A	Mai Kalonga	4	2	None	None	Yes!	Yes!
Magomero	3	3B	Mai Kalonga	1	1	Tephrosia	Tephrosia	No!	No!
Magomero	3	3B	Mai Kalonga	1	2	Tephrosia	Tephrosia	Yes!	Yes!
Magomero	3	3B	Mai Kalonga	2	1	Cowpea	Cowpea	Yes!	Yes!
Magomero	3	3B	Mai Kalonga	2	2	Cowpea	Cowpea	No!	No!
Magomero	3	3B	Mai Kalonga	3	1	None	Crotalaria	Yes!	Yes!
Magomero	3	3B	Mai Kalonga	3	2	None	Crotalaria	No!	No!
Magomero	3	3B	Mai Kalonga	4	1	None	None	No!	No!
Magomero	3	3B	Mai Kalonga	4	2	None	None	Yes!	Yes!
Kambuwa	4	4	Gustino Simon	1	1	None	None	Yes!	Yes!
Kambuwa	4	4	Gustino Simon	1	2	None	None	No!	No!
Kambuwa	4	4	Gustino Simon	2	1	Cowpea	Cowpea	Yes!	Yes!
Kambuwa	4	4	Gustino Simon	2	2	Cowpea	Cowpea	No!	No!
Kambuwa	4	4	Gustino Simon	3	1	Tephrosia	Tephrosia	Yes!	Yes!
Kambuwa	4	4	Gustino Simon	3	2	Tephrosia	Tephrosia	No!	No!
Kambuwa	4	4	Gustino Simon	4	1	None	Crotalaria	Yes!	Yes!
Kambuwa	4	4	Gustino Simon	4	2	None	Crotalaria	No!	No!
Kambuwa	5	5A	Mai Golden (A)	1	1	Tephrosia	Tephrosia	No!	No!
Kambuwa	5	5A	Mai Golden (A)	1	2	Tephrosia	Tephrosia	Yes!	Yes!
Kambuwa	5	5A	Mai Golden (A)	2	1	Cowpea	Cowpea	Yes!	Yes!
Kambuwa	5	5A	Mai Golden (A)	2	2	Cowpea	Cowpea	No!	No!
Kambuwa	5	5A	Mai Golden (A)	3	1	None	None	Yes!	Yes!
Kambuwa	5	5A	Mai Golden (A)	3	2	None	None	No!	No!
Kambuwa	5	5A	Mai Golden (A)	4	1	None	Crotalaria	No!	No!
Kambuwa	5	5A	Mai Golden (A)	4	2	None	Crotalaria	Yes!	Yes!
Kambuwa	5	5B	Mai Golden (B)	1	1	Cowpea	Cowpea	No!	No!
Kambuwa	5	5B	Mai Golden (B)	1	2	Cowpea	Cowpea	Yes!	Yes!
Kambuwa	5	5B	Mai Golden (B)	2	1	None	Crotalaria	No!	No!
Kambuwa	5	5B	Mai Golden (B)	2	2	None	Crotalaria	Yes!	Yes!
Kambuwa	5	5B	Mai Golden (B)	3	1	Tephrosia	Tephrosia	Yes!	Yes!
Kambuwa	5	5B	Mai Golden (B)	3	2	Tephrosia	Tephrosia	No!	No!
Kambuwa	5	5B	Mai Golden (B)	4	1	None	None	No!	No!
Kambuwa	5	5B	Mai Golden (B)	4	2	None	None	Yes!	Yes!

Table 4. FSIPM PROJECT STRIGA TRIAL 1998/99. PARTICIPATING FARMERS AND PLOT TREATMENTS (Contd).

Village	Farmer No	Block	Name	Plot No.	Sub plot	Legume (1997/98)	Legume (1998/99)	Fertilizer (1998/99)	Fertilizer (1997/98)
Kambuwa	6	6A	Chief Kambuwa (A)	1	1	None	Crotalaria	No!	No!
Kambuwa	6	6A	Chief Kambuwa (A)	1	2	None	Crotalaria	Yes!	Yes!
Kambuwa	6	6A	Chief Kambuwa (A)	2	1	None	None	No!	No!
Kambuwa	6	6A	Chief Kambuwa (A)	2	2	None	None	Yes!	Yes!
Kambuwa	6	6A	Chief Kambuwa (A)	3	1	Cowpea	Cowpea	Yes!	Yes!
Kambuwa	6	6A	Chief Kambuwa (A)	3	2	Cowpea	Cowpea	No!	No!
Kambuwa	6	6A	Chief Kambuwa (A)	4	1	Tephrosia	Tephrosia	Yes!	Yes!
Kambuwa	6	6A	Chief Kambuwa (A)	4	2	Tephrosia	Tephrosia	No!	No!
Kambuwa	6	6B	Chief Kambuwa (B)	1	1	None	Crotalaria	No!	No!
Kambuwa	6	6B	Chief Kambuwa (B)	1	2	None	Crotalaria	Yes!	Yes!
Kambuwa	6	6B	Chief Kambuwa (B)	2	1	Cowpea	Cowpea	Yes!	Yes!
Kambuwa	6	6B	Chief Kambuwa (B)	2	2	Cowpea	Cowpea	No!	No!
Kambuwa	6	6B	Chief Kambuwa (B)	3	1	Tephrosia	Tephrosia	Yes!	Yes!
Kambuwa	6	6B	Chief Kambuwa (B)	3	2	Tephrosia	Tephrosia	No!	No!
Kambuwa	6	6B	Chief Kambuwa (B)	4	1	None	None	No!	No!
Kambuwa	6	6B	Chief Kambuwa (B)	4	2	None	None	Yes!	Yes!
Kambuwa	6	6C	Chief Kambuwa (C)	1	1	Tephrosia	Tephrosia	No!	No!
Kambuwa	6	6C	Chief Kambuwa (C)	1	2	Tephrosia	Tephrosia	Yes!	Yes!
Kambuwa	6	6C	Chief Kambuwa (C)	2	1	Cowpea	Cowpea	Yes!	Yes!
Kambuwa	6	6C	Chief Kambuwa (C)	2	2	Cowpea	Cowpea	No!	No!
Kambuwa	6	6C	Chief Kambuwa (C)	3	1	None	None	Yes!	Yes!
Kambuwa	6	6C	Chief Kambuwa (C)	3	2	None	None	No!	No!
Kambuwa	6	6C	Chief Kambuwa (C)	4	1	None	Crotalaria	No!	No!
Kambuwa	6	6C	Chief Kambuwa (C)	4	2	None	Crotalaria	Yes!	Yes!

Farmer observation plots

Following two seasons of involvement with the project, farmers hosting *Striga* trials indicated at evaluation meetings that they would like to assess a greater range of leguminous inter-crops which may be suitable as "trap-crops". It must be borne in mind that inter-crops grown on *Striga* infested land may have a number of impacts on *Striga* populations. As trap-crops ie false hosts whose roots cause the "suicidal" germination of *Striga*, the inter-crop species when grown for a number of seasons will lead the gradual reduction of the *Striga* population. An effect in the first year of growth of the trap crop ie reduced *Striga* emergence in that maize crop may not be particularly obvious. The roots of some inter-crop species by smothering the land, may reduce *Striga* emergence in itself by modifying the micro-climate in the crop canopy. This effect has been observed for a good cover of groundnut, both in Malawi and elsewhere in the region. Additionally any legume grown as an inter-crop should contribute nitrogen i.e will improve the fertility of the soil. This is the reason the project is emphasising *Tephrosia and Crotalaria* at *Striga* infested sites. It is of course also the case that any *Striga* that emerges during the trap-cropping will set seed and add to the problem. So to accelerate a reduction of the seedbank, which is **a gradual process**, farmers should be encourage to pull-up or hoe out and *Striga* which is seen. We already know that the likelihood of this happening, to allow an integrated system of control, will depend upon farmers understanding the parasite life cycle - this has been addressed for the *Striga* group by the farmer field school held earlier in 1998.

The farmers indicated they would like to see as many "trap-crops" as possible under their own management. They will therefore be provided with sufficient seed for planting a single plot of soya bean, groundnut, cowpea, *Tephrosia*, *Crotalaria ochroleuca* and wild *Crotalaria* (*C. pallida*), and *Mucuna* for observation under their own management.

Purpose of observation plots

1. To enable farmers to assess the suitability of "trap-crops" under their own management on-farm.

2. To provide the FSIPM project with an entry point for discussion of the use of a range of trap-crop species with farmers.

Because of the factors discussed above it may well be that no immediate effect of some trap-crops will be seen in terms of less *Striga* this season. As this is the final season of the project there will not be an opportunity to follow-up the effects of continued use of the trap-crop on *Striga* in subsequent maize crops. This will have an influence on how monitoring and evaluation is undertaken. These trials do no therefore lend themselves to extensive technical evaluation: rather they will allow farmers to think about how each crop may fit into a maize-based system.

Methods

Farmers will be given small quantities of seed of each trap-crop. Plot size, position and other crop components are at the farmers discretion but test crops should be adjacent to each other and plot size should be small enough to allow for this within one field. If possible the farmer should choose a *Striga* infested portion of land. While we want the farmer to grow the crops according to their own management it is important to emphasis that adequate plant stands of the inter-crop are needed if there is to be a consistent effect on *Striga* across a plot. In other words it is important to achieve a cover of the soil in the case of groundnut, cowpea and *Mucuna*, for example. On the other hand no pressure is to be applied to influence other management decisions (e.g. weeding, fertilisers) by the team. Timely planting with maize should be encouraged for soya bean, cowpea, groundnut and *Tephrosia*. The two *Crotalaria* species should be planted **following first weeding** while *Mucuna* is best suited for planting **following second weeding** in order to limit competition with maize. An explanation will need to be given on an appropriate way of planting *Crotalaria* as this will be new to farmers. The use of 2g/5m seed planted along one side of the ridge should be demonstrated. A suggested target for *Mucuna* is to plant a station of one seed between maize planting stations. This is the seed rate which resulted in least competition between *Mucuna* and maize in trials conducted in Malawi during 1996/97 and reported by Gilbert to the Soil Fertility Network (1998).

Mucuna is a minor crop grown by some farmers, often at low densities. It has two possible values for improving maize production on *Striga* infested land - as a trap crop and as a green manure. For these purposes it will need to be planted at a higher density than usual. This will need to be discussed with farmers at the implementation meetings i.e. farmers will need to see *Mucuna* in a different light.

Monitoring visits:

The use of under-sown green manures is currently under development with farmers. There are no definite recommendations and furthermore farmers participating in the *Striga* work have no previous experience of planting *Crotalaria* and do not, to our knowledge, use *Mucuna* as a green-manure. Any information which the project has on the use of these species should be given to the farmers and with them work through when the most appropriate planting time is likely to be. This process will be best undertaken through group discussion. Individual site visits will also be needed to capture information about inter-crop and maize performance.

At time of first weeding (2-3 weeks after planting):

1. *Group discussion.* The team will need to explain how undersowing of *Crotalaria* and *Mucuna* can be done in order to allow farmers to decide when they should plant. During discussion it could be pointed out that the projects experience with *Crotalaria* has involved planting at first weeding of maize which does not seem to have effected maize growth. Gilbert reported that *Mucuna* can compete strongly with maize and suggests that it should not be sown until the second weeding. Farmers will have experience of *Mucuna* so their views should be explored to allow them to reach a decision as to when to undersow the inter-crop.

2. *Individual farm visits* will provide an opportunity to map plot locations and to discuss emergence and early growth of the inter-crops.

At cowpea maturity (12-14 weeks after planting):

Individual farm visits:

1. Evaluate production of legumes at this stage on scale of 1 (poor) to 5 (excellent). This will be needed for soya, cowpea and groundnut.

2. Evaluate competitive effect of the intercrops on maize growth on scale of 1 (excessive) to 5 (none).

3. Record when *Crotalaria* and *Mucuna* were planted.

4. Evaluate *Striga* emergence in maize for each plot on scale of 1 (a lot) to 5 (a little).

Group discussion

While in the field at one of the plots, discuss *Crotalaria, Mucuna* and *Tephrosia* growth and when these will be ready for incorporation. It will hopefully be possible at this stage to visualise the biomass. Farmers will need to think through how incorporation can be fitted into their cultivation system and this will be the main focus of the group meeting. The project will be able to contribute the experience with *Crotalaria* from last season in Chiradzulu. A key determinant of when *Crotalaria* will be incorporated is whether or not the farmer intends to plant a winter bean or pea crop. If so the green manure will need to be incorporated during *mbwera*. If not it will be incorporated during *kuwojeka* after maize harvest. *Crotalaria* on the researcher-managed *Striga* plots will be incorporated during *kuwojeka*. Farmer knowledge of the growth cycle of *Mucuna* will be valuable. The farmers should have seen incorporation of *Tephrosia* as part of last season's trial and may remember the extent of *Tephrosia* leaf and wood production at the sites established for 1997/98 season.

On the day the Striga researcher-managed trial is harvested (17-20 weeks after planting):

Individual farm visits:

1. Farmers to individually rank observation plot maize yields on each inter-cropped plot using 1-5 scale.

At *Tephrosia* incorporation (during September/October): Timing will depend upon weather and how the plants have developed and continued to grow through the dry season. Collect together the farmers and visit each site as a group to assess biomass production. At one site demonstrate incorporation.

Evaluation meeting:

To take place after maize harvest as for other farmer managed plots. At this meeting the results of the researcher-managed trial will be discussed first - this will be the opportunity for the project team to present the yield results of the main *Striga* trial. Possible discussion points on the farmer observation plots will be overall group ranking of maize yields, ranking of legume yields and marketability for pulse crops, biomass and any wood production for green manures. Also group rank effect on *Striga*. Probe views on any effect inter-crops have had on maize vigour and growth and on timing and feasibility of incorporation. Also discuss farmer perceptions of hand-pulling: is it more or less feasible with one or more of the inter-crops tested. Did any farmer do it?

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT
FERTILISER AND GREEN MANURE TRIAL 1998/99 (Revised 29-01-99)

Background: During 1997/98 fertiliser was applied to main trial plots by dolloping at crop emergence. During evaluation interviews, farmers expressed a strong opinion that this is too early, results in a loss of fertiliser through vegetative growth but little contribution to grain production and is therefore a waste. Also, with increasing fertiliser prices, the project has begun to focus on the use of green manures as a low cost (cash) approach to fertility restoration for stable crop production. Observation plots in Chiradzulu during 1997/98 indicated that 2000 kg/ha biomass can be produced by undersowing maize with *Crotalaria ochroleuca* following first weeding. The biomass can be incorporated during either *mbwera*, if a winter legume crop is to be planted, or during *kuwojeka*, the first stage of ridging after maize harvest. The 1996/97 *Striga* trials indicated that a similar level of biomass can also be produced from *Tephrosia* planted at the same time as maize. In this case the legume is allowed to grow through the dry season prior to incorporation during the final stages of ridge making in September/October.

Methods: The time of fertiliser application and green manure production will be assessed within one researcher-managed trial replicated at the 22 sites which last season were used for the time of weeding study. There are four plots at each site - two received 50 kg/ha N and two received no fertiliser in 1997. The plots will be laid out as follows:

Early Fertiliser – green manure (Zero N in 1997)	Late Fertiliser – green manure (50 kg N in 1997)
Early Fertiliser (Zero N in 1997)	Late Fertiliser (50 kg N in 1997)

These plots are available at 11 dambo and 11 upland sites distributed between Kambuwa and Magomero villages. *Crotalaria* will be planted as the green manure at 6 dambo and 5 upland sites. *Tephrosia* will be planted at 5 dambo and 6 upland sites. For "early application" fertiliser will be applied following crop emergence and for "late application" it will be used at four weeks after emergence. All plots will receive 50 kg/ha N. Farmers will be supplied with fertilizer and seeds of maize and pigeon pea for the trial.

SET A: *Crotalaria* fields

- Early fertilizer application + *Crotalaria*
- Early fertilizer application alone
- Late fertilizer application + *Crotalaria*
- Late fertilizer application alone

SET B: *Tephrosia* fields

- Early fertilizer application + *Tephrosia*
- Early fertilizer application alone
- Late fertilizer application + *Tephrosia*
- Late fertilizer application alone

The treatment structure for the trial is given in Table 5.

Table 5. FSIPM PROJECT FERTILIZER & GREEN MANURE TRIAL 1998/99.
TREATMENT STRUCTURE

Village	Zone	Farmer No	Name	Plot No.	Fertilizer (1997/98)	Farmer weeded = 0, researcher weeded =1 (1997/98)	Fertilizer (1998/99)	Fertilizer timing (1998/99)	Green manure (1998/99)
Magomero	Upland	1	Bambo Kapoto	1	Yes	1	Yes	Late	Crotalaria
Magomero	Upland	1		2	Yes	0	Yes	Late	No
Magomero	Upland	1		3	No	1	Yes	Early	Crotalaria
Magomero	Upland	1		4	No	0	Yes	Early	No
Magomero	Upland	2	Dickson Julius	1	No	1	Yes	Early	Tephrosia
Magomero	Upland	2		2	Yes	0	Yes	Late	No
Magomero	Upland	2		3	No	0	Yes	Early	No
Magomero	Upland	2		4	Yes	1	Yes	Late	Tephrosia
Magomero	Upland	3	Roya Chitedze	1	Yes	1	Yes	Late	No
Magomero	Upland	3		2	No	0	Yes	Early	No
Magomero	Upland	3		3	Yes	0	Yes	Late	Crotalaria
Magomero	Upland	3		4	No	1	Yes	Early	Crotalaria
Magomero	Upland	4	Davison mangochi	1	Yes	0	Yes	Late	Tephrosia
Magomero	Upland	4		2	Yes	1	Yes	Late	No
Magomero	Upland	4		3	No	0	Yes	Early	No
Magomero	Upland	4		4	No	1	Yes	Early	Tephrosia
Magomero	Upland	5	Linda Laudoni	1	No	0	Yes	Early	No
Magomero	Upland	5		2	Yes	1	Yes	Late	Tephrosia
Magomero	Upland	5		3	No	1	Yes	Early	Tephrosia
Magomero	Upland	5		4	Yes	0	Yes	Late	No
Magomero	Upland	6	Estere Rabichi	1	No	0	Yes	Early	Crotalaria
Magomero	Upland	6		2	No	1	Yes	Early	No
Magomero	Upland	6		3	Yes	0	Yes	Late	Crotalaria
Magomero	Upland	6		4	Yes	1	Yes	Late	No
Magomero	Upland	7	Mai Maluwa	1	No	0	Yes	Early	No
Magomero	Upland	7		2	Yes	0	Yes	Late	Crotalaria
Magomero	Upland	7		3	Yes	1	Yes	Late	No
Magomero	Upland	7		4	No	1	Yes	Early	Crotalaria
Magomero	Upland	8	Njiwa Chiwoko	1	No	0	Yes	Early	Crotalaria
Magomero	Upland	8		2	Yes	0	Yes	Late	Crotalaria
Magomero	Upland	8		3	No	1	Yes	Early	No
Magomero	Upland	8		4	Yes	1	Yes	Late	No
Magomero	Dambo	9	Yolamu Willie	1	Yes	1	Yes	Late	Tephrosia
Magomero	Dambo	9		2	Yes	0	Yes	Late	No
Magomero	Dambo	9		3	No	0	Yes	Early	Tephrosia
Magomero	Dambo	9		4	No	1	Yes	Early	No
Magomero	Dambo	10	Yolamu Willie (2)	1	Yes	1	Yes	Late	No
Magomero	Dambo	10		2	No	0	Yes	Early	No
Magomero	Dambo	10		3	No	1	Yes	Early	Tephrosia
Magomero	Dambo	10		4	Yes	0	Yes	Late	Tephrosia
Magomero	Dambo	11	Mai Makoto	1	No	0	Yes	Early	No
Magomero	Dambo	11		2	Yes	0	Yes	Late	Crotalaria
Magomero	Dambo	11		3	Yes	1	Yes	Late	No
Magomero	Dambo	11		4	No	1	Yes	Early	Crotalaria
Magomero	Dambo	12	Mai Kwikanda	1	No	1	Yes	Early	Crotalaria
Magomero	Dambo	12		2	Yes	1	Yes	Late	No
Magomero	Dambo	12		3	No	0	Yes	Early	No
Magomero	Dambo	12		4	Yes	0	Yes	Late	Crotalaria
Magomero	Dambo	13	Mai Zaburoni	1	No	1	Yes	Early	No
Magomero	Dambo	13		2	No	0	Yes	Early	Tephrosia
Magomero	Dambo	13		3	Yes	0	Yes	Late	Tephrosia
Magomero	Dambo	13		4	Yes	1	Yes	Late	No

Table 5. FSIPM PROJECT FERTILIZER & GREEN MANURE TRIAL 1998/99. TREATMENT STRUCTURE (Contd).

Village	Zone	Farmer No	Name	Plot No.	Fertilizer (1997/98)	Farmer weeded = 0, researcher weeded =1 (1997/98)	Fertilizer (1998/99)	Fertilizer timing (1998/99)	Green manure (1998/99)
Magomero	Dambo	14	Bambo Mondiwa	1	Yes	0	Yes	Late	Crotalaria
Magomero	Dambo	14		2	No	0	Yes	Early	Crotalaria
Magomero	Dambo	14		3	Yes	1	Yes	Late	No
Magomero	Dambo	14		4	No	1	Yes	Early	No
Magomero	Dambo	15	Mai Tobias	1	Yes	1	Yes	Late	Crotalaria
Magomero	Dambo	15		2	Yes	0	Yes	Late	No
Magomero	Dambo	15		3	No	0	Yes	Early	Crotalaria
Magomero	Dambo	15		4	No	1	Yes	Early	No
Magomero	Dambo	16	Mai Sukali	1	Yes	0	Yes	Late	Tephrosia
Magomero	Dambo	16		2	Yes	1	Yes	Late	No
Magomero	Dambo	16		3	No	1	Yes	Early	Tephrosia
Magomero	Dambo	16		4	No	0	Yes	Early	No
Magomero	Dambo	17	Mai Mukhumba	1	Yes	1	Yes	Late	No
Magomero	Dambo	17		2	Yes	0	Yes	Late	Crotalaria
Magomero	Dambo	17		3	No	1	Yes	Early	No
Magomero	Dambo	17		4	No	0	Yes	Early	Crotalaria
Kambuwa	Upland	18	Bambo Sapali	1	Yes	1	Yes	Late	No
Kambuwa	Upland	18		2	No	1	Yes	Early	No
Kambuwa	Upland	18		3	No	0	Yes	Early	Tephrosia
Kambuwa	Upland	18		4	Yes	0	Yes	Late	Tephrosia
Kambuwa	Upland	19	Mai Tholo	1	No	0	Yes	Early	No
Kambuwa	Upland	19		2	No	1	Yes	Early	Tephrosia
Kambuwa	Upland	19		3	Yes	1	Yes	Late	Tephrosia
Kambuwa	Upland	19		4	Yes	0	Yes	Late	No
Kambuwa	Upland	20	Mai Kalibeti	1	Yes	1	Yes	Late	Tephrosia
Kambuwa	Upland	20		2	Yes	0	Yes	Late	No
Kambuwa	Upland	20		3	No	1	Yes	Early	Tephrosia
Kambuwa	Upland	20		4	No	0	Yes	Early	No
Kambuwa	Dambo	21	Mai Nambewe	1	Yes	0	Yes	Late	Crotalaria
Kambuwa	Dambo	21		2	Yes	1	Yes	Late	No
Kambuwa	Dambo	21		3	No	1	Yes	Early	Crotalaria
Kambuwa	Dambo	21		4	No	0	Yes	Early	No
Kambuwa	Dambo	22	Monica Mkweza	1	Yes	0	Yes	Late	Tephrosia
Kambuwa	Dambo	22		2	No	0	Yes	Early	No
Kambuwa	Dambo	22		3	No	1	Yes	Early	Tephrosia
Kambuwa	Dambo	22		4	Yes	1	Yes	Late	No

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Monitoring visits: These will follow the usual pattern for a researcher-managed trial but data will only be collected for maize and the green-manure crops.

At crop emergence at 2 weeks after planting:

1. Emergence count.
2. "Early fertiliser" application, with farmer.
3. Farmer comments on emergence and what s/he hopes to learn from the plots.

At 4 weeks after emergence:

1. "Late fertiliser" application with farmer.
2. Plant *Crotalaria* with farmer, following first weeding.

At 12-14 weeks after emergence - *Group discussion*:

1. Discuss the general growth pattern and possible effect of *Crotalaria* and *Tephrosia* on maize yield.
2. Discuss *Crotalaria* incorporation: pros and cons of timing of operation with *mbwera* or *kuwojeka*.
3. Discuss the timing of fertilizer application with farmers in relation to green manure technology.

At 16-20 weeks, maize harvest:

1. Farmer to assess and score maize yields (1-5) for each of four plots and to comment on maize growth. Probe for any perceived differences due to fertiiser timing or competition from green-manures.
2. Harvest and weigh yield with farmer (separating them into usable and unusable grains).
3. Weigh *Crotalaria* biomass and incorporate?.

During September, following pigeon pea harvest:

1. Weigh *Tephrosia* biomass and undertake final ridging.
2. Discuss strengths and weakness of *Tephrosia* with each farmer.

Evaluation: Group meeting after maize harvest, when project has collated maize yield results. Discussion of results, strengths and weakness of each time of fertiliser application and of each of the two green manures. Project to contribute data from other trials where maize will have been grown following incorporation of either *Tephrosia* or *Crotalaria*. Assist farmers to plan for the coming season.

Data collection

A. Maize
  1. Stand count at emergence and at harvest.
  2. Plant height of the 5 random plants within a net plot.
  3. No. of cobs.
  4. Weight of the usable grain.
  5. Weight of unusable grain.
  6. Total grain weight.

B. *Crotalaria*
  1. Plant stand score at 12-14 weeks after emergence.
  2. Plant stand counts at 'harvest' time per gross ridge length.
  3. Plant weights at 'harvest' time per gross ridge length.

C. *Tephrosia*
  1. Plant stand score at 12-14 weeks after emergence.
  2. Plant stand counts at 'harvest' time per gross ridge length.
  3. Plant weights at 'harvest' time per gross ridge length.

Please note that incorporation will be based on spreading evenly the biomass available within each ridge for practical convenience.

FSIPM PIGEONPEA TRIAL 1998/99, MANGUNDA SECTION, MATAPWATA EPA

Background

During the 1997/98 season, seven pigeonpea varieties were investigated in the fields of five farmers (who also hosted the sweet potato experiment). The farmers invited to take part in this trial included a group of four farmers from Pindani village and a single larger-scale farmer from Chimwanga village of Mangunda section in Matapwata EPA. All farmers were originally visited in August 1997 (Mkandawire et al., 1997) with a view to questioning them about sweet potato weevil problems. They grow crops (especially sweet potato) for sale and employ labourers. The work was a follow-up to on-station variety trials at Thuchila Research station. Mangunda is closer to Bvumbwe and to the other project sites in Matapwata than Thuchila. The advantages of conducting the trial on farm include the reduction of security and labour problems experienced at Thuchila and the involvement of highly-motivated farmers in evaluating varieties.

The varieties chosen for the trial included those being used in the main intercropping IPM on-farm trials (ICP 9145, Matapwata local, ICEAP 00040 and ICEAP 00053) plus two medium duration varieties previously included in a varietal trial at Thuchila in 1996/97 season (Royes and QP 38). The two ICEAP varieties (00040 and 00053) are wilt-resistant land-races from Kenya supplied by ICRISAT for testing on farm. A further variety, ICEAP 00020, supplied by ICRISAT, has large white seeds and is high yielding but is not specifically wilt-resistant. The pigeonpeas were supposed to be interplanted in previously planted maize fields at emergence or else planted at the same time as the maize. However, the pigeonpeas ended up being either a sole crop or intercropped with maize. In one intercropped field the pigeonpea was planted at maize emergence and was lost due to strong competition from the maize.

Results Of 1997/98 Trial

The varieties were evaluated by farmers at harvest and scored individually for a range of desirable characteristics selected by farmers. Overall there was a clear preference for ICEAP 00020, followed by ICEAP 00053, then ICEAP 00040. ICP 9145 was the next variety followed by Royes. Only QP 38 was scored lower than the local variety. When agreeing to continue the trial in 1998/99, farmers decided to drop the local variety because they are already familiar with it and performance was judged relatively poor. QP38 was dropped because it flowers early and was therefore exposed to high pest attack. Royes was left out because it was believed to be small-seeded, low-yielding and not marketable. Farmers agreed to continue with the trial with the following varieties: ICEAP 00020, ICEAP 00040, ICEAP 00053 and ICP 9145, which functions as the local check or control in the experiment, since farmers are familiar with its performance and already use it.

Farmers originally indicated that the trial should be tested in a sole-cropping system because one of the farmers had lost a superimposed pigeonpea crop in a maize field. However, farmers later changed their minds and opted to grow pigeonpea intercropped with maize due to shortage of land. To have a fair comparison between 1997/98 season (which had a majority of plots as sole crop pigeonpea) and 1998/99 season, farmers and researchers agreed to have sole and intercropped plots side by side.

An agreement was also reached that the same farmers should grow 3 varieties of medium maturity pigeonpea (ICEAP 00068, ICEAP 00073 and ICP 6927) kindly provided by the ICRISAT Programme in Nairobi, Kenya, plus one reputed local medium maturity variety (known as Chilinga). These varieties will be grown in intercropping system with a single plot for each variety per farm. The treatment structure is shown in Table 1. below.

Objectives

a) To compare levels of resistance/tolerance to *Fusarium* wilt in 8 pigeonpea varieties in farmers' fields under farmer management.

b) To assess the susceptibility of the medium and long-term varieties to pests and other diseases under farmer management.

c) To obtain farmers' assessment of the suitability of four medium and four long-duration varieties in terms of yield and other qualities considered by farmers to be important.

d) To enable farmers to assess the influence of intercropping and sole cropping on growth and yield in 4 long duration varieties.

Field Layout

1	2	3
Intercrop (long duration)	Sole crop (long duration)	Intercrop (medium duration)
Intercrop (long duration)	Sole crop (long duration)	Intercrop (medium duration)
Intercrop (long duration)	Sole crop (long duration)	Intercrop (medium duration)
Intercrop (long duration)	Sole crop (long duration)	Intercrop (medium duration)

Experimental Design

Randomised complete block design with five farmers as the blocks and three main plots per farm assigned three main treatments: i.e. 1. intercropped. long duration: 2. sole cropped. long duration: 3. intercropped. medium duration. Each main plot was split into four sub-plots to include four varieties of pigeonpea. The four sub-treatments (varieties) are randomly assigned to sub-plots within each of the three main plots (Table 1). With this arrangement. comparisons can be made between the groups of four intercropped medium and four long duration varieties (main plots 1 and 3) for their effect on the maize crop. and between the same four varieties which are sole-cropped or intercropped on each farm (main plots 1 and 2). provided that it can be assumed that conditions do not differ significantly between each of the three main plots (1-3). The planting areas have been selected to minimise inter-plot environmental differences. The third main plot departs from the standard form of a split-plot design since it contains four different medium-duration varieties not represented in the other two main plots. All eight individual pigeonpea varieties can be compared as treatments for yield across all farms. if it is assumed that there is no Variety x Farm interaction.

Responses

Researchers will carry out initial stand counts after germination and establish causes of death. The plots will be visited initially every two weeks to assess wilt and other pest damage. Once plants are well established assessment will be scaled down with a disease assessment during the late vegetative stage and again at flowering and at podding. Assessment of flower and pod pests will be carried out at the appropriate times. Overall percentages of wilt and other pest damage will be calculated. Yield and other agronomic factors will be recorded.

1. Stand count: 2 and 4 weeks after planting and at harvest:
2. Plant height (at harvest):
3. Wilting percentage (fortnightly and at harvest):
4. Date of 50% flowering (days to maturity extrapolated):
5. Nematode index (based on 10 random plants at harvest):
6. Seed size (weight of 100 seeds):
7. Seeds per pod (based on 20 random pods):
8. Seed yield

Management

All the intercropped plots will be planted to MH 18 and 50 kg N/ha applied at 4 weeks after planting. Maize stations will be spaced at 90 cm apart and pigeonpea will be planted between two maize station. Both maize and pigeonpea will be planted at 3 (three) seeds per station. No thinning is required and supplying will only be required if there is complete absence of a seedling on a planting station.

Monitoring

The major aspects of the visits will be to give farmers adequate opportunity to assess how the pigeonpea varieties under investigation fit into their cropping systems and their food/market requirements.

At emergence time: approximately 2-3 weeke after planting **with farmers.**

1. Stand count at emergence
2. Farmers' comments on emergence and their expectations on new learning

At 4 weeks after planting

1. Apply fertilizer together with farmers where possible.
2. Make observations on weeding i.e. whether done or not but make no statement on weeding.

At 18-20 weeks (maize harvest) **with farmers.**

1. Visual assessment of pigeonpeas growth pattern (erect or spreading and/or branching)
2. Score the eight maize intercrop plots for maize yield on a 1-5 scale where 1 = poor yield and 5 = very good yield. with maize standing. to assess pigeonpea competition with maize.
3. Probe for any perceived differences pertaining to the two assessments above.
4. Score pigeonpea development on 1-5 scale on all plots to assess competition from maize.
5. Ask farmer about differences between them if any.
6. Harvest maize. compare heaps. and weigh with the farmer.

At 24-28 weeks **with farmers** (at 50% flowering and early podding of medium-duration varieties)

1. Farmers' assessment of yield potential of the medium-duration varieties and perceived differences.
2. Farmers' assessment of flower and pod pests and diseases of the varieties and perceived differences.

At 28-30 weeks **with farmers** (at 50% flowering and early podding of long-duration varieties)

1. Farmers' assessment of yield potential of the long-duration varieties and perceived differences.
2. Farmers' assessment of flower and pod pests and diseases of the varieties and perceived differences.

At 30-34 weeks **with farmers** (first pigeonpea harvests)

1. Farmers to assess and score the pigeonpea 1(very poor yield) to 5 (very good yield)
2. Pests and disease assessment by the farmers.

After pigeonpea harvest (Individual and group evaluation) **with all the farmers.**

As done during August. 1998 session with the same farmers.

Table 6. FSIPM PROJECT PIGEONPEA VARIETY TRIAL 1998/99: THYOLO NORTH RDP, MANGUNDA SECTION. TREATMENT STRUCTURE AND PARTICIPATING FARMERS

Farmer No.	Name	Block No.	Variety No.	Plot No.	Duration of crop	Intercrop or sole crop?	Pigeonpea Variety	Fertilizer ?
1	Bambo Makwiti	1	4	1	Long	Intercrop	ICP 9145	1
1	Bambo Makwiti	1	3	2	Long	Intercrop	ICEAP 00053	1
1	Bambo Makwiti	1	2	3	Long	Intercrop	ICEAP 00040	1
1	Bambo Makwiti	1	1	4	Long	Intercrop	ICEAP 00020	1
1	Bambo Makwiti	2	1	1	Long	Sole crop	ICEAP 00020	0
1	Bambo Makwiti	2	4	2	Long	Sole crop	ICP 9145	0
1	Bambo Makwiti	2	3	3	Long	Sole crop	ICEAP 00053	0
1	Bambo Makwiti	2	2	4	Long	Sole crop	ICEAP 00040	0
1	Bambo Makwiti	3	4	1	Medium	Intercrop	ICP 6927	1
1	Bambo Makwiti	3	1	2	Medium	Intercrop	CHILINGA	1
1	Bambo Makwiti	3	3	3	Medium	Intercrop	ICEAP 00073	1
1	Bambo Makwiti	3	2	4	Medium	Intercrop	ICEAP 00068	1
2	Mai Chisanga	1	3	1	Long	Intercrop	ICEAP 00053	1
2	Mai Chisanga	1	2	2	Long	Intercrop	ICEAP 00040	1
2	Mai Chisanga	1	1	3	Long	Intercrop	ICEAP 00020	1
2	Mai Chisanga	1	4	4	Long	Intercrop	ICP 9145	1
2	Mai Chisanga	2	4	1	Long	Sole crop	ICP 9145	0
2	Mai Chisanga	2	3	2	Long	Sole crop	ICEAP 00053	0
2	Mai Chisanga	2	1	3	Long	Sole crop	ICEAP 00020	0
2	Mai Chisanga	2	2	4	Long	Sole crop	ICEAP 00040	0
2	Mai Chisanga	3	1	1	Medium	Intercrop	CHILINGA	1
2	Mai Chisanga	3	2	2	Medium	Intercrop	ICEAP 00068	1
2	Mai Chisanga	3	3	3	Medium	Intercrop	ICEAP 00073	1
2	Mai Chisanga	3	4	4	Medium	Intercrop	ICP 6927	1
3	Bambo Mangani	1	2	1	Long	Intercrop	ICEAP 00040	1
3	Bambo Mangani	1	4	2	Long	Intercrop	ICP 9145	1
3	Bambo Mangani	1	3	3	Long	Intercrop	ICEAP 00053	1
3	Bambo Mangani	1	1	4	Long	Intercrop	ICEAP 00020	1
3	Bambo Mangani	2	3	1	Long	Sole crop	ICEAP 00053	0
3	Bambo Mangani	2	2	2	Long	Sole crop	ICEAP 00040	0
3	Bambo Mangani	2	1	3	Long	Sole crop	ICEAP 00020	0
3	Bambo Mangani	2	4	4	Long	Sole crop	ICP 9145	0
3	Bambo Mangani	3	2	1	Medium	Intercrop	ICEAP 00068	1
3	Bambo Mangani	3	1	2	Medium	Intercrop	CHILINGA	1
3	Bambo Mangani	3	3	3	Medium	Intercrop	ICEAP 00073	1
3	Bambo Mangani	3	4	4	Medium	Intercrop	ICP 6927	1
4	Bambo Mankhanamba	1	2	1	Long	Intercrop	ICEAP 00040	1
4	Bambo Mankhanamba	1	3	2	Long	Intercrop	ICEAP 00053	1
4	Bambo Mankhanamba	1	1	3	Long	Intercrop	ICEAP 00020	1
4	Bambo Mankhanamba	1	4	4	Long	Intercrop	ICP 9145	1
4	Bambo Mankhanamba	2	1	1	Long	Sole crop	ICEAP 00020	0
4	Bambo Mankhanamba	2	2	2	Long	Sole crop	ICEAP 00040	0
4	Bambo Mankhanamba	2	3	3	Long	Sole crop	ICEAP 00053	0
4	Bambo Mankhanamba	2	4	4	Long	Sole crop	ICP 9145	0
4	Bambo Mankhanamba	3	4	1	Medium	Intercrop	ICP 6927	1
4	Bambo Mankhanamba	3	1	2	Medium	Intercrop	CHILINGA	1
4	Bambo Mankhanamba	3	3	3	Medium	Intercrop	ICEAP 00073	1
4	Bambo Mankhanamba	3	2	4	Medium	Intercrop	ICEAP 00068	1
5	Bambo Phambala	1	2	1	Long	Intercrop	ICEAP 00040	1
5	Bambo Phambala	1	1	2	Long	Intercrop	ICEAP 00020	1
5	Bambo Phambala	1	3	3	Long	Intercrop	ICEAP 00053	1
5	Bambo Phambala	1	4	4	Long	Intercrop	ICP 9145	1
5	Bambo Phambala	2	3	1	Long	Sole crop	ICEAP 00053	0
5	Bambo Phambala	2	2	2	Long	Sole crop	ICEAP 00040	0
5	Bambo Phambala	2	4	3	Long	Sole crop	ICP 9145	0
5	Bambo Phambala	2	1	4	Long	Sole crop	ICEAP 00020	0
5	Bambo Phambala	3	4	1	Medium	Intercrop	ICP 6927	1
5	Bambo Phambala	3	3	2	Medium	Intercrop	ICEAP 00073	1
5	Bambo Phambala	3	1	3	Medium	Intercrop	CHILINGA	1
5	Bambo Phambala	3	2	4	Medium	Intercrop	ICEAP 00068	1

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

ON-FARM TRIALS OF SOIL CRACK-SEALING AGAINST SWEET POTATO WEEVIL 1999 SEASON

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT: SWEET POTATO CRACK-SEALING TRIAL 1999

INTRODUCTION

In the 1991 92 season the Soil Pests Project of Chancellor College conducted a random survey on sweet potato weevil *Cylas puncticollis* in Mangunda section of Matapwata EPA. The aim of the survey was to determine the impact of tuber damage and evaluate economic losses due to damage caused by *Cylas puncticollis*. The survey fund that the pest was present at a high level, causing significant losses to yield. Sealing of soil cracks is known to prevent Cylas adults from reaching developing sweet potato tubers below ground (Pardales & Cerna, 1987). The method was tested sucessfully in Katuli EPA, Mangochi in 1993-95 by the Chancellor College NRI Soil Pest Project but no detailed report of their results has been produced. Farmers later abandoned the technique due to low pest levels and labour constraints, though one farmer suggested that the method was actually harmful to developing tubers (Jere et al., 1997).

Previous trials of crack-sealing

In the 1996 97 season the Farming Systems IPM Project conducted a sweet potato crack sealing trial at Bvumbwe Research Farm. The aim of the trial was to test the efficacy of sealing cracks of different sweet potato varieties to *Cylas* attack and varietal resistance. However, data collected from the trial showed that there was no significant tuber damage caused by the sweet potato weevil. This indicated that at Bvumbwe the populations of *Cylas puncticollis* were too low to cause any economic damage. Consequently, a new site which had the pest problem had to be chosen. A team of FSIPM staff visited Mangunda in August 1997 (Mkandawire et al., 1997) to interview farmers and survey damage in fields. The survey again found high weevil population levels and farmer perceptions of damage. Preliminary Pheromone trap survey indicated that there was high population of sweet potato weevils in the area.

Five farmers who grow sweetpotato commercially were interested in trying crack-sealing and screening varieties for tolerance or resistance to the pest. Mangunda Section was therefore chosen for a repeat of the abortive 1997 trial. The trial had two objectives:

1. To test the efficacy of sealing cracks of different sweet potato varieties to *Cylas* attack.
2. To test the resistance or tolerance of different sweet potato varieties to *Cylas* damage.

The trial was conducted at Mangunda Section in Matapwata Extension Planning Area in the 1997 98 season. Six sweet potato varieties were evaluated. Twelve plots were marked out per farmer and each plot had six ridges at the spacing of 90 cm . Each plot was divided into two sub-plots of 5.4 M each. Spacing between planting stations was 30 cm and vine length 30 cm. Sealing cracks was done weekly starting from one month after planting and thereafter for 8-12 weeks. Each farmer was responsible for crack sealing. In each plot one half was sealed and the other half left unsealed. At harvest the net plot of four (4) ridges per sub-plot were assessed per variety. All the tubers from each net sub-plot were sorted into damaged and undamaged categories and weighed. Ten damaged tubers were chosen at random and dissected and weevils found counted. All clean tubers and those of the damaged tubers that were not dissected became the property of each farmer.

Preliminary results of the trial were reported by Ritchie et al. (1998) and a fuller report of the trial is in preparation (Chanika et al. in prep.). A farmer evaluation with economic analysis was carried out by Orr et al. (1998). The conclusion reached was that crack-sealing on up to eight occasions was excessively laborious and counterproductive owing to an adverse effect on yield despite a slight reduction in weevil infestation.

PROPOSALS FOR THE 1999 SEASON

Mangunda farmers (planting 1st February)

The 1998 crack-sealing trial was reviewed with farmers at a meeting in Mangunda on 24 August 1998 with participating farmers (see Report by Sutherland 1998: 30-34). The conclusions were that the crack-sealing had reduced weevil infestation but reduced overall weight of tubers. It was agreed to repeat the experiment with only one variety (Kenya) and to use no more than three crack-sealing occasions per plot, which were drawn on a time-line by farmers (treatments A, C, D, E in table below).

Farmers suggested that a single crack-sealing occasion (treatment C) should be timed to coincide with the second sealing of the two treatments with two or more sealings. However subsequently researchers have noted that this arrangement is different from that used in both the Chiradzulu trials where the first and only sealing takes place on the same date as the first sealing of the treatments with two or three sealing occasions. To check whether this change affects sealing effectiveness, an additional treatment has been inserted into the experiment (treatent B) with a single sealing occasion on the same date as the first sealing of the two multiple sealing treatments (D and E, see table below).

At the 24 August meeting farmers agreed a planting date of 1st March, but this was changed by agreement at a meeting on 11 September (see Mwale, 1998: 6) to 1st February, since there was a real danger of reduced yield with late planting, if the rains should terminate early.

In Mangunda farmers normally weed at 3 weeks after planting and bank (*kukwezera*) once at 7 weeks after planting. Treatments were therefore agreed as follows:

Treatment ref. no.	Treatment description	Date of first sealing	Date of second sealing	Date of third sealing
A (Control)	Farmer Practice (weeding 3 weeks after planting and banking 7 weeks after planting)	N A	N A	N A
B	Farmer practice plus 1 early sealing	10 wks after planting	N A	N A
C	Farmer practice plus 1 later sealing	N A	13 wks after planting	N A
D	Farmer practice plus 2 sealings	10 wks after planting	13 wks after planting	N A
E	Farmer practice plus 3 sealings	10 wks after planting	13 wks after planting	15 wks after planting

Background to inclusion of Chiradzulu sweet potato farmers.

A PRA exercise was carried out in Chiwinja village in July 1997, which estimated that 80% of villagers were growing sweet potato and that it was regarded as the most important source of income after field peas and the fourth most important crop for food after maize, beans and pigeonpeas (Jere et al., 1997). Weevil damage was regarded as an important constraint on yield, though shortage of planting materials, poor soils and lack of markets were seen as even more important problems.

A survey of weevil damage and yield loss in the fields of 20 farmers in Chiwinja and Lidala villages was carried out in May and June 1998 (Chanika. Maulana and Ritchie. in prep.). This demonstrated losses of between 35 and 45% of yield due to damage by *Cylas*. with the highest losses occurring in the dambo fields where yields are also lower. though not significantly so when assessed by ANOVA.

At the project planning meeting on 5 October 1998. a final decision was taken to initiate an additional trial of crack-sealing in Chiradzulu with 12 farmers to be evenly split between upland and dambo fields.

In Chiradzulu. the preferred timing for crack-sealing and the number of occasions on which the treatment would be applied was decided by farmers in conjunction with researchers at a planning meeting in Chiwinja village on 20 October 1998. with 12 farmers (6 with upland and 6 with dambo fields) who were interested in participating (see Report by Mwale et al.. 1998). It emerged that farmers normally weed once only and do not bank. Here farmers expect peak tuber damage by *Cylas* in late March. on the second crop of vines planted in January (Mwale. pers. comm.). The third crop planted in February is a dambo crop which is at risk of reduced yield from drought if the rains end early.

Treatments were discussed and agreed as follows:

Chiradzulu upland farmers (planting end of January)

Treatment ref. no.	Treatment description	Date of first sealing	Date of second sealing	Date of third sealing
0 (Control)	Farmer Practice (weeding 3 weeks after planting)	N A	N A	N A
1	Farmer practice plus 1 sealing	5 wks after planting	N A	N A
2	Farmer practice plus 2 sealings	5 wks after planting	7 wks after planting	N A
3	Farmer practice plus 3 sealings	5 wks after planting	7 wks after planting	9 wks after planting

Chiradzulu dambo Farmers (planting end of February)

Treatment ref. no.	Treatment description	Date of first sealing	Date of second sealing	Date of third sealing
0 (Control)	Farmer Practice (weeding 3 weeks after planting)	N A	N A	N A
1	Farmer practice plus 1 crack-sealing	6 wks after planting	N A	N A
2	Farmer practice plus 2 crack-sealings	6 wks after planting	8 wks after planting	N A
3	Farmer practice plus 3 crack-sealings	6 wks after planting	8 wks after planting	10 wks after planting

It is evident that farmers in Mangunda opted for the three sealing occasions to be spread over a longer period than the Chiradzulu farmers, beginning 3 weeks after banking (10 wks after planting) and ending 15 weeks after planting. In Chiradzulu the additional crack-sealing occasions are spread at short but equal intervals beginning only 3 weeks after the only farmer weeding and ending at 9 or 10 weeks after planting in upland and dambo fields respectively. This will leave a much longer period from the last crack-sealing until harvest in which damage by weevils may increase due to development of cracks. The logic of this is that since Chiradzulu farmers do not bank, they need to begin protecting the tubers by crack-sealing much earlier than Mangunda farmers. Chiradzulu farmers also opted to displace the only crack-sealing occasion in the "farmer practice – 1 crack-sealing" treatment to occur at the same time as the second sealing under the other two treatments. This ensures that the time available for cracks to develop is more evenly split before and after crack-sealing. However it is a radical departure from the pattern adopted by farmers in Chiradzulu.

TRIAL DESIGN

The three experimental groups will form separate trials in Chiradzulu upland, Chiradzuluu dambo and Mangunda. Each of the Chiradzulu trials will have six farmers, each with three experimental treatments (plus the local farmers' practice as control) replicated on eight plots, each farmer constituting a complete block with two replicates of the treatments completely randomised.

At Mangunda there will be five farmers as last year, each with 8 plots. Since the Mangunda experiment now has five treatments (A-E, above), including the control (farmer practice), the treatments have been unequally replicated and are arranged as a completely randomised incomplete block design (see Annex 1).

DATA RECORDING

Data recording from the experiments in Mangunda and in Chiradzulu will be identical to that carried out in 1998 (with the addition of item 10). Soil samples will be taken from the top 15 cms of each farmer's field to determine pH, texture, % C and % N. Performance or non-performance of crack-sealing by the farmer will be checked and recorded against the schedule in Annex 1.

For each plot the following data will be collected at harvest:

1. Nett plot stand count:
2. Number of clean tubers:
3. Total weight of clean tubers:
4. Number of damaged tubers:
5. Total weight of damaged tubers:
6. Damage scored (1-5) on the upper and lower half of each of 20 randomly selected damaged tubers:
7. The number of all stages of the weevil found by dissection in each of ten randomly selected tubers from the previous twenty:
8. The percentage ground cover of sweet potato plants within the plots estimated visually before harvest:
9. Presence or absence of internal and external crown damage to five randomly selected plants.
10. Plot scores for soil cracking at harvest (1-5 scale)

Apart from the need to monitor and record the dates on which weeding, banking, and crack-sealing actually occur, all other data gathering takes place at or just before harvest. The data recording forms are all contained in a single Excel spreadsheet workbook SWP993.XLS and copies of blank forms are appended to this report.

SAMPLING PROGRAMME TO MONITOR WEEVIL POPULATIONS

Methodology

The population pressure of adult weevils (*Cylas puncticollis*) available to attack tubers will be assessed using pheromone traps of a constant design in both Mangunda and in Chiradzulu. The sampling survey began in Mangunda Section in Matapwata Extension Planning Area in the 1997/98 season. There are ten pheromone traps placed throughout five villages of the section. In January 1999 ten further traps will be set up in Chiradzulu EPA in Lidala and Chiwinja villages, five each in the dambo and upland fields, to monitor weevil populations in the areas where trials of crack-sealing are to take place.

Trap design

This design is taken from that described by Smit (1997) which uses a standard 5 - litre plastic jerry can. In Ugandan trials this design was found to provide the best combination of easy construction, robustness and catching effectiveness. The can has four rectangular holes (11x5 and 6x5 cms) cut in the four sides of the upper half of the can (see Fig. 1). The lure hangs from a paperclip fixed through the lid of the can. The can is attached to a post with the lure approximately 0.5 metres above ground. This has been found to be the optimum height for catching flying weevils. At the base of the container 0.5 litres of water is poured, containing about 0.5 grammes of Surf soap powder (well mixed).

Lures

Lures consist of pheromone dispensers in the form of polyethylene vials (23 mm x 9 mm x 1.5 mm) which have been impregnated with 0.1 mg of decyl (*E*) - 2 - butenoate, the female sex pheromone of *Cylas puncticollis*. Research in Uganda has shown that lures may be exposed in the field for at least one month without significant decline in catching efficiency (Smit, 1997; Downham, personal communication). The assistance of colleagues in the pheromone chemistry group at Natural Resources Institute in making up batches of lures is gratefully acknowledged.

Trap placement

Traps should be placed in sweet potato fields around the area where the trials are being conducted but should under no circumstances be placed closer than 50 metres from an experimental plot, to avoid disruption of weevil attack on the crop. Traps should also be placed in situations where they are least likely to be disturbed by children or stolen. This is very important as the time series of the data from each trap is being used to estimate changes in population abundance and missing data will reduce the sensitivity of this estimation.

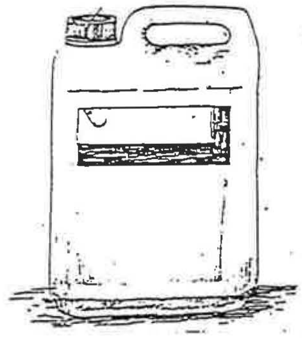

Figure 1. 5 - litre plastic jerry can trap (Smit, 1997).

Data collection

Traps will be monitored weekly. The sweet potato weevils will be collected, counted and preserved and the detergent mixture replaced with fresh solution. The pheromone lures will be replaced at monthly intervals.

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ANNEX 1. FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT
MANGUNDA SWEET POTATO CRACK-SEALING TRIAL 1999
TREATMENT STRUCTURE AND CALENDAR OF TREATMENTS

Farmer No.	Name	Plot No.	Treatment Letter	Treatment description	Median planting date	Agreed Date of 1st crack-sealing (70 days post-planting)	Agreed Date of 2nd crack-sealing (91 days post-planting)	Agreed Date of 3rd crack-sealing (105 days post-planting)
1	Bambo Makwiti	1	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
1	Bambo Makwiti	2	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
1	Bambo Makwiti	3	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
1	Bambo Makwiti	4	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
1	Bambo Makwiti	5	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99
1	Bambo Makwiti	6	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
1	Bambo Makwiti	7	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
1	Bambo Makwiti	8	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
2	Mai Chisanga	1	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
2	Mai Chisanga	2	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
2	Mai Chisanga	3	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
2	Mai Chisanga	4	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	18-May-99
2	Mai Chisanga	5	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99
2	Mai Chisanga	6	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
2	Mai Chisanga	7	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
2	Mai Chisanga	8	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99
3	Bambo Mangani	1	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
3	Bambo Mangani	2	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
3	Bambo Mangani	3	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99
3	Bambo Mangani	4	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
3	Bambo Mangani	5	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
3	Bambo Mangani	6	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
3	Bambo Mangani	7	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
3	Bambo Mangani	8	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
4	Bambo Mankhanamba	1	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
4	Bambo Mankhanamba	2	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
4	Bambo Mankhanamba	3	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
4	Bambo Mankhanamba	4	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99
4	Bambo Mankhanamba	5	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
4	Bambo Mankhanamba	6	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
4	Bambo Mankhanamba	7	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
4	Bambo Mankhanamba	8	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
5	Bambo Phambala	1	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
5	Bambo Phambala	2	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
5	Bambo Phambala	3	B	FP + 1 early sealing	02-Feb-99	13-Apr-99	N/A	N/A
5	Bambo Phambala	4	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99
5	Bambo Phambala	5	D	FP + 2 sealings	02-Feb-99	13-Apr-99	04-May-99	N/A
5	Bambo Phambala	6	A	Farmer practice (FP)	02-Feb-99	N/A	N/A	N/A
5	Bambo Phambala	7	C	FP + 1 later sealing	02-Feb-99	N/A	04-May-99	N/A
5	Bambo Phambala	8	E	FP + 3 sealings	02-Feb-99	13-Apr-99	04-May-99	18-May-99

A Farmer practice (FP)
B FP + 1 early sealing
C FP + 1 later sealing
D FP + 2 sealings
E FP + 3 sealings

SUN HEMP (*CROTALARIA JUNCEA*) OBSERVATION PLOTS IN MOMBEZI EXTENSION PLANNING AREA, 1998.

C.S.M. Chanika

Background

One of the factors identified as limiting crop production, particularly maize, is the low soil fertility in the area where the FSIPM Project is operating (Orr, A. et.al., 1996; 1997). The declining soil fertility is of major concern since crop protection aspects are of secondary importance. Thus, the farmer will protect what is already produced or what is seen to be potentially possible to produce. During a consultation meeting with some members of the Southern Africa Soil Fertility Network, *Crotalaria juncea* was identified as a possible legume to be included in the soil enhancement activity (Ritchie, M., A. Orr and P.Jere, 1997). However, *Crotalaria* was not included in the trial work for the 1997/98 activities but was planted in farmers' fields as an observation to be incorporated into the soil at appropriate time and evaluated properly in the 1998/99 season.

Plot establishment

In December, 1997, five farmers' fields were chosen. The criteria used to choose the fields were:

- The field should belong to one of our collaborating farmers on the main trial.
- The maize crop is 3-4 weeks old (i.e. 3-4 weeks after emergence).
- The field has just been weeded within a few days before being chosen.

A plot of 6 ridges spaced at 90 cm apart and 5.4 m long, was marked and *Crotalaria* seed was drilled beside one side of the ridge at 1.8g per 5.4m ridge (0.72g /100 seed). The *Crotalaria* seed was placed in the drill and partially covered using the same stick used for drilling. Plants emerged within one week after planting. During second weeding (banking), the side where *Crotalaria* was drilled was handweeded but the other side was either banked or handweeded as well.

Progress

- One of our farmers buried the *Crotalaria* plants at the time of banking. The farmer admitted having misunderstood the instruction.
- *Crotalaria* grows very fast such that by the middle of March, 1998, the plants were big enough to be incorporated into the soil, though not with high dry matter available.
- *Crotalaria* plants were healthy and vigorous despite being grown in very poor soils (as shown by a poor crop of maize)
- In one field where a *Crotalaria* plant was uprooted and examined, good nodulation was noted.

Preliminary results

The *Crotalaria* plants were harvested in mid-May, 1998 and the wet dry matter was recorded which was later converted into dry matter per hectare after a subsample was dried in the oven. Then nitrogen content was determined from the subsample. The dry matter and nitrogen content data are shown in Table 1. From this data, we have seen that *Crotalaria* can produce more than 2000 kg of dry matter within a period of five months. The expected contribution of nitrogen from *Crotalaria* of more than 50 Kg N/ha within this short period is quite good. The low dry matter production at Chilewe's field was due to low emergence. This was the only dambo field.

Table 1: Dry matter production, nitrogen content and expected nitrogen contribution in the system

Farmer's name	DM, Kg/ha	% N	Expected Kg N/ha
Chilewe	1418.4	3.19	45.24
Sapuwa	2866.5	2.79	79.97
Magreen	2922.2	3.74	109.29
Nankhonya	2847.5	2.74	78.02

Follow-up work

We have agreed with the farmers to compare two adjacent plots, one where we have buried *Crotalaria* plants together with crop/weed residues and another where only crop/weed residues have been buried. This work will be done in the 1998/99 season. However, a more detailed experiment, other than an observation may be planned to address the use of *Crotalaria* in this farming system.

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June 1998.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

METHODS FOR ECONOMIC EVALUATION OF ON-FARM TRIALS 1996/97 SEASON

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LIMBE

1.0 INTRODUCTION

Following the recommendation of the FSIPM Project Output to Purpose Review (Hansell *et. al.*, 1996), this paper sets out how the FSIPM Project will include quantitative economic evaluation in its programme of On-Farm Trials (OFTs) in the 1996/97 crop year.

The FSIPM Project will conduct a total of 74 OFTs in Matapwata and Chiradzulu North (Mombesi) Extension Planning Areas (EPAs). Of these, 10 will test IPM interventions against *striga asiatica*, while 64 will test interventions against pests of maize, beans, and pigeonpea. Economic evaluation of these OFTs is necessary to determine the profitability of these IPM interventions. Primary responsibility for the evaluation rests with the two economists in the FSIPM team.

2.0 METHODS

The methodology for economic evaluation of OFTs is well-established (eg. CYMMT, 1988). Economic evaluation includes a wide range of analytical techniques, including: (1) partial budget analysis; (2) marginal analysis; and (3) sensitivity analysis. Of these, the most widely used is partial budget analysis. In essence, partial budget analysis is a balance-sheet which compares the costs and returns of the intervention with the farmers' existing practice. Data collection, therefore, focuses on the economic value of the *differences* with existing farmer practice due to the intervention. These differences may represent either savings or additional costs.

3.0 DATA REQUIREMENTS

An inventory of additional inputs required by the OFTs was obtained from the experimental design (FSIPM Project, 1996). These are summarised in Table 1. In total, there are eight major inputs/outputs on which information is required for economic evaluation. Yield data will be collected for technical evaluation of the OFTs, and not exclusively for economic evaluation.

Master tables for the economic evaluation of the three types of OFTs are presented in Tables 2, 3 and 4. Differences in variable costs between treatments for which data will be collected are marked with an 'X'.

4.0 INPUTS

This section describes the instruments which will be used for the collection of seed prices, labour inputs, and wages. Data collection for other variables in Table 1 is self-explanatory.

Seed prices. Data on seed prices is currently being collected from Bvumbwe and Mbulunbuzi markets on a weekly or twice-weekly basis. Price collection will start in mid-November. Output prices will be collected in March-April 1997 using the same methods and an appropriately modified format. The data collection sheet for prices is shown in Table 5.

Labour inputs. Measurement will be based on timing of field operations as observed on the OFT research plots. The following labour operations will be measured: (1) planting tephrosia; (2) planting maize; (3) planting soya; (4) dolloping fertiliser; (5) spreading fertiliser on ridge; (6) mulching and earthing-up beans; (7) kaselera ridging; (8) weeding and banking; (9) seed dressing for maize and beans; and (1) planting beans at high density. Since the plots are small (10 sq. m), the sample size should be not less than 10.

As far as possible, the analysis will use secondary data on labour requirements for field operations in Malawi (Farrington, 1975; Nothale, 1980; Werner, 1987). These norms may not provide sufficiently accurate data on labour requirements for weeding, however. The experimental design breaks weeding into: (1) first weeding; (2) second weeding with banking; (3) second weeding without banking. In addition, farmers with high levels of *striga* infestation may weed differently from others. It will be necessary, therefore, to time labour requirements for different weeding operations. To capture farmers' actual practices, these observations will be based on practices on the main garden, ie. excluding the farmer's OFT plot. Data will be collected using the sheet shown in Table 6.

Wages. Wage data is difficult to collect since hired labour is frequently paid by contract or by piece rates. The baseline survey will collect data on wage rates paid to hired labour for operations on specific gardens which can later be measured. The operations for which labour is most widely used are: (1) planting; (2) weeding; (3) harvesting. Wherever possible, data will be disaggregated by age and gender. Data will be collected using the sheet shown in Table 7.

25 November 1996

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TABLE 1. DATA REQUIREMENTS FOR ECONOMIC EVALUATION OF OFTs, 1996/97

No.	Input/Outputs	Item	Data requirement	Source
1	Fertiliser	23: 21: 0 +4S	price/kg	ADMARC baseline survey
2	Seed	Local maize MH18 maize Local pigeonpea ICP9145 Chimbana beans Kaulesi beans Soya Tephrosia Neem	price/kg	local markets " " Bunda College local markets Bunda College local markets Bvumbwe RS Shire Valley ADD
3	Insecticide	Sevin	price/packet	PTC
4	Equipment	Plastic bag Plastic glove	price/unit	PTC Polypack
5	Labour	seed dressing MH18 seed dressing beans planting soya planting tephrosia planting beans high/low density dolloping fertiliser spreading fertiliser mulching beans earthing-up beans modified kaselera weeding striga weeding without banking banking	hrs/ha	Field data from OFT research plots Field data from farmers' non-OFT plots
6	Wages	Planting Weeding Harvesting	price/hour	Baseline survey
7	Yields	Local maize MH18 maize Chimbamba beans Kaulesi beans Local pigeonpea ICP9145 Soya Tephrosia (?)	kg/ha	Field data from research and farmers OFT plots
8	Output prices	Local maize MH18 maize Chimbamba beans Kaulesi beans Local pigeonpea ICP9145 Soya Tephrosia (?)	price/kg	local markets ADMARC

TABLE 2. PARTIAL BUDGET FOR MAIN INTERCROP TRIAL. 1996/97.

('X' indicates costs that vary)

VARIABLES	TREATMENT								
	1	2	3	4	5	6	7	8	9
Average maize yield (kg/ha)									
Average beans yield (kg/ha)									
Average pigeonpea yield (kg/ha)									
Adjusted maize yield (kg/ha)									
Adjusted beans yield (kg/ha)									
Adjusted pigeonpea yield (kg/ha)									
Gross field benefits									
Maize (Mk/ha)									
Beans (Mk/ha)									
Pigeonpea (Mk/ha)									
Cost of Sevin insecticide for maize (Mk/ha)		X	X	X	X	X	X	X	X
Cost of Sevin insecticide for beans (Mk/ha)						X	X	X	X
Cost of MH18 maize seed (Mk/ha)		X	X	X	X	X	X	X	X
Cost of ICP9145 seed (Mk/ha)		X	X	X	X	X	X	X	X
Cost of Kaulesi bean seed (Mk/ha)					X	X	X	X	X
Cost of labour for maize seed dressing (Mk/ha)		X	X	X	X	X	X	X	X
Cost of labour for bean seed dressing (Mk/ha)						X	X	X	X
Cost of labour for maize termite treatment (weeding without banking/ modified kaselera) (Mk/ha)				X	X	X	X	X	X
Cost of labour for earthing up beans (Mk/ha)							X	X	X
Cost of labour for mulching beans (Mk/ha)								X	X
Total costs that vary (Mk/ha)									
Net benefits (Mk/ha)									

Notes for Table 2:

Treatment 1: Control
2: Maize seed dressing + ICP9145
3: Maize seed dressing + ICP9145 + side-planting
4: Maize seed dressing + ICP9145 + side-planting + maize termite treatment
5: Maize seed dressing + ICP9145 + side-planting + maize termite treatment + Kaulesi
6: Maize seed dressing + ICP9145 + side-planting+maize termite treatment + Kaulesi + bean seed dressing
7: Maize seed dressing + ICP9145 + side-planting + maize termite treatment + Kaulesi + bean seed dressing + earthing up
8: Maize seed dressing + ICP9145 + side-planting + maize termite treatment + Kaulesi + bean seed dressing + earthing up + mulching
9: Maize seed dressing + ICP9145 + side-planting + maize termite treatment + Kaulesi + bean seed dressing + earthing up + mulching + high density planting.

TABLE 3. PARTIAL BUDGET FOR RELAY BEANS TRIAL, 1996/97.

('X' indicates variation in cost)

VARIABLE	TREATMENTS				
	1	**2**	**3**	**4**	**5**
Average maize yield (kg/ha)					
Average bean yield (kg/ha)					
Average pigeonpea yield (kg/ha)					
Adjusted maize yield (kg/ha)					
Adjusted bean yield (kg/ha)					
Adjusted pigeonpea yield (kg/ha)					
Gross field benefits (Mk/ha)					
Maize (Mk/ha)					
Beans (Mk/ha)					
Pigeonpea (Mk/ha)					
Total gross field benefits (Mk/ha)					
Cost of Kaulesi seed (Mk/ha)		X	X	X	X
Cost of bean seed dressing (Mk/ha)		X	X	X	X
Cost of labour for earthing up (Mk/ha)			X	X	X
Cost of labour for mulching (Mk/ha)				X	X
Cost of labour for planting (Mk/ha)					X
Total costs that vary (Mk/ha)					
Net benefits (Mk/ha)					

Notes for Table 3:

Treatment 1: Farmer's practice
Treatment 2: Seed dressing + earthing up
Treatment 3: Seed dressing + earthing up + mulching
Treatment 4: Seed dressing + earthing up + mulching + Kaulesi variety
Treatment 5: Seed dressing + earthing up + mulching + Kaulesi variety + high density planting

TABLE 4. PARTIAL BUDGET FOR STRIGA TRIAL, 1996/97.

('X' indicates costs that vary)

VARIABLES	TREATMENTS								
	1 (f0 t0)	2 (f1 t0)	3 (f2 t0)	4 (f0 t1)	5 (f1 t1)	6 (f2 t1)	7 (f0 t2)	8 (f1 t2)	9 (f2 t2)
Average maize yield (kg/ha)									
Average beans yield (kg/ha)									
Average pigeonpea yield (kg/ha)									
Adjusted maize yield (kg/ha)									
Adjusted beans yield (kg/ha)									
Adjusted pigeonpea yield (kg/ha)									
Gross field benefits									
Maize (kg/ha)									
Beans (kg/ha)									
Pigeonpea (kg/ha)									
Cost of Tephrosia seed (Mk/ha)				X	X	X		X	X
Cost of soya bean seed (Mk/ha)							X	X	X
Cost of fertiliser (Mk/ha)		X	X		X	X			
Cost of labour for planting Tephrosia (Mk/ha)				X	X	X			
Cost of labour for planting soya (Mk/ha)							X	X	X
Cost of labour for dolloping fertiliser (Mk/ha)		X			X			X	
Cost of labour for spreading fertiliser (Mk/ha)			X			X			X
Cost of labour for harvesting soya (Mk/ha)									
Total costs that vary (Mk/ha)									
Net benefits (Mk/ha)									

SEED PRICES, 1996/97 SEASON

MARKET: ______________________________

DATE: ____________ MONTH: __________

Crop	No	Variety	Kwacha	Plate size
Local Maize	1			
	2			
	3			
	4			
Hybrid maize	1			
	2			
	3			
	4			
Pigeonpea	1			
	2			
	3			
	4			
Beans	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
Others				

22 October 1996

TABLE 6. LABOUR INPUTS FOR ECONOMIC EVALUATION OF IPM INTERVENTIONS

VILLAGE: ____________________

FARMER: ____________________

PLOT: 1 = RESEARCHER OFT
2 = FARMER OFT
3 = MAIN GARDEN

AREA OF GARDEN:

DATE: --------/---------/-------

LABOUR OPERATION (S)	TIME TAKEN				NO. OF WORKERS		
	START		STOP		MALE	FEMA LE	CHILD
	HR	MIN	HR	MIN			

TABLE 7. WAGES DATA FOR ECONOMIC EVALUATION OF IPM INTERVENTIONS

Village: ____________________

Farmer: ____________________

Date: ____________________

Operation				Number of Workers			Male		Female		Child	
	Days	Hours/ day	Total hours	Male	Female	Child	Cash	Kind	Cash	Kind	Cash	Kind

365

Farming Systems Integrated Pest Management Project (FSIPM)

Economic analysis of OFTs
1997/98- 1998/99
06/01/2000

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Why economic analysis?

It helps to look at the results of OFT from the farmers' viewpoint, to decide which treatment merit further investigation and which recommendations can be made to farmers. Farmers will want to evaluate all the changes that are involved in doing new practice. It is, therefore, important to take into consideration all inputs that are affected in any way by changing from one treatment to another.

It is said, 'developing recommendations that fit farmers' goals and situations is not necessarily difficult, but it is certainly easy to make poor recommendations by ignoring factors that are important to the farmer. An economic analysis of the experimental results is, therefore, essential.

Definitions

Adjusted yield: adjusted yield for a treatment is the average yield adjusted downward by a certain percentage to reflect the difference between the experimental yield and the yield farmers could expect from the same treatment.

Gross benefits: values adjusted yield for each treatment. It is calculated by multiplying the unit price by the adjusted yield.

Unit price: simply is the value of one kilogram of the crop prior to harvest or input at planting

Variable costs-: those costs that differ across treatments

Total costs that vary: is the sum of all costs that vary for a particular treatment

Imputed labour costs: is calculated by wage rate by total labour days. One Labour Day = 6 hours

Return over variable costs/net benefits: the difference between the total costs that vary from the gross benefits for each treatment-

Benefit cost ratio- full cost basis: simply divides gross benefits with total costs that vary. Generally, a benefit cost ratio of 2 is the minimum required for farmers to accept a crop management innovation.

Benefit cost ratio- cash basis: is calculated by dividing gross benefits by total costs that vary less cost of labour

Gross returns to labour: is calculated by subtracting the total costs that vary from the gross field benefits

Marginal rate of return: simply divides marginal net benefit (i.e. change in net benefits) by marginal cost (i.e. change in costs) expressed as a percentage

Assumptions used in calculating costs and benefits for economic analysis:

- Yields are from the FSIPM Project OFT are used for the economic analysis; yields are adjusted downwards by 20% reflecting differences between experimental yield and to yield farmers could expect from the same treatment.

- Maize damaged by termites, one month before harvest is not considered as a loss because farmers normally savage them for home use.

- 1998/99-consumer price of MK8.50 is used for maize and MK 6.50 in 1997/98. Prices of other crops reflect harvest price on the local markets. For other crops, prices used in the analysis reflect the market prices that prevailed during either harvesting or planting times.

- Seed rate for crops is from OFT or Guide to Agricultural production

- Fertiliser rate of 50 kg N/ha is used. Using 23:21:04s, about 108.7 kg/ha is needed. The 1997/98-fertiliser cost price of MK 372/bag was used for analysis while in 1998/99, MK 895/bag (reflecting the effect of devaluation) was used. A 10% cost is added for transport. MRFC interest rate of 30%, payable in 10 months is added to reflect cost of borrowing.

- Gaucho price for 1997/98 was US $ 41.50/125gm @ an exchange rate of US $ 1= MK15 > MK 622.50/125GM. In 1998/99 GauchoT' input price of approximately 2/3 of US $ 41.50 = US $ 27.6 @ an exchange rate of US $ 1= MK 43 > MK 1190/125GM. Seed dressing rate of 5gm/ 1 kg of maize seed is used, translating into 125gm of Gaucho/ha for maize seed rate of 25 kg/ha.

- Labour requirements are from Werner (separately for light and heavy soils (1987) and from own field measurements of IPM interventions. One Labour Day = 6 hours.

- Average wage rate for male labour, 1998/99, in Matapwata and Mombezi EPAs, at 6hours/day of MK23 is used. In cases where farmers may do the work themselves rather than hire others to do it, the opportunity cost of their weeding is the net wage they would have earned had they chosen not to stay on the farm and do the weeding. For 1997/98, a wage rate of MK 15/day was used.

- The sweet potato vine cost was calculated as follows: the recommended planting density requires 37,000 plants per ha using vines of 25 to 30 cm. One 30cm vine weighs approximately 20gm. Thus a total weight per ha is 751kg. Farmers buy vines normally in bags that carry 50 kg of fertiliser. One such bag is estimated to weigh 30kg. The market price of such bags in 1998/99 ranged between MK 30- MK 50. Taking the higher rate, the cost of vines per ha was MK 1251.

Summaries of economic analysis of IPM interventions

- *Whitegrub*

Table 1 compares the economic returns of seed dressing maize seed with Gaucho at FSIPM research sites in Matapwata and Chiradzulu uplands in 1997/98.

In Chiradzulu upland, maize yields with seed dressing were 2976 kg/ha and 2472 kg/ha without seed dressing. Adjusted downwards by 20% to allow for farmer management, these were equivalent to 2381 kg/ha and 1978 kg/ha respectively. Gross benefits were higher for plots where maize was seed dressed with Gaucho (MK 15, 477/ha) than where it was not seed dressed (MK 12, 857/ha). When the cost of Gaucho was included in the variable costs, returns over variable costs (net benefits) were MK 9,504/ha for seed dressing and MK 7,507/ha without seed dressing. On full cost basis, the benefit cost ratio for seed dressing was also higher for seed dressing (2.59) compared to 2.40. But gross returns to labour were also high for seed dressing (MK 75.08/day) compared to MK 60.99/da without seed dressing. The marginal rate of return, which is the marginal net benefit divided by the marginal cost, was 320% indicating that farmers could expect to gain, on average, in return for their investment in buying Gaucho for maize seed dressing for controlling whitegrub.

In Matapwata, the story was similar. Maize yields seed dressing averaged 2465 kg/ha compared to 1960 kg/ha without seed dressing. Adjusted downwards by 20% to allow for farmer management, these were equivalent to 1972 kg/ha and 1568 kg/ha respectively. Gross benefits were also higher for plots with seed dressing (MK 12,818/ha) than without seed dressing (MK 10, 192/ha). When the cost of Gaucho was included in the variable costs, net benefits were MK 6,845/ha and MK 4,842/ha, respectively. The benefit cost ratio (full cost basis) for seed dressing was higher with seed dressing (2.15) than without seed dressing

(1.91). Overall gross returns to labour were also high for seed dressing (MK 56.31 compared to MK 42.18). The marginal rate of return for Matapwata in 1997/98 was 321%, also indicating that farmers could expect to gain in return for their investment when they decide to seed dress their maize seed with Gaucho.

In 1998/99 season, Gaucho-T was used instead of Gaucho. The price of Gaucho-T was almost two-thirds that of Gaucho. No economic analysis was done for Matapwata because the results showed no significant differences. Yields were also generally very low during the season in all plots. Again, the results in Chiradzulu favoured seed dressing against no seed dressing. Gross benefits with seed dressing were MK 23, 486/ha compared to MK 19899/ha without seed dressing. Net benefits with seed dressing were MK 15,412/ha and without seed dressing were MK 13,015/ha. The benefit cost ratios at full cost were similar but returns to labour were higher for seed dressing (MK 108/day compared to MK 92/day. With a marginal rate of return of 201%, farmers should also expect to gain if they seed dress their maize seed with Gaucho-T.

The two seasons' data (at least in Chiradzulu) shows clear economic benefits of seed dressing with either Gaucho or Gaucho-T for controlling whitegrubs in maize

- *Crack sealing*

Tables 3, 4 and 5 present the economic analysis of crack sealing trial in 1998/99 season for both Matapwata and Mombezi (Upland and dambo) EPAs.

In the uplands of both EPAs, crack sealing did not show any economic benefit over existing farmers' practice. Crack sealing tended to reduce yields of sweet potato as a result, the treatments yielded lower gross benefits but yet had higher costs than existing farmer practice. The automatic choice, therefore, would be for the farmer to continue with the existing farmer situation because it offers high gross and net benefits at a low cost.

In the dambo, crack sealing showed positive effects on both total yield and clean yield of sweet potato. Crack sealing up to two occasions had positive net returns of MK 8209 (including net benefits of field peas- an intercrop) over variable costs when yields were adjusted downwards by 20% for farmer management. The benefit cost ratio (1.5) was also highest at two crack sealings. The marginal rate of return for adopting two additional sealings from the existing farmers' practice was 255%. This means that for every MK 1/ha a farmers invests in labour for two crack sealing, he/she recovers his/her MK 1 plus an additional MK 255. This rate of return is well above the minimum acceptable rate of return which ranges between 50% to 100%.

- *Striga*

Tables 6 and 7 present the economic analysis of the striga trial 1998/99 for farmers with serious incidence. Table 6 compares the treatments, tephrosia, cowpeas and crotalaria with no legume. All plots were also applied with fertiliser. Table 7 presents the same analysis for the same treatments but without fertiliser application.

With fertiliser applied, adjusted maize yields were 673 kg/ha, 883 kg/ha, 642 kg/ha and 605 kg/ha for no legume, tephrosia, cowpeas and crotalaria respectively. These yields are quite below the RDP's official average of 1.300 kg/ha. Without fertiliser, adjusting maize yields were even worse, 486 kg/ha for no legume treatment, 604 kg/ha for *Tephrosia* treatment, 442 kg/ha for cowpeas and 348 kg/ha for *Crotalaria* treatment.

Gross benefits were high for 'Tephrosia' treatment, followed by no legume, cowpeas and crotalaria respectively. When all costs are taken into account, only tephrosia treatment had positive returns of MK 82/ha over variable costs with fertiliser applied to all plots. The rest of the treatments had negative net benefits. Without fertiliser, overall benefits were also high for Tephrosia treatment. The net benefits for Tephrosia treatment rose to MK 441/ha from MK 82/ha while no legume registered a net benefit of MK 19/ha. The other treatments also had negative net benefits. From this analysis, tephrosia appeared to be the only economic option for striga management.

- *Termite*

Tables 8 to 11 present an economic evaluation of *'not banking'* as a termite management strategy in two seasons, first in 1997/98 and then 1998/99.

Table 8 compares the economic returns for termite management between Matapwata and Chiradzulu uplands in 1997/98 with all the 31 farmers who seed dressed their maize seed. Average yields without banking in Matapwata were 2634 kg/ha and with banking, maize yields were 2245 kg/ha. Adjusted downwards by 20% to allow for farmer management, these were equivalent to 2107 kg/ha and 1796 kg/ha respectively.

Gross benefits were higher for plots where maize was not banked (MK 13696/ha) than where it was banked (MK 11674/ha). When the cost of labour for banking was included in the variable costs, returns over variable costs (net benefits) were MK 8997/ha '*without banking*' compared to MK 4539/ha with b*anking*. The benefit cost ratio (full cost basis) for '*not banking*' (2.91) was higher than the ratio with banking (1.64). Gross returns to labour were also high where maize was not banked (MK 87.39/day) compared to MK 52.64/day with '*banking*'. The marginal rate of return, which is the marginal net benefit divided by the marginal cost (575%) indicates that farmers can expect to gain, on average, they decide '*not to bank*' in their maize field as a control strategy for termite.

In Matapwata, Maize yields in the 1997/98 season had a slight difference, *with 'banking treatment*' having a slight edge over *'without banking'* treatment. *'Without banking'* had average maize yield of 1902 kg/ha while with '*banking*', maize yield was 1947 kg/ha. Adjusted downwards by 20% to allow for farmer management, these were equivalent to 1522 kg/ha and 1558 kg/ha respectively. Gross benefits were higher for plots with banking (MK 10,127/ha) than without banking (MK 9893/ha). When the cost of labour for banking was included in the variable costs, net benefits were high where maize not banked (MK 6101/ha compared to MK 5910/ha where maize was banked. The benefit cost ratio (full cost basis) for not banking was also higher (2.61) than with banking (1.40). Gross returns to labour were also high for not banking (MK 53.83/day) compared to MK 41.72/day for banking. The marginal rate of return for Matapwata was only 45%, indicating a very small gain or saving if farmers decided not to bank their maize.

When the sample of farmers was reduced to 19 farmers in the analysis (Table 9), not banking had also high overall economic benefits over banking only in Chiradzulu.

In 1998/99, the analysis shows that *'not banking'* had no economic advantage in Matapwata over banking (Tables 10 and 11). All economic variables were in favour of banking. While in Chiradzulu, the analysis again was in favour of '*not banking' as in* 1997/98, with a marginal rate of return of 641%.

> ***Note: The data in Chiradzulu showed clear economic benefits of not banking as a control strategy for termite. However, in Matapwata, the economic benefits***

were either negligible or non-existent. Consistent in the Matapwata data for the two seasons was also reduced yield in the plots where maize was not banked.

- ***Bean stem maggot***

Tables 12 to 18 compare economic returns of growing Kaulesi against the CIAT recommended improved bean varieties in both Chiradzulu and Matapwata.

In Chiradzulu, overall gross benefits were higher in the Upland than in the dambo, in respective of variety. But, Kaulesi consistently performed better than the other bean varieties in both 1997/98 and 1998/99 cropping seasons (Tables 12 –15). It had higher gross and net benefits than any other bean varieties. Gross returns to labour were also higher for Kaulesi than the other bean varieties.

In Matapwata, the two seasons were generally not good years for beans. Unadjusted bean yields ranged from 10.9 kg/ha to 81.5 kg/ha in the 1997/998 season and 53.8 kg/ha to 59.8 kg/ha in 1998/99 season. Napirira and Nagaga showed most variability in yield in the two seasons while Kaulesi showed least variability. No economic analysis could be done because of low yield levels, in respective of the zone.

- **Fusarium wilt in pigeon peas**

Tables 19 to 23 compares the economics of producing ICEAP 00040 (not yet released) against the already released varieties, ICP 00053 and ICP 9145 plus a local variety in both Matapwata and Mombezi EPAs.

It should be noted that in the two seasons (97/98 and 98/99), performance of pigeon was variable. In Chiradzulu, pigeon peas performed better in the upland than in the in the dambo in both seasons. In 1997/98 cropping season, unadjusted pigeon pea yield in the dambo was below 100kg/ha while in the upland, the highest for ICEAP 00040 was 457kg/ha. In 1998/99, the highest yield in the dambo was 121 kg/ha while in the upland was 656kg/ha. For Matapwata, 1997/98 cropping season was a bad year for pigeon peas, both in the dambo and upland. Average yields ranged from 9kg/ha to 39kg/ha for the dambo and 21kg/ha to 40kg/ha in the upland. In 1998/99, performance of pigeon peas improved and the dambo zone had better average yields than the upland (Tables 22 &23).

The economic analysis showed that ICEAP 00040 had consistent higher economic net benefits than the rest of the other pigeon pea varieties tested in both Matapwata and Mombezi. Higher net benefits were particularly realised in Chiradzulu because average yields were generally higher than Matapwata. The greatest benefits in Chiradzulu were for those farmers who grew 1CEAP 00040 in the upland in both 1997/98 and 1998/99. In Matapwata, dambo production of ICEAP 00040 gave higher net benefits than upland production in 1998/99 cropping season.

Annex: Economic analysis of on-farm trials

Table 1: Economic evaluation of Gaucho for treatment against whitegrub- 1997/98 (sample size 61)

Variable	Chiradzulu upland		Matapwata Upland	
	Without seed dressing	With seed dressing	Without seed dressing	With seed dressing
Benefits				
Yield (kg/ha)	2472	2976	1960	2465
Adjusted yield (kg/ha)	1978	2381	1568	1972
Unit price	6.50	6.50	6.50	6.50
Gross benefits	**12,857**	**15,477**	**10,192**	**12,818**
Variable costs				
1 Materials (MK/ha)				
Seed	1000	1000	1000	1000
Fertiliser	890	890	890	890
Credit	202	202	202	202
Other material inputs (Gaucho)	0	623	0	623
Labour requirements (Hours/ha)	850	850	850	850
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	850	850	850	850
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	2125	2125	2125	2125
Total costs	**4217**	**4840**	**4217**	**4840**
Net benefits				
Return over variable costs (MK/ha)	**8640**	**10637**	**5975**	**7978**
Benefit-cost ratio (full-cost basis)	3.05	3.67	2.42	3.04
Benefit cost-ratio (cash cost basis)	6.15	5.70	4.87	4.72
Gross returns to labour (MK/day)	60.99	75.08	42.18	56.31

Marginal rate of return for applying Gaucho:

(a) Chiradzulu upland

= Marginal benefit/marginal cost
= (10637-8640)/(4840-4217)
=1997/623
=3.2054=320.54

(b) **Matapwata upland**

= marginal benefit/marginal cost
= (7978-5975)/4840-4217
=2003/623
=3.2150=321.5%

Table 2 Economic evaluation of Gaucho for treatment against whitegrub- 1998/99 (sample size 9)=- Chiradzulu upland only.

Variable	Chiradzulu upland	
	Without seed dressing	With seed dressing
Benefits		
Yield (kg/ha)	2926	3454
Adjusted yield (kg/ha)	2341	2763
Unit price	8.50	8.50
Gross benefits	**19,899**	**23,486**
Variable costs		
1 Materials (MK/ha)		
Seed	1000	1000
Fertiliser	2140	2140
Credit	486	486
Other material inputs (GauchoT)		1190
Labour requirements (Hours/ha)	850	850
Labour for intervention (hours/ha)	0	0
Total labour requirements (hours/ha)	850	850
Unit price (MK/day)	23	23
Imputed labour cost (MK/ha)	3258	3258
Total costs	**6884**	**8074**
Net benefits		
Return over variable costs (MK/ha)	**13015**	**15412**
Benefit-cost ratio (full-cost basis)	2.892	2.91
Benefit cost-ratio (cash cost basis)	5.49	4.88
Gross returns to labour (MK/day)	91.87	108.79

Marginal rate of return for applying GauchoT

=Marginal benefit/marginal cost
=(15,412- 13,015)/(8074-6884)
=2397/1190
=2.0142=201.42%

Sweet potato crack sealing trial

Table 3: Economic analysis for Crack Sealing- Upland Farmers, Mombezi EPA

Variable	Farmer Practice (FP)	FP+ 1 late Crack sealing	FP + 2 Crack sealings	FP + 3 Crack Sealings
Benefits				
Yield(kg/ha)	6092	5958	5893	5526
Clean yield	4769	3872	3853	3844
Adjusted yield (kg/ha)	3815	3098	3082	3075
Unit price (MK/kg)	3	3	3	3
Gross Benefits (MK/ha)	**11445**	**9294**	**9246**	**9225**
Variable costs				
Materials-MK/ha-				
Vines	1251	1251	1251	1251
Labour requirements- (hours/ha)	768	768	768	768
Labour for intervention (hours/ha)	0	144	270	378
Total labour requirements (hours/ha)	768	912	1038	1146
Unit price (MK/day)	23	23	23	23
Imputed Labour Cost (MK/ha)	2944	3496	3979	4397
Total variable costs (MK/ha)	4195	4747	5230	5648
Net benefits				
Return over variable costs (MK/ha)	**10112**	**6869**	**6329**	**5884**
Benefit-cost ratio (full-cost basis)	2.73	1.96	1.77	1.63
Benefit cost-ratio (cash cost basis)	9.15	7.43	7.39	7.37
Gross returns to labour (MK/day)	89.41	61.14	53.45	48.30

Table 4: Economic analysis for Crack Sealing- Dambo Farmers, Mombezi EPA

Variable	Farmer Practice (FP)	FP+ 1 late Crack sealing	FP + 2 Crack sealings	FP + 3 Crack Sealings
Benefits				
Sweet potato yield(kg/ha)	2450	3303	3684	3381
Clean yield	1577	1741	2397	2098
Adjusted clean yield Kg/ha	1262	1393	1918	1678
Unit price (MK/kg)	3	3	3	3
Gross Benefits (MK/ha)	**3786**	**4179**	**5754**	**5035**
Field peas yield(kg/ha)	949	720	1097	886
Adjusted clean yield Kg/ha	759	576	877	708
Unit price (MK/kg)	20	20	20	20
Gross Benefits (MK/ha)	15,180	11,520	17,540	14,160
Total Gross Benefits (MK/ha)	19,911	16743	24,731	20,454
Materials-MK/ha				
Vines (MK/ha)	1251	1251	1251	1251
Field peas seed (MK/ha)	10,855	10,855	10,855	10,855
Labour requirements- (hours/ha)	798	798	798	798
Labour for intervention (hours/ha)	0	186	354	480
Total labour requirements (hours/ha)	798	984	1152	1278
Unit price (MK/day)	23	23	23	23
Imputed Labour Cost (MK/ha)	3059	3768	4416	4891
Total variable costs (MK/ha)	**15,165**	**15,874**	**16,522**	**16,997**
Net benefits				
Return over variable costs (MK/ha)	**4,746**	**869**	**8,209**	**3,457**
Benefit-cost ratio (full-cost basis)	1.31	1.05	1.50	1.20
Benefit cost-ratio (cash cost basis)	1.64	1.38	2.04	1.69
Gross returns to labour (MK/day)	35.68	5.30	42.75	16.23

Table 5: Economic analysis for Crack Sealing- Mangunda, Matapwata EPA

Variable	Farmer Practice (FP)	**FP +1 early sealing**	FP+ 1 late Crack sealing	FP + 2 Crack sealings	FP + 3 Crack Sealings
Benefits					
Yield(kg/ha)	19381	17517	15839	14988	14502
Clean yield	11360	7917	8142	7824	8212
Adjusted yield (kg/ha)	9888	4334	6514	6259	6570
Unit price (MK/kg)	3	3	3	3	3
Gross Benefits (MK/ha)	**27264**	**19002**	**19542**	**18777**	**19710**
Variable costs					
Materials-MK/ha					
Vines (M/ha)	**1251**	**1251**	**1251**	**1251**	**1251**
Labour requirements- (hours/ha)	912	912	912	912	912
Labour for intervention (hours/ha)	0	132	276	402	510
Total labour requirements (hours/ha)	912	1044	1188	1314	1422
Unit price (MK/day)	23	23	23	23	23
Imputed Labour Cost (MK/ha)	3496	4002	4554	5037	5451
Total variable costs (MK/ha)	**4747**	**5253**	**5805**	**6288**	**6702**
Net benefits					
Return over variable costs (MK/ha)	**22517**	**13749**	**13737**	**12489**	**13008**
Benefit-cost ratio (full-cost basis)	5.74	3.62	3.37	2.99	2.94
Benefit cost-ratio (cash cost basis)	21.79	15.19	15.62	15.01	15.76
Gross returns to labour (MK/day)	148.14	79.00	69.37	57.02	54.89

STRIGA TRIAL

Table 6: Economic evaluation of Striga Trial with fertiliser applied 98/99 (n=6)

Variable	Matapwata Upland			
	No legume	Tephrosia	Cowpeas	Crotalaria
Benefits				
Maize yield (kg/ha)	841	1104	802	756
Adjusted yield (kg/ha)	673	883	642	605
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**5721**	**7506**	**5457**	**5141**
Pigeon pea yield (kg/ha)	164	77	85	100
Adjusted yield (kg/ha)	131	62	68	80
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**1114**	**527**	**578**	**680**
Cowpeas yield (kg/ha)	0	0	7	0
Adjusted yield (kg/ha)	0	0	6	0
Unit price	0	0	16	0
Gross benefits	0	0	96	0
Total gross benefits	**6,835**	**8033**	**6035**	**5821**
Variable costs				
1 Materials (MK/ha)				
Maize seed	1000	1000	1000	1000
Pigeon pea seed	120	120	120	120
Cowpeas seed	0	0	240	0
Fertiliser	2140	2140	2140	2140
Credit	486	486	486	486
Labour requirements[1] (Hours/ha)	980	980	980	980
Labour for intervention[2] (hours/ha)	0	117	139	57
Total labour requirements (hours/ha)	980	1097	1119	1037
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	*3757*	*4205*	*4290*	*3975*
Total costs	**7503**	**7951**	**8276**	**7721**
Net benefits				
Return over variable costs (MK/ha)	**-668**	**82**	**-2241**	**-1900**
Benefit-cost ratio (full-cost basis)	0.91	1.01	0.73	0.75
Benefit cost-ratio (cash cost basis)	1.82	2.14	1.51	1.55
Gross returns to labour (MK/day)	-4.09	0.45	-12.01	-10.99

[1] Include labour for planting and harvesting pigeon pea (130 manhours), an intercrop
[2] Labour for planting and incorporating tephrosia = 117 manhours; planting Crotalaria = 57 manhours and planting and harvesting cowpeas = 139 manhours

Table 7: Economic evaluation of Striga Trial with no fertiliser applied 98/99 (n=6)

Variable	Chiradzulu upland		Matapwata Upland	
	No legume	Tephrosia	Cowpeas	Crotalaria
Benefits				
Maize yield (kg/ha)	608	755	552	435
Adjusted yield (kg/ha)	486	604	442	348
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**4131**	**5134**	**3757**	**2958**
Pigeon pea yield (kg/ha)	113	93	103	147
Adjusted yield (kg/ha)	90	74	82	118
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**765**	**632**	**700**	**1000**
Cowpeas yield (kg/ha)	0	0	5	0
Adjusted yield (kg/ha)	0	0	4	0
Unit price	0	0	16	0
Gross benefits	0	0	64	0
Total gross benefits	**4896**	**5766**	**4521**	**3958**
Variable costs				
1 Materials (MK/ha)				
Maize seed	1000	1000	1000	1000
Pigeon pea seed	120	120	120	120
Cowpeas seed	0	0	240	0
Labour requirements (Hours/ha)	980	980	980	980
Labour for intervention (hours/ha)	0	117	139	57
Total labour requirements (hours/ha)	980	1097	1119	1037
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	3757	4205	4290	3975
Total costs	**4877**	**5325**	**5650**	**5095**
Net benefits				
Return over variable costs (MK/ha)	**19**	**441**	**-1129**	**-1137**
Benefit-cost ratio (full-cost basis)	1.00	1.08	0.80	0.78
Benefit cost-ratio (cash cost basis)	3.71	5.15	4.24	3.53
Gross returns to labour (MK/day)	0.12	2.41	-6.05	-6.58

MRR= No legume to Tephrosia
=(441-19))/5325-4877
=422/448
=0.94196
=94.20%

Termite Trial

Table 8: Economic evaluation of termite- restricted to plots not seed dressed (1997/98 (sample size 31)

Variable	Chiradzulu upland		Matapwata Upland	
	Without banking	With banking	Without banking	With banking
Benefits				
Yield (kg/ha)	2634	22454	1902	1947
Adjusted yield (kg/ha)	2107	1796	1522	1558
Unit price	6.50	6.50	6.50	6.50
Gross benefits	**13696**	**11674**	**9893**	**10127**
Variable costs				
1 Materials (MK/ha)				
Seed	1000	1000	1000	1000
Fertiliser	890	890	890	890
Credit	202	202	202	202
Labour requirements (Hours/ha)	850	850	850	850
Labour for intervention (hours/ha)	-170	0	-170	0
Total labour requirements (hours/ha)	680	850	680	850
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	1700	2125	1700	2125
Total costs	**3792**	**4217**	**3792**	**4217**
Net benefits				
Return over variable costs (MK/ha)	**9904**	**7457**	**6101**	**5910**
Benefit-cost ratio (full-cost basis)	3.61	2.77	2.61	2.40
Benefit cost-ratio (cash cost basis)	6.55	5.58	4.73	4.84
Gross returns to labour (MK/day)	87.39	52.64	53.83	41.72

Marginal rate of return for not banking treatment

(b) Chiradzulu upland

= Marginal benefit/marginal cost
= (9904-7457)/(4217-3792)
=2447/425
=5.7576=575.76%

(b) **Matapwata upland**

= marginal benefit/marginal cost
= (6101-5910)/(4217-3792
=191/425
=0.4494=44.94%

Table 9: Economic evaluation of termite- restricted to plots not seed dressed (1997/98 (sample size 19)

Variable	Chiradzulu upland		Matapwata Upland	
	Without banking	With banking	Without banking	With banking
Benefits				
Yield (kg/ha)	2512	23524	1569	2021
Adjusted yield (kg/ha)	22010	1882	1255	1617
Unit price	6.50	6.50	6.50	6.50
Gross benefits	**13062**	**12233**	**8158**	**10511**
Variable costs				
1 Materials (MK/ha)				
Seed	1000	1000	1000	1000
Fertiliser	890	890	890	890
Credit	202	202	202	202
Labour requirements (Hours/ha)	850	850	850	850
Labour for intervention (hours/ha)	-170	0	-170	0
Total labour requirements (hours/ha)	680	850	680	850
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	1700	2125	1700	2125
Total costs	**3792**	**4217**	**3792**	**4217**
Net benefits				
Return over variable costs (MK/ha)	**9270**	**8016**	**4366**	**6294**
Benefit-cost ratio (full-cost basis)	3.44	2.90	2.15	2.49
Benefit cost-ratio (cash cost basis)	6.24	5.85	3.89	5.02
Gross returns to labour (MK/day)	81.796	56.58	38.52	44.43

Marginal rate of return for not banking treatment

(a) Chiradzulu upland

= Marginal benefit/marginal cost
= (9270-8016)/(4217-3792)
=1254/425
=2.9505=295.05%

(b) Matapwata upland

= marginal benefit/marginal cost
= (4366-6294)/(4217-3792
=-1928/425
=-4.5365=-453.65%

Table 10: Economic evaluation of termite- all plots used, including under seed priming treatment factor (1998/99(sample size 8)

Variable	Chiradzulu upland		Matapwata Upland	
	Without banking	With banking	Without banking	With banking
Benefits				
Yield (kg/ha)	2914	2355	1329	1767
Adjusted yield (kg/ha)	2331	1884	1063	1414
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**19,815**	**16014**	**9036**	**12019**
Variable costs				
1 Materials (MK/ha)				
Seed	1000	1000	1000	1000
Fertiliser	2140	2140	2140	2140
Credit	486	486	486	486
Labour requirements (Hours/ha)	850	850	850	850
Labour for intervention (hours/ha)	-170	0	-170	0
Total labour requirements (hours/ha)	680	850	680	850
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	2607	3258	2607	3258
Total costs	**6233**	**6884**	**6233**	**6884**
Net benefits				
Return over variable costs (MK/ha)	**13582**	**9130**	**2803**	**5135**
Benefit-cost ratio (full-cost basis)	3.18	2.33	1.45	1.75
Benefit cost-ratio (cash cost basis)	5.46	4.42	2.49	3.31
Gross returns to labour (MK/day)	119.84	64.45	24.73	36.25

Marginal rate of return for not banking treatment

(a) Chiradzulu upland

= Marginal benefit/marginal cost
= (13582-9130)/(6884-6233)
=4452/651
=6.8387=683.87%

(b) Matapwata upland

= marginal benefit/marginal cost
= (2803-5135)/(6884-6233
=-2332/651
=-3.5821=-358.21%

Table 11: Economic evaluation of termite- all plots used, including those under seed priming treatment factor (1998/99(sample size 7)

Variable	Chiradzulu upland		Matapwata Upland	
	Without banking	With banking	Without banking	With banking
Benefits				
Yield (kg/ha)	2853	2334	1327	1768
Adjusted yield (kg/ha)	2282	1867	1062	1414
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**19,397**	**15870**	**9027**	**12019**
Variable costs				
1 Materials (MK/ha)				
Seed	1000	1000	1000	1000
Fertiliser	2140	2140	2140	2140
Credit	486	486	486	486
Labour requirements (Hours/ha)	850	850	850	850
Labour for intervention (hours/ha)	-170	0	-170	0
Total labour requirements (hours/ha)	680	850	680	850
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	2607	3258	2607	3258
Total costs	**6233**	**6884**	**6233**	**6884**
Net benefits				
Return over variable costs (MK/ha)	**13164**	**8986**	**2794**	**5135**
Benefit-cost ratio (full-cost basis)	3.18	2.31	1.45	1.75
Benefit cost-ratio (cash cost basis)	5.46	4.38	2.49	3.31
Gross returns to labour (MK/day)	116.15	63.43	24.65	36.25

Marginal rate of return for not banking treatment

(b) Chiradzulu upland

= Marginal benefit/marginal cost
= (13164-8986)/(6884-6233)
=4178/651
=6.4178=641.78%

(b) Matapwata upland

= marginal benefit/marginal cost
= (2794-5135)/(6884-6233
=-2341/651
=-3.5960=-359.60%

BSM trial

Table 12: Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 61) -1997/98

Variable	Chiradzulu upland			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	361	334	318	278
Adjusted yield (kg/ha)	289	267	254	224
Unit price	18	30	18	18
Gross benefits	**5202**	**8010**	**4572**	**4032**
Variable costs				
1 Materials (MK/ha)				
Seed[3]	1250	2500	1250	1250
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	700	700	700	700
Total costs	**1950**	**3200**	**1950**	**1950**
Net benefits				
Return over variable costs (MK/ha)	3252	**4810**	2622	2082
Benefit-cost ratio (full-cost basis)	2.67	2.50	2.34	2.07
Benefit cost-ratio (cash cost basis)	4.16	3.20	3.66	3.22
Gross returns to labour (MK/day)	69.69	**103.07**	56.19	44.61

[3] seed rate under intercropping is 50kg/ha

Table 12: Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 61) -1997/98

Variable	Chiradzulu dambo			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	163	193	145	162
Adjusted yield (kg/ha)	130	154	116	130
Unit price	18	30	18	18
Gross benefits	**2340**	**4620**	**2088**	**2340**
Variable costs				
1 Materials (MK/ha)				
Seed	1250	2500	1250	1250
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	700	700	700	700
Total costs	**1950**	**3200**	**1950**	**1950**
Net benefits				
Return over variable costs (MK/ha)	390	**1420**	138	390
Benefit-cost ratio (full-cost basis)	1.20	1.44	1.07	1.20
Benefit cost-ratio (cash cost basis)	1.87	1.85	1.67	1.87
Gross returns to labour (MK/day)	0.36	22.44	-5.04	0.36

Table 14: Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 40) -1998/99

Variable	Chiradzulu upland			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	212	218	216	213
Adjusted yield (kg/ha)	170	174	173	170
Unit price	24	60	24	24
Gross benefits	**4080**	**10440**	**4152**	**4080**
Variable costs				
1 Materials (MK/ha)				
Seed	1500	4000	1500	1500
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	1073	1073	1073	1073
Total costs	**2573**	**5073**	**2573**	**2573**
Net benefits				
Return over variable costs (MK/ha)	1507	**5367**	1579	1507
Benefit-cost ratio (full-cost basis)	1.59	2.06	1.61	1.59
Benefit cost-ratio (cash cost basis)	2.72	2.61	2.77	2.72
Gross returns to labour (MK/day)	32.29	**115.00**	33.84	32.29

Table 15: Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 40) -1998/99

Variable	Chiradzulu dambo			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	116.5	120.2	120.5	117.9
Adjusted yield (kg/ha)	93	96	96	94
Unit price	24	60	24	24
Gross benefits	**2232**	**5760**	**2304**	**2256**
Variable costs				
1 Materials (MK/ha)				
Seed	1500	4000	1500	1500
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	1073	1073	1073	1073
Total costs	**2573**	**5073**	**2573**	**2573**
Net benefits				
Return over variable costs (MK/ha)	-341	**687**	-269	-317
Benefit-cost ratio (full-cost basis)	0.87	1.14	0.90	0.88
Benefit cost-ratio (cash cost basis)	1.49	1.44	1.54	1.50
Gross returns to labour (MK/day)	-7.31	14.72	-5.76	-6.79

Table 16: Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 61) -1997/98

Variable	Matapwata upland			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	81.5	51.8	38.2	0
Adjusted yield (kg/ha)	65.2	41.44	30.56	0
Unit price	18	30	18	18
Gross benefits	**1174**	**1243**	**550**	**0**
Variable costs				
1 Materials (MK/ha)				
Seed[4]	1250	2500	1250	1250
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	700	700	700	700
Total costs	**1950**	**3200**	**1950**	**1950**
Net benefits				
Return over variable costs (MK/ha)	-776	**-1957**	-1399	-1950
Benefit-cost ratio (full-cost basis)	0.60	0.39	0.28	0
Benefit cost-ratio (cash cost basis)	0.94	0.50	0.44	0
Gross returns to labour (MK/day)	-16.63	**-41.94**	-29.98	0

[4] seed rate under intercropping is 50kg/ha

Table 17 Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 61) -1997/98

Variable	**Matapwata dambo**			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	31.9	56.6	14.4	26.1
Adjusted yield (kg/ha)	25.52	45.28	11.52	20.88
Unit price	18	30	18	18
Gross benefits	**459**	**1358**	**207**	**376**
Variable costs				
1 Materials (MK/ha)				
Seed	1250	2500	1250	1250
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	700	700	700	700
Total costs	**1950**	**3200**	**1950**	**1950**
Net benefits				
Return over variable costs (MK/ha)	-1,491	**-1,842**	-1,743	-1,574
Benefit-cost ratio (full-cost basis)	0.24	0.42	0.11	0.19
Benefit cost-ratio (cash cost basis)	0.37	0.54	0.17	0.30
Gross returns to labour (MK/day)	-31.95	-39.47	-37.35	-33.73

Table 18: Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 40) -1998/99

Variable	Matapwata upland			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	59.6	65.6	63.6	61.0
Adjusted yield (kg/ha)	47.68	52.48	50.88	48.8
Unit price	24	60	24	24
Gross benefits	**1144**	**3149**	**1221**	**1171**
Variable costs				
1 Materials (MK/ha)				
Seed	1500	4000	1500	1500
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	1073	1073	1073	1073
Total costs	**2573**	**5073**	**2573**	**2573**
Net benefits				
Return over variable costs (MK/ha)	-1429	**-1924**	-1352	-1402
Benefit-cost ratio (full-cost basis)	0.44	0.62	0.47	0.46
Benefit cost-ratio (cash cost basis)	0.76	0.79	0.81	0.78
Gross returns to labour (MK/day)	-30.62	**-41.23**	-28.97	-30.04

Table 19 Economic evaluation of bean trial - summer/bean intercrop with Kaulesi as local check (sample size 40) -1998/99

Variable	Matapwata dambo			
	Kalima	Kaulesi	Nagaga	Napirira
Benefits				
Yield (kg/ha)	49.7	55.7	53.8	51.1
Adjusted yield (kg/ha)	39.76	44.56	43.04	40.88
Unit price	24	60	24	24
Gross benefits	**954**	**2674**	**1033**	**981**
Variable costs				
1 Materials (MK/ha)				
Seed	1500	4000	1500	1500
Fertiliser				
Credit				
Labour requirements (Hours/ha)	280	280	280	280
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	280	280	280	280
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	1073	1073	1073	1073
Total costs	**2573**	**5073**	**2573**	**2573**
Net benefits				
Return over variable costs (MK/ha)	-1619	**-2399**	-1540	-1592
Benefit-cost ratio (full-cost basis)	0.37	0.53	0.20	0.38
Benefit cost-ratio (cash cost basis)	0.64	0.67	0.69	0.65
Gross returns to labour (MK/day)	-34.69	-51.41	-33.00	-34.11

Table 19: Economic evaluation of Pigeon pea from MAIN Intercrop Trials (ICP 9145 local check) -1997/98

Variable	Chiradzulu upland			
	Local	ICEAP 00053	ICEAP 00040	ICP 9145
Benefits				
Yield (kg/ha)	296	187	457	327
Adjusted yield (kg/ha)	237	150	366	262
Unit price	6.50	6.50	6.50	6.50
Gross benefits	**1541**	**975**	**2379**	**1703**
Variable costs				
1 Materials (MK/ha)				
Seed	90	90	90	90
Fertiliser				
Credit				
Labour requirements (Hours/ha)	130	130	130	130
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements[5] (hours/ha)	130	130	130	130
Unit price (MK/day)	15	15	15	15
Imputed labour cost (MK/ha)	325	325	325	325
Total costs	**415**	**415**	**415**	**415**
Net benefits				
Return over variable costs (MK/ha)	1126	560	**1964**	1288
Benefit-cost ratio (full-cost basis)	3.71	2.35	5.73	4.10
Benefit cost-ratio (cash cost basis)	17.12	10.83	26.43	18.92
Gross returns to labour (MK/day)	51.96	25.85	90.64	59.45

[5] Labour for planting and harvesting only

Table 20: Economic evaluation of Pigeon pea from MAIN Intercrop Trials (ICP 9145 local check) –1998/99

Variable	Chiradzulu upland			
	Local	ICEAP 00053	ICEAP 00040	ICP 9145
Benefits				
Yield (kg/ha)	424	538	656	375
Adjusted yield (kg/ha)	339	430	525	300
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**2882**	**3655**	**4463**	**2550**
Variable costs				
1 Materials (MK/ha)				
Seed	120	120	120	120
Fertiliser				
Credit				
Labour requirements (Hours/ha)	130	130	130	130
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements[6] (hours/ha)	130	130	130	130
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	498	498	498	498
Total costs	**618**	**618**	**618**	**618**
Net benefits				
Return over variable costs (MK/ha)	2264	3037	**3845**	1932
Benefit-cost ratio (full-cost basis)	4.66	5.91	7.22	4.13
Benefit cost-ratio (cash cost basis)	24.02	30.46	37.19	2125
Gross returns to labour (MK/day)	104.49	140.17	**177.46**	89.17

[6] Labour for planting and harvesting only

Table 21: Economic evaluation of Pigeon pea from MAIN Intercrop Trials (ICP 9145 local check) –1998/99

Variable	Chiradzulu dambo			
	Local	ICEAP 00053	ICEAP 00040	ICP 9145
Benefits				
Yield (kg/ha)	82	104	121	87
Adjusted yield (kg/ha)	66	83	97	70
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**561**	**706**	**825**	**595**
Variable costs				
1 Materials (MK/ha)				
Seed	120	120	120	120
Fertiliser				
Credit				
Labour requirements (Hours/ha)	130	130	130	130
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	130	130	130	130
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	498	498	498	498
Total costs	**618**	**618**	**618**	**618**
Net benefits				
Return over variable costs (MK/ha)	-57	**88**	**207**	-23
Benefit-cost ratio (full-cost basis)	0.91	1.14	1.33	0.96
Benefit cost-ratio (cash cost basis)	4.68	5.88	6.88	4.96
Gross returns to labour (MK/day)	-2.63	4.06	9.55	-1.06

Table 22: Economic evaluation of Pigeon pea from MAIN Intercrop Trials (ICP 9145 local check) –1998/99

Variable	Matapwata upland			
	Local	ICEAP 00053	ICEAP 00040	ICP 9145
Benefits				
Yield (kg/ha)	149	138	230	132
Adjusted yield (kg/ha)	119	110	184	106
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**1012**	**935**	**1564**	**901**
Variable costs				
1 Materials (MK/ha)				
Seed	120	120	120	120
Fertiliser				
Credit				
Labour requirements (Hours/ha)	130	130	130	130
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	130	130	130	130
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	498	498	498	498
Total costs	**618**	**618**	**618**	**618**
Net benefits				
Return over variable costs (MK/ha)	394	317	**946**	283
Benefit-cost ratio (full-cost basis)	1.64	1.51	2.53	1.46
Benefit cost-ratio (cash cost basis)	8.43	7.79	13.03	7.79
Gross returns to labour (MK/day)	18.18	14.63	43.66	13.06

Table 23: Economic evaluation of Pigeon pea from MAIN Intercrop Trials (ICP 9145 local check) –1998/99

Variable	**Matapwata dambo**			
	Local	ICEAP 00053	ICEAP 00040	ICP 9145
Benefits				
Yield (kg/ha)	155	197	239	137
Adjusted yield (kg/ha)	124	158	191	110
Unit price	8.50	8.50	8.50	8.50
Gross benefits	**1054**	**1343**	**1624**	**935**
Variable costs				
1 Materials (MK/ha)				
Seed	120	120	120	120
Fertiliser				
Credit				
Labour requirements (Hours/ha)	130	130	130	130
Labour for intervention (hours/ha)	0	0	0	0
Total labour requirements (hours/ha)	130	130	130	130
Unit price (MK/day)	23	23	23	23
Imputed labour cost (MK/ha)	498	498	498	498
Total costs	**618**	**618**	**618**	**618**
Net benefits				
Return over variable costs (MK/ha)	436	725	**1006**	317
Benefit-cost ratio (full-cost basis)	1.71	2.17	2.63	1.51
Benefit cost-ratio (cash cost basis)	8.78	11.19	13.53	7.79
Gross returns to labour (MK/day)	20.12	33.46	46.43	14.63

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

FSIPM Pigeon pea Trial 1998/99, Mangunda Section, Matapwata EPA: An Economic analysis
02/02/2000

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Introduction and background

The pigeoenpea trial at Mangunda was first initiated in 1997/98. The varieties that were tested during the first year included those being used in the main intercropping IPM on-farm trials, namely, ICP 9145, Matapwata local, ICEAP 00040 and ICEAP 00053. Two medium duration varieties (Royes and QP 38) that were previously included in a variety trial at Thuchila in 1996/97 seasons were also included. A further variety, ICEAP 00020, supplied by ICRISAT was also included. Farmers' evaluation of that trial showed preference for ICEAP 00020, ICEAP 00040, ICEAP 00053 and ICP 9145. Farmers agreed to continue the trial with these varieties in the 1998/99 season.

In the first year, the majority of the plots had a sole crop pigeon pea. One farmer, however, lost her superimposed pigeon pea crop in maize field and did not want an intercrop arrangement. Farmers first thought of planting pigeon peas as sole crop but later changed to intercropping because of shortage of land. To have a better comparison between the 1997/98 and 1998/99 seasons, farmers and researchers agreed to have sole and intercropped plots side by side. Three other medium duration varieties from ICRISAT, Nairobi, ICEAP 00068, ICEAP 00073 and ICP 6927 were included in the trial to assess their suitability in terms of yield and other qualities considered by farmers to be important. due to an error by the seed supplier, no seed of ICEAP 00020 was available for the trial and it is, therefore, omitted for consideration in this report.

The specific trial objectives were as follows:

- To enable farmers to assess the influence of intercropping and sole cropping on growth and yield of four long duration varieties.
- To obtain farmers' assessment of the suitability of four medium and long duration varieties in terms of yield and other qualities considered by farmers to be important.
- To compare levels of resistance/tolerance *to Fusarium* wilt with 8 pigeon pea varieties in farmers' fields under farmer management
- To assess susceptibility of medium and long duration varieties to pests and other diseases under farmer management

Trial Results and discussion

Table 1 presents yield summaries for economic evaluations of pigeon pea production for both long duration and medium duration varieties. The mean values for usable seed weight for long duration varieties according to type of cropping pattern is shown in Table 2. Statistically, there were significant differences in mean usable seed weight for both long duration and medium duration pigeon pea varieties.

The economic analysis

Table 3 compares the economic returns of long duration pigeon pea varieties under different cropping patterns.

Under sole cropping, ICP 9145 showed the greatest gross benefits after adjusting yields downward by 20% to allow for farmer management, seconded by ICEAP 00040 and ICEAP 00053 had the least gross benefits. The values of gross benefits were K 3,250 /ha, K 3,182/ha and K 612/ha for ICP 9145, ICEAP 00040 and ICEAP 00053 respectively.

The trend was similar for the intercropped pigeon peas, with ICP 9145 getting the most gross benefits, followed by ICEAP 00040 and again ICEAP 00053 had least gross benefit.

Of the two cropping systems, sole cropping was superior to intercropping on the per hectare gross benefits, except for ICEAP 00053 which registered higher gross benefits under intercropping system.

When variable costs are taken into account, farmers realise higher benefits when pigeon peas are grown as intercrop than when they are grown as sole crops. The higher yields under sole cropping do not compensate for the increase in cost of labour when you sole crop pigeon peas. Returns over variable costs were all negative with sole cropping compared to positive returns to variable costs for intercropping. Under an intercropping system, pigeon peas are just an additional benefit to the farmer because the same field operations (land preparation, weeding, ridging and banking) he does for maize-the main crop, are also beneficial for the pigeon peas.

The benefit-cost (B/C) ratios for sole cropping for all varieties are below unity. A benefit cost ratio of two would economically justify the production of pigeon peas under sole cropping system. For the intercropped pigeon peas, the B/C ratios for both ICEAP 00040 and ICP 9145 were almost similar at above 4 but returns to labour were higher for ICP 9145 at K 107 per day compared to K 95/day. The yield advantage of sole cropping was not enough to compensate the loss in benefits due to high labour input cost.

The economic returns of long duration and medium duration pigeon peas are compared in Table 4.

In terms of both gross and net benefits, ICEAP 00040 and ICP 9145 were superior to all the medium duration varieties except for ICEAP 00073. ICEAP 00040 and ICP 9145 had gross benefits of K 2693/ha and K 2958/ha respectively while the other three medium duration varieties had K 2108/ha for Chilinga, K 2536/ha for ICEAP 00068 and K 1122/ha for ICP 6927. The highest benefits were realised with the medium duration variety ICEAP 00073 with a gross field benefit of K 4,196/ha and net benefit of K 3577/ha, a net benefit even higher than any of the gross benefits of the other varieties. ICEAP 00073 had also the highest benefit cost ratio (6.79) and returns to labour (K 165/day).

Conclusions

There are substantial losses in net benefits when pigeon peas are sole cropped. It is shown that farmers may be better off economically by planting pigeon pea as an intercrop.

All varieties, except for ICP 6927 and ICEAP 00053 had strong economic indicators that would justify their production under intercropping system. These varieties had a B/C ratio of above three. ICEAP 00073, however, was the most superior of all the pigeon pea varieties that were tested, given also its high yielding characteristic.

Although ICP 9145 was superior to ICEAP 00040 both under sole cropping and intercropping, the difference in both gross and net benefits were only marginal.

Overall, the long duration pigeon peas performed better than medium duration pigeon peas economically.

Table 1: Mean values for a range of yield parameters for medium and long duration pigeon pea varieties under intercropping system

Variety	Duration to maturity	Usable seed weight (kg/ha)	Weight of 100 seeds (gm)	Mean number of seeds per pod
Chilinga	Medium	310	17.3	5.1
ICEAP 00068	Medium	373	20.1	5.3
ICEAP 00073	Medium	617	18.8	5.4
ICP 6927	Medium	165	19.8	5.4
s.e. (diff. in means		99.5	2.44	0.233
Sig. Prob.		P=0.007	P=0.621	P=0.673
ICEAP 00040	Long	432	20.0	5.2
ICEAP 00053	Long	114	22.0	4.5
ICP 9145	Long	457	19.5	4.9
s.e. (diff. in means		82.6	1.7	0.214
Sig. Prob.		P=0.001	P=0.33	P=0.017

Table 2: Mean values of yield parameters for long duration varieties according to cropping pattern

Variety	Cropping pattern	
	Intercropped Kg/ha	Sole cropped Kg/ha
ICEAP 00040	396	468
ICEAP 00053	137	90
ICP 9145	435	478

Table 3: Economic evaluation of long duration pigeon peas in Mangunda under sole cropping and intercropping (1998/99)

Variable	Sole cropped			Intercropped		
	ICEAP 00040	ICEAP 00053	ICP 9145	ICEAP 00040	ICEAP 00053	ICP 9145
Benefits						
Yield (kg/ha)	468	90	478	396	137	435
Adjusted yield (kg/ha)[1]	374.4	72	382.4	316.8	109.6	348
Unit price (MK/kg)	8.5	8.5	8.5	8.5	8.5	8.5
Gross benefits	3182	612	3250	2693	932	2958
Variable costs						
Materials (MK/ha)						
Seed	120	120	120	120	120	120
Fertiliser	0	0	0	0	0	0
Credit	0	0	0	0	0	0
Labour requirements[2] (Hours/ha)	850	850	850	130	130	130
Labour for intervention (hours/ha)	0	0	0	0	0	0
Total labour requirements (hours/ha)	850	850	850	130	130	130
Unit price (MK/day)[3]	23	23	23	23	23	23
Imputed labour cost (MK/ha)	3258	3258	3258	498	498	498
Total costs	3378	3378	3378	618	618	618
Net benefits						
Return over variable costs (MK/ha)	-196	-2766	-128	2074	314	2340
Benefit-cost ratio (full-cost basis)	0.94	0.18	0.96	4.35	1.51	4.78
Benefit cost-ratio (cash cost basis)	26.52	5.10	27.09	22.44	7.76	24.65
Gross returns to labour (MK/day)	-1.38	-19.53	-0.90	95.74	14.46	107.98

[1] Yield is adjusted downwards by 20% reflecting farmer management

[2]For intercropping system, labour requirements are only for planting and harvesting pigeon pea. Pigeon pea is just a secondary crop to maize, the main crop. Full labour requirements are given where pigeon pea is sole cropped. Source for labour requirements – Liwonde ADD Adaptive Research Report

[3] wage rate for estate labour 1998/99 season for male

Table 4: Economic evaluation of Pigeon pea production in Mangunda- Long duration varieties Vs medium duration varieties (1998/99)

Variable	Long duration varieties			Medium duration varieties			
	ICEAP 00040	ICEAP 00053	ICP 9145	CHIL INGA	ICEA P 00068	ICEAP 00073	ICP 6927
Benefits							
Yield (kg/ha)	396	137	435	310	373	617	165
Adjusted yield (kg/ha)	316.8	109.6	348	248	298	493	132
Unit price	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Gross benefits	2693	932	2958	2108	2536	4196	1122
Variable costs							
Materials (MK/ha)							
Seed	120	120	120	120	120	120	120
Fertiliser	0	0	0	0	0	0	0
Credit	0	0	0	0	0	0	0
Labour requirements (Hours/ha)	130	130	130	130	130	130	130
Labour for intervention (hours/ha)	0	0	0	0	0	0	0
Total labour requirements (hours/ha)	130	130	130	130	130	130	130
Unit price (MK/day)	23	23	23	23	23	23	23
Imputed labour cost (MK/ha)	498	498	498	498	498	498	498
Total costs	618	618	618	618	618	618	618
Net benefits							
Return over variable costs (MK/ha)	2074	314	2340	1490	1918	3577	504
Benefit-cost ratio (full-cost basis)	4.35	1.51	4.78	3.41	4.10	6.79	1.81
Benefit cost-ratio (cash cost basis)	22.44	7.76	24.65	17.57	21.14	34.96	9.35
Gross returns to labour (MK/day)	95.74	14.46	107.98	68.75	88.53	165.10	23.25

Annex: economic definitions

Adjusted yield: adjusted yield for a treatment is the average yield adjusted downward by a certain percentage to reflect the difference between the experimental yield and the yield farmers could expect from the same treatment.

Gross benefits: values adjusted yield for each treatment. It is calculated by multiplying the unit price by the adjusted yield.

Unit price: the value of one kilogram of the crop prior to harvest or input at planting

Variable costs-: those costs that differ across treatments

Total costs that vary: is the sum of all costs that vary for a particular treatment

Imputed labour costs: is calculated by multiplying wage rate by total labour days. One Labour Day = 6 hours

Return over variable costs/net benefits: the difference between the total costs that vary from the gross benefits for each treatment-

Benefit cost ratio- full cost basis: divides gross benefits with total costs that vary. Generally, a benefit cost ratio of 2 is the minimum required for farmers to accept a crop management innovation.

Benefit cost ratio- cash basis: is calculated by dividing gross benefits by total costs that vary less cost of labour

Gross returns to labour: is calculated by dividing returns over variable costs by total man-days.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

Modelling Integrated Pest Management Decisions of Smallholder Farmers in Blantyre Shire Highlands

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Abstract

*A set of linear programming farm models were developed to analyse IPM options decisions of typical household groups in Blantyre Shire Highlands that will maximise their net returns subject to resource constraints. The farmer's objective function was supposed to be linear in regard to net return, where net return is defined to be the value of all crop enterprises produced in excess of the survival requirements plus wage earnings minus expenditures for production of all activities including hiring of labour. The IPM strategies included varietal resistance in beans and pigeon peas, cultural methods for sweet potato weevil (crack sealing in ridges) and maize (not banking for termite management), seed dressing for whitegrub in maize, and trap cropping with Tephrosia for striga control. The results based on all five typical smallholder farmer groups illustrates that farm plans with IPM interventions (composite maize seed-dressed with GauchoT against whitegrub and improved pigeon pea variety ICEAP 00040 against Fusarium wilt) gives smallholder farmers higher profits than farm plans without IPM interventions. The increase in profits ranges from 10.78% to 14.52% depending on household group, with Stable Male household cluster getting the most profit increase (14.52%) and the burley household cluster the least increase in profits of 10.78. Overall, the mean increase in profits for clusters was **12.84%**. Farm plans with IPM strategies also ensure food security at household level for all households and release some family labour for off-farm employment opportunities for some household groups, thus generating extra income for the households. Overall, linear programming models suggest that combining crop enterprises with IPM interventions will give smallholder farmers in Blantyre Shire Highlands the most desirable result- the one that attains the highest profit, output and ensures household food and income security.*

1.0 Introduction

Food Security and poverty alleviation remain the Government of Malawi's priority objectives. Since 1996/97 season, the Farming Systems Integrated Pest Management (FSIPM) Project has been researching on IPM options for the field pests in maize, sweet potato, pigeon peas and beans using a variety of cultural, genetic and chemical strategies. The ultimate goal of the project was to develop, in collaboration with farmers, integrated pest management strategies that would maintain the pest population below an economic damage level, therefore, contributing to the Government's objective of food security. An economic analysis of the trials (Mwale 2,000) showed that most of the IPM options considered were economically justifiable when all variable costs were taken into account. These options included use of cultural, variety resistance and chemical controls.

However, farmers' decisions to adapt to changing technological advancement can not be taken for granted. Individual farmers must repeatedly make decisions about what commodities to produce, by what method and in what quantities. Crop production may involve choices about varieties (local or improved), cultural requirements (labour intensive or labour saving) and cost of pesticide treatments. Or the production options open to the farmer may be restricted by the farmer's desire to be self-sufficient in feeding his family or by his desire to avoid risks. These are complex decisions a farmer must repeatedly face. Traditionally, farmers have relied on experience, intuition, and comparisons with their neighbours to make these decisions. Formal techniques of budgeting and comparative analysis have been developed by farm management specialists but these can be useful aids for making decisions in less complex situations or for analysing selected decisions when all the other farm decisions are taken as given.

Whole-farm planing can assist farmers in efficiently adapting to a changing economic and technological environment. The mathematical programming format- ***sometimes known as process analysis or activity analysis***- is particularly suitable for analysis of whole-farm planning. There are many examples of this normative use of linear programming in the literature. This paper describes a linear programming model that captures a farm plan that will yield the most desired combination of crop enterprises with IPM options plus non-crop enterprises for a typical representative household in Blantyre Shire Highlands.

The major objective of the paper is, therefore, is to analyse IPM options decisions of typical household groups in Blantyre Shire Highlands that will maximise their net returns subject to resource constraints. The farmer's objective function is supposed to be linear in regard to net return, where net return is defined to be the value of all crop enterprises produced in excess of the survival requirements plus wage earnings minus expenditures for production of all activities including hiring of labour.

Specifically, we

- Model whole-farm plans with IPM options of typical households clusters to identify the most profit maximising enterprise / enterprise mix taking into account resources available at farmers' disposal

- Model whole-farm plans without IPM interventions of a typical smallholder farmer based on the existing farmer practice, and

- Compare the profits of whole farm plans with IPM options and the associated levels of real activities and optimal resource use to that of farmers' practice and determine the best farm plan decision between the two.

2.0 The project area and target pests

The Farming Systems IPM (FSIPM) Project has been operating in the Blantyre Shire Highlands Rural Development Project (RDP) for the past three years. The cropping system is maize dominated. Pigeon peas and beans are the main intercrops. Relay planting of beans is a common practice but has been declining in the recent years due to (1) recent changes in weather pattern, characterised by droughts and or frequent dry spells and early stoppages, and (2) substitution effects of sweet potato and field peas which have also become important components of household food and income security strategy (Mwale et.al, 1999).

The target pests of food crops in the RDP were identified through surveys between 1990/92 and the results showed that termites, whitegrubs and *Striga asiatica,* bean stem maggot (*Ophiomyia spp.*) and *Ootheca* as major pests of beans. *Fusarium* wilt was identified the disease of pigeon pea (Munthali et. al., 1993). These rankings were confirmed by a stakeholder Workshop of Malawian crop protection professionals and by diagnostic surveys using participatory techniques in four villages in Mombezi and Matapwata EPAs (Orr *et.al.*,1996). Sweet potato weevil (*Cylas puncticollis*) is also a major constraint to smallholder sweet production. Field crop losses from these pests in the RDP have recently been estimated at 15% of the total value of crop production. This ranges from 1% to 30% (Mwale et al. 1999).

3.0 Data and Methods

Cluster analysis was used to identify representative farm households for modelling (Orr and Jere, 1998). The results of the analysis showed that smallholders in the project area could be stratified into five broad groups:

- *Dimba* households (one third of which were FHHs) producing maize and vegetables

- Stable male-headed households (MHHs) producing neither vegetables or burley tobacco, but enough maize to be reasonably food secure

- Vulnerable households which produced neither vegetables nor burley tobacco, without enough maize to be food secure

- Burley households which did not produce vegetables but enough maize to be reasonably food secure

- Stable female-headed households (FHHs) which produced neither vegetables nor burley tobacco, but enough maize to be reasonably food secure

Data for constructing partial budgets (crop yields, losses or loss reduction) were obtained from On-farm trials (OFTs). Labour inputs were from own trial recordings plus other secondary sources. Input and output prices included those from local markets (obtained through informal surveys during marketing days) plus official ADMARC prices for the 1998/99 season for fertiliser and consumer prices. Average land holding sizes for each cluster were based on baseline survey of the project. The consumer maize price of K8.50 per kilogram was used in the modelling. The assumed interest rate on agricultural credit is 37%. Wage rates, for hired labour and off-farm family labour , were drawn from representative sample village households who were monitored between November 1998 and September 1999 (Orr et.al. 2000). The rates generally ranged from K25 – K30/day of six working hours per day depending on the type of activity.

The cropping activities with IPM interventions that were modelled included: -

- Composite maize with *Tephrosia* incorporation for striga,

- early maturing bean variety, Kaulesi,

- improved pigeon pea ICEAP 00040 for *Fusarium* wilt,

- sweet potato in the dambo intercropped with field peas with additional *crack sealing* to prevent entry by sweet weevil *(Cylas puncticollis)* [Pardales and Cerna, 1987],

- composite maize seed- dressed with *GauchoT* for whitegrub; and

- composite maize without *banking* for termite management.

These crop enterprise plus other non-crop enterprises were modelled in a spreadsheet software, 'WHAT'S BEST' for each cluster to solve farm plans that yield the most desirable result- the one that attains the highest profit, output, or happiness or the one that achieves the lowest cost or discomfort.

4.0 Applying the LP Model

4.1 A Conceptual framework

In mathematical terms, the linear programming model can be written as follows:

$$\max Z = \sum_{j=1}^{n} c_j X_j \qquad \text{equation 1}$$

Such that

$$\sum_{j=1}^{n} a_{ij} X_j \le b_i, \quad \text{all } i = 1 \text{ to } m \qquad \text{equation 2}$$

and

$$X_j \ge 0, \quad \text{all } j = 1 \text{ to } n \qquad \text{equation 3}$$

where:

X_j = the level of the *j* th farm activity, such as hectares of sweet potato grown. Let *n* denote the number of possible activities; then *j*=1 to *n*.

c_j = the forecasted gross margin of a unit of the *j* th activity (e.g. MK per ha)

a_{ij} = the quantity of the *i* th resource (e.g. hectares of land, days of labour) required to produce one unit of the *j* th activity. Let *m* denote the number of resources; then *i*= 1 to *m*.

b_i= the amount of the *i* th resource available (e.g. hectares of land, days of labour).

In words, the problem is to find the farm plan (defined by a set of activity levels X_j, $j = 1$ to n) that has the largest possible total gross margin Z, but which does not violate any of the fixed resource constraints (equation 2) or involve any negative activity levels (equation 3).

The problem defined in equations 1 to 3 is portrayed in **Table 2**, a matrix showing all the coefficients of the algebraic statement of the model.

A number of assumptions about the nature of the production process, the resources, and activities are implicit in the linear programming model equation 1 to 3.

- *Optimisation:* It is assumed that an appropriate objective function is either maximised or minimised. In all the models, total gross margin is maximised.
- *Fixedness*: at least one constraint has nonzero right hand side coefficient
- *Finiteness:* it assumed that there are only a finite number of activities and constraints to be considered so that a solution may be sought

- *Determinism:* all c_j, a_{ij} and b_i coefficients in the model are assumed to be known constants.
- Homogeneity: it is assumed that all units of the same resource or activity are identical
- *Continuity.* It is assumed that resources can be used and activities produced in quantities that are functional units
- *Additivity:* the activities are assumed to be additive in the sense that when two or more are used, their total product is the sum of their individual products. That is, no interaction effects between activities are permitted.
- *Proportionality:* the gross margin and resource requirements per unit of activity are assumed to be constant regardless of the level of the activity used. A constant gross margin per unit of activity assumes a perfectly elastic demand curve for the product, and perfectly elastic supplies of any variable inputs that may be used. Constant resource requirements per unit of activity are equivalent to a Leontief production function (that is, a linear ray through the origin).

4.2 Operationalising the model

In this section, a set of simple linear programming models is developed to predict the choices of enterprise (s) that will form a farm plan that maximises revenue for the five smallholder clusters in Blantyre Shire Highlands. The model is kept as simple as possible in an attempt to reach a wide audience. To simplify the exposition further, single general model is developed, **Table 3.** This model is then made more specific to different types of household clusters by appropriate alteration of resource availability (e.g. cultivated land and days of labour etc) and enterprises. Where a particular crop enterprise is completely inapplicable for a household type, the activity is effectively excluded by either fixing the adjustable values for that activity to zero or just removing the entire activity.

4.2.1 Activities

The farming activities entering the LP Model include all crop enterprises with IPM options (composite maize without banking against termite, composite maize seed dressed with GauchoT against whitegrub, composite maize with *Tephrosia* incorporated, use of Kaulesi beans against pests, growing of ICEAP 00040 pigeon pea against Fusarium wilt, sweet potato with additional crack sealing against Cylas weevil. The LP model is set up to maximise net monetary returns to selected cropping and non-cropping activities, subject to a set of constraints on resource availability and subsistence needs. Two general LP Models are developed for each cluster, one with crop enterprises that had integrated pest management strategies and the other one with farmers' existing practice. Additional crop enterprises relevant to the models were maize intercropped with pulses, cassava, and local pigeon peas. For some household groups, cabbage, tomato and burley were also important farm activities. A smallholder decision making for weed control in Blantyre Shire Highlands study (Chamango, A.M.Z., 1999) showed that timely weeding has an economic advantage over late weeding. Thus, maize enterprises with early weeding and late weeding were also included in the farm activity alternatives.

Other activities entering the objective function are purchase of maize for home consumption, payment of interest for inputs acquired on credit, allocation of household labour to off-farm employment and hiring of agricultural labour for crop production. Off-farm and hired labour are each disaggregated into six time periods, each period spanning from one month to four months. The objective function coefficients for cropping activities are the gross margin/net returns per ha indicated by the budgets in **Table 4.** Thus, separate activities are not specified for seed, pesticide and fertiliser purchase; these are already embodied in the net returns from the budgets and do not need to be repeated in the LP model. A list of variable names of real activities/enterprises used in the LP model appears with brief variable descriptions in **Table 5.**

4.2.2 Constraints

There are twenty-two constraints in the general model that represent a range of constraints applicable to smallholder farmers.[1]

The first row of the constraint matrix, labelled **Land**, simply specifies that the sum of the areas allocated to each crop or crop mix cannot exceed the total amount of land available to the household. This land constraint specifically applies to maize, pulses, sweet potato and cassava crop enterprises. Two additional land constraints, BurMaxland and MaxlandD , restricting the amount of land allocated to burley and vegetables for the Burley and Dimba households respectively. Under the Smallholder Food Security Programme, smallholder farmers are given inputs to grow burley tobacco on 0.10 ha of land. The forth constraint, labelled **FoodSec**, is the ***safety-first constraint*** – as described by Low **(1974)**- that requires the household to have enough grain or cassava or sweet potato available to meet household requirements, estimated here as 200 kilograms per capita. This amount falls within the range of calorie requirements specified by **FAO** (1973) for moderately to very active persons, taking into consideration the household compositions, individual body weights, and dietary patterns typically found in Blantyre shire highlands. This staple food can come from maize purchases or household own production of local or hybrid maize, sweet potato or cassava.

The fifth constraint, labelled **Budget**, requires that the household's expenditures on maize, hired labour, and interest payments do not exceed the total value of earnings from crop production and off-farm employment. The sixth constraint, labelled **Inputbuy**, restricts the amount that can be spent on crop inputs such as seed, fertiliser and chemicals to the cash available at the beginning of the season plus any credit made available. The seventh constraint, **CashAvl**, is a simple identity used to capture the timing of expenditure using any cash held at the beginning of the cropping season. In this model, we have used cash earned through agriculture sales, gifts and other Income generating activities (IGAs) that we found in our representative village households during the months of December 1998 –February 1999 (Orr et al. 2000). The eighth constraint, **SeasCons**, limits the amount that can be spent on maize and hired labour to the amount of savings remaining after purchasing non-labour inputs plus earnings from off-farm employment.[2] The next constraint, labelled **Creditmax,** restricts the amount of credit available to some predetermined value. Taken together, these four constraints add considerable realism to the model by preventing the household from financing operations by dissaving, which is not a realistic option for most households, and not sustainable option for any household. The set of the four constraints also captures some liquidity crunch that leads to many smallholders to seek off-farm employment to earn food, or wages with which to buy food, during the growing season.

The **MinMix** constraint is crude attempt to account for risk and improve realism of the LP model by requiring the optimal solution to include some of the cropping diversity that is shown in most smallholder cropping patterns in Blantyre Shire Highlands. Specifically, the

[1] In addition to these twenty-two constraints, there are thirty-two non-negative constraints restricting each of the 32 activities to values that are greater or equal to zero
[2] Households would only use off-farm earnings to finance hired labour if a member of the household can earn an off-farm wage above that paid to farm labourers. Otherwise, households would typically use family labour instead of hired labour, as long as family labour is sufficient. This is taken care in the LP model by setting hired labour wages of hired labour K5.OO higher than off-farm wage. The difference may be interpreted as the supervisory cost to the household of managing hired labour.

constraint requires that at least one-sixth of the total area under cultivation be allocated to maize intercropped with pulses. Pulses are important as relish ingredients and risk spreaders.

The next six constraints limit labour input for crop production in each of the six periods to available family labour plus any hired labour, less any time that family members work off-farm. The six periods are June-September, October-November, December, January, February-March, and April-May. The number of family members available for agricultural labour is estimated at 50% of the household size, and each member is assumed to be available to work an average of 15 days except for December and January, when illness (and possibly food shortages) reduces his number to 12 days. These numbers may appear too low because they take into account of other demands on time, including gathering firewood, fetching water, food preparation, and community social and ceremonial obligations. The last six constraints limit the number of person days per a household can allocate labour to work off-farm between the same periods to a maximum of 30 mean man-days per month. The number of days for ganyu varied depending on cluster and has a strong season pattern since it depends chiefly on employment from agriculture. The data on labour requirements for each cropping activity were from secondary sources.

5.0 Results and discussions

All the linear programming models yielded outputs that were feasible i.e. no resource was used above what the particular household had. Tables 6 and 7 summaries the results in terms of profits, choice of enterprises and the associated resource usage to achieve the desired output.

It is clear from Table 6 that farm plans with IPM options give smallholder farmers the most desirable mix of enterprises – farm plans that yield the highest profit. Given their current constraints, farmers would be happier by practising IPM than following their current practices in pest management. The increases in profits from the farmers' practice were MK 1,654 (14.52%) for Stable Male households, MK 1,108 (13.9%) for Stable Female households, MK 827 (11.35%) for Vulnerable households, MK 1,289 (10.7%) for burley households and MK 1,413.00 (13.73%) for Dimba household cluster. $\bar{x}$ 12.84%

The adjustable cells give the levels of the real farm activities constituting a particular farm plan. Composite maize seed-dressed with GauchoT for whitegrub was a common enterprise in all the farm plans with IPM options. Except for Burley households, improved pigeon pea (ICEAP 00040) also entered into the farm plans for the stable male, stable female dimba and vulnerable households when IPM interventions were taken into account. Maize intercropped with pulses was also included in all the farm plans to reflect the reality of Blantyre Shire Highlands where maize is grown with pulses such as beans and pigeon peas. The non-farm enterprises in the farm plans off-farm employment in form of ganyu. Farm plans with IPM had more days allocated to off-farm employment than those plans without IPM. Vulnerable households had the least off-farm man-days, 12, compared to 80.63 man-days for burley households, 72.87 man-days for Stable Male households, 42.75 man-days for Stable Female households and 25.52 man-days for Dimba households.

Hiring of labour was only observed in the Stable Male (7.13 man-days) and Burley (2.82 man-days) households farm plans with IPM strategies. These households hired additional labour in the month of January. Understandably, this is a labour peak period, especially for banking and topping in tobacco. Cabbage did not enter the farm plan for the Dimba household despite having a higher gross margin than tomato. Cabbage is generally a high input vegetable than tomato, particularly in terms of fertiliser, pesticide use and transport costs.

On resource use, all the farm plans with IPM except for the Burley household used less labour than farm plans without IPM crop enterprises. The Burley household farm plan with IPM required extra 5 man-days above the man-days requirements for the farm plan without IPM. For the Stable Male, Stable Female, Vulnerable and Dimba households, they had 5 man-days, 14 man-days and 8 man-days less in their farm plans with IPM than in those farm plans without IPM. In the farm plans with IPM, reduction in labour days partly came from the substitution effects of Local maize without fertiliser and /or cassava with ICEAP 00040. ICEAP00040 grown as intercrop requires much less labour input than Local Maize without fertiliser or cassava.

Reduction in total man-days for farm activities in the farm plans with IPM had a positive effect on the total off-farm employment while an increase in total man-days had the opposite effect. For all households, except Burley, reduction in farm activities' man-days in the farm plans with IPM resulted in increases in the number of off-farm employment man-days, although the increase was not necessarily equal to the reduction in farm activities' man-days. Similarly, an increase in farm activities' man-days for the Burley household cluster resulted in the reduction in off-farm employment man-days. The increase in number of off-farm man-days ranged from 1 to 19 man-days. The Stable Male and Stable Female households shared almost the same increase (approximately 19 man-days), Vulnerable household had 5 more man-days while the Dimba household had only 1 man-day difference (see Table 7).

All farm plans with IPM options also ensured food security at household level. They all resulted in extra maize production above the households' own requirements of 200kg per capita per year as follows: 822 kg for Stable Male, 498 kg for Burley household, 327 kg for Dimba household, 73kg for Vulnerable household and 6kg for Stable Female household.

All farm plans with IPM, except for Burley household, also yielded high cash earnings that the households could use to buy maize and hire labour or purchases other household needs to the amount of savings remaining after purchasing non labour inputs plus earnings from off-farm employment. The Stable male had the highest earning of MK 1,357 compared to MK 1,080 for Stable Female, MK 300 for Vulnerable household and MK 638 for Dimba household.

The dual cells in each of the LP Model report the shadow prices (or dual values) for the fixed resources and constraints that are fully used or of an adjustable cell. These shadow prices are calculated for each resource as the cost to the objective function value if one unit of the resource were withdrawn from use by increasing the corresponding slack activity by one unit. All shadow prices for fixed resources and constraints are, therefore, negative. The negative of a shadow price indicates the maximum amount by which the model's objective function could be increased if an additional unit of the resource were to become available. In three out of five clusters, farm plans with IPM options had higher shadow prices for land than farm plans without IPM strategies. The shadow price for land for Stable Male household farm plan with IPM, for example, was MK–1,854 compared to MK –1,341 for the farm plan without IPM options. This implies that the farmer should be willing to pay a higher maximum rent for an extra hectare of land beyond his 0.92 hectares if he adopts IPM farm plan than if he continues with a farm plan without IPM interventions. In other words, the value of land increases with adoption of IPM strategies.

6.0 *Conclusion*

Results of the LP Models based on typical farmer households in Blantyre Shire Highlands illustrate that farmers will maximise their returns if in their farm plans they adopt IPM strategies- seed dressing with GauchoT in maize against whitegrub and they grow pigeon pea variety ICEAP 00040. These farm plans also ensure that smallholder farmers will be food-secure, a primary objective a typical smallholder farmer in Malawi. Farm plans with IPM options also release some of the family labour for off-farm employment, thus giving the farmers an opportunity to generate extra income for the household. The rent value of land also increases with IPM options. Overall, LP modelling suggests that farm plans that take into account integrated pest management options maximise farm profits and ensure household food security in Blantyre Shire Highlands and increases the value of land, the most important fixed resource that farmers have.

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Table 1: IPM interventions modelled, FSIPM Project

Existing enterprises	IPM intervention
Unfertilised hybrid maize	
Unfertilised local maize	
Fertilised local maize	
Local maize with striga	Trap crops i.e. Tephrosia, cow peas, Crotalaria
Unfertilised composite maize	
Fertilised composite maize with striga	Trap crops i.e. Tephrosia, cow peas, Crotalaria
Fertilised composite maizè with termite	Not banking
Fertilised composite maize with whitegrub	Seed dressing with GauchoT
Beans with BSM, main intercrop	Resistant bean variety
Field peas	
Modern variety pigeon pea	
Pigeon pea with fusarium wilt	Resistant pigeon pea variety
Sweet potato in the dambo with weevils	Crack sealing
Sweet potato in the upland with weevils	Crack sealing
Fertilised hybrid	
Cabbage	
Tomato	
Fertilised maize with late weeding	
Fertilised maize with early weeding	
Cassava	

Table 2: Linear Programming Tableau in algebraic form

		Activities			
Constraints	**LHS**	X_1	X_2	....	X_n
Objective Function	Maximise	c_1	c_2	....	c_n
Resource constraints					
1	$b_1 \geq$	a_{11}	a_{12}	......	a_{1n}
2	$b_2 \geq$	a_{21}	a_{22}	......	a_{2n}
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M	$b_m \geq$	a_{m1}	a_{m2}	....	a_{mn}

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Table 3: Generalised Linear Programming Model

									LMZNF	LMZF	CMZNB	CMGAU	BUR	CMZST	KAUL	PP40	LOPPE	SWPFP	CASS	MMX	BYMZ
Profit	**0**								ha	Ha	Ha	ha	ha	Ha	Ha	ha		ha	ha		
							Gross Margin		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	.13850	12459	-8.5
							Adjustable value		0.36	0.00	0.00	0.22	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.135	0.00
							Dual		0.00	8593	1668	0.00	9357	15496	8232	0.00	1581	37480	10917	0.00	8.50
		Resource Availability by cluster																			
Constraint	**Units**	**Smh**	**Sfh**	**Vnh**	**Dhh**	**Bur**	**Sign**														
Land	Ha	0.92	0.83	0.81	0.89	0.85	>=	0	1	1	1	1		1	1	1	1	1	1	1	
MaxlandD	Ha				0.052		>=	0													
BurMaxland	Ha					0.1	>=	0					1								
Inputbuy	Kg	890	926	934	1018	1182	Not <=	0	213	2839	3626	3626	4619	3626	3000	120	120	12106	6172	6746	
Creditmax	Mk	900	800	0	1700	3200	>=	0													
FoodSec	Mk	0	0	0	0	0	=>=	0	900	1250	2331	2763	0	883							
Budget	MK	0	0	0	0	0	<		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5
MinMIx	Mk	0	0	0	0	0	<=	0	1	1	1	1	1	1	1	1	1	1	1	-5	
CashAvl	Mk	2400	1400	1800	1500	1100	Not <=	0													
SeasCons	Ha	0	0	0	0	0	<=	0													-8.5
Jun-sepLab	Mday	134	139	140	153	177	>=	0	28	28	28	40	97	28		18	17	12	31	18	
OcNovLab	mday	66	69	70	76	88	>=	0	18	18	35	35	15	35	28	5	5	48	40	57	
DecLab	mday	26	28	29	31	35	>=	0	25	25	30	30	17	28	0	0	0	8	2	10	
JanLab	mday	26	28	29	31	35	>=	0	25	30	6	48	55	28	0	0	0	50	17	22	
FebMaLab	mday	53	56	58	62	70	>=	0	4	0	0	0	178	14	19	0	0	47	4	14	
ApMayLab	mday	66	69	70	76	88	>=	0	10	10	30	41	96	20	0	0	0	15	32	27	
OFFJSEPT	mday	30	10	0	2	30	>=	0													
OFFOCNV	mday	17	2	0	6	15	>=	0													
OFFDEC	mday	23	14	5	2	15	>=	0													
OFFJAN	mday	15	10	7	3	8	>=	0													
OFFEBMR	mday	0	4	0	6	4	=>=	0													
OFFAPMAY	mday	10	4	0	8	18	=>=	0													

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Table 3 conti.

	CREDIT	CSHS	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	CABB	TOMA	MZWL	MZW
	-0.37			25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13,644	13,058	8248	12348
	0.00	0.00	1800	0.00	0.00	5.00	6.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constraint																			
Land																			
MaxlandD Ha																1	1		
BurMaxland Ha																			
Inputbuy	-1		-1													7204	3756	3626	3626
Creditmax	1																		
FoodSec																		1838	2342
Budget	-0.37	0	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13644	13058	8248	12348
MinMix																		1	1
CashAvl		1	1																
SeasCons		1		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30				
Jun-sepLab				1						-1						43	543	28	28
OcNovLab					1						-1					0	0	35	35
DecLab						1						-1				0	0	30	30
JanLab							1						-1			0	0	40	48
FebMaLab								1						-1		120	126	0	0
ApMayLab									1						-1	1180	800	30	30
OFFJSEPT				1															
OFFOCNV					1														
OFFDEC						1													
OFFJAN							1												
OFFEBMR								1											
OFFAPMAY									1										

Table 4: Partial budgets per ha for LP Models

Sweet potato intercropped with field peas in the dambo	**With additional crack sealing**	**No additional crack** sealing
Seed/planting material cost	12,106	1251
Labour cost	4416	4416
Fertiliser cost	0	0
Other material costs	0	0
Total cost	16,522	16,522
Total value	24,731	19,911
Net return	**8209**	**4746**
Beans	**Kaulesi**	**Kalima beans**
Seed cost	4000	1500
Labour cost	1073	1073
Fertiliser cost	0	0
Other material costs	0	0
Total cost	5073	5073
Value of production	10,440	4080
Net return	**5367**	**1507**
Composite maize with whitegrub	**Maize seed dressing**	**No seed dressing**
Seed cost	1000	1000
Labour cost	3258	3258
Fertiliser cost	2626	2626
Other material costs GauchoT	1190	0
Total cost	8074	6884
Value of production	23,486	29,889
Net return	**15412**	**13015**
Composite maize with termite	**Without banking**	**With banking**
Seed cost	1000	1000
Labour cost	2607	3258
Fertiliser cost	2626	2626
Other material costs GauchoT	0	0
Total cost	6233	6884
Value of production	1,9162	16,014
Net return	**12,929**	**9130**
Composite maize with striga + pigeon peas	**With Tephrosia**	**Without ant legume**
Seed cost	1120	1120
Labour cost	4205	3757
Fertiliser cost	0	0
Other material costs	0	0
Total cost	5325	4877
Total output value	5766	4896
Net return	**441**	**19**

Pigeon peas intercrop	ICEAP 00040	Local
Seed cost	120	120
Labour cost	498	498
Fertiliser cost	0	0
Other material costs	0	0
Total cost	618	618
Total value	4463	2882
Net return	**3845**	**2264**
Burley		**Cassava**
Seed cost	26	7552
Fertiliser cost	3860	0
Labour cost	10534	2898
Other material costs	663	0
Total cost	15,083	10,450
Value of production	26,086	24,300 (2700 kg @ K9/~~head~~ kg)
Net return	**11,000**	**13,850**
Tomato		**Cabbage**
Seed cost	1,050	1,050
Fertiliser cost	4,300	8,833
Labour cost	33,787	29,969
Other material costs	3,100	4000
Total cost	45,237	43,852
Total output value (5377 @ K10.80/kg)	58,295	57,496 (23,000@ K2.50/head)
Net return	**13,058**	**13,644**
Local maize	**With fertiliser**	**With no fertiliser**
	213	213
Seed cost	3258	3143
Labour cost	2626	0
Fertiliser cost	0	0
Other material costs	6097	3356
Total cost		
	10,625	7650
Net Return	**4528**	**4294**
Composite maize	**Late weeding**	**Early weeding**
Seed cost	1000	1000
Labour cost	3749	3933
Fertiliser cost	2626	2626
Other material costs	7,375	7559
Total cost		
	15,623	19,907
Net Return	**8,248**	**12,348**

Table 5: variable names and descriptions for linear programming model

Variable name	Description
LMZNF	Local maize, no fertiliser
LMZF	Local maize, fertilised
CMZNB	Composite maize, fertilised and no banking
CMGAU	Composite maize, fertilised and seed dressed with GauchoT
BUR	Burley
CMZST	Composite maize, fertilised with Tephrosia for Striga
CMNL	Composite maize, no legume
KAUL	Integrated pest management beans (Kaulesi)
PP40	Integrated pest management pigeon pea (ICEAP 00040)
PP45	ICP 9145 Pigeon pea
LOPPE	Local pigeon pea
SWPFP	Sweet potato intercropped with field peas with crack sealing
SWNCS	Sweet potato no crack sealing
CMWG	Composite maize with whitegrub
CMBAN	Composite with banking
CMNL	Composite maize no legume
CASS	Cassava
KALI	Kalima beans
MZWE	Maize weeded early (research recommended practice
MZWL	Maize weeded late (farmer practice)
CABB	Cabbage
TOMA	Tomato
MMX	Maize & pulse intercrop
BYMZ	Buy maize
CREDIT	Credit
CSHS	Initial cash balance not spent on non-labour inputs
CSHSP	Initial cash balance spend on non-labour inputs
LOFJS	Off-farm labour, June- September
LOFON	Off-farm labour, October- November
LOFDC	Off-farm labour, December
LOFJA	Off-farm labour, January
LOFM	Off-farm labour, February- March
LOAM	Off-farm labour, April- May
HLJS	Hired labour, June- September
HLON	Hired labour, October- November
HLDC	Hired labour, December
HLJA	Hired labour, January
HLFM	Hired labour, February- March
HLAM	Hired labour, April- May

Table 6: Optimal levels of mix of enterprises and the objective function by cluster

	STABLE MALE HOUSEHOLD		STABLE FEMALE HOUSEHOLD		BURLEY HOUSEHOLD		VULNERABLE HOUSEHOLD		DIMBA HOUSEHOLD	
	With IPM	Farmer Practice	With IPM	Farmer Practice	With IPM	Farmer Practice	With IPM	Farmer Practice	With IPM	Farmer Practice
Activities **PROFIT**	MK 13.054	MK 11,400	MK 9,061	MK 7,953	MK 13,248	MK 11,959	MK 8,145	MK 7,318	MK 11,705	MK 10,292
LMZNF	0	0.151	0	0.364	0	0	0.163	0.359	0	0.198
LMZF	0	0	0	0	0	0	0	0	0	0
CMZNB	0	0	0	0	0	0	0	0	0	0
CMGAU	0.620	0.616	0.338	0.328	0.608	0428	0.312	0.306	0.482	0.543
BUR	0	0	0	0	0.1	0.1	0	0	0	0
CMZST	0	0	0	0	0	0	0	0	0	0
KAUL	0	0	0	0	0	0	0	0	0	0
PP40	0.147	0	0.354	0	0	0	0.201	0	0.323	0
LOPPE	0	0	0	0	0	0	0	0	0	0
SWPFP	0	0	0	0	0	0	0	0	0	0
CASS	0	0	0	0	0	0.181	0	0	0	0
MMX	0.153	0.153	0.138	0.138	0.142	0.142	0.135	0.135	0.161	0.148
BYMZ	0	0	0	0	0	0	0	0	0	0
CREDIT	900	900	800	800	2523	2983	300	300	1700	1700
CSHS	0	0	0	0	0	0	0	0	0	0
CSHSP	2400	2400	1400	1400	1100	1100	1800	1800	1500	1500
LOFJS	30	30	10	10	30	30	0	0	2	2
LOFON	17	17	2	2	15	15	0	0	6	6
LOFDC	5.87	2.22	14	7.68	13.63	15	5	5	2	2
LOFJA	0	0	8.75	0.12	0	2.78	7	2.11	1.53	0
LOFM	0	0	4	4	4	4	0	0	6	6
LOAM	10	10	4	4	18	18	0	0	8	8
HLJS	0	0	0	0	0	0	0	0	0	0
HLON	0	0	0	0	0	0	0	0	0	0
HLDC	0	0	0	0	0	0	0	0	0	0
HLJA	7.13	10.71	0	0	2.82	0	0	0	0	0
HLFM	0	0	0	0	0	0	0	0	0	0
HLAM	0	0	0	0	0	0	0	0	0	3.30
CABB	-	-	-	-	-	-	-	-	0	0
TOMA	-	-	-	-	-	-	-	-	0.052	0.05

Table 7: Optimal resource use by cluster

	STABLE MALE HOUSEHOLD		STABLE FEMALE HOUSEHOLD		VULNERABLE HOUSEHOLD		BURLEY HOUSEHOLD		DIMBA HOUSEHOLD	
Resource use	With IPM	Farmer Practice	With IPM	Farmer Practice	With IPM	Farmer practice	With IPM	Farmer Practice	With IPM	Farmer Practice
LAND	0.92	0.92	0.83	0.83	0.81	0.81	0.75	0.75	0.89	0.89
MaxlandD							0.10		0.052	0.050
BurMaxland										
CREDITMAX	900	900	800	800	300	300	2523	2983	1700	1700
FOODSEC	1712.98	1837	932.92	1233	1007	1078	1680	1182	1509	1535
CASHAVL	2400	2400	1400	1400	1800	1800	1100	1100	1500	1500
SEASCONS	1357	1159	1068	695.15	300	177	1931.33	2119.50	638	0
JUN-SEPLAB	60.20	61.61	32.37	35.79	23.06	25.00	66.58	64.96	58.27	58.92
OCNOVLAB	48.17	50.01	23.47	27.91	22.53	25.05	45.87	46.77	34.55	37.04
DECLAB	26	26	25.51	28	19.76	24.76	35.00	31.31	19.87	24.74
JANLAB	26	26	28	28	29	29	35.00	35	31.00	31
FEBMALAB	2.14	2.74	5.94	7.39	2.54	3.36	23.78	24.51	14.63	15.12
APMAYLAB	39.56	40.90	21.58	24.82	18.05	19.89	56.37	54.74	76	76
TOTAL FARM mn-dys	**202.07**	**207.26**	**136.87**	**151.91**	**114.94**	**127.06**	**262.60**	**257.29**	**234.32**	**242.82**
OFFJSEPT	30	30	10	10	0	0	30	30	2	2
OFFOCNV	17	17	2	2	0	0	15	15	6	6
OFFDEC	5.87	2.2	14	7.69	5	5	13.63	15	2	2
OFFJAN	0	0	8.75	0.12	7	2.11	0	2.78	1.53	0
OFFEBMR	0	0	4	4	0	0	4	4	6	6
OFFAPMAY	10	10	4	4	0	0	18	18	8	8
TOTAL OFF-FARM mn-dys	**72.87**	**53.2**	**42.75**	**23.81**	**12**	**7.11**	**80.63**	**84.78**	**25.53**	**24**

Annex A: LP Model outputs with IMP interventions

A1: Vulnerable household

						LMZNF	LMZF	CMZNB	CMGAU	BUR	CMZST	KAUL	PP40	LOPPE	SWPFP	CASS	MMX	BYMZ
						ha	Ha	Ha	ha	ha	Ha	Ha	ha		ha	ha		
Profit	**MK 7281.12**			Net Return / GM		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5
				Adjustable values		**0.36**	0.00	0.00	**0.22**	0.00	0.00	0.00	**0.09**	0.00	0.00	0.00	**0.135**	0.00
					Dual	0.00	8593	1668	0.00	9357	15496	8232	0.00	1581	37480	10917	0.00	8.50
Constraint	Units	Level	Sign															
Land	Ha	0.81	=>=	0.81	-1319	1	1	1	1	1	1	1	1	1	1	1	1	
Inputbuy	Mk	0.00	=>=	0.00	-3.22	213	2839	3626	3626	4619	3626	3000	120	120	12106	6172	6746	
Creditmax	Mk	0.00	=>=	0.00	-2.85													
FoodSec	Kg	934.00	=<=	934.00	0.00	900	1250	2331	2763	0	883							
Budget	Mk	0.00	<=	7281.12	0.00	4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5
MinMIx	ha	0.00	=>=	0.00	-2139	1	1	1	1	1	1	1	1	1	1	1	-5	
CashAvl	Mk	1800.00	=	1800.00	-3.22													
SeasCons	Mk	0.00	<=	285.99	0.00													-8.5
Jun-sepLab	mndys	140.00	>=	23.03	0.00	28	28	28	40	97	28		18	17	12	31	18	
OcNovLab	mndys	70.00	>=	22.37	0.00	18	18	35	35	15	35	28	5	5	48	40	57	
DecLab	mndys	29.00	>=	21.96	0.00	25	25	30	30	17	28	0	0	0	8	2	10	
JanLab	mndys	29.00	=>=	29.00	-5.99	25	30	6	48	55	28	0	0	0	50	17	22	
FebMaLab	mndys	58.00	>=	3.33	0.00	4	0	0	0	178	14	19	0	0	47	4	14	
ApMayLab	mndys	70.00	>=	16.30	0.00	10	10	30	41	96	20	0	0	0	15	32	27	
OFFJSEPT	mndys	0.00	=>=	0.00	-25.00													
OFFOCNV	mndys	0.00	=>=	0.00	-25.00													
OFFDEC	mndys	5.00	=>=	5.00	-25.00													
OFFJAN	mndys	7.00	>=	6.44	-19.01													
OFFEBMR	mndys	0.00	=>=	0.00	-25.00													
OFFAPMAY	mndys	0.00	=>=	0.00	-25.00													

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A1 Conti.

	CREDIT	CSHS	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWE
	-0.37			25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
	0.00	0.00	1800	0.00	0.00	5.00	6.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	3.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30	30	30	5	30	30	2342
Constraint																
Land																1
Inputbuy	-1		-1													3626
Creditmax	1															
FoodSec																2342
Budget	-0.37	0	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
MinMix																1
CashAvl		1	1													
SeasCons		1		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab				1						-1						28
OcNovLab					1						-1					35
DecLab						1						-1				30
JanLab							1						-1			48
FebMaLab								1						-1		0
ApMayLab									1						-1	30
OFFJSEPT				1												
OFFOCNV					1											
OFFDEC						1										
OFFJAN							1									
OFFEBMR								1								
OFFAPMAY									1							

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A2: Stable female household

						LMZNF	LMZF	CMZNB	CMGAU	BUR	CMZST	KAUL	PP40	LOPPE	SWPFP	CASS	MMX	BYMZ	CREDIT	CSHS
						Ha	ha	ha	ha	ha	ha	ha	ha		ha	ha				
Profit MK 9061				Net return/ GM		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.14	0.00	800.00	0.00
					Dual	450	8106	1433	0.00	7423	14471	6993	0.00	1581	32327	8315	0.00	8.50	0.00	2.96
Constraint	Units	Level	Sign																	
Land	Ha	0.83	=>=	0.83	-1568	1	1	1	1	1	1	1	1	1	1	1	1			
Inputbuy	Mk	0.00	=>=	0.00	-2.96	213	2839	3626	3626	4619	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	800.00	=>=	800.00	-2.59														1	
FoodSec	Kg	926.00	<=	932.93	0.00	900	1250	2331	2763	0.00	883									
Budget	Mk	0.00	<=	9061.29	0.00	4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMIx	Ha	0.00	=>=	0.00	-1921	1	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	1400.00	=	1400.00	-2.96															1
SeasCons	Mk	0.00	<=	1068.74	0.00													-8.5		1
Jun-sepLab	Mndys	139.00	>=	32.37	0.00	28	28	28	40	97	28		18	17	12	31	18			
OcNovLab	Mndys	69.00	>=	23.47	0.00	18	18	35	35	15	35	28	5	5	48	40	57			
DecLab	Mndys	28.00	>=	25.51	0.00	25	25	30	30	17	28	0	0	0	8	2	10			
JanLab	Mndys	28.00	=>=	28.00	-25	25	30	6	48	55	28	0	0	0	50	17	22			
FebMaLab	Mndys	56.00	>=	5.94	0.00	4	0	0	0	178	14	19	0	0	47	4	14			
ApMayLab	Mndys	69.00	>=	21.58	0.00	10	10	30	41	96	20	0	0	0	15	32	27			
OFFJSEPT	Mndys	10.00	=>=	10.00	-25															
OFFOCNV	Mndys	2.00	=>=	2.00	-25															
OFFDEC	Mndys	14.00	=>=	14.00	-25															
OFFJAN	Mndys	10.00	>=	8.75	0.00															
OFFEBMR	Mndys	4.00	=>=	4.00	-25															
OFFAPMAY	Mndys	4.00	=>=	4.00	-25															

A2 conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWE
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
	1400	10.00	2.00	14.00	8.75	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30	30	30	5.00	30.	30	2390
Constraint														
Land														1
Inputbuy	-1													3626
Creditmax														
FoodSec														2342
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
MinMix														1
CashAvl	1													
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab		1						-1						28
OcNovLab			1						-1					35
DecLab				1						-1				30
JanLab					1						-1			48
FebMaLab						1						-1		0
ApMayLab							1						-1	30
OFFJSEPT		1												
OFFOCNV			1											
OFFDEC				1										
OFFJAN					1									
OFFEBMR						1								
OFFAPMAY							1							

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A3: Stable male LP Model output

Profit MK 13,054

Constraint	Units	Level	Sign			LMZNF	LMZF	CMZNB	CMGAU	BUR	CMZST	KAUL	PP40	LOPPE	SWPFP	CASS	MMX	BYMZ	CREDIT	CSHS
						ha	ha	ha	Ha	ha	ha	Ha	ha		Ha	Ha				
				Net return/GM		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		0.000	0.000	0.000	0.620	0.000	0.000	0.000	0.147	0.000	0.000	0.000	0.153	0.000	900.00	0.00
				Dual		1175	8114	1223	0.00	6853	14321	6181	0.00	1581	29393	6741	0.00	8.50	0.00	2.67
Land	Ha	0.92	=>=	0.92	-1854	1	1	1	1	1	1	1	1	1	1	1	1			
Inputbuy	Mk	0.00	=>=	0.00	-2.67	213	2839	3626	3626	4619	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	900.00	=>=	900.00	-2.30														1	
FoodSec	Kg	890.00	<=	1712.98	0	900	1250	2331	2763	0.00	883									
Budget	Mk	0.00	<=	13054.13	0	4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMIx	Ha	0.00	=>=	0.00	-1670	1	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	2400.00	=	2400.00	-2.67															1
SeasCons	Mk	0.00	<=	1357.73	0													-8.5		1
Jun-sepLab	Mndys	134.00	>=	60.20	0	28	28	28	40	97	28		18	17	12	31	18			
OcNovLab	Mndys	66.00	>=	48.17	0	18	18	35	35	15	35	28	5	5	48	40	57			
DecLab	Mndys	26.00	=>=	26.00	-25	25	25	30	30	17	28	0	0	0	8	2	10			
JanLab	Mndys	26.00	=>=	26.00	-30	25	30	6	48	55	28	0	0	0	50	17	22			
FebMaLab	Mndys	53.00	>=	2.15	0	4	0	0	0	178	14	19	0	0	47	4	14			
ApMayLab	Mndys	66.00	>=	39.56	0	10	10	30	41	96	20	0	0	0	15	32	27			
OFFJSEPT	Mndys	30.00	=>=	30.00	-25															
OFFOCNV	Mndys	17.00	=>=	17.00	-25															
OFFDEC	Mndys	23.00	>=	5.87	0															
OFFJAN	Mndys	15.00	>=	0.00	0															
OFFEBMR	Mndys	0.00	=>=	0.00	-25															
OFFAPMAY	Mndys	10.00	=>=	10.00	-25															

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A3 conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWE
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
	2400	30.00	17.00	5.87	0.00	0.00	10.00	0.00	0.00	0.00	7.13	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	5.00	0.00	0.00	30.00	30.00	5.00	0.00	30.00	30.00	2150
Constraint														
Land														1
Inputbuy	-1													3626
Creditmax														
FoodSec														2342
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
MinMix														1
CashAvl	1													
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab		1						-1						28
OcNovLab			1						-1					35
DecLab				1						-1				30
JanLab					1						-1			48
FebMaLab						1						-1		0
ApMayLab							1						-1	30
OFFJSEPT		1												
OFFOCNV			1											
OFFDEC				1										
OFFJAN					1									
OFFEBMR						1								
OFFAPMAY							1							

A4: Burley LP Model output

						LMZNF	LMZF	CMZNB	CMGAU	BUR	CMZST	KAUL	PP40	LOPPE	SWPFP	CASS	MMX	BYMZ	CREDIT	CSHS
						Ha	ha	ha	Ha	ha	ha	ha	ha		ha	Ha				
Profit MK 13,248				Net return /GM		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		0.00	0.00	0.00	0.608	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.142	0.00	2523	0.00
					Dual	9040	9927	1223	0.00	0.00	14321	7623	8080	9661	9850	874	0.00	8.50	0.00	0.37
Constraint	Units	Level	Sign																	
Land	ha	0.75	=>=	0.75	-11409	1	1	1	1		1	1	1	1	1	1	1			
MaxBuland	ha	0.10	=>=	0.10	-6844					1										
Inputbuy	Mk	0.00	=>=	0.00	-0.37	213	2839	3626	3626	4619	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	3200.00	>=	2523	0														1	
FoodSec	Kg	1182.00	<=	1680	0	900	1250	2331	2763	0.00	883									
Budget	Mk	0.00	<=	13248	0	4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMIx	ha	0.00	=>=	0.00	-471	1	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	1100.00	=	1100	-0.37															1
SeasCons	Mk	0.00	<=	1931	0													-8.5		1
Jun-sepLab	mndys	177.00	>=	66.58	0	28	28	28	40	97	28		18	17	12	31	18			
OcNovLab	mndys	88.00	>=	45.87	0	18	18	35	35	15	35	28	5	5	48	40	57			
DecLab	mndys	35.00	=>=	35.00	-25	25	25	30	30	17	28	0	0	0	8	2	10			
JanLab	mndys	35.00	=>=	35.00	-30	25	30	6	48	55	28	0	0	0	50	17	22			
FebMaLab	mndys	70.00	>=	23.78	0	4	0	0	0	178	14	19	0	0	47	4	14			
ApMayLab	mndys	88.00	>=	56.37	0	10	10	30	41	96	20	0	0	0	15	32	27			
OFFJSEPT	mndys	30.00	=>=	30.00	-25															
OFFOCNV	mndys	15.00	=>=	15.00	-25															
OFFDEC	mndys	15.00	>=	13.63	0															
OFFJAN	mndys	8.00	>=	0.00	0															
OFFEBMR	mndys	4.00	=>=	4.00	-25															
OFFAPMAY	mndys	18.00	=>=	18.00	-25															

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A4 conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWE
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
	1100	30.00	15.00	13.63	0.00	4.00	18.00	0.00	0.00	0.00	2.82	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	5.00	0.00	0.00	30.00	30.00	5.00	0.00	30.00	30.00	2390
Constraint														
Land														1
MaxBurland														
Inputbuy	-1													3626
Creditmax														
FoodSec														2342
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13022
MinMix														1
CashAvl	1													
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab		1						-1						28
OcNovLab			1						-1					35
DecLab				1						-1				30
JanLab					1						-1			48
FebMaLab						1						-1		0
ApMayLab							1						-1	30
OFFJSEPT		1												
OFFOCNV			1											
OFFDEC				1										
OFFJAN					1									
OFFEBMR						1								
OFFAPMAY							1							

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A5: Dimba LP Model output

						LMZNF	LMZF	CMZNB	CMGAU	CMZST	KAUL	PP40	LOPPE	SWPFP	CASS	MMX	BYMZ	CREDIT	CSHS
						Ha	ha	ha	Ha	ha	ha	ha		Ha	Ha				
Profit MK 11,705				Net return /GM		4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		**0**	**0**	**0**	**0.546**	**0**	**0**	**0.195**	**0**	**0**	**0.00**	**0.148**	**0**	**1700**	**0**
						474	8050	1404	0.00	14416	6907	0	1580	32004	8215	0	8.5	0	2.93
Constraint	Units	Level	Sign																
Land	ha	0.89	=>=	0.89	-1594	1	1	1	1	1	1	1	1	1	1	1			
MaxlandD	ha	0.109	=>=	0.052	0.00														
Inputbuy	Mk	0.00	=>=	0.00	-2.93	213	2839	3626	3626	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	1700.00	>=	1700	-2.56													1	
FoodSec	Kg	1018.00	<=	1509	0	900	1250	2331	2763	883									
Budget	Mk	0.00	<=	13248	0	4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMix	Ha	0.00	=>=	0.00	-1899	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	1500.00	=	1500	-2.93														1
SeasCons	Mk	0.00	<=	638	0												-8.5		1
Jun-sepLab	Mndys	153.00	>=	58.27	0	28	28	28	40	28		18	17	12	31	18			
OcNovLab	Mndys	76.00	>=	34.55	0	18	18	35	35	35	28	5	5	48	40	57			
DecLab	Mndys	31.00	=>=	19.87	0	25	25	30	30	28	0	0	0	8	2	10			
JanLab	Mndys	31.00	=>=	31.00	-25	25	30	6	48	28	0	0	0	50	17	22			
FebMaLab	Mndys	62.00	>=	14.63	0	4	0	0	0	14	19	0	0	47	4	14			
ApMayLab	Mndys	76.00	>=	76.00	2.58	10	10	30	41	20	0	0	0	15	32	27			
OFFJSEPT	Mndys	2.00	=>=	2.00	-25														
OFFOCNV	Mndys	6.00	=>=	6.00	-25														
OFFDEC	Mndys	2.00	>=	2.00	-25														
OFFJAN	Mndys	3.00	>=	1.52	0														
OFFEBMR	Mndys	6.00	=>=	6.00	-25														
OFFAPMAY	Mndys	8.00	=>=	8.00	-22.42														

A5 Conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	CABB	TOMA	MZWE
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13,644	13,058	13022
	1500.00	2.00	6.00	2.00	1.52	6.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.052	0.00
	0	0	0	0	0	0	0	30	30	30	5	30	27.41	10486	0.00	2342
Constraint																
Land														1	1	1
Inputbuy	-1													7204	3756	3626
Creditmax																
FoodSec																2342
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13644	13058	13022
MinMix																1
CashAvl	1															
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30			
Jun-sepLab		1						-1						43	543	28
OcNovLab			1						-1					0	0	35
DecLab				1						-1				0	0	30
JanLab					1						-1			0	0	48
FebMaLab						1						-1		120	126	0
ApMayLab							1						-1	1180	800	30
OFFJSEPT		1														
OFFOCNV			1													
OFFDEC				1												
OFFJAN					1											
OFFEBMR						1										
OFFAPMAY							1									

Annex B: LP Model outputs for farmer's practice

B1: Vulnerable household

						LMZNF	LMZF	CMBAN	CMWG	CMNL	KALI	PP45	LOPPE	SWNCS	CASS	MMX	BYMZ
						ha	Ha	Ha	ha	Ha	Ha	Ha		Ha	Ha		
Profit	**MK 7281.12**			Net Return / GM		4294	4528	9130	13015	19	1507	1932	2264	4746	13850	12459	-8.5
				Adjustable values		**0.369**	**0.00**	**0.00**	**0.306**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.135**	**0.00**
						0	6159	2835	4460	8814	1515	1183	28559	4467	0	8.5	8.50
Constraint	Units	Level	Sign		Dual												
Land	Ha	0.81	=>=	0.81	-1935	1	1	1	1	1	1	1	1	1	1	1	
Inputbuy	Mk	0.00	=>=	0.00	-2.39	213	2839	3626	3626	3626	3000	120	120	12106	6172	6746	
Creditmax	Mk	0.00	=>=	0.00	-2.02												
FoodSec	Kg	934.00	=<=	934.00	0.00	900	1250	2331	2763	883							
Budget	Mk	0.00	<=	7281.12	0.00	4294	4528	9130	13015	19	1507	1932	2264	4746	13850	12459	-8.5
MinMIx	Ha	0.00	=>=	0.00	-1225	1	1	1	1	1	1	1	1	1	1	-5	
Cash Avl	Mk	1800.00	=	1800.00	-2.39												
SeasCons	Mk	0.00	<=	285.99	0.00												-8.5
Jun-sepLab	Mndys	140.00	>=	23.03	0.00	28	28	28	40	28		18	17	12	31	18	
OcNovLab	Mndys	70.00	>=	22.37	0.00	18	18	35	35	35	28	5	5	48	40	57	
DecLab	Mndys	29.00	>=	21.96	0.00	25	25	30	30	28	0	0	0	8	2	10	
JanLab	Mndys	29.00	=>=	29.00	-25.00	25	30	6	48	28	0	0	0	50	17	22	
FebMaLab	Mndys	58.00	>=	3.33	0.00	4	0	0	0	14	19	0	0	47	4	14	
ApMayLab	Mndys	70.00	>=	16.30	0.00	10	10	30	41	20	0	0	0	15	32	27	
OFFJSEPT	Mndys	0.00	=>=	0.00	-25.00												
OFFOCNV	Mndys	0.00	=>=	0.00	-25.00												
OFFDEC	Mndys	5.00	=>=	5.00	-25.00												
OFFJAN	Mndys	7.00	>=	6.44	0.00												
OFFEBMR	Mndys	0.00	=>=	0.00	-25.00												
OFFAPMAY	Mndys	0.00	=>=	0.00	-25.00												

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B1 conti.

	CREDIT	CSHS	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWL
	-0.37			25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
	0.00	0.00	1800.00	0.00	0.00	5.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	2.39	0	0	0	0	0	0	0	30	30	30	5	30	30	4077
Constraint																
Land																1
Inputbuy	-1		-1													3626
Creditmax	1															
FoodSec																1838
Budget	-0.37	0	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
MinMix																1
CashAvl		1	1													
SeasCons		1		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab				1						-1						28
OcNovLab					1						-1					35
DecLab						1						-1				30
JanLab							1						-1			40
FebMaLab								1						-1		0
ApMayLab									1						-1	30
OFFJSEPT				1												
OFFOCNV					1											
OFFDEC						1										
OFFJAN							1									
OFFEBMR								1								
OFFAPMAY									1							

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B2: Stable female household

Constraint	Units	Level	Sign		Dual	LMZNF	LMZF	CMBAN	CMWG	CMNL	KALI	PP45	LOPPE	SWNCS	CASS	MMX	BYMZ	CREDIT	CSHS
						ha	ha	ha	Ha	ha	ha	ha	ha	ha	Ha	ha			
Profit MK 9061				Net return/ GM		4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		**0.364**	**0.000**	**0.000**	**0.328**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.138**	**0.000**	800	0.000
						0.000	6062	2835	0.000	12446	8087	893	561	27198	3673	0.00	8.50	0	2.35
Land	Ha	0.83	=>=	0.83	-1420	1	1	1	1	1	1	1	1	1	1	1			
Inputbuy	Mk	0.00	=>=	0.00	-2.35	213	2839	3626	3626	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	800.00	=>=	800.00	-1980													1	
FoodSec	Kg	926.00	<=	932.93	0.00	900	1250	2331	2763	883									
Budget	Mk	0.00	<=	9061.29	0.00	4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMIx	Ha	0.00	=>=	0.00	-1123	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	1400.00	=	1400.00	-2.35														1
SeasCons	Mk	0.00	<=	1068.74	0.00												-8.5		1
Jun-sepLab	Mndys	139.00	>=	32.37	0.00	28	28	28	40	28		18	17	12	31	18			
OcNovLab	Mndys	69.00	>=	23.47	0.00	18	18	35	35	35	28	5	5	48	40	57			
DecLab	Mndys	28.00	>=	25.51	-25	25	25	30	30	28	0	0	0	8	2	10			
JanLab	Mndys	28.00	=>=	28.00	-25	25	30	6	48	28	0	0	0	50	17	22			
FebMaLab	Mndys	56.00	>=	5.94	0.00	4	0	0	0	14	19	0	0	47	4	14			
ApMayLab	Mndys	69.00	>=	21.58	0.00	10	10	30	41	20	0	0	0	15	32	27			
OFFJSEPT	Mndys	10.00	=>=	10.00	-25														
OFFOCNV	Mndys	2.00	=>=	2.00	-25														
OFFDEC	Mndys	14.00	=>=	14.00	0.00														
OFFJAN	Mndys	10.00	>=	8.75	0.00														
OFFEBMR	Mndys	4.00	=>=	4.00	-25														
OFFAPMAY	Mndys	4.00	=>=	4.00	-25														

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B2 conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWL
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
	1400	**10.00**	**2.00**	**7.68**	**0.12**	**4.00**	**4.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	0	0	0	0	0	0	0	30	30	5	5	30	30	4077
Constraint														
Land														1
Inputbuy	-1													3626
Creditmax														
FoodSec														1838
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
MinMix														
CashAvl	1													
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab		1						-1						28
OcNovLab			1						-1					35
DecLab				1						-1				30
JanLab					1						-1			48
FebMaLab						1						-1		0
ApMayLab							1						-1	30
OFFJSEPT		1												
OFFOCNV			1											
OFFDEC				1										
OFFJAN					1									
OFFEBMR						1								
OFFAPMAY							1							

B3: Stable male LP Model output

Profit MK 11,400

Constraint	Units	Level	Sign			LMZNF	LMZF	CMBAN	CMWG	CMNL	KALI	PP45	LOPPE	SWNCS	CASS	MMX	BYMZ	CREDIT	CSHS
						ha	ha	ha	Ha	ha	Ha	ha		ha	Ha				
				Net return/GM		4294	4528	9130	13015	19	1507	3845	2264	4746	13850	12459	-8.5	-0.37	
				Adjustable values		**0.151**	**0.00**	**0.00**	**0.616**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.153**	**0.00**	900.00	0.00
						0	5998	2625	0	12346	7868	772	439	27422	3433	0	8.5	0	2.32
Land	Ha	0.92	=>=	0.92	0	1	1	1	1	1	1	1	1	1	1	1			
Inputbuy	Mk	0.00	=>=	0.00	0	213	2839	3626	3626	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	900.00	=>=	900.00	0													1	
FoodSec	Kg	890.00	<=	1712.98	0	900	1250	2331	2763	883									
Budget	Mk	0.00	<=	13054.13	0	4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMIx	Ha	0.00	=>=	0.00	0	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	2400.00	=	2400.00	0														1
SeasCons	Mk	0.00	<=	1357.73	0												-8.5		1
Jun-sepLab	Mndys	134.00	>=	60.20	0	28	28	28	40	28		18	17	12	31	18			
OcNovLab	Mndys	66.00	>=	48.17	0	18	18	35	35	35	28	5	5	48	40	57			
DecLab	Mndys	26.00	=>=	26.00	-25	25	25	30	30	28	0	0	0	8	2	10			
JanLab	Mndys	26.00	=>=	26.00	-30	25	30	6	48	28	0	0	0	50	17	22			
FebMaLab	Mndys	53.00	>=	2.15	0	4	0	0	0	14	19	0	0	47	4	14			
ApMayLab	Mndys	66.00	>=	39.56	0	10	10	30	41	20	0	0	0	15	32	27			
OFFJSEPT	Mndys	30.00	=>=	30.00	-25														
OFFOCNV	Mndys	17.00	=>=	17.00	-25														
OFFDEC	Mndys	23.00	>=	5.87	0														
OFFJAN	Mndys	15.00	>=	0.00	0														
OFFEBMR	Mndys	0.00	=>=	0.00	-25														
OFFAPMAY	Mndys	10.00	=>=	10.00	-25														

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B3 conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWL
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
	2400.00	**30.00**	**17.00**	**2.22**	**0.00**	**0.00**	**10.00**	**0.00**	**0.00**	**0.00**	**10.71**	**0.00**	**0.00**	**0.00**
	0	0	0	0	5	0	0	30	30	5	0	30,	30	4037
Constraint														
Land														1
Inputbuy	-1													3626
Creditmax														
FoodSec														1838
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
MinMix														1
CashAvl	1													
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab		1						-1						28
OcNovLab			1						-1					35
DecLab				1						-1				30
JanLab					1						-1			48
FebMaLab						1						-1		0
ApMayLab							1						-1	30
OFFJSEPT		1												
OFFOCNV			1											
OFFDEC				1										
OFFJAN					1									
OFFEBMR						1								
OFFAPMAY							1							

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B4: Burley LP Model output

						LMZNF	LMZF	CMBAN	CMWG	CMNL	KALI	PP45	LOPPE	SWNCS	CASS	CASS	MMX	BYMZ	CREDIT	CSHS
						Ha	ha	ha	Ha	ha	ha	ha	ha		ha	ha				
Profit MK 11,959				Net return /GM		4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		**0**	**0**	**0**	**0.428**	**0.10**	**0**	**0**	**0**	**0**	**0**	**0.181**	**0.142**	**0**	**2983**	**0**
						7334	8112	2939	0.00	0.00	12951	1074	9254	8922	1212	0	0	8.5	0	0.37
Constraint	Units	Level	Sign																	
Land	ha	0.75	=>=	0.75	-10833	1	1	1	1		1	1	1	1	1	1	1			
BurMaxland	ha	0.10	=>=	0.10	-7727					1										
Inputbuy	Mk	0.00	=>=	0.00	-0.37	213	2839	3626	3626	4619	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	3200.00	>=	2523	0														1	
FoodSec	Kg	1182.00	<=	1182	0.24	900	1250	2331	2763	0.00	883									
Budget	Mk	0.00	<=	13248	0	4294	4528	12929	15412	11100	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMIx	ha	0.00	=>=	0.00	-288	1	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	1100.00	=	1100	-0.37															1
SeasCons	Mk	0.00	<=	1931	0													-8.5		1
Jun-sepLab	mndys	177.00	>=	66.58	0	28	28	28	40	97	28		18	17	12	31	18			
OcNovLab	mndys	88.00	>=	45.87	0	18	18	35	35	15	35	28	5	5	48	40	57			
DecLab	mndys	35.00	=>=	35.00	0	25	25	30	30	17	28	0	0	0	8	2	10			
JanLab	mndys	35.00	=>=	35.00	-25	25	30	6	48	55	28	0	0	0	50	17	22			
FebMaLab	mndys	70.00	>=	23.78	0	4	0	0	0	178	14	19	0	0	47	4	14			
ApMayLab	mndys	88.00	>=	56.37	0	10	10	30	41	96	20	0	0	0	15	32	27			
OFFJSEPT	mndys	30.00	=>=	30.00	-25															
OFFOCNV	mndys	15.00	=>=	15.00	-25															
OFFDEC	mndys	15.00	>=	13.63	-25															
OFFJAN	mndys	8.00	>=	0.00	0															
OFFEBMR	mndys	4.00	=>=	4.00	-25															
OFFAPMAY	mndys	18.00	=>=	18.00	-25															

B4 conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	MZWL
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
	1100.00	30.00	15.00	15.00	2.78	4.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0	30	30	30	5	30	30	4300
Constraint														
Land														1
BurMaxland														
Inputbuy	-1													3626
Creditmax														
FoodSec														1838
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	8738
MinMix														1
CashAvl	1													
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	
Jun-sepLab		1						-1						28
OcNovLab			1						-1					35
DecLab				1						-1				30
JanLab					1						-1			40
FebMaLab						1						-1		0
ApMayLab							1						-1	30
OFFJSEPT		1												
OFFOCNV			1											
OFFDEC				1										
OFFJAN					1									
OFFEBMR						1								
OFFAPMAY							1							

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B5: Dimba LP Model output

						LMZNF	LMZF	CMBAN	CMWG	CMNL	KALI	PP45	LOPPE	SWNCS	CASS	MMX	BYMZ	CREDIT	CSHS
						Ha	ha	ha	Ha	ha	ha	ha		ha	Ha				
Profit MK 10,292				Net return /GM		4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	
				Adjustable values		**0**	**0**	**0**	**0.428**	**0**	**0**	**0**	**0**	**0**	**0.181**	**0.142**	**0**	**2983**	**0**
						7334	8112	2939	0.00	12951	1074	9254	8922	1212	0	0	8.5	0	0.37
Constraint	Units	Level	Sign																
Land	ha	0.89	=>=	0.89	-1858	1	1	1	1	1	1	1	1	1	1	1			
MaxlandD	HA	0.109	=>=	0.049	0														
Inputbuy	Mk	0.00	=>=	0.00	-2.30	213	2839	3626	3626	3626	3000	120	120	12106	6172	6746		-1	
Creditmax	Mk	1700.00	>=	1700	-1.93													1	
FoodSec	Kg	1018.00	<=	1679	0	900	1250	2331	2763	883									
Budget	Mk	0.00	<=	10292	0	4294	4528	12929	15412	441	5367	3845	2264	8209	13850	12459	-8.5	-0.37	0.00
MinMix	ha	0.00	=>=	0.00	-1147	1	1	1	1	1	1	1	1	1	1	-5			
CashAvl	Mk	1500.00	=	1500.00	2.30														1
SeasCons	Mk	0.00	<=	500.86	0												-8.5		1
Jun-sepLab	mndys	153.00	>=	58.92	0	28	28	28	40	28		18	17	12	31	18			
OcNovLab	mndys	76.00	>=	37.04	0	18	18	35	35	35	28	5	5	48	40	57			
DecLab	mndys	31.00	=>=	24.74	0	25	25	30	30	28	0	0	0	8	2	10			
JanLab	mndys	31.00	=>=	31.00	-30	25	30	6	48	28	0	0	0	50	17	22			
FebMaLab	mndys	62.00	>=	15.12	0	4	0	0	0	14	19	0	0	47	4	14			
ApMayLab	mndys	76.00	>=	76	-5.50	10	10	30	41	20	0	0	0	15	32	27			
OFFJSEPT	mndys	2.00	=>=	2.00	-25														
OFFOCNV	mndys	6.00	=>=	6.00	-25														
OFFDEC	mndys	2.00	>=	2.00	-25														
OFFJAN	mndys	3.00	>=	0.00	0														
OFFEBMR	mndys	6.00	=>=	6.00	-25														
OFFAPMAY	mndys	8.00	=>=	8.00	-19														

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B5 Conti.

	CSHSP	LOFJS	LOFON	LOFDC	LOFJA	LOFM	LOAM	HLJS	HLON	HLDC	HLJA	HLFM	HLAM	CABB	TOMA	MZWL
		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13,644	13,058	8738
	1500.00	2.00	6.00	2.00	0.00	6.00	8.00	0.00	0.00	0.00	3.30	0.00	0.00	0.00	0.050	0.00
	0	0	0	0	0	0	0	30	30	30	0	30	24.49	9448	0.00	2829
Constraint																
Land																1
Inputbuy	-1													7204	3756	3626
Creditmax																
FoodSec																1838
Budget	0	25	25	25	25	25	25	-30	-30	-30	-30	-30	-30	13644	13058	8738
MinMix																1
CashAvl	1															
SeasCons		25	25	25	25	25	25	-30	-30	-30	-30	-30	-30			
Jun-sepLab		1						-1						43	543	28
OcNovLab			1						-1					0	0	35
DecLab				1						-1				0	0	30
JanLab					1						-1			0	0	40
FebMaLab						1						-1		120	126	0
ApMayLab							1						-1	1180	800	30
OFFJSEPT		1														
OFFOCNV			1													
OFFDEC				1												
OFFJAN					1											
OFFEBMR						1										
OFFAPMAY							1									

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

IPM STRATEGIES FOR *STRIGA* IN SOUTHERN MALAWI

SUMMARY REPORT OF A CONSULTATION MEETING, 6 OCTOBER, 1997

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EXECUTIVE SUMMARY

The parasitic weed *Striga asiatica* is a major pest of maize in Malawi, where farming systems are characterised by continuous maize cropping, low soil fertility, and low use of inorganic and organic sources of N. The FSIPM project hosted a one-day consultation of weed scientists and others to share research results and experiences from OFTs. Highlights of research presentations included the patchy distribution of *Striga* at FSIPM research sites; genotype variation in maize and trap crops in inducing *Striga* germination and emergence; and farmer knowledge gaps which limited their participation in evaluating IPM strategies. Discussion focused on four major IPM strategies: inorganic fertiliser, trap crops, green manure crops, and additional hand weeding. On fertiliser, research was needed on optimal timing for *Striga* suppression. Among trap crops, cowpea seemed more promising than either soya or groundnut. Of the four green manure crops considered, *Tephrosia vogelii* was more suitable than *Mucuna*, pigeonpea, or *Crotalaria*, despite encouraging nematodes. Hand-weeding required to be later than farmer practice at second weeding if it was to be effective. An integrated approach was more effective. A combination of inorganic fertiliser, and maize intercropped with *Tephrosia* and cowpea currrently appeared to be the most promising IPM strategies for *Striga* among resource-poor smallholders in the southern region.

INTRODUCTION

The parasitic weed *Striga asiatica* is widespread in Malawi, particularly in the southern region where the farming system is characterised by acute population pressure on land, continuous maize cropping, low soil fertility, and lack of access to inorganic and inorganic sources of nitrogen. The FSIPM Project is conducting on-farm research to identify pest management strategies for smallholders in the southern region, operating in two EPAs in Blantyre Shire Highlands RDP. Diagnostic research showed that farmers in these areas ranked Striga asiatica as a major pest of maize. As part of its programme of OFTs in 1996/97, the Project conducted 10 OFTs to test IPM inteventions for *Striga*. Results from these trials were evaluated by farmers in addition to formal statistical analysis. Finally, information on the distribution of *Striga* and farmers' weed management practices were obtained through a formal, baseline survey of 120 smallholder households.

Experience in 1996/97 pointed to the need for a better understanding of available IPM strategies for *Striga*, which took account of recent research findings by weed scientists in Malawi and elsewhere. The FSIPM Project therefore hosted a one-day consultation at Bvumbwe on 6 October, 1997, for scientists in the national agricultural research system.

RATIONALE

The rationale for the consultation was the FSIPM Project's need to learn more from weed scientists about potential 'best-bet' interventions for *Striga* which could then be tested in OFTs during 1997/98. It was anticipated that the sharing of research experiences by weed scientists would help identify knowledge gaps which might warrant on-farm research. Finally, it was hoped that the consultation might encourage greater collaboration among *Striga* researchers.

PARTICIPANTS

A total of 19 participants attended the consultation. These included weed scientists from Bunda College of Agriculture and Chitedze, representatives from agricultural extension, and members of the FSIPM Project. A full list of participants is given in Appendix 1.

OBJECTIVES

The general objective of the consultation was to share current research experience on *Striga* in Malawi. Specifically, the objectives were to identify: (1) gaps in current knowledge; (2) 'best-bet' interventions for OFTs in the forthcoming season (1997/98); and (3) opportunities for collaboration between researchers.

ACTIVITIES

The participants were welcomed to Bvumbwe Research Station by M. N. Nsanjama, ADARTS and officer-in-charge. They were then briefed on the objectives and rationale for the consultation by J. M. Ritchie, TC Team Leader and IPM Specialist, FSIPM Project. The morning session was devoted to five presentations of research experiences on *Striga* by participants. Following lunch in the Bvumbwe Conference Room, a plenary session chaired by C. Riches (Consultant, NRI) reviewed the strengths and weaknesses of current interventions against *Striga*. The consultation closed at 16:30 hrs. The programme for the consultation is reproduced in Appendix 2.

RESEARCH PRESENTATIONS

A socio-economic perspective on weeds and weed management at FSIPM sites, 1996/97.
A. Orr and P. Jere, FSIPM Project (see Orr et al. 1997)

This joint presentation by A. Orr (weeds and weed management) and P. Jere (*Striga*) summarised relevant data from the FSIPM Project's baseline survey made in 1996/97 for a sample of 120 smallholder households in Mombezi and Matapwata EPAs. The major findings were:

- *Eleusine indica*, *Bidens pilosa*, and *Panicum maximum* were identified by farmers as the three most common weeds. *Eleusine indica* and *Bidens pilosa* were among the five most common weeds identified in the 1991/92 weed survey made by the Soil Pests Project.

- Weed management practices seemed sub-optimal, from a technical if not economic point of view. Seventy-one percent of the area planted to maize was fully weeded at first weeding, but only 24 % was fully weeded at second weeding, and only 42 % was fully banked.

- Weed management practices differed between EPAs and between male- and female-headed households. Matapwata EPA had a slower start to second weeding and a higher proportion of fields were partly weeded and partly banked. Fewer female-headed households fully weeded at first weeding, but a higher proportion banked their maize.

- Farmers ranked *Striga asiatica* as the second-most important pest of maize, and reported *Striga* as present on 37 % of the area cultivated. Only 9% of the area cultivated was reported to contain 'a lot' of *Striga*, however.

- Incidence of *Striga* was higher on upland and hillslope fields and on fields which were not weeded or only partly weeded at second weeding.

- Limited farmer knowledge of *Striga* biology reduced effective farmer evaluation of OFTs.

Questions/comments on Orr/Jere presentation

What was the definition of a 'common' weed ?

Dr Mloza Banda asked when questions on weeding had been asked. Answer was that several visits had been made throughout the growing season. These are high population density areas with small fields, so why is there a labour problem with weeding? Answer was that there is a high proprtion of female-headed households and off-farm employment opportunities peak just when farmers have to weed their own fields. Mr Fero suggested that labour requirements for vegetable growing in Matapwata might explain less thorough, slower weeding of maize in this EPA compared to Mombezi?

Mr Nsanjama asked if heavy rain might reduce *Striga* emergence? Mr Mkandawire responded that low temperatures associated with heavy rain could do so.

Dr. Riches observed that the 'patchiness' of *Striga* infestation offered an opportunity for weed scientists, since it was not a whole-farm problem, but could be solved in patches on specific areas of the field. Interventions which might be inappropriate at the level of the whole farm (eg. handpulling) might be practical on small, badly-infested areas.

Dr Kabambe asked how we could reconcile farmers' high ranking of *Striga* as a pest of maize, with the finding that only 10 % of the area cultivated was badly infested. Suggested answer was that it is serious for those who have it, but not all do. Mr Mkandawire commented that farmers' perceptions of importance of *Striga* are affected by messages from Extension staff. Dr. Ritchie noted that 37 % was a high proportion of the cultivated area and justified efforts to find effective interventions.

What was the difference between upland and dambo soils ? Runoff brought fertiliser down to dambos from the upland, reducing *Striga* there.

***Lessons from GTZ training course on biological control of* Striga *for farm level management of* Striga.**
C. B. K. Mkandawire, FSIPM Project

Species so far found in Malawi included *Striga asiatica*, *Striga forbesii* (only Lilongwe ADD) and *Alectra vogelii*, which is only parasitic on leguminous crops. In Malawi, estimated average maize production loss of 6.2 % was valued at MK 59.6 million (GTZ, 1997).

Striga biology was divided into underground and overground stages. Host seedling produced a chemical stimulant effective within 10 mm of *Striga* seeds, resulting in attachment of germinating *Striga* seed to the roots of the host plant. After emergence, the weed flowered and seeds were dispersed during the capsule stage. Each capsule produced 7-8000 seeds, with 40-60,000 seeds/plant. Dispersal methods included crop seeds (eg. on maize cobs), tools, farmers, animals, wind and runoff water.

Favourable conditions for *Striga* in the smallholder farming system were sole cropping of host plants (maize, sorghum, millet), shortened or non-existent fallows, low soil fertility and crop productivity, low input of plant nutrients from fertiliser and manure, no use of improved seeds, and lack of crop rotation.

To be effective, control methods (handweeding, fertiliser, intercropping, and crop rotation) had to be integrated. Separate weeding was required for *Striga*, since it flowered soon after most farmers had already completed second weeding. Handpulling was necessary rather than hoeing. After weeding, *Striga* should be heaped and burned. Rotations to increase soil fertility included maize-sweet potato-groundnut-tobacco. Sweet potato intercrops could blanket emerging Striga, preventing development.

Questions/comments on Mkandawire presentation

Paul Jere asked: was burning crop residues effective in reducing the seed bank; did soil fumigation for tobacco reduce incidence; what was the definition of a *tolerable* level of *Striga* ?

Why was distribution of *Striga* so patchy at the field level, given the large number of seeds/plant, and the variety of dispersal mechanisms ?

The ineffectiveness of second weeding in controlling *Striga* limited the value of hand-pulling for farmers, since it required additional weeding after most weeds of the main crop had been removed. On the other hand, the patchy distribution of *Striga* may make additional weeding worthwhile.

Dr Daudi asked how many years were required for hand-pulling to be effective ? Dr. Riches replied that this was not as difficult as previously thought. Evidence from W. Africa suggested 1-2 years for *Striga hermonthica*, and 4-5 years on greenpeas in the USA. But hand-pulling of *Striga asiatica* was more difficult than for other *Striga* species because the weed was so small.

Overview of the 1996/97 FSIPM* Striga *Trial.
J. M. Ritchie, FSIPM Project (see Ritchie, 1997)

The FSIPM Project conducted OFTs with 10 farmers in four villages in two EPAs in 1996/97, testing five interventions against *Striga asiatica.*

Shaxson and Riches (1995) reported 30 kg/ha N applied as 23:21:0 + 4S incorporated in the ridge gave the highest revenue-cost ratio. Addition of inorganic fertiliser and organic nitrogen may reduce *Striga* severity and improve maize yields, but does not reduce the seed bank in the soil for future years. Interventions which reduce the seed bank include catch cropping (planting a crop which is infected by germinating *Striga* then ploughed in) and trap cropping (planting a crop which causes *Striga* germination but which cannot be infected and therefore need not be destroyed). Catch cropping is not appropriate for smallholders with limited land. Trap crops for smallholders must be food crops such as pigeonpea, cowpea, groundnut, field pea, pearl millet, and various bean species. Three crop seasons are needed for significant benefit.

Treatments:

1. Fertiliser: 30 kg/N/ha (23:21:0 +4S) banded in ridge at sowing, no topdressing;
2. Fertiliser: 30 kg/N/ha (23:21:0 +4S) dolloped to one side of maize plant at sowing, no topdressing;
3. Control: no fertiliser;
4. *Tephrosia* (2 seeds/station) planted at 45 cm spacing in furrow and incorporated at maturity;
5. Soya bean sown at 5cm spacing along one side of ridge; and
6. No *Tephrosia* or soya beans.

The experimental was designed as a 3 x 3 factorial with unequal replication, having a factorial treatment structure.

Results revealed that only 5 farmers had emerged *Striga* on their plots and of these only one had a severe infestation. Thus, it was not possible to relate *Striga* incidence and severity to maize yields. The effect of fertiliser was visually striking though the effect on maize yield was not significant. Soya grew well on the ridge but *Tephrosia* suffered from waterlogging and trampling in the furrow. The side of the ridge may be a better location for green manure crops.

Questions/comments on Ritchie presentation

Most of the discussion revolved around the relative merits of banding vs. dolloping, and the timing of fertiliser application.

Dr Riches observed that urea was not good for dolloping since it took time for N to be released and for a period it might be toxic to plant roots. The Maize Task Force had conducted trials last year on different methods and times of fertiliser application; results showed similar yields from banding and dolloping. This might have been because they used 23: 20: 21 + 4S rather than urea, however. Mr Nsanjama said CAN was better than urea, citing a paper given at the DAR annual research meetings by the Maize Commodity Team.

Dr Kabambe said that banding was done before planting for OFTs, to facilitate timely planting, but not recommended for farmers. The appropriate time of fertiliser application depended on the level of soil fertility: low soil fertility required early application. If fertility was high then later fertilizer application was effective. Dr Riches said farmers used fertiliser for maize, so it was rational for them to view timing of fertiliser application in terms of effects on the maize plant (yellowing, leaching). They did not see fertiliser in terms of reducing *Striga*. But if provided with more information about the link between *Striga* and the presence of nitrogen in the seed bed, they might be prepared to apply fertiliser at planting on those patches of the field which were badly infested.

Research on* Striga asiatica *and its implications for smallholder farmers
V. Kabambe, Chitedze Research Station

The presenter summarised findings from his recently completed Ph.D research on *Striga,* and results from on-farm trials. Overheads for this presentation are reproduced in Appendix 3.

Striga germination rates for trap crops

The effectiveness of various crop species as trap crops was evaluated by removing exudates from the crop, adding them to *Striga* seed in pot experiments, and testing the proportion of seeds which germinated. Results showed a wide range of *Striga* germination for cowpea and pigeonpea, indicating that certain varieties were better trap crops than others. Dilution with water to simulate rainfall reduced *Striga* germination.

The host crop maize was a good stimulant of *Striga* germination (38-60%). An experiment comparing 9 maize hybrids showed significant variation in inducing germination of Striga but failed to identify a variety with a low stimulus.

An experiment comparing *Striga* germination and emergence rates between composite and hybrid varieties showed significant variation, illustrating the existence of genetic potential for varietal resistance. The composite DK657 (from the US) had the lowest rate of *Striga* germination. Generally, composites were associated with lower rates of *Striga* germination than hybrids but had higher rates of *Striga* emergence.

Pot rotation evaluation for trap crops

This experiment compared rates of *Striga* germination and emergence after planting of various trap crops. Cowpeas, Mucuna and cotton stimulated germination well, but maize was the most effective and could be used as a catch crop. Emergence results showed a lot of genotype variation, but generally low emergence for cowpea (1.3-5.0 %) and some varieties of pigeonpea (2.7-11.0 %).

Trap crop OFTs, 1993/94-1995/96

On-farm research was conducted for three consecutive seasons at Manjawila and Mpingu to test the effectiveness of intercropping various trap crops with maize. Treatments included groundnut, cotton, and sunflower grown in rotation with maize, and maize intercropped with cowpea. Plots had fertilizer applied.

Results showed significant differences in maize yield between treatments at Manjawila for all three seasons, and for the third season at Mpingu. At both sites, the maize+ cowpea intercrop was the most effective treatment in reducing *Striga* emergence. The effectiveness of cowpea as a trap crop may be due to shading out of emerged *Striga* or more likely - since *Striga* is parasitic on the root system - by the cowpea canopy lowering soil temperatures and inhibiting germination. Even without removal of *Striga* there was a decline in severity of infestation by the third year.

Questions/comments on Kabambe presentation

Answering questions about the composite variety DK657, Dr Kabambe noted that this was a temperate variety unsuitable for semi-arid environments, with a short plant type, and protected by US patent. Seed was not available from IARCs. Under Malawian field conditions the leaves get scorched.

Dr. Mloza Banda pointed out that the rate of *Striga* germination between maize varieties was also affected by rooting volume. Composites have lower root volume than hybrids. They are also not genetically pure seed, leading to high variation between plants. To determine germination rates, therefore, field experiments with high plant populations gave better results than pot experiments.

M. N. Nsanjama observed that pot experiments did not capture the relative vigour of plant growth, which was an important plant characteristic for a trap crop.

What effect does burning of crop residues have on the *Striga* seed bank? Little effect because seed has already been spread across the land from seed pods when preparing the land. Could maize seed be treated with herbicide to kill *Striga*? Dr Riches responded that genetically emgineered maize with herbicide resistance was being developed. Imidazalone-resistant maize is being tested now in the Lake Victoria basin. *Striga* attaches to the maize root but then dies. This may be developed commercially but this conflicts with the farmer practice of recycling seed. How can potential genes reach farmers? The cost might be about US$ 5-8 per hectare.

What is a tolerable yield loss from *Striga*? Work is needed using sick plots and clean plots cleared by methyl bromide fumigation. Maize yield loss to *Striga* can only be evaluated in the context of a known effect of specific fertility levels on maize yield in the presence of *Striga*, and not in isolation.

Proposals for* Striga *research in Malawi
H. R. Mloza Banda, Bunda College of Agriculture

The speaker outlined his current research proposal submitted to Rockefeller Foundation for funding under the Academic Forum. The proposed subject areas were *Striga* biology and farmer knowledge of *Striga*.

Methods involved (1) a nationwide survey, covering farmer practices, weeding practices, and *Striga* incidence and (2) OFTs in specific agro-ecological zones (approx. 12) to test 3-4 interventions as student Msc projects. OFTs might possibly be conducted in collaboration with DAET trials in 1997/98.

Questions/comments on Mloza Banda presentation

Dr. Daudi noted that the 1995/96 Fertiliser Verification Trials had asked FAs to score fertiliser treatments 1= no *Striga* present, 2= < half planting stations affected, and 3 = > half planting stations affected. He pointed out that analysis of this data might be useful in measuring the distribution of *Striga* in Malawi. Dr Orr commented that the FSIPM Project had obtained the raw data for BLADD and

MADD from the Maize Commodity Team but had not yet found time to analyse it. Dr. Daudi supplied the consultation with a printout showing *Striga* scores for each of six treatments, by EPA.

Extension messages for Striga
Ms. Thaulo, Crop Protection

The speaker was invited to give a brief, unscheduled presentation highlighting the concerns of extension.

The main extension recommendations for *Striga* control were manure, applying the recommended fertiliser rates, hand-pulling of *Striga*, and intercropping maize with cowpea. These interventions were demonstrated in 1996/97 in most ADDs. Next season (1997/98) would see a revised set of interventions based on the recent GTZ training course for extension officers.

Demonstration trials and farmer field days would be conducted in selected 'hotspot' areas where *Striga* was endemic. These included Namwera EPA (MADD), and Lilongwe and Dedza Hills EPAs (LADD).

DISCUSSION OF INTERVENTIONS

Plenary session: Strengths, weaknesses, and research gaps of **Striga** ***interventions***
Facilitator: C. Riches, NRI

Discussion of *Striga* interventions was structured around Table 1, which summarises the views of participants on the strengths, weaknesses, and research gaps of four major control methods, namely inorganic fertiliser, intercropped trap crops, intercropped green manure crops, and additional hand-weeding. Participants' identification of research gaps, some of which may be explored in OFTs during 1997/98, are reviewed below:

Fertiliser

Time of fertiliser application is important for *Striga* suppression. The recommendation for maize is basal application at planting, followed by topdressing within 3 to 4 weeks after emergence (depending on the basal dressing fertilizer type) (Goldman, 1994: 128)). Evidence from elsewhere suggests that topdressing may be more effective than basal in suppressing *Striga*. This may also match current farmer practice, which regards basal application as risky and wasteful. More information is needed on (1) farmers' fertiliser practices (when, how, how much) and (2) effects of time of application on *Striga* suppression.

Table 1. *Striga* control component technologies - Inorganic fertiliser.

<table>
<tr><th>Strengths</th><th>Weakness</th><th>Research Gaps/Action</th></tr>
<tr><td>Known by farmers to be "key input";
Considerable farmer knowledge on use;
Readily available;
Maize yield benefit seen in season of use;
Benefits other crops in mixture;
Striga suppression;
Can be used to kick start growth of/value to maize of green manure.</td><td>Cost;
Can be used by associated crop (poor return on investment?);
Farmers lack knowledge on how to manage fertiliser use to maximise returns;
There may be considerable Striga emergence despite benefit to maize growth and yield (especially in infertile soils).</td><td rowspan="3">There is some indication that farmers perceive that application at planting may not be an efficient use of fertiliser (increases risk ?);

In heavy rain there may be leaching so maize crop is not sustained by low application rate;

Suggested that application at 3 weeks after planting may result in better Striga suppression (work elsewhere);

Urea may be toxic if dolloped at planting BUT Urea may be better source of N for Striga suppression;

On-farm compare N application at planting with application at three weeks after planting using rate of 30 - 60 kg ha^{-1}.

Need for further characterisation work on farmer fertiliser practices and perceptions of early application.</td></tr>
<tr><td><u>Dolloping at planting</u>

Quick (60 hrs ha^{-1} for one dollop per maize station);
Farmers accepted method of application;
Farmers believe allows most efficient use of nutrients by maize.</td><td></td></tr>
<tr><td><u>Spreading in ridge at planting</u>

Can be done during ridge preparation when labour is available.</td><td>Slow (96 hrs ha^{-1} in dry soil);
Farmers perceive fertiliser feeds weeds;
Farmer knowledge gap on position of maize roots in ridge;
May not be efficient method at low N application rates;</td></tr>
</table>

Table 1 (contd) *Striga* control component technologies - Intercropped trap-crops.

Strengths	Weakness	Research gaps/action
Cowpea Grown as food and cash crop; Good trap-crop; Contributes N; Can suppress other weeds.	Unavailability of seed for high density planting - cost, available in local market. Can slow down weeding; Low yields; Not compatible with beans; Aphids, *Alcidodes*, leaf eaters, *Alectra*.	**Use as an inter-crop in trials at *Striga* infested sites.**
Groundnut Known by some farmers for *Striga* control by late planting in maize; Good trap crop; Good market; Seed available at local market	Seed cost and availability for increased plantings in Shire highlands. Not widely grown in area; Low yields/poor pod formation; *Alectra* susceptibility.	Acceptability as a crop to farmers in project area needs further investigation - Why is it not grown more widely?
Soya Good trap crop; Contributes N (unless biomass removed at harvest); Price currently high; Increasing farmer experience and knowledge.	Unstable market demand and price, farmers lack incentives to grow the crop; Competition with maize, yield penalty; High labour at planting; *Alectra*, nematodes;	Further production information needed ie seed rate?

Table 1 (contd) ***Striga*** **control component technologies - Intercropped green-manure.**

Strengths	Weakness	Research gap/action
Tephrosia High dry matter production; N available - low C:N ratio, improves fertility; Easy to establish, good late season growth; Not too competitive with maize; Goat proof; Provides pesticide; Seed available.	Not a food crop; Farmer knowledge on its' use especially on incorporation not, as yet, widespread; Requires extra labour at planting and for incorporation - complicated weeding? May conflict with mbwera. Supports nematode populations.	Need to check on trap-crop ability; Transfer information on its utilisation to farming community; study incorporation options at farmer level - is it best to incorporate it during early ridge preparation. Labour issues.
Mucuna A known trap-crop with a high dry matter yield; Well known to farmers (some farmer knowledge re effect on *Striga*); Grown for seed and cash.	Highly competitive with maize; Complicates weeding - labour issue; Problems with end use of seed, slow cooking, poisonous, reduces value? Favoured by some ethnic groups only.	Thought to be better options otherwise more farmers would grow it; **Further characterisation needed on its' role in farming system and farmer perceptions before trials are undertaken**; Scope for screening variety collections.
Pigeon pea Commonly grown as inter-crop, not competitive with maize, produced for food,cash and firewood; A trap-crop; Contributes $\pm$ 30 kg N ha^{-1}; Adaptable across environments can be grown as annual or perennial;	Availability of wilt resistant variety seed can still be a problem;	Further information needed on planting density ie can population be increased on *Striga* infested patches for trap-crop effect or to increase N contribution.
Crotalaria A trap-crop, contributes 70-80 kg N ha^{-1}; Fast growing; Plant with maize or at weeding to reduce labour input; Should be easy to produce seed on field margin.	Competitive with maize; Could become weed? Farmers have no knowledge of this option; Not a food crop, limited uses (but insect trap?); Conflicts with mbwera (because broadcast).	On-farm research gap; Information needed on production practices and incorporation; Need to transfer information on use to farmers; **Concept needs to be introduced to farmers.**

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Table 1 (contd) *Striga* control component technologies - Additional hand-weeding.

Strengths	Weakness	Research gap/action.
By Hoe Readily available; used by farmers; *Striga* control may be consequence of late banking;	No immediate effect seen by farmer, may need to be done for a number of seasons; timing critical; Difficult to do close to maize plants without damaging maize roots; Will not be done where there is termite problem.	**Can any change in timing of weeding help reduce *Striga* population?** **If knowledge of biology of *Striga* is transferred to farmers will they see removal of the parasite from infested patches as an option?** **Further characterisation of household labour allocation needed** ie many families looking for off-farm income to fund food purchase by the time *Striga* is emerging.
Hand pulling Could be done readily on patches of field with sparse infestation;	Extra operation which may conflict with mbwera (as with use of hoe); Laborious; *Striga* needs to be removed from field; Farmer knowledge gap linking *Striga* removal with prevention of seeding. Timing critical.	

Trap crops

Research has shown that the maize-cowpea intercrop performs well in suppressing weeds (Khonga, 1997) and reduces the germination of *Striga*, perhaps by lowering soil temperature (Kabambe, this volume). This intercrop is also popular with farmers in Blantyre Shire Highlands. The two major drawbacks are that cowpea is not compatible with beans (another popular intercrop) and it is vulnerable to pests, including aphids, *Alcidodes*, leaf eaters, and the parasitic weed *Alectra*.

By contrast, groundnut and soya are compatible with beans and may have fewer pest problems. Relatively few farmers grow these crops in Blantyre Shire Highlands, however. Low adoption of groundnut may reflect climatic conditions, while low prices have reduced the incentive for soya.

Green manure intercrops

Tephrosia vogelii scores highly as a source of biomass and organic N. Two interactions with existing practices may pose problems, however. First, *Tephrosia* encourages growth in population of nematodes, which have been shown to be associated with the breakdown of varietal resistance to *Fusarium* wilt in pigeonpea. Since pigeonpea is a major intercrop with maize in the Shire Highlands, there is a danger that intercropping with *Tephrosia* will improve soil fertility but also increase crop losses from wilting among wilt-resistant varieties like ICP 9145. Second, since *Tephrosia* grows best when planted on the side of the ridge, it may prove incompatible with the farmers' practice of *mbwera*, where soil is removed from the ridge to form a flat bed in the furrow for planting relay beans.

Little is known about the acceptability to farmers of other green manures such as *Mucuna* and *Crotalaria*. Their potential for improving soil fertility may not be widely known. Pigeonpea, which is widely grown, is not normally planted in dense stands. Constraints on higher seeding rates - conflicts with other intercrops? - need to be investigated.

Additional hand weeding

The optimal time of weeding for *Striga* needs to be late enough for the *Striga* stem to remain intact and pull up the roots, but not too late to prevent dispersal of the seed. Early flowering is the best time if labour is available but removal needs to continue up to and beyond harvest. Farmers normally start second weeding earlier than this, however. Furthermore, normal practice at second weeding is to bank earth around the maize plant with a hoe, whereas it is necessary to hand-pull *Striga*, remove it from the field, and burn it.

If farmers knew more about the biology of *Striga*, however, they might be willing to change their current weeding practices, at least on those parts of their fields which were badly infested. Farmer evaluations of *Striga* trials by the FSIPM Project in 1997/98 will provide more information on this issue.

Additional comments made during the plenary session are recorded below.

- Some interventions had great potential but were considered too 'upstream' for Malawian smallholders at present. Examples included (1) genetically modified maize, engineered to tolerate wide-spectrum herbicides. Maize seed is coated with the herbicide before sale, thus killing *Striga* when it attempts to parasitise the young seedling, and (2) herbicides, which have become increasingly popular in Asia.

- It was emphasised that interventions should be integrated, not used in isolation. Participants suggested that all Striga OFTs should receive a low dose of fertiliser.

- Existing farmer practice could be used as a control. Information on farmer fertiliser use and application practice was seen as gap in researcher knowledge.

- More information was needed on the appropriate time for incorporation of green manures under on-farm conditions.

- Was crop rotation a real option for smallholders in the Blantyre Shire Highlands in face of population pressure? Participants suggested that it may have a role where maize yields are critically low, or could be used selectively on badly infested patches of fields. Rotation may be appropriate for other, less densely populated regions of Malawi, however.

- Integration of socio-economic and agronomic studies was required. A major component of future FSIPM *Striga* work should be transfer of information to farmers, particularly on *Striga* biology, so they can appreciate the purpose of interventions. Plots could be used as demonstrations to sensitise non-participants also.

CONCLUSION

The one-day *Striga* consultation met its objectives, proving a useful forum for sharing research results, assessing the current state of knowledge, and identifying the most promising IPM strategies for further OFTs.

Four major IPM strategies were identified - inorganic fertiliser, intercropped trap crops, intercropped green manure crops, and additional hand-weeding - which required adaptive research to fine-tune these technologies to fit the existing farming system. The consultation approved an integrated approach using two or more strategies.

Research gaps four these four IPM strategies were: the optimal time of N application for *Striga* suppression; farmers' apparent reluctance to adopt groundnut and soya as trap crops; the acceptability of *Mucuna*, *Crotalaria* and pigeonpea as green manure crops; and farmers' willingness to weed later for than current practice in order to reduce the *Striga* seed bank.

From the standpoint of the FSIPM Project, the most promising strategies for smallholders in southern Malawi appear to be a combination of inorganic fertiliser, cowpea and *Tephrosia vogelii* intercropped with maize, and hand-pulling on badly infested patches of fields.

ACKNOWLEDGEMENTS

We are grateful to C. Riches for facilitating the plenary session and producing Table 1.

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ABBREVIATIONS

ADD	Agricultural Development Division
DAR	Department of Agricultural Research
DO	Development Officer
EPA	Economic Planning Area
FA	Field Assistant
FSIPM	Farming Systems Integrated Pest Management
GOM	Government of Malawi
IARC	International Agricultural Research Centre
IPM	Integrated Pest Management
MOAI	Ministry of Agriculture and Irrigation
NGO	Non-Government Organisation
NPK	Nitrogen, Potassium, Phosphorous
OFT	On-farm trial
PMS	Pest management strategy
VR	Varietal resistance

Appendix 1. List of Participants

Ministry of Agriculture and Irrigation

H. Gwembere	ADO, Matapwata EPA
G. H. M. Thaulo	SAGO, Crop Protection

Bunda Collage of Agriculture

H. R. Mloza Banda	Agronomist, Crop Science Department
A. M. Z. Chamango	M.Sc. student, Crop Science Department

Bvumbwe Research Station

M. N. Nsanjama	ADARTS, Officer-in-Charge
S. D. T. Phiri	STO, Cereals

Chitedze Research Station

V. Kabambe	Agronomist, Maize Commodity Team

Consultant

C. R. Riches	Natural Resources Institute, UK

FSIPM Project

A. T. Daudi	ADARTS and Project Manager
J. M. Ritchie	TC Team Leader and IPM specialist
A. Orr	Farming Systems Economist
P. Jere	Agricultural Economist
C. Chanika	Agronomist
W. K. Fero	STO
C. B. K. Mkandawire	Field Supervisor
A. Koloko	Field Supervisor
T. H. Maulana	TA
T. T. K.Milanzi	TA
C. R. Shawa	TA

STRIGA RESEARCH MEETING, BVUMBWE RESEARCH STATION CONFERENCE ROOM, 6 OCTOBER 1997

DRAFT PROGRAMME

MORNING

08.30	Welcome (Mr M.N. Nsanjama, ADARTS)
08.45	Introduction to meeting (Mark Ritchie, FSIPM)
	Invited presentations by participants (Chair, Mr M.N. Nsanjama)
09.00	Socio-economic perspective on weeds and weed management at FSIPM sites, 1996/97. Dr A. Orr and Mr P. Jere (FSIPM)
09.40	Lessons from the GTZ training course on biological control of Striga for farm-level management of Striga. Mr C.B.K. Mkandawire (FSIPM)
10.10	Overview of the 1996/97 FSIPM Striga trial. Dr M. Ritchie (FSIPM)
10.40	Research on Striga asiatica and its implications for smallholder farmers. Dr Vernon Kabambe (Chitedze ARS)
[11.00	*Tea/coffee served during presentations]*
11.30	Proposals for Striga research in Malawi. Dr H.R. Mloza Banda (Bunda College)
12.00	General Discussion
12.30	Lunch in Conference Room

AFTERNOON

13.30	Plenary group work: Strengths and weaknesses of potential Striga management technologies. (Facilitator: Dr C. Riches, NRI, UK)
[15.30	*Tea/Coffee served during discussions]*
16.30	Disperse

SELECTION FOR EFFICIENT TRAP CROPS FOR CONTROL

OF *STRIGA ASIATICA* (L.) KUNTZE IN MAIZE (*ZEA MAYS L.*)

IN MALAWI

VERNON H. KABAMBE

SUPERVISOR: DR D.H.S. DRENNAN

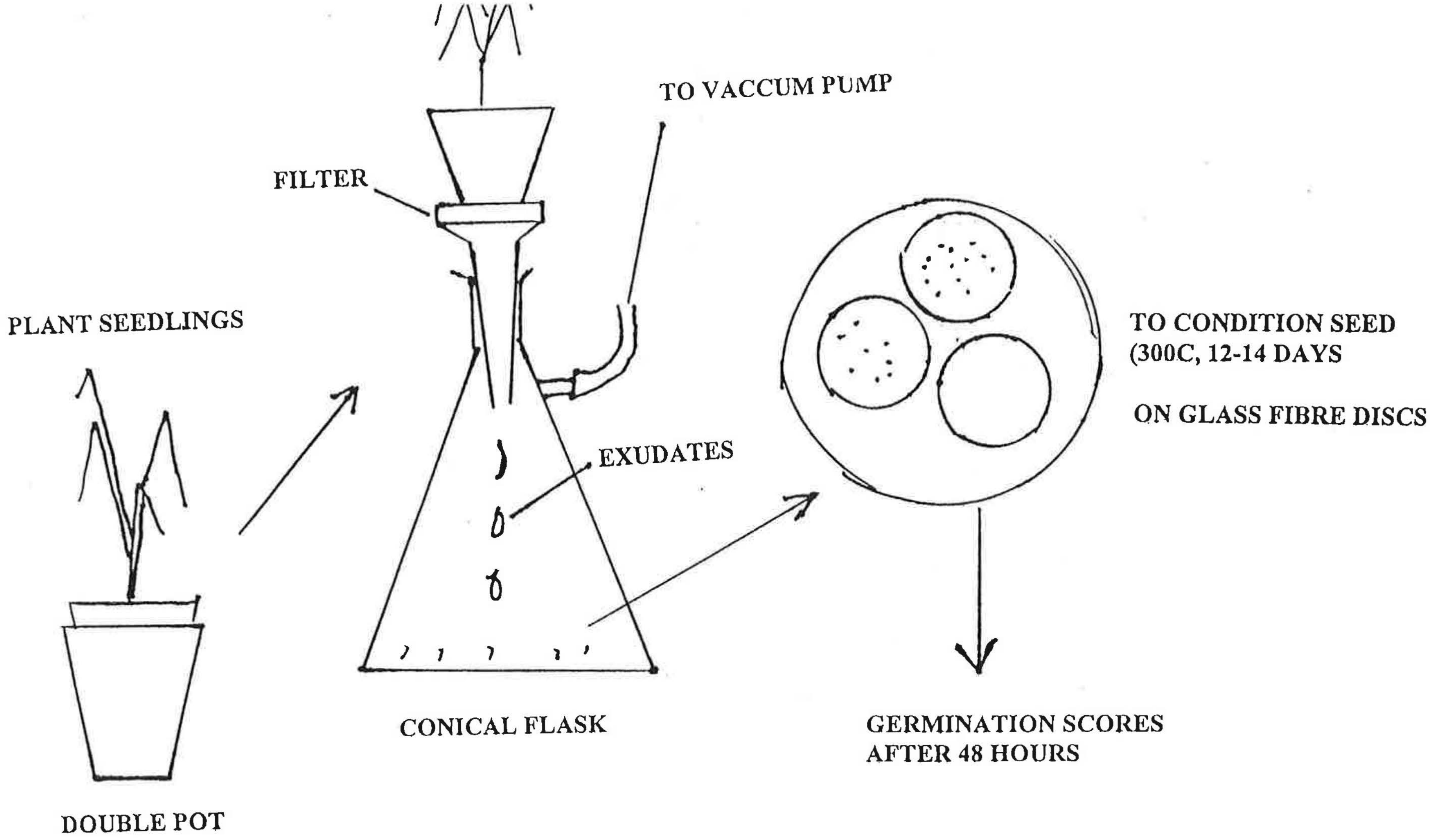
RATIONALE (BACKGROUND) FOR STUDIES OF THIS REPORT

Striga biology:

- germination only upon exposure to warm, moist conditions
- actual germination requires chemical stimulant
- haustorial initiation and attachment requires signal
- some plant roots can EXUDE such chemical signals

Objectives:

1. to sreen for efficient trap crops against *S. asiatica* via root exudate bioassays and pot rotation experiments
2. to screen maize varieties for reaction to S. asiatica and identify possible resistance mechanisms against it
3. to compare roles and mechanisms of organic and inorganic N on *S. asiatica* control and maize growth
4. to compare roles of legume and non-legume rotation crops, duration of rotation, hand-pulling and intercropping on *S. asiatica* population dynamics and maize crop and soil fertility changes
5. to determine role of maize density and spatial arrangement on *S. asiatica* population dynamics and maize growth


TO VACCUM PUMP
FILTER
PLANT SEEDLINGS
TO CONDITION SEED
(300C, 12-14 DAYS
ON GLASS FIBRE DISCS
EXUDATES
CONICAL FLASK
GERMINATION SCORES
AFTER 48 HOURS
DOUBLE POT

S. asiatica germination induction in dilution and extraction method studies

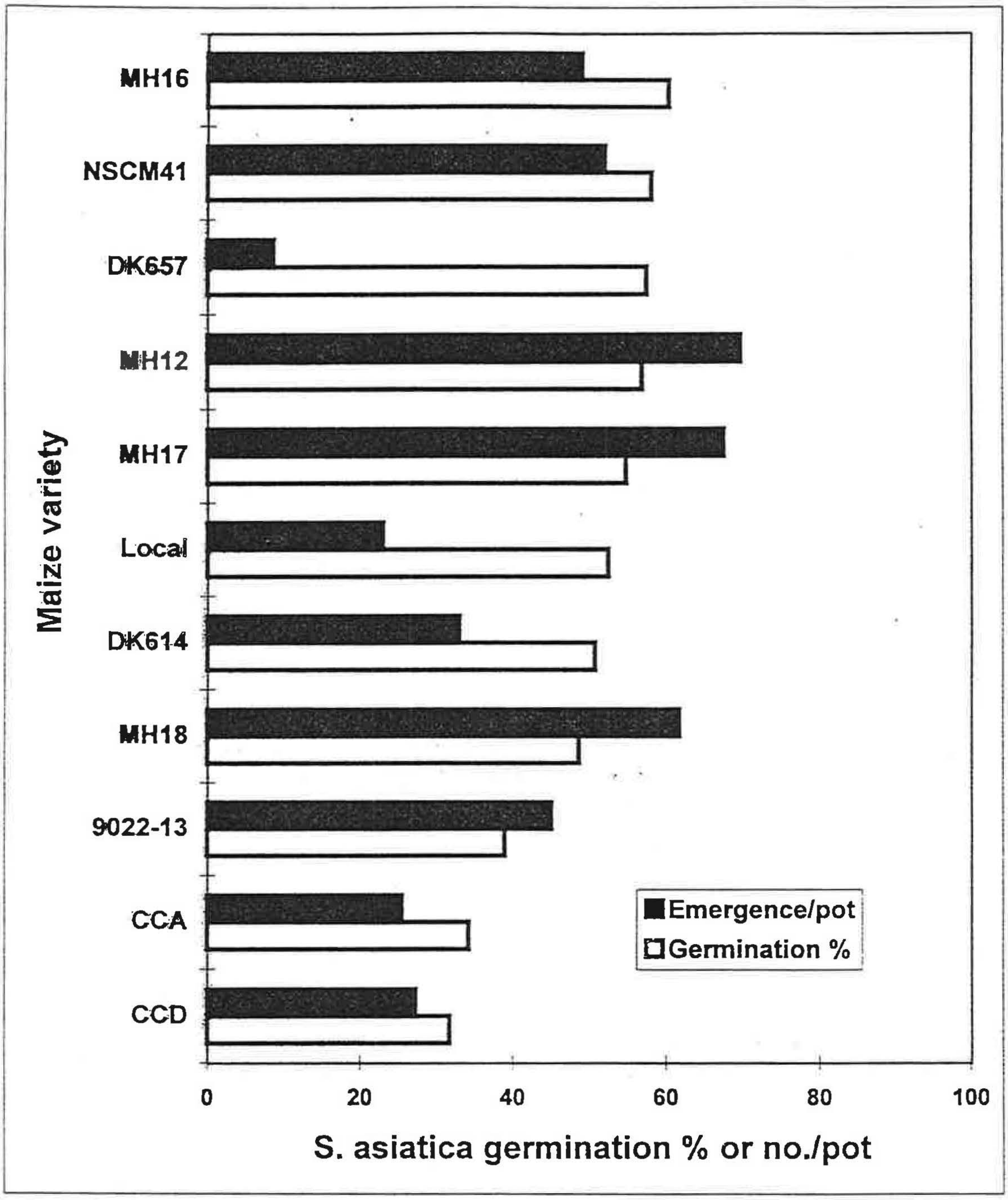
Entry/ Extraction method	undiluted	1 in 3 dilution	Prob level	maize germ %
Crushed	germination %, mean (range)			
Maize hybrids (5)	24 (12 - 49)	45 (27-72)	0.184	-
Groundnuts (2)	15 (14-16)	-	-	50
beans	26 (10-28)	33 (22-39)	0.001	50
double pot				
maize composites	41 (36-45)	28 (19-34)	0.02	46
Pigeon peas 1	39	27	*	50
Pigeon peas 2	25	4	*	50
Cowpeas 1	26	27	*	46
Cowpeas 2	15	10	*	46
Dolichos	23	3	*	56
Mucuna	52	30	*	56

* interction involved

Germination induction of *S. asiatica* by maize hybrids

Hybrid	Germination %
Water(control)*	6.74
9022-13STR(ex-IITA)	38.94
MH18(Malawi)	48.65
Local(Malawi)	52.41
8535-23(ex-IITA)	53.86
MH17(Malawi)	54.69
MH12(Malawi)	56.76
DK657(ex-USA)	57.49
NSCM41(Malawi)	57.96
MH16(Malawi)	60.27
Mean	**53.41**
SED	**9.09**
P level (%)	**0.001**

***=not included in analysis or mean**



MH16
NSCM41
DK657
MH12
MH17
Local
DK614
MH18
9022-13
CCA
CCD
Maize variety
Emergence/pot
Germination %
0
20
40
60
80
100
S. asiatica germination % or no./pot

S. asiatica germination induction by various crop species, compared to maize

Crop species (no. of entries)	germination % range	SED of expt	Maize % germination
Maize inbreds (4)	45 - 53	4.8	56
Sunhemp (1)	53	4.8	56
Sunflower (5)	45 - 55	4.8	56
Cotton (5)	35 - 50	6.0	45
Cowpeas (9)	15 - 37	4.2	46
Pigeon peas (7)	25 - 53	5.3	50

Maize variety evaluation

Entries: 5 Malawi hybrids (MH's)
2 ex-USA hybrids
1 ex-IITA hybrid
6 open pollinated varieties
1 farmers' local maize

Other details:
- Approx. 2,500 seeds/pot, 1 maize plant/pot
- same 1:3 sand:soil mixture, 25 cm diam, 6.6 litre pots
- open space, rain + supplement irrigation

Design: Randomized complete block, 4 replications

Data (in this presentation): periodic *Striga* emergence, fresh weight

Maize variety effect on *Striga* emergence through time, and fresh weight/pot

Maize variety	Striga incidence x DAP 59 DAP	77 DAP	92 DAP	107 DAP	Striga fresh wt (g)
MH12	6.3	69.7	56.0	55.0	19.9
MH16	5.5	49.0	40.5	36.7	12.8
MH17	0.3	40.7	67.5	65.0	18.0
MH18	4.0	55.2	61.7	47.2	20.3
NSCM41	6.3	52.0	49.7	50.0	18.4
9022-13STR	0.0	45.0	35.0	25.3	8.8
DK614	0.0	33.0	23.0	22.5	6.4
DK657	0.0	12.5	7.7	8.5	1.9
Tuxpeno	1.5	11.3	18.2	21.0	6.4
CCC	0.5	44.0	45.2	48.2	12.1
CCD	0.0	26.0	22.2	27.3	8.1
UCA	0.0	3.5	5.7	14.8	1.9
CCA	0.0	8.3	12.2	25.5	5.8
Local	0.0	10.3	23.0	16.5	2.7
Mean	1.8	32.9	33.4	33.1	2.7
P level (%)	0.013	<.001	0.001	0.026	0.009
SED	2.3	15.0	15.3	16.3	5.8

Pot rotation evaluation for trap crops

Entries: cotton, maize (control), blank (control) sunflower, pigeon peas, cowpeas, soybeans, finger millet, bambara groundnut

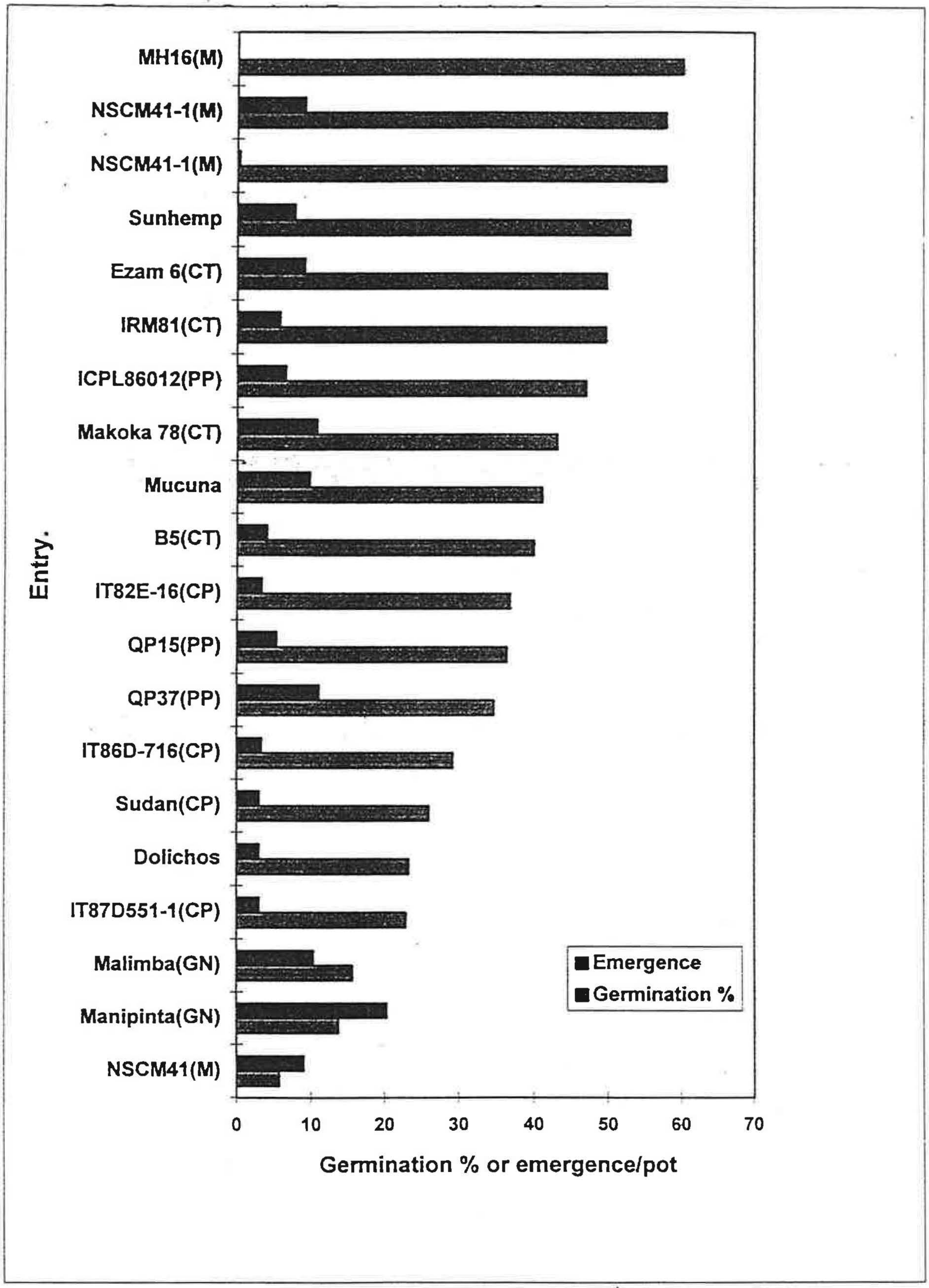
Experimental:

- cm diam pots, 1:3 sand soil, greenhouse, Malawi
- series of experiments, to accomodate large no. of entries
- Approx. 1,500 *S.asiatica* seeds (15 mg)
- second season: all maize cv MH16

Data: *Striga* emergence in 2 nd season

S. asiatica emergence on maize in pots previously planted to various trap crops at about 100 days after planting

Crop spp/ no. of entries	*Striga* emergence per pot, range	SED of Expt	SD (within spp.)
Blank	5.0 - 27	-	-
Maize (6)	0 - 9	-	-
Cowpeas (8)	1.3 - 5.0	4.1	0.49
Soybean (9)	4.3 - 10.7	4.1	1.14
Cotton (4)	2.7 - 11.4	5.7	1.63
Groundnuts (6)	1.7 - 20.3	5.7	2.97
Sunflower (4)	2.3 - 15.0	5.7	2.69
pigeon peas (5)	2.7 - 11.0	4.0	1.37
beans (5)	0.7 - 5.3	4.0	0.90
mucuna (1)	7.0	4.0	-
Bambara nut (1)	7.7	4.0	-
Dolichos (1)	2.3	4.0	-
Sunhemp (1)	7.7	4.0	-
Finger millet (2)	3.7 - 6.0	4.0	-



M=maize GN=groundnut CT=cotton
CP=cowpeas PP=pigeon peas

Summary and conclusions

* there exists between and within crop genotype variation in germination induction

* crushed undiluted exudates suppressive on germination, except for composites

* effects of exudate dilution on germination genotype dependent

* variation in *S. asiatica emergence* on maize following different crops spp/varieties

* differential *S. asiatica* susceptibility by maize varieties

* little relation between germination and emergence or trap crop efficiency

* efficient trap crops/tolerant hosts selection must be confirmed after interaction with soil

* maize has highest germination induction activity, soil seed depletion

treatment number	system	season year 1	year 2	year 3	year 4
1	mono, *Striga* +	Maize	Maize	Maize	Maize
2	mono, *Striga* -	Maize	Maize	Maize	Maize
3	trap cropping	LegTC	LegTC	LegTC	Maize
4	trap cropping	LegTC	LegTC	Maize	Maize
5	trap cropping	LegTC	Maize	LegTC	Maize
6	trap cropping	NLegTC	NLegTC	NLegTC	Maize
7	trap cropping	NLegTC	NLegTC	Maize	Maize
8	trap cropping	NLegTC	Maize	NLegTC	Maize
9	maize/cowpea intercrop, planted same time in the row, 3 x				Maize
10	late legume 3 x				Maize

legend: *Striga+* = *S. asiatica* not removed from plots

Striga- = flowered *S. asiatica* removed from plots

LegTC = legume trap crop, groundnuts at both sites

NLegTC = non-legume trap crop, cotton at Manjawila, sunflower at Mpingu

Table 6.3.1. Photosynthetically active radiation (PAR) and sunfleck interception in pure maize and maize cowpea intercrop expressed as % of unintercepted value (blank) at Manjawila in 1994/95 and '95/96 seasons and at Mpingu in 1993/94 at various days after planting (DAP).

Site & Season	date	canopy PAR as % of blank by treatment		sunfleck as % of blank by treatment	
Manjawila		maize str-	maize/ cowpea	maize str-	maize/ cowpea
1994/95	63 DAP	17.7	1.5	83.5	23.3
	78 DAP	32.9	19.7	91.2	77.4
1995/96	61 DAP	31.9	24.6	79.8	33.8
Mpingu, 1993/94	66 DAP	61.6	35.7	89.4	37.7

Table 6.3.2. Soil temperature (°C) in intercropped and sole maize at Manjawila and Mpingu in 1995/96 season.

Treatment+	Site and date	
	Manjawila, 61 DAP	Mpingu, 70 DAP
MMMstr-	35.5	24.8
MiMiMi	30.6	23.8

Table 6.3.4. **Economic yield of crops at Manjawila and Mpingu in first 3 seasons, kg/ha.**

Site ---->	Manjawila			Mpingu		
Treatment no. & code	season 1	season 2	season 3	season 1	season 2	season 3
	------------------------ **grain yield, kg/ha** ------------------------					
1:MMMstr+	1114	4091	1530	939	113	2295
2:MMstr_-	1092	4041	1598	723	288	2402
3:GGG	-	454	507	114	0	801
4:GGM	-	416	2094	148	0	2491
5:GMG	-	4457	834	95	300	1321
6:SSS/CCC	-	1274	917	512	0	1258
7:SSM/CCM	-	1364	1647	612	0	2473
8:SMS/CMC	-	5941	1418	517	367	1940
9:MiMiMi	468	3891	1294	203	58	1942
10:LGLGLG	-	123	78	2	0	138
Statistical summary, all data						
Mean	-	2605	1192	386	-	1808
SED	-	551	296	190	-	538
P level	-	<.001	<.001	<.001	-	<.001
% CV	-	26	30	70	-	36
Maize data only						
Mean	891	4484	1682	622	255	2164
SED	454	787	512	293	110	413
P level	0.367	0.15	0.412	0.107	0.068	0.135
% CV	62	22	37	67	69	29

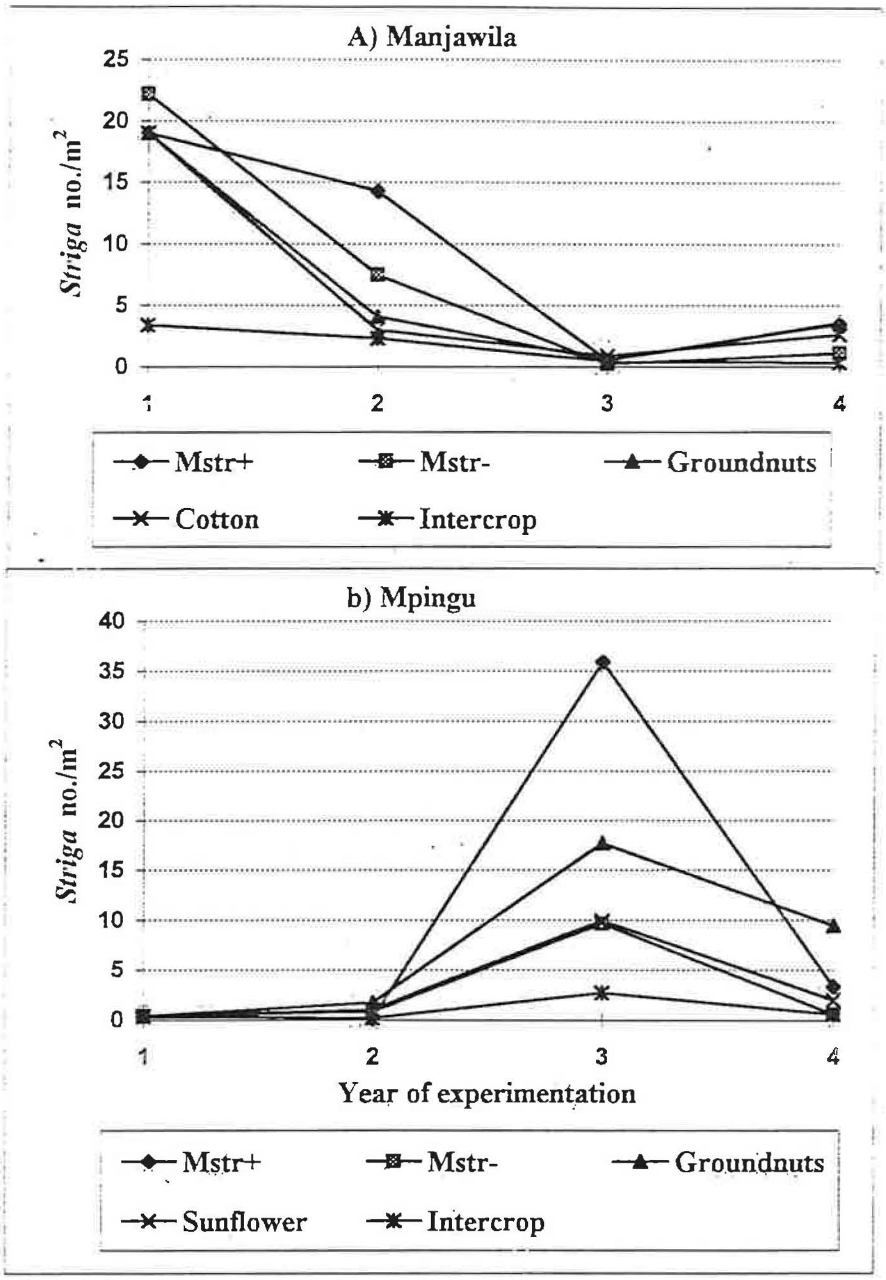


Figure 6.3.6 Yearly maximum *S. asiatica* emergence in maize for each of uncontrolled (Mstr+), *Striga* removal (Mstr-), groundnut, cotton or sunflower rotations and maize cowpea intercrop treatments Year 2 of the experimentation was the first season to asses trap crop effects. *Striga* emergence in Mstr+ was regarded the bench mark for plots with trap crops in the first year.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

INTEGRATING SOIL FERTILITY WITH IPM FOR SMALLHOLDERS IN SOUTHERN MALAWI

SUMMARY REPORT OF A CONSULTATION MEETING, 19 JUNE 1997

Edited by

J. Mark Ritchie
TC Team Leader, IPM Specialist

Alastair Orr
Farming Systems Economist

Paul Jere
Agricultural Economist

11 July 1997

Ministry of Agriculture and Livestock Development
Department of Agricultural Research
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Limbe

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Appendix 1: List of participants

Appendix 2: Consultation programme

Appendix 3: Status of technology evaluation at the farm level and implications for extension.

EXECUTIVE SUMMARY

Low soil fertility is a major cause of poor crop yields in Malawi. In turn, low crop yields reduce the economic incentive for pest management among smallholders. The FSIPM Project hosted a one-day meeting of agronomists and soil scientists conducting on-farm research on low-cost soil fertility interventions in the southern region. Based on research presentations, a matrix summarising key features of nine interventions was developed by participants. Research was required to develop pest management strategies for *Tephrosia* (nematodes) and *Sesbania* (beetles and nematodes).
Proposals for a local soil fertility network as a Technical subcommittee of the National Steering Committee on Agro-Forestry were rejected in favour of informal contacts and *ad hoc* meetings similar to this consultation. In the absence of agreed extension recommendations, *Tephrosia* or other legumes undersown in maize in combination with low inputs of inorganic fertilizer, may be the most appropriate technology for smallholders to increase soil fertility in the FSIPM Project area.

INTRODUCTION

The FSIPM Project is seeking to develop pest management interventions for smallholders intercropping maize, beans, and pigeonpea in Blantyre Shire Highlands RDP, Blantyre ADD, southern Malawi. A constraint on the adoption and usefulness of these interventions is the low level of soil fertility found in smallholdings in this area. Inorganic fertilisers are currently too expensive to be affordable by large numbers of smallholder farmers. If fertility can be raised without costly inputs of inorganic fertiliser, then the value of yields will be increased and pest management interventions will become more attractive to farmers. However, incorporating green manure crops and other plants into the farming system may alter the pest complex (pathogens, diseases, insects) thereby reducing yields.

Several projects in Malawi are conducting experiments with farmers to improve soil fertility using organic methods. However, there seems to be a need to share aims, methods, and achievements to enhance their collective effectiveness. Therefore, the FSIPM Project invited representatives of these projects to a one-day consultation on incorporating inorganic sources of fertility into existing maize-based smallholder farming systems in southern Malawi.

RATIONALE

The rationale of the consultation was to familiarise the FSIPM Project with current field research activities conducted by the national agricultural research system in non-inorganic methods of enhancing soil fertility. In addition, it was hoped that the opportunity for interaction would prove useful to soil fertility researchers based at separate research stations and in Blantyre ADD.

PARTICIPANTS

Invitations were restricted to those with on-farm research programmes in soil fertility enhancement. A total of 13 participants representing five Projects attended the consultation. The FSIPM Project was represented by three members representing both pest management and farming systems economics. A list of participants is given in Appendix 1.

OBJECTIVES

The specific objectives were to : (1) bring together practitioners of organic soil fertility enhancement technologies to share information, identify areas of common interest and/or complementarity, and facilitate cooperative planning and discussion; (2) identify 'best bet' interventions to improve soil fertility compatible with low-input pest management for on-farm trials in the southern region of Malawi during the 1997/98 cropping season; (3) explore possibilities for collaboration between projects in field-testing and evaluating green manure technologies with farmers; and (4) decide whether further meeting (s) of a 'Farming Systems/Soil Fertility Network' would be useful.

ACTIVITIES

Participants were welcomed to Bvumbwe Research Station by the ADARTS, Mr. M. N. Nsanjama. In the absence of the Project Manager, the TC Team Leader, Dr. M. Ritchie briefed participants on the rationale for the consultation. The morning session was devoted to short presentations of research and implementation activities. In the afternoon, there was a round table discussion of the major soil fertility interventions, followed by shorter discussions about collaboration and networking. The programme is reproduced in Appendix 2.

RESEARCH PRESENTATIONS

Project representatives were asked to provide a short outline of their current research programme. Twenty minutes were allotted for each presentation, plus 10 minutes for questions of clarification. The summary reports of each presentation given below are based on notes made by FSIPM *rapporteurs* and materials provided subsequently by the presenters.

Potentially, the number of organic soil conservation methods is large. An inventory of technology options summarising stage of testing, unresolved technical problems, and extension recommendations is reproduced from the MAFE presentation in Appendix 3. Of the 12 technology groups listed in Appendix 3, the discussion focused primarily on three: undersowing with legumes; alley or hedge intercropping; and contour vegetation strips.

Unfortunately Dr A.B.C. Mkandawire (Bunda College of Agriculture) was unable to attend the consultation to present research findings from on-farm trials at Domasi, near Zomba. The trials involve a soybean+pigeonpea-maize-maize rotation, with maize undersown with *Tephrosia* or *Crotalaria*, at three different nitrogen levels (Orr and Jere, 1997).

The FSIPM Project's on-farm research trials 1996/97
Dr. M. Ritchie

Dr. Ritchie gave a short introduction to the purpose and objectives of the FSIPM Project, and outlined the design of the 1996/97 FSIPM on-farm trials, with particular reference to soil fertility interventions for *Striga asiatica*. Among the problems encountered in implementing IPM was the fact that yields may be too poor to justify the farmer investing time or cash in pest management.

The FSIPM Project's main interest in green manure technologies was: (1) to improve soil fertility and main crop yield at low cost to the farmer; (2) their potential for additional benefits (eg. shading out weeds, useful subsidiary crop yield); (3) increase the value of the main crop and the attractiveness of pest management; and (4) to reduce *Striga* infestation.

Potential problems integrating green manure crops into the existing farming system included: (1) compatibility with main crops in terms of competition and tillage practices; (2) the hidden cost of labour requirements; (3) timely access to seed; (4) the lack of market pathways for some green manure crops (eg. soya); and last but not least (5) the potential for new or increased pest problems (nematodes, diseases, termites).

Comments/questions on FSIPM presentation

Experience with other projects had shown that *Tephrosia* planted in the furrow was vulnerable to waterlogging. It was preferable to plant *Tephrosia* on the side or on top of the ridge.

Banking pigeonpea and incorporating biomass while this intercrop was still in the field had increased damage by termites.

Kaselera was contrasted with farmers' intercropping practices in Machinga, where maize is planted on the flat and beans are planted in between the maize rows. This was felt to have some advantages over moving the maize ridges because it reduced the risk of the maize plant lodging and may also reduce damage from termites.

Green Manure management for smallholder farmers in Southern Malawi.
Prof. J.A. Maghembe and Ms G. Kooi. Presented by Ms G. Kooi (ICRAF)

Ms. Kooi outlined the main features of the maize-pulses farming system in southern Malawi, including: small average farm size, continuous intercropping; shifting ridges; low fertiliser use (25 % of farmers); increasing fertiliser prices; the importance of non-farm income, income from cash crops (tobacco, vegetables, sunflower, fruit), and dairy cows. Low soil fertility (N), soil erosion, and the lack of cash and credit were major constraints operating on the productivity of the farming system.

Four main interventions currently being tested were:

1. Mixed intercropping with *Glyricidia sepium*. *Glyricidia* was sown in every second furrow at 90 cm spacing to provide green manure. A perennial, it was pruned 3-4 times each year.

2. Relay-cropping with *Sesbania sesban*, planted after maize emergence.

3. Undersowing with *Tephrosia vogelii. Tephrosia* was sown half-way up the side of the ridge. Planting in the furrow made *Tephrosia* vulnerable to washout, waterlogging and accidental weeding. Early planting and high planting densities led to competition with the main crop and intercrops.

4. Contour planting on marker ridges. Contour ridges represented an empty niche waiting for vegetation. Options included: vetiver planting on steep slopes; Napier grass for fodder; *Glyricidia* for green manure; and pigeonpea can be used as to ratoon as a perennial crop.

Three types of on-farm trials were used to test these interventions. Type I trials (researcher-designed, researcher-managed) were used to collect only biophysical data. Type II trials (researcher-designed, farmer-managed) were used to collect limited biophysical data (yields, biomass) and some socioeconomic information. Finally Type III trials (farmer-designed, farmer-managed) were used to collect data about farmer adaptation of the technology and assess adoption potential. For example farmers stripped *Glyricidia* leaves to obtain biomass rather than pruning. Type III trials were easily neglected because of the need for intensive follow-up, but gave valuable insights.

Measurable improvements in soil fertility were not expected until the second season. Based on three seasons' work, the general results were: *no* significant increase in maize yields; *Tephrosia* was most easily propagated since no nursery was needed; labour for pruning 3-4 times/year was a problem with *Glyricidia*; by-products other than green manure (poles, firewood) were desirable; pest problems (particularly beetles and nematodes) discouraged further work with *Sesbania sesban*; nematodes also posed problems for *Tephrosia* but, this aside, it seemed the most promising intervention.

It was important to combine inorganic and organic sources of soil fertility enhancement, because: (1) no no improvement was expected in the first year; (2). low soil fertility meant that green manure crops produced little biomass initially; (3) high rainfall (1000 mm) led to erosion and leaching of soil nutrients. Consequently, one-quarter of the recommended rate could be used as a 'starter' treatment in the first season, when no benefit from the green manure was expected, and one-quarter to one-third of the recommended rate used annually thereafter.

In conclusion, Ms. Kooi made five points: (1) while researchers compared treatment *versus* control, farmers compared yields from the same land in different years. Theoretically, there was no reason why researchers could not change their hypothesis and have a completely fertilised control. This was how farmers based their comparisons; (2) in the conditions prevailing in southern Malawi, restoring soil fertility using organic methods might take 4-5 years; (3) interventions should be robust enough to perform well in abnormal years (drought, heavy rains); (4) extension efforts should wait until the benefits from organic methods were clear; (5) a combination of technologies and species was required to fit farmer circumstances, eg. *Glyricidia* as a perennial on marker and boundary ridges, *Tephrosia* or *Sesbania* as an annual in fields.

Questions/comments on ICRAF presentation

Restoring soil fertility could be achieved simply by fallowing, but cropping meant that nutrients were continuously being added and subtracted from the soil. The role of green manure crops was to re-establish equilibrium and achieve a net balance of soil nutrients.

Root knot nematode was a problem with tobacco as well as green manure crops. *Tephrosia* was more resistant to beanfly than *Sesbania.* Was *Tephrosia* indigenous to Malawi ?

Release of N was delayed when biomass was incorporated but speeded up when inorganic N was added. How much N was needed to offset N immobilisation ? Was one-quarter of the recommended rate enough ? It might be preferable to add the full recommended rate in the first year because no benefit was expected from agro-forestry.

Leaf biomass cannot provide all the nutrients required, a combination was required, say 500-100 kg biomass plus up to 20 kg/ha N as inorganic fertiliser. There was a need to incorporate a more diverse selection of legume species in the system.

Screening green manures for optimal soil fertility enhancement when undersown to maize: preliminary results.
R.A. Gilbert and J.D.T Kumwenda. Presented by Dr. Robert Gilbert, (Rockefeller/Chitedze)

An on-farm experimental program was established in the 1996-97 growing season at 11 sites in southern and central Malawi to determine if intercropped green manures can produce adequate biomass without reducing maize yields. The experiments will run for at least two seasons, and aim to quantify the amount of nitrogen added to maize-based cropping systems.

A factorial design with three factors was used to examine management options realistically available to farmers. The factors are:

A. Crops
1. *Crotalaria juncea* / maize
2. *Mucuna pruriens* / maize
3. *Tephrosia vogelii* / maize
4. *Lablab purpureus* / maize
5. Sole maize

B. Time of undersowing
1. First weeding (T1, 2 weeks after planting maize)
2. Second weeding (T2, 6 weeks after planting maize)

C. Seeding rate
1. Low (S1)
2. Medium (S2)

In the second season the plots will be split and one-half the area-specific fertiliser rate added to quantify the organic x inorganic nutrient interactions. At present in Malawi, farmers do not have enough land for improved fallows to generate large amounts of biomass, nor do they have enough cash for optimal fertiliser application. However, using the little amount of land and capital they do have in combination may be sufficient to increase soil fertility to acceptable levels.

The 'target biomass' concept was explained as follows. At the current maize:fertiliser price ratio, the optimum economic fertiliser rate is 60 kg/ha N. To be effective, green manure crops need to supply at least half the economic optimum (30 kg/ha N). Since green manure N is only half as effective as inorganic fertiliser N, 2,000 kg/ha of biomass is needed, assuming an N content of c. 3%. The precise target biomass will vary with N mineralisation (timing of incorporation), the percentage of N in the biomass, and the percentage of N fixed by legumes. This target biomass concept also implies that the cost of producing biomass should not be more than the cost of 30 kg ha^{-1} of urea (currently MK450).

Preliminary results indicated that *Crotalaria* and *Mucuna* can produce significant amounts of biomass (> 2000 kg/ha) when intercropped with maize in Malawi. However *Mucuna,* especially at T1, tends to be overly competitive with maize. *Lablab*, the only species parasitized by *Alectra vogelii*, has not reached this target biomass at any site. *Tephrosia*, which grows slowly and is not competitive with the maize crop, has yet to be harvested. Broadcasting seed of *Crotalaria* and *Tephrosia* led to survival rates of < 30% for these species, thus seed cost needs to be weighed against the labour advantages of this method. Plant tissue nitrogen percentages are being measured to determine the amount of N being added to maize cropping systems on-farm. This will be the major criterion in determining their utility.

Questions/comments on Dr. Gilbert's presentation

It would be important to incorporate crops such as *Crotalaria* and *Mucuna* which did not survive the dry season while their leaves were still green to avoid loss of N. According to one participant the 2000 kg/ha target biomass had been established by researchers in 1988. The average amount of biomass generated in on-farm trials was about 500 kg/ha, which was insufficient to provide two-thirds of the recommended rate for inorganic fertiliser. Biomass yields could be increased by keeping *Tephrosia* in the field and incorporating it in October/November.

Implementation of the PROSCARP Project
Mr. J. Goodman (PROSCARP)

The Project's objectives were to: (1) improve and stabilise the soil; (2) reduce dependence on maize; (3) incease yields; and (4) increase cash income to facilitate soil conservation. The Project currently had 200 on-farm sites throughout Malawi, with an expansion to 1,000 sites planned over the next five years. The Project worked through the ADDs. Sites were located in catchment areas, with villagers' participation in development committees.

Soil conservation interventions included:

(1) Marker ridges with permanent vegetation (vetiver, treecrops, agro-forestry seed);

(2) Realigning ridges to reduce soil erosion;

(3) Perennial trees and shrubs (*Tephrosia, Senna spectabilis, Glyricidia, Acacia albida*, etc);

(4) Fruit trees on marker ridges;

(5) Minority species for cash income;

(6) Improved crop varieties (maize, pigeonpea, soya);

(7) Reduced tillage (ie. maize planted in the same station each year without ridging) to improve soil structure. This technology had been developed by commercial farmers in Zimbabwe. It relied heavily on use of mulch which was not always available in sufficient quantities in Malawi.

(8) Gully reclamation.

Tephrosia was grown intercropped with maize or during a two-month fallow in Mwanza. It was stock-resistant and seeds could be sold for cash or made into insecticide. *Glyricidia* and *Senna spectabilis* were used for alley cropping but gave low biomass. *Msangu*, an indigenous tree which did not compete with crops because leafless in the wet season, was used for systematic interplanting. Fruit trees and Macadamia were grown to provide farmers with a source of cash income. It was important to work with a few technologies which could be integrated and which were sustainable.

The strengths of the PROSCARP approach were summarised as: using the existing extension system; flexibility; and the promotion of simple technologies. Weaknesses noted were excessive bureaucracy; weak monitoring and evaluation; and little use of a participatory approach.

Questions/comments on Mr Goodman's presentation.

Use of incentives for government field staff cast doubt on the sustainability of the programme. This has been addressed by reducing incentives and relating them to performance. It was stressed that this was an MoALD-owned project.

The priority of the project was expressed as integrating approaches to soil conservation, while avoiding over-diversification of activities. The project worked on sites of 350-400ha and began by realigning marker ridges in the catchment.

Effects of organic legume residues and inorganic fertilizers on maize yield.
Dr. J. Kumwenda (Chitedze)

Dr. Kumwenda outlined results of on-farm trials for the 1995/96 and 1996/97 cropping seasons. Treatments included: (1) maize grown after one year of pigeonpea, *Crotalaria*, and *Mucuna*; (2) maize grown intercropped with pigeonpea, *Crotolaria*, and *Mucuna*; and (3) three nitrogen rates (0, 48 kg/ha and 96 kg/ha). Plots were monocropped with maize for several seasons to reduce soil fertility prior to the trials.

1. Mean grain yields were higher when maize was grown in rotation with legume crops. Of the three rotations, pigeonpea-maize-maize gave the highest mean maize yield (5.7 t/ha compared to 3.5 t/ha for maize after maize). Average maize yields from rotating legumes with maize partly compensated in the second season for yield loss of maize in the first season. The average increase in maize yield was higher when legumes were grown in rotation rather than as intercrops, largely due to higher biomass production.

2. Of the maize/legume intercropping systems, the maize/pigeonpea and maize/sunnhemp systems gave substantially higher maize yields than sole cropped maize, while maize/*Mucuna* gave a lower yield than sole maize, perhaps because of competition from *Mucuna*.

3. High variability meant that results were not statistically significant.

Soil Fertility Network trial on green manure 1996/97.
J.D.T Kumwenda and R.A. Gilbert. Presented by J.D.T Kumwenda

Dr Kumwenda briefly outlined initial results of an on-farm trial to determine the effects of Phosphorous application on biomass production of legumes: *Mucuna* (MP), sunnhemp (CJ), and *Tephrosia* (TV) intercropped with maize. All plots received 20 Kg of N ha^{-1} and either 0 or 100 kgP_2O_5 ha^{-1}. Highest mean yield was by MP (7371 kg ha^{-1} with P and 5702 kg ha^{-1} without P) and lowest was by TV (3003 kg ha^{-1} with P and 2974 kg ha^{-1} without P). However TV evidently does not benefit substantially from the addition of P.

Questions/comments on Dr. Kumwenda's presentations

In response to a question about the different rates of N release, it was pointed out that the Annual Report of the Maize Commodity Team (1995/96) gave some information on this topic. It was mentioned that N was higher for fresh than dry leaves. Mr. Webster Sakala's forthcoming Ph. D. (Wye College, University of London) explores some of these questions.

Incorporation of crop residues ran contrary to farmers' practice in central Malawi, where farmers burned residues rather than buried them as in the south. Farmers in the central region were also unfamiliar with pigeonpea as an intercrop and there was a shortage of seed.

Some problems encountered intercropping green manures with maize were that stock ate the grren manure after the harvest of maize, and that termites ate green manure after incorporation, reducing contribution of N and increasing the risk of termite damage to maize.

Pigeonpea was the legume intercrop of choice throughout southern Malawi. Farmers might be unwilling to grow green manure crops which competed with pigeonpea, which could be grown with other green manure crops in a complementary way. The choice of green manure crop had to be made by the farmer. More data were needed on the release of N by green manures after incorporation. Incoporation of maize stover leads to immobilization of N even in animal dung.

Those who valued grain rather than green manure might favour pigeonpea as a green manure crop while those valuing green manure biomass might favour *Tephrosia*. It might be possible to increase planting density of pigeonpea in intercrops. ICRAF used ICP 9145 pigeonpea along with green manures.

Status of soil conservation and soil improving agroforestry technologies at the farm level.
W.T. Bunderson, F. Bodnar and G.K. Siyeni. Presented by Ferko Bodnar (MAFE)

Mr. Bodnar summarised preliminary results from the 1996/97 on-farm trials, with major emphasis on alley-cropping. Strong effects on maize yields were reported for three sites, comparing the impact of hedges that were 3.5-4 years old, for a total sample of 31 fields. Results showed a significant increase in average maize yield at all three sites. Average yield increase was higher for hybrid than for local maize. Average hybrid maize yield (unfertilised) in 1996/97 was 2,287 kg/ha under hedges compared to 828 kg/ha without hedges. It was often difficult to interpret yield results because of the high variability in farmers' management practices (eg. time and frequency of pruning, time and method of biomass application). Hybrid maize without fertiliser and alley-cropping with *Senna spectabilis* seemed to give the best results.

ICRAF fallows trials sown with *Sesbania sesban* and *Tephrosia vogelii* were located at one MAFE site. The 73% yield increase of maize after two years of *Tephrosia* fallow did not compensate for two years of maize yield loss but maize could be sown with the *Tephrosia* in year one of the fallow to reduce the loss of yield without seriously affecting *Tephrosia* growth.

Trials on biomass production in undersown fallows led to conclusions that: legumes should be planted within two weeks of the maize to accumulate sufficient biomass. Broadcasting was expensive, led to low germination and obstructed weeding. Direct sowing was preferable to seedlings because of the labour involved in handling large numbers of plants. A seed rate of 5-10 kg ha^{-1} for *Tephrosia* was sufficient to achieve a good cover after the maize crop was harvested and to produce enough biomass. This year has produced no discernible increase in maize yield given small sample size and low biomass. Several years of continuous undersown fallow would be needed to produce visible effects.

Trials on competition between intercrops and maize in Salima ADD have suggested yield reductions in maize intercropped with Pigeonpea and *Tephrosia*. These effects were worse for unfertilized plots and for *Tephrosia*. Data are being analysed from other sites.

Table 1 of this paper *"Status of technology evaluation at the farm level and implications for extension"* is a useful summary of the technologies available for extension to farmers. The table is reproduced as Appendix 3 of this report.

Questions/comments on MAFE presentation

The area under the hedges was included in measuring maize yield with alley-cropping.

Some agro-forestry species (especially *Leucaena*) are badly damaged by psyllids. *Senna spectabilis* is not so badly affected and has free-living bacterial nitrogen fixation.

Alley-cropping was first developed by IITA under favourable soil and rainfall conditions (>1000mm) but has enjoyed less success in semi-arid regions. With the high rainfall in southern Malawi, contour alleycropping may be useful for controlling soil erosion. Pruned biomass should be covered with soil as soon as it is laid in the furrow.

DISCUSSION OF INTERVENTIONS

Discussion of technology options for green manuring was structured around Table 1, which summarises key variables for nine major soil fertility interventions identified during the individual presentations.

In addition, comments were made about each of these technologies which highlighted other possible problems not included in Table 1. On technology description, participants noted that terms such as relay-cropping, intercropping, and mixed intercropping described practices for field crops but could be confusing applied to agro-forestry species which were grown both during the field duration of main crops and intercrops and after harvest of these crops.

With undersowing with *Tephrosia*, there was disagreement on the most appropriate date of planting, with some favouring planting after the first weeding or two weeks after planting, while others favoured planting after final land preparation. Time of planting and density of planting *Tephrosia* determined the degree of competition with crops for sunlight and soil nutrients.

A problem with incorporating maize stover was that it locked up N and harbourerd pests and diseases. It could be left to decompose in the furrow. Burning destroyed some but not all N and Sulphur in stover.

Crotalaria required a seed bank (20 x 20 m pure stand). It was necessary to broadcast seed to achieve the target biomass, but this increased seed costs. Farmers also used seeds as relish. This species grew rapidly and could be difficult for farmers to control. There was a potential danger of becoming a weed.

Mucuna also required a seed bank. Because of rapid growth it might be more appropriate as a fallow crop rather than intercropped with maize.

The maize/pigeonpea intercrop required high density planting of pigeonpea because incorporating when leaves were dry in October reduced contribution of N.

On mixed intercropping with *Glyricidia,* participants noted that seed availability might pose problems. This intervention also represented a major change in the farming system, from shifting ridges each year to a permanent ridge system. This posed potential problems: weeds might increase; ridges might degrade over time and could cause waterlogging. *Glyricidia* was initially planted in every second furrow and was vulnerable to waterlogging.

Table 1: Summary of key variables for nine green manure interventions discussed by presenters

No.	Technology	Is 2000 kg/ha biomass feasible ?	Time of incorporation	Competition effects with maize	Labour requirements (planting, pruning, incorporation)	Pests and diseases	Additional comments
1	Undersowing with *Tephrosia*	Yes, after 1 season if planted early (2 wks after maize)	a) annual - October b) biannual - October 2nd season or later	Low, except at high densities	Requirement for direct seeding lower than planting Low for incorporation	Nematodes	
2	Undersowing with *Crotalaria*	Yes, after 1 season if planted early at high density (40 kg ha^{-1})	80 days after maize planting maximises green leaf biomass	Low	Incorporation medium - higher than *Tephrosia*	Robust, but disease increases over years; leafspots; termites after incorporation	20m x 20m pure stand seedbank provides enough seed for 1 hectare undersown; border planting possible, dehiscent pods
3	Undersowing with *Mucuna*	Yes, after 1 season	With maize stover after maize harvest	High	High labour for incorporation	Stemrot, leaf diseases	
4	Alley cropping (various species)	Yes, after 3-5 seasons	After maize harvest; or 2 weeks after planting	Low	High, timely pruning critical	Psyllids (*Leucaena*), nematodes (*Tephrosia*)	
5	Maize/pigeonpea intercrop	Yes, at 37,000 plants/ha	October, or at time of making ridges	None	Labour for denser planting- lower than *Mucuna*	Stock, fusarium wilt in ratooned ICP 9145, nematodes.	
6	Mixed intercrop *Glyricidia*	Yes, after 1 season	August, October, January	Low	High, timely pruning critical	None	Lower altitude, up to 1200 m; seed expensive (K250/kg); planted every second furrow at 90cm; permanent ridge needed
7	Relay cropppig with *Sesbania sesban*	Yes, after 1 season, in absence of pest attack	October	Low	Medium to high for nursery seedlings	Beetles (*Mesoplatys*), nematodes	seedlings planted on every ridge side; trap crop for *Striga*
8	Undersowing with *Sesbania macrantha*	Yes	October	Low	Low if direct sown	Fewer than *S. sesban*	direct seeded on every ridge side; trap crop for *Striga*
9	Systematic tree planting with *Faidherbia albida* (*Msangu*), *Acacia polyacantha*, *A. albida*	Yes, after 20 + years	Not applicable	Low	Low	None	Seed can be collected from trees. *Msangu* planted at 10 x 10 m spacing thinned later to 20-40 m. *A. albida* for lowland hot areas, *A. polyacantha* for upland. *Msangu* for lowland, easily weeded out if not protected; seed available from FRIM.

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DISSEMINATION STRATEGIES

A paper entitled *"Proposed Initial agro-forestry dissemination strategy for SADC-ICRAF Makoka"* was provided by Mr Nobel Moyo. This proposes that three technologies are ready for testing by farmers, namely, mixed intercropping of maize with *Gliricidia sepium*, relay cropping of *Sesbania sesban* with maize and improved fallows using *S. sesban* and *S. macrantha*. A meeting was held with stakeholders from DAET, NGOs and other in October 1996 to present these technologies. The paper proposes follow-up with selected NGOs that have professional capacity in agroforestry, while continuing to network more widely. Four ADDs could act as pilot sites for extension activity.

The dcument proposes a six month schedule of activities to implement extension activity with colaborators, as follows:

- Follow-up visits to selected NGOs and DAET personnel to describe available technologies, select suitable field sites, select most suitable components for local application, identify local extension workers and plan field activities (July/August).

- Organize course to train field extension workers, including familiarizing them with technologies and jointly drawing up action plans for the targeted field sites and clarifying ICRAF's supporting role in later farmer-level activities (September).

- Identify clusters of 3-5 farmers to participate, demarcate plots and distribute seed (October). Establish nurseries (November). Transplant seedlings (December/January).

In the short time available at the meeting to discuss dissemination strategies, participants made the following points.

Demand for green manure crops was increasing both from NGOs promoting these technologies (e.g. Evangelical Lutheran Development Programme) and to some extent from farmers. But farmers faced adoption constraints. Labour was tight at critical times such as incorporation and pruning. Farmers' thinking was also more short-term, and they favoured technologies which gave rapid results. The most appropriate techniques for dissemination at present appeared to be use of *Tephrosia*, marker ridge planting of green manure species, fruit trees and Vetiver grass.

Participants noted the need for researchers to build strong links with extension personnel to create a sense of ownership. MAFE has produced a *Field Manual for Agroforestry Practices in Malawi.* ICRAF was starting a training programme for FAs and LHAs, using its own training materials. Once extensionists were trained, researchers had to continue supporting their trainees with resources such as seed. The Land Husbandry section of MOALD has adopted implementation of the PROSCARP Project as their own activity.

Finally, it was noted that despite the volume of research on green manure crops, few clear recommendations were available for extension. There has been conflicting advice on issues such as planting and spacing of *Sesbania*. There was a need for the NSC and the research/extension projects (ICRAF/MAFE/PROSCARP) to agree on policy issues and to coordinate their research recommendations and extension messages to the ADDs.

COLLABORATION

There was an opportunity for the FSIPM Project to share information and collaborate on *Striga* with Mr Vernon Kabambe, currently completing his Ph. D at the University of Reading on the subject of *Striga* and trap crops. He is expected to return to Malawi in August 1997.

Opportunities also existed for the FSIPM Project to develop pest management strategies for pest problems in specific green manure systems, particularly *Tephrosia* (nematodes) and *Sesbania sesban* (beetles and nematodes).

It was suggested that the on farm trials under Action Group 4 were an obvious starting point for collaborative trials. A report by DAR on instructions to field workers contains the rationale and field layout of these demonstration trials. FSIPM could collaborate by: (1) determining pest dynamics in long-term trials; (2) developing common treatments. Dr Gilbert also welcomed FSIPM to observe pest activity in his plots.

NETWORKING

Sources of information about other projects and technologies were available through: (1) the Soil Fertility Network for Southern Africa (Coordinator, Dr. Stephen Waddington, CIMMYT); and (2) the ICRAF Newsletter for the SADC region produced by AFRENA.

It was proposed to establish a Soil Fertility Network as a Technical subcommittee of the NSC for Agro-Forestry. The Secretary of the NSC suggested that the FSIPM Project could take the lead in establishing this network. It was pointed out, however, that the Project's mandate was not directly with soil fertility but with IPM. In the absence of a lead from the NSC, it was resolved to maintain informal contacts and convene further consultations if necessary. FSIPM project staff indicated that they would informally submit designs for on-farm trials integrating IPM and green manure treatments to soil fertility researchers for their comments before the start of the next cropping season.

CONCLUSION

The consultation proved an efficient way for the FSIPM Project to learn from agronomists and soil scientists about technologies to improve soil fertility currently being tested in the southern region of Malawi. Participants from other Projects also found the consultation useful, though not sufficiently useful to warrant regular meetings as part of a local Soil Fertility Network.

For the FSIPM Project, important lessons from the consultation were: (1) the need to combine organic and inorganic sources of N to meet the target biomass of 60 kg/ha N, required to improve soil fertility effectively; (2) introduction of green manure crops altered pest complexes, and suceptibility to pests made several such crops less effective sources of organic nitrogen; (3) the need for careful consideration of the economic implications of different green manure crops, particularly the timely availability of seed and labour; (4) depending on the intervention, two seasons or more were required before there would be any significant increase in average maize yields; (5) conditions on smallholder farms in southern Malawi suggested that undersowing green manure technologies were preferable to legume/maize rotations, fallows, alley cropping or mixed intercropping with *Gliricidia* which required radical changes in current tillage practices.

REFERENCES

A Orr and P Jere, Trip Report # 11: Lilongwe 22-25 April 1997.

GLOSSARY

ADARTS	Assistant Director of Agricultural Research and Technical Services
ADD	Agricultural Development Division
AFRENA	Agro-Forestry Research and Extension Network in Africa
CIMMYT	International Maize and Wheat Improvement Center
DAET	Department of Agricultural Extension and Training
DAR	Department of Agricultural Research
DARTS	Department of Agricultural Research and Technical Services
FA	Field Assistant
FRIM	Forestry Research Institute of Malawi
FSIPM	Farming Systems Integrated Pest Management
ICRAF	International Centre for Research on Agro-Forestry
IITA	International Institute for Tropical Agriculture
IPM	Integrated Pest Management
LHA	Land Husbandry Assistant
MAFE	Malawi Agro-forestry Extension Project
MOALD	Ministry of Agriculture and Livestock Development
NGO	Non-Government Organisation
NSC	National Steering Committee for Agroforestry
PROSCARP	Promotion of Soil Conservation and Rural Production
RDP	Rural Development Project
SADC	Southern Africa Development Community
TC	Technical Cooperation

Appendix 1: List of participants

Bvumbwe Research Station

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FSIPM Project

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MAFE Project

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M. D. Yush, address as above.

PROSCARP

Jim Goodman, PROSCARP (BLADD) Private Bag 379, Blantyre 3. Tel: 672 022

G. Chaguza, address as above.

SOIL FERTILITY MEETING, BVUMBWE CONFERENCE ROOM 19 JUNE, 1997

PROGRAMME

MORNING

0830 Welcome (Mr. N. Nsanjama, ADARTS)

08.45 Introduction to Meeting (Mark Ritchie, FSIPM)

09.30 Invited Presentations by participants (Chair, Mr M.N. Nsanjama)

Green manure management for smallholder farmers in Southern Malawi
Prof J. Maghembe and Ms G. Kooi, ICRAF, Makoka Research Station

Undersowing green manures in maize-based cropping systems: preliminary results Dr R. Gilbert, Rockefeller Foundation

PROSCARP demonstration trials, 1996/97 season
Mr J Goodwin and Mr G. Chaguza, PROSCARP, BLADD

(up to 4 further presentations, maximum 20 minutes each, titles to be advise)

1100 Tea/coffee served during presentations

1230 Lunch in Conference Room

AFTERNOON

1330 Discussion session (Facilitator: A. Orr, FSIPM)

Suggested topic questions:

1. What technologies have we got ?
2. How well do they fit with smallholder farming systems ?
   (eg. pests/crops/labour requirements/ seed supply etc.)
3. How can they be disseminated ?

15.30 Tea/coffee served during discussions

1600 Future directions (Facilitator, Paul Jere, FSIPM)

1. Collaboration
2. Networking
3. Any other relevant issues

1700 Departure

Rapporteurs: FSIPM Project.

TABLE 1: STATUS OF TECHNOLOGY EVALUATION AT THE FARM LEVEL AND IMPLICATIONS FOR EXTENSION

Technology or Practice	Stage of Testing	Modifications Ongoing or Completed	Unresolved Technical Issues or Problems	Recommendations for Extension			
				Farm Impact	Farmer Demand	Environment (Soils & Altitudes)	Management Needs
Pegging & Building Marker Ridges	Complete	Train farmers to use the A-frame & line level to improve accuracy, impacts, and costs.	• Local production of line levels at affordable costs. • Widescale training of farmers.	High	High	All	• Dry season supervision by extension staff. • Community participation with oversight from village committee.
Contour and Tied Ridging	Complete	• Align top half to upper marker ridge and bottom half to lower marker ridge. • Tie ridges next to paths, boundaries & drainages.	• Limited extension and training of farmers. • Lack of community participation. • Labor demanding.	High	Moderate from low exposure	All	• Awareness & educational campaigns with demonstrations. • Good community participation.
Gully Reclamation	Advanced	• Checkdams of wooden stakes with rocks and vetiver grass. • Planting bananas & sugar cane in gullies.	• Lack of community participation. • Ineffective with deep gullies.	High	Moderate from low exposure & participation	All	• Awareness & educational campaigns with demonstrations. • Good community participation.
Tree Nurseries	Advanced	• Individual/group focus. • Option for indiv. beds in communal compound. • Avoid hired labor.	• Level of support for water, seed & other inputs. • Support/supervision with multiple sites.	High	High	All where reliable water is available.	• Access to quality seed & other inputs. • Staff monitoring & supervision.
Vetiver Nurseries	Complete	• Communal & individual nurseries. • Contract farmer/estates for multiplication.	• Need large & widescale multiplication. • Need incentives to maintain & expand nurseries.	High	High	Best in dambos but suitable elsewhere.	• Early planting & weeding with close spacing. • Dambos for quick multiplication. • Protection from animals.
Contour Veg. Strips	Complete	• Early planting in furrow or upper side of ridge. • Space slips 10-15 cm apart. • Variety comparisons.	• Insuffient planting material for demands. • Limited nos. of nurseries. • Labor intensive.	High	High	All	• Establish nurseries first to multiply material & reduce costs/waste. • Good community organizatn & participation.
Systematic Tree Interplanting	Advanced	• Species tests by environment. • Improved propagation & direct sowing. • Protection against weeding, trampling, browsing.	• Quality seed supply. • Value of other species, *Acacia* & *Erythrina* spp. • Costs of new propagation methods.	High but slow returns.	High	All, except high plateaus.	• Early planting with rains. • Protection from weeding & trampling. • Need to reduce propagation costs.

TABLE 1: STATUS OF TECHNOLOGY EVALUATION AT THE FARM LEVEL AND IMPLICATIONS FOR EXTENSION

Technology or Practice	Stage of Testing	Modifications Ongoing or Completed	Unresolved Technical Issues or Problems	Recommendations for Extension			
				Farm Impact	Farmer Demand	Environment (Soils / Altitudes)	Management Needs
Alley or Hedge Intercropping	Advanced	• Species tests by environment. *Reduced Labor & Costs:* • Direct sowing vs seedlings. • Wider spacing for seedlings of long-lived species. • Improved pruning methods & tools with 1 timely pruning. • Flexible mid & late prunings. • Biomass left in situ.	• Supply of quality seed. • Protection against weeding and browsing. • Negative effects with poor management. • Potential nematode problem for tobacco with *pigeon peas, Sesbania* or *Tephrosia*	Variable with 3-5 years before returns	High for good farmers	Need careful matching of species to environment and farm system	• Need for good and timely hedge management. • High labor costs. • High returns from combinations with modest use of fertilizers or manure. • Use hybrid maize
Improved or Short-term Fallows	Early	• Species tests by environment. • Direct sowing vs seedlings. • Intercropping during 1st year. • Wood & seed for use or sale. • Value/impact of small plots with incremental expansion. • Assessment of available land.	• Supply of quality seed. • Potential nematode problem for tobacco with *pigeon peas, Sesbania* or *Tephrosia.* • Skepticism due to apparent lack of fallow land.	Not yet on MAFE sites; Positive on ICRAF sites	Limited where exposed in pilot sites	All	• Land. • Campaigns with demos for wider exposure of staff and farmers to assess potential.
Green Manure Banks	Early	• Timing of pruning and biomass application • Species tests by environment.	Land and labor costs and conflicts.	Under evaluation.			High land and labor costs.
Undersowing Leg. Shrubs	Early	• Species tests in different environments. • Optimal seed rates. • Time & method of undersowing. • Time & method of incorporating green manure.	• Unquantified impacts & farmer responses. • High seed costs and related supply concerns. • Labor for incorporating green manure. • Pest/disease risks to crops.	Not yet in MAFE sites; Positive by Maize Task Force	Not yet exposed to results	Need matching species to environment	• Intercrop on ridge • Seed rate for *T.vogelii* 5-10 kg/ha • Direct sow *T.vogelii.* • Timing for *T.vogelii*: plant 0-2 weeks after planting maize.
Reduced Tillage with Crop Residue Management	Very early	• Initial boost by one-time application fertiliser. • Combine low and high quality crop residue. • Planned: different amounts and timing of residue application.	• Quantity biomass needed for impact.	Under evaluation	Not yet exposed to results	All	• Weeding: light, minimum soil disturbance; frequent, reduce seed setting. • Avoid grazing crop residue.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

FIELD DAY FOR NGO IPM NETWORK, 10 MARCH, 1997

SUMMARY REPORT

Edited by

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18 March, 1997

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EXECUTIVE SUMMARY

The FSIPM Project hosted a Field Day on 10 March 1997 for members of the NGO IPM Network (Malawi). Representatives from 11 NGOs, DAET, and the GTZ IPM Project attended the Field Day. After a short briefing, visits were made to 9 FSIPM on-farm trial plots in Chiradzulu North and Matapwata EPAs, Blantyre Shire Highlands RDP. The Field Day gave Network members an opportunity to learn more about IPM PMS on maize, beans, and pigeonpea, and provided valuable feedback to the Project. Measures were discussed to help identify prospective 'partner' NGOs with which the FSIPM Project might collaborate during the next cropping season (1997-98).

INTRODUCTION

The purpose of the FSIPM Project, as stated in the revised Logical Framework, is to improve local capacity for IPM, which includes both the national agricultural research system, to which the Project belongs, and NGO research and extension systems (Ritchie, 1996). The Project Output to Purpose Review in October 1996 recommended stronger linkages with NGOs, with a view to collaboration during the next (1997-98) cropping season (Hansell *et. al.*, 1996).

To date, contacts with NGOs have included a presentation on the FSIPM Project at CURE's 10 th Environmental Coordination Meeting (March 28, 1996), and an article contributed to CURE's Newsletter. The FSIPM team also gave an extended presentation to the third general meeting of the NGO IPM Network (Malawi) on 7 January, 1997. Responding to the interest shown by the NGO IPM Network, it was agreed that Network members would visit Bvumbwe Research Station to learn more about the IPM PMS being tested by the FSIPM Project in the 1996-97 cropping season.

FIELD DAY RATIONALE AND PREPARATION

The rationale of the Field Day was to demonstrate IPM PMS to members of the NGO IPM Network, with a view to collaboration in research and extension in the 1997-98 cropping season. Consequently, the Field Day focused on the Project's on-farm trials, where promising PMS were being tested, rather than on more basic research being made on-station.

Since time did not permit same-day visits to both EPAs, separate visits were arranged, with one group of participants visiting each location. The specific trials to be visited were agreed at a Project meeting on 6 March. Village chiefs and farmers selected were then contacted and briefed.

Figure 1: On-Farm Trials selected for NGO IPM Network Field Day

No.	Name of Farmer	Type of Trial	Treatments	Remarks
1	Linily Matakesa	Main intercop	Banking maize; low density beans, earthed up beans	Banking caused increased termite attack; low bean yield
2	Ester Thom	*Striga*	Soya; *Tephrosia*	No *striga* detected; *Alectra vogelii* on beans
3	Kassimu Sapanga	Main intercrop	Weeding without banking; ICP9145 side-planted on ridge; Kaulesi beans; bean mulching; bean seed treatment	Poor bean crop due to toxic effect seed treatment and disease
4	Dorothy Ayimu	Main intercrop	High density beans	Good bean crop
5	Elube Nankhonya	*Striga*		Little *striga* visible because of banking; good bean crop
6	Mai Golden	*Striga*	Soya; *Tephrosia*	Heavy striga attack
7	Luka Dinala	*Striga*	Soya; *Tephrosia*	No emerged *striga* but *Alectra vogelii* on beans
8	Bambo Tomato	Main intercrop	Modified *kaselera*; ICP9145; low density beans	High bean yield
9	Mai Muthowa	Main intercrop	Modified *kaselera*; low density beans; no seed treatment; local pigeonpea	High bean yield

The Field Day was held on Monday, 10 March, 1997. Invitations to members of the IPM Network (Malawi) were issued by the Network secretariat. In addition, the Project issued invitations to the FAs and DOs in Chiradzulu North and Matapwata EPAs, where the on-farm trials were located, and to the Blantyre ADD representative on the Project Steering Committee. Bvumbwe Research Station was represented by the ADARTS, Mr. M. N. Nsanjama. Since the focus of the Field Day was on collaboration with NGOs, invitations were not issued to other researchers with the exception of the Coordinator of the GTZ IPM Project.

The Project provided transport from Blantyre/Limbe for participants without vehicles, and lunch in the Bvumbwe conference room.

FIELD DAY PARTICIPANTS

A total of 24 visitors attended the Field Day. Besides representatives from DAET and the GTZ IPM Project, these included representatives from 11 NGOs. Unfortunately, ActionAid was not represented.

Representatives from CSC and CU had previously attended the FSIPM Stakeholder Workshop in June, 1996. A list of Field Day participants is provided in Appendix 1.

FIELD DAY OBJECTIVES

The specific objectives were to: (1) provide NGO IPM Network members with an opportunity to learn more about the FSIPM Project, particularly its on-farm trials; (2) obtain feedback from NGOs on the Project's choice of crops, pests, and PMS; (3) explore avenues for future collaboration between NGOs and the FSIPM Project.

ACTIVITIES

Participants were welcomed to Bvumbwe by the ADARTS, Mr. M. N. Nsanjama. In the absence of the Project Manager, Dr. J. Mark Ritchie (TCO Team Leader) briefed participants on the Project and on the programme for the Field Day. Participants were then divided into two groups for field visits. Following the field visits, a wrap-up discussion distilled impressions and suggestions from visitors. The Field Day programme and the summary briefing given to participants is given in Appendix 2.

VISITS TO ON-FARM TRIALS

Visitors' comments during visits to on-farm trials were recorded by Ms. Lawson-McDowall (*rapporteur,* Chiradzulu North) and Mr. W. K. Fero (*rapporteur,* Matapwata). Field guides were Dr. J. Mark Ritchie and Mr. P. Jere (Chiradzulu North) and Mr. B. Mkandawire and Dr. A. Orr (Matapwata).

Crops

- The choice of the maize variety MH18 was questioned since it is susceptible to head-smut.
- ICP 9145 was tolerant to fusarium wilt and Kalima was tolerant to beanfly. Was MH18 considered tolerant to termites ? Were there maize varieties which are resistant to termites ?
- Poor maize stands prompted the observation that cassava or sorghum might be more appropriate crops than maize for some of the fields visited.

Pest Management Strategies

- Visitors asked if participating farmers had previous experience with soya or *Tephrosia.* Why was *Tephrosia* being used as a treatment against *Striga* ? How would the *Tephrosia* plants be used ?
- Is pigeonpea affected by either *Striga* or *Alectra* ?
- Farmers using the modified *kaselera* system had to plant the relay bean crop (two rows) on the ridge, whereas in the farmers' normal practice in Thyolo (*mbwera*) relay beans are planted in the furrow to take advantage of any residual moisture. In the modified *kaselera*, however, relay beans are planted earlier than with *mbwera* so there is less risk of moisture stress.
- Where were the control plots for the main crop on-farm trials ? Farmers' plots should not be described as 'control' plots since they used different varieties, practices, and no data was being collected from them. If control plots were not located side-by-side with the experiment, but on different fields, then soil, slope, and pests might differ considerably from the experimental plot. We were subjecting the treatments to different micro-environments. This would affect data analysis.
- Were we going to retain the same plots and fields for next season ?
- Most visitors had never before seen *Alectra vogelii* (*kaufiti wamkulu*) in farmers' fields. They pointed out that farmers may have misled us about the presence of *striga* just in order to be included in the experiments. They implied that this would not be unusual.

WRAP-UP DISCUSSION

The session was facilitated by Dr. A. Orr with Mr. P. Jere as *rapporteur*.

Relevance of FSIPM On-Farm Trials

- **Choice of crops**

- Participants questioned the choice of MH18 as the maize variety in OFTs with resource-poor farmers. How many participating farmers had previously used this variety in its pure, un-recycled form ? Open-pollinated varieties, which can be recycled without loss of vigour, and save on seed costs, may be more appropriate for resource-poor farmers. Further information about the varieties currently available can be obtained from the Maize Task Force, Chitedze.

- The maize-beans-pigeonpea intercrop was felt to be a good combination which met the need for crop diversification. Farmers' intercrop combinations differed from researchers in being scattered and random, but intercrops in field experiments had to be planted systematically.

- Soybean attracted much discussion. Its use as a trap crop for *Striga asiatica* was new to most participants. Question were asked about time of planting. Soybean intercropped with maize was generally planted later, as the crop has a short field duration (90-120 days for self-inoculated Magoye, compared to 130-140 days for MH18 and 140 + days for local maize).

- MOALD and NGOs were promoting soybean primarily to improve household food security and nutrition. Experience showed, however, that farmers valued soybean primarily as a cash crop. This reflected the priority given by resource-poor farmers to generating cash income to pay for inputs and essential expenditure. There was a need to be aware that farmers' crop choices had multiple objectives, including income, nutrition, and soil fertility.

- **Pest Management Strategies**

- Considerable time was spent discussing the experimental design of the maincrop trials. Participants felt the need for a control plot side-by-side to the experimental plot so that farmers could clearly evaluate the impact of the PMS being tested. The 'with' and 'without' demonstration model was a powerful tool. The FSIPM experimental design meant that controls and treatments were on plots operated by different farmers.

- Participants approved the use of *Tephrosia* to increase soil fertility on *striga* plots.

- The timing of the Field Day was inappropriate for assessing different treatments and yield of beans, since these had already been harvested.

What would you change or improve for your own working areas ?

- Some participants anticipated problems persuading farmers that weeding without banking was an effective control method for termites. Others pointed out that farmer practices varied between areas. In areas where termite damage was common, farmers were already accustomed to weeding without banking maize. In some areas, banking was used to plant sweet potatoes.

- Participants felt that IPM PMS should also be developed for horticulture crops. CU had developed vegetable packages for poorer farmers, using inexpensive vegetable seed, which incorporated IPM recommendations (eg. *Tephrosia* sprays). Development of IPM PMS for tomato and cabbage was being conducted by the GTZ IPM Project in the central region.

- There was a need for IPM interventions for cassava and sweet potatoes. But participants acknowledged resource constraints might mean developing these PMS at a later date.

- Participants felt it was important that other farmers, not just those participating in on-farm trials, be given the opportunity to visit the on-farm trials and discuss treatments with the FSIPM team.

Where do we go from here ?

- Participants voiced the need for an IPM Newsletter, with articles about PMS and Project activities. Some were unaware of the GTZ IPM Newsletter, to which the FSIPM Project recently contributed an article describing its on-farm trials. The CURE Newsletter also carried information on IPM. It was decided that wider circulation of the GTZ IPM Newsletter should be discussed at the next meeting of the IPM Network.

- Exchange visits between Projects and NGOs were proposed, to be arranged either through the IPM Network or independently. Visits were important since not all IPM activities by NGOs were documented.

- DAET felt excluded from the NGO IPM Network and had little opportunity to learn about IPM. It was proposed that they be included in exchange visits wherever possible.

- There was a need for some kind of directory of IPM activities among NGOs. A short questionnaire could be prepared for circulation at the next NGO IPM Network meeting. Dr. Orr offered to draft this.

- NGOs were open to collaborative research trials with research workers. Some already had experience of these (eg. CIAT bean trials, Bembeke) while others had demonstration plots with DAET. Field trials by NGOs, however, were often made simply on a trial and error basis and were not properly documented.

CONCLUSION

The Field Day successfully attracted a large number of NGOs to visit FSIPM on-farm trials, and was an enjoyable experience for all concerned. Among the valuable points made by visitors:

- the need for wider dissemination of information about IPM PMS, by arranging visits to trial sites by non-participating farmers from our working villages;

- the importance, for extension and demonstration purposes, of experimental designs which allowed clear comparisons between PMS and non-PMS plots;

- the potential for IPM PMS on crops which gave resource-poor farmers cash income (particularly vegetables); and

- the need for exchange visits between the FSIPM Project and prospective 'partner' NGOs to learn about NGO agriculture programmes at field level. Ways should be found of including DAET in such visits, wherever possible.

ACKNOWLEDGEMENT

The FSIPM Team wishes to record its appreciation to Ms. Lingareleni Mihowa of the NGO IPM Network secretariat for her efficiency in issuing invitations and coordinating transport.

REFERENCES

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J. R. F. Hansell, G. Poulter, M. Smart, and H. Potter, FSIPM Project Output to Purpose Review, 16-18 October 1996. Mimeo, 15 pp.

GLOSSARY

ADARTS	Assistant Director of Agricultural Research and Technical Services
ADD	Agricultural Development Division
CARD	Churches Alliance for Relief and Development
CU	Concern Universal
CURE	Coordination Unit for the Rehabilitation of the Environment
DAET	Department of Agricultural Extension and Training
DAR	Department of Agricultural Research
DO	Development Officer
EPA	Extension Planning Area
FA	Field Assistant
FSIPM	Farming Systems Integrated Pest Management Project
GTZ	German Technical Cooperation
IPM	Integrated Pest Management
MOALD	Ministry of Agriculture and Livestock Development
NGO	Non-Government Organisation
PMS	Pest Management Strategy
RDP	Rural Development Project

Appendix 1. FIELD DAY PARTICIPANTS

Non-Government Organisations

Mr. David Balsbaugh, Malawi Nazarene Vocational School
Mr. Richard Mwanza, Concern Universal (CU)
Mr. Essau Mkandawire, Concern Universal (CU)
Mr. Joshua Banda, Concern Universal (CU)
Mr. Wellings Mwalabu, Concern Universal (CU)
Ms. Joyce Kaligwenje, Concern Universal (CU)
Ms. Hazel Mwawemle, Concern Universal (CU)
Mr. Roberti Kawiya, City of Blantyre Environmental Unit
Ms. Lingalireni Mihowa, CURE
Mr. Melton Luhanga, Churches Action in Relief and Development (CARD)
Mr. Peterson Nanga, Wildlife Society of Malawi (WSM)
Mr. Blessings Kadzongwe, EVARD
Mr. Black Kamwaza, World Vision, Luchenza
Mr. Walter Mwachande, World Vision, Chiradzulu
Mr. Daud Chitedze, Greenline Movement
Mr. Nobel Moyo, Christian Service Committee (CSC)

Ministry of Agriculture and Livestock Development

Mr. M. N. Nsanjama, ADARTS, Bvumbwe Research Station
Mr. L. A. P. Munthali, DO, Matapwata EPA
Mr. M. W. Msonkho, FA, Nansadi
Mr. E. Nyozani, DO, Mombezi EPA
Mr. W. Dausi, Asst. DO, Mombezi EPA
Mr. D. Kadalinga, FA, Mombezi

GTZ IPM Project

Mr. Joost Gwinner, Coordinator

FSIPM Project

Dr. J. Mark Ritchie
Dr. A. Orr
Ms. J. Lawson-McDowall
Mr. P. Jere
Mr. W. K. Fero
Mr. M. F. Nuka
Ms. C. Chiumia
Mr. C. B. K. Mkandawire
Mr. T. H. Maulana
Mr. E. R. Shaba
Mr. T. K. Milanzi

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

ON-FARM RESEARCH TRIALS FIELD DAY FOR NGO IPM NETWORK

10 March 1997

STAFF:

Dr A.T. Daudi, Project Manager
Dr J.M. Ritchie, TC Team Leader
Dr A. Orr, Farming Systems Economist
Ms J. Lawson-McDowall, Social Anthropologist
Mr P. Jere, Agricultural Economist
Mr W.K. Fero, STO Entomology
Mr M.F. Nuka, Administrative Assistant
Ms C. Chiumia, Res. Asst, Social Anthropology
Mr C.B.K. Mkandawire, Field Supervisor
Mr A.M. Koloko, Field Supervisor
Mr T.H. Maulana, Technical Assistant
Mr E.R. Shaba, Technical Assistant
Mr T. K. Milanzi, Technical Assistant

Ministry of Agriculture and Livestock Development
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FARMING SYSTEMS IPM PROJECT

ON-FARM RESEARCH TRIALS
FIELD DAY
FOR NGO IPM NETWORK

MONDAY 10 MARCH 1997

PROGRAMME AND TIMETABLE

09.00 Bvumbwe Research Station Conference Room:
Welcome:
Mr M.N. Nsanjama, ADARTS
Introductory Briefing on the purpose and programme for the day:
Dr J.M: Ritchie, TC Team Leader FSIPM Project

09.30 Visitors depart from Bvumbwe to visit on-farm trial sites in either Chiradzulu North EPA or Matapwata EPA.

10.00 - 10.30 Rendezvous with DOs and FAs at Chaone ADMARC (Matapwata) and Chiwinja (Chiradzulu N). Visit Farmers' fields as follows:

Matapwata:

Drivers: Dr Orr, Mr Mkandawire. Guide: Mr Mkandawire. Rapporteur: Mr Fero

Kambuwa village	1 Mai Golden (*Striga* trial plot with serious *Striga* attack)
	2 Luka Dinala (*Striga* plot with little *Striga* attack but with *Alectra* parasite on beans)
	3 Bambo Tomato (Main trial plot with ICP 9145)
Magomero section	4 Mai Muthowa (modified Kaselera in progress)

Chiradzulu North:

Drivers: Dr Ritchie, Mrs Lawson-McDowall. Guide: Mr Koloko. Rapporteur: Mrs Lawson-McDowall

Chiwinja village	1 Linily Matekesa (Main trial, showing effect of banking on termite attack)
Lidala village	2 Ester Thom (*Striga* plot with no *Striga* but with *Alectra* attacking beans)
	3 Kassimu Sapanga (Main trial with low density kaulesi beans)
	4 Dorothy Ayimu (Main trial with high density chimbamba beans)
	5 Elube Nankhonya (*Striga* trial plots with *Striga*)

12.00 Leave field sites to return to Bvumbwe Research Station.

13.00 Light lunch in Conference Room, Bvumbwe Research Station.

14.00 Wrap-up Meeting, Conference Room. Chairman: Dr Alastair Orr. Rapporteur: Mr Paul Jere

15.30 Visitors depart from Bvumbwe Research Station.

The Farming Systems Integrated Pest Management Project, Malawi

J. Mark Ritchie and Andrew T. Daudi

The Farming Systems Integrated Pest Management Project is based at Bvumbwe Research Station near Blantyre in the Blantyre-Shire Highlands Rural Development Project area of Southern Malawi.

The overall Goal of the Project is that smallholder farmers should adopt low-cost sustainable pest management strategies. The Purpose of the project is to improve national capability for carrying out IPM by strengthening capacity in farming systems IPM research, developing IPM strategies suitable for resource-poor farmers and preparing and disseminating IPM extension materials.

The Project team currently includes the Malawian Project Manager employed by the Department of Agricultural Research (DAR), three expatriates (IPM specialist, Farming Systems Economist, Social Anthropologist), a Malawian Socio-economist, and Malawian support staff (DAR and directly employed).

The FSIPM Project held a Stakeholder Workshop in Limbe in June 1996, involving 29 participants from 11 agencies with a direct interest in the outcomes of the project. The clear message of the Workshop was that the project should concentrate initially on the major pests of maize, pigeonpeas and common beans.

During the first year of the project the team has selected two EPAs within Blantyre Shire Highlands RDP (Chiradzulu North and Matapwata EPAs) because of their representative cropping conditions for the RDP and the highest population levels of any EPA in Malawi. These EPAs were recommended by extension officials and are known to experience serious pest problems which were identified through reconnaisssance surveys. Within the EPAs villages were selected for size, accessibility, range of land types and prevalence of pest problems.

Participatory Rural Appraisal techniques were used to discover details of village history, seasonality, geography and cropping patterns. In particular groups of farmers were asked about their major crops and their perceptions of important pests and diseases. Farmers were also questioned about indigenous technology for pest management.

Since the remit of the FSIPM Project is to target poorer households, especially those that are female-headed, social mapping has been used to provide an approximate census of the lineages within the villages and to record relevant economic socio-economic indicators. Farmers were then selected to represent lineages and according to economic criteria. A baseline survey is currently being made of 120 farm households to compare the socio-economic status and management practices of 60 participating and 60 non-participating farmers.

The main pests of the maize/pigeonpea/beans cropping system which which are being addressed by the FSIPM Project in the 1996/97 season are the parasitic weed, *Striga asiatica*, termites (Macrotermitinae), and whitegrubs (mainly larvae of scarabeid beetles) which affect maize; *Fusarium* wilt of pigeonpea; and beanfly (bean stem maggot) affecting common beans. A series of trials have been set up in the fields of 74 farmers in four villages with a further three on-station experiments looking at maize and pigeonpea varietal performance against termites and whitegrubs and testing botanical insecticides against beanflies.

A strategy being tested against termites involves dragging the ridge into the furrow when the maize is mature (modified *Kaselera*). This keeps organic matter away from the maize roots which are left on small islands of soil in a new furrow while beans are planted on the new ridge. Termites are said to be attracted to the new ridge and away from the maize plant. For whitegrubs on maize and bean flies on beans, seed dressing has been tested using carbaryl which some farmers were already using on their own initiative. Management strategies for Striga are concentrating on intercropping with trap crops and improving fertility.

FSIPM PROJECT PROGRAMME OF ON-FARM PEST MANAGEMENT TRIALS 1996/97

The on-farm trials are set within one of the common cropping systems found in both Matapwata and Chiradzulu EPAs in which maize is intercropped with pigeonpea and beans planted in November - December. In Matapwata a relay crop of beans or other legumes is planted in March. A summary of the proposed on-farm trials is shown in the accompanying table.

Trial 1. Striga management on upland (munda) farmland

Standard plot size: 5.4 m x 5.4 m gross, 3.6m x 3.6m nett.

Ten farmers, with five in each EPA. Five plots per farmer. 40 experimental plots and 10 farmer practice plots.

Cropping pattern: Maize (MH18) + pigeonpea (local) + beans (Kalima) intercropped on ridge

Treatments:

1. Fertilizer: 30 Kg N (23: 21: 0 + 4S) per hectare spread in ridge at sowing, no top dressing (see Shaxson & Riches, 1995).
2. Fertilizer 30 Kg N (23: 21: 0 + 4 S) dolloped to one side of maize plant
3. Control: no fertilizer
4. *Tephrosia* sown in furrow at planting and incorporated after harvest.
5. Soya beans sown on one side of ridge.
6. No *Tephrosia* or soya beans.

Responses:

1. Count all emerged Striga stems fortnightly in three quadrats (0.9 m x 0.9m) each formed by enclosing area between four maize stems in nett plot.
2. Determine yield from treatment nett plots.

Trial 2. Pest management for maize/pigeopea/bean intercrop (Table 2).

Cropping pattern: Maize (MH18) + pigeonpea (local/ICP9145) + beans (Kaulesi] / Chimbamba) intercropped on ridge

Standard plot size: 10.8m x 10.8m gross, 9.9m x 9.9m nett (100 maize plants).

There are 64 farmers in four villages in the two EPAs in this trial. Each farmer has a second plot with his own methodology applied.

Maize

Whitegrubs (seedling attack) - dambo only (Chiradzulu and Matapwata)

Purpose of trial: *to determine whether insecticidal seed dressing offers an economically viable treatment to prevent or reduce whitegrub attack for smallholder maize.*

1. Seed dressing with Sevin (Carbaryl) (85% WP formulation) (level 1)
2. Seed dressing with Sevin (Carbaryl) (85% WP formulation) (level 2)
3. Control: no seed dressing.

Termites (lodging mature plant) - upland only

Purpose of trial: *to determine whether weeding without banking at second weeding and removing the ridge from around mature maize plants (modified kaselera) can reduce lodging due to termite attack on mature maize.*

Chiradzulu (no relay bean crop):

1. Hand weed without banking maize at second weeding.
2. Control: weed and bank at second weeding.

Matapwata (followed by relay bean crop - see Trial 3)

1. Use modified "kaselera"system: hand weed without banking at second weeding around time of cob formation (Feb), leave weeds to dry in furrow, form new "kaselera" ridge in centre of furrow (mid March) and plant beans on new ridge in two rows 20 cms apart.
2. Control: weed and bank at second weeding. Pull down ridge into furrow for beans when maize is drying (late March) and plant beans on the flat in two rows 20 cms apart (see Trial 3 below).

Responses:

1. Count live plants on selected rows and record dead plants due to whitegrub damage fortnightly.
2. Count live plants on selected rows and record dead plants due to termite damage fortnightly.
3. Determine maize yield from treatment nett plots.

Pigeonpea:

Fusarium wilt.

Purpose of trial: *to determine whether plant deaths due to Fusarium wilt of pigeonpea can be reduced by use of the resistant variety ICP 9145 and by planting on the side of the ridge instead of the ridge top.*

1. Resistant variety, ICP 9145 planted in row.
2. Resistant variety, ICP 9145 planted on ridge side.
3. Local planted on ridge side.
4. Control: Local planted in row.

Responses:

1. Record deaths due to wilting and other causes fortnightly on all plants in selected rows.
2. Determine pigeonpea yield for nett plot.

Beans :

Beanfly (bean stem maggot): Chiradzulu: Upland only (because beans get waterlogged in dambo). Matapwata: Dambo and upland. First crop (Nov/Dec)

Purpose of trial: *to determine whether bean plant deaths and yield loss caused by the bean stem maggot can be reduced by seed dressing and by cultural practices (earthing up, mulching and high density planting).*

1. Seed dressing with sevin.
2. Control, no seed dressing.
3. Earthing up plants (to allow adventitious root formation).
4. Control, no earthing up.
5. Mulching with available materials (dry banana leaves, grass, etc).
6. Control, no mulching.
7. Varietal resistance/tolerance (Kaulesi)
8. Control, local check: Chimbamba.
9. Plant density high (three bean stations between each maize and pigeonpea station)
10. Plant density low (one bean station between each maize and pigeonpea station)

Responses:

1. Count dead plants fortnightly in selected rows and record cause of death.
2. Remove dead plants and count puparia in stems. Rear adults + parasitoids in laboratory.

Trial 3. Relay beans (March/April) - Matapwata only

Beanfly (Bean stem maggot)

Purpose of trial: *to determine whether bean plant deaths and yield loss caused by the bean stem maggot can be reduced by seed dressing and by cultural practices (earthing up, mulching and high density planting).*

Same farmers as for Trial 2. Standard plot size as for Trial 2. Beans grown on new ridge formed in old furrow.

Treatments:

1. Seed dressing with gaucho.
2. Control, no seed dressing.
3. Earthing up plants (to allow adventitious root formation).
4. Control, no earthing up.
5. Mulching with available materials (dry banana leaves, grass).
6. Control, no mulching.
7. Varietal resistance/tolerance (Kaulesi)
8. Control, local check: Chimbamba.
9. Plant density high (two rows 20 cms apart with 20 cms between planting stations along ridge)
10. Control: Plant density low (two rows 20 cms apart with 30 cms between planting stations)

Responses: As for first crop.

Farming Systems IPM Project: locations of on-farm pest management trials 1996/97

Trial	Crop	Pest	PMS	Matapwata EPA				Chiradzulu North EPA			
				Magomero section (Chaoni village)		Kambuwa village		Chiwinja village		Lidala village	
				Dambo	Upland	Dambo	Upland	Dambo	Upland	Dambo	Upland
1. Striga	Maize	Striga	Fertilizer (spread)	-	+	-	+	-	+	-	+
	Maize	Striga	Fertilizer (dollop)	-	+	-	+	-	+	-	+
	Maize	Striga	Tephrosia	-	+	-	+	-	+	-	+
	Maize	Striga	Soya	-	+	-	+	-	+	-	+
2. Intercrop	Maize	Whitegrub	Seed dressing (Sevin)	+	-	+	-	+	-	+	-
	Maize	Termites	Weed without banking	-	-	-	-	-	+	-	+
	Maize	Termites	Modified "kaselera"	-	+	-	+	-	-	-	-
	Pigeonpea	Fusarium wilt	ICP9145	+	+	+	+	+	+	+	+
	Pigeonpea	Fusarium wilt	Planting position	+	+	+	+	+	+	+	+
	Beans	Beanfly	seed dressing	+	+	+	+	-	+	-	+
	Beans	Beanfly	earthing up	+	+	+	+	-	+	-	+
	Beans	Beanfly	mulching	+	+	+	+	-	+	-	+
	Beans	Beanfly	plant density	+	+	+	+	-	+	-	+
	Beans	Beanfly	varietal tolerance	+	+	+	+	-	+	-	+
3. Relay	Beans	Beanfly	seed dressing	+	+	+	+	-	-	-	-
	Beans	Beanfly	earthing up	+	+	+	+	-	-	-	-
	Beans	Beanfly	mulching	+	+	+	+	-	-	-	-
	Beans	Beanfly	plant density	+	+	+	+	-	-	-	-
	Beans	Beanfly	varietal tolerance	+	+	+	+	-	-	-	-

FSIPM PROJECT

NGO IPM NETWORK FIELD DAY

NOTES ON FARMERS' FIELDS TO BE VISITED

CHIRADZULU NORTH EPA

1. Linily Matkesa

Main trial No seed treatments. Farmer was to bank at second weeding. This was done in Mid-January and caused an immediate increase in lodging of maize by termites. Low density chimbamba beans were earthed up to allow extra root formation as a means of tolerating beanfly attack. Yield was low (275g) due to disease attack and heavy rain.

2. Ester Thom

4 Striga plots. Plot 2 has Alectra parasite on beans. Plot 3 has termite lodging of maize by Macrotermes. Good bean yield overall (1415g. Kalima). No Striga detected yet despite information given to FSIPM team.

3. Kassim Sapanga

Main trial: weeding without banking to reduce termite attack. ICP 9145 side-planted on ridge to reduce wilt. beans tolerant variety (Kaulesi) mulched and seed treated against beanfly. Poor crop due to toxic effect of treatment and disease attack.

4. Dorothy Ayimu

Main trial. High density beans (Chimbamba) to reduce beanfly damage. Maize weeded and banked mid-January. Local pigeonpea planted on ridgetop. Good bean crop (1190g) harvested 26 Feb from 431 plants.

5. Elube Nankhonya

Striga plots. Plot 2 has maize lodged by termites. plot 4 has Alectra parasite on beans. Plot 5 (farmer's plot) badly lodged by termites. Little emerged Striga because of banking in mid-February. Very good bean crop (Kalima) (1875g against average of 1220g).

MATAPWATA

1. Mai Golden

Striga plots with heavy parasite attack. especially plots 2 and 3. Kalima beans moderate yield. Plots 1 and 5. recently banked killed emerging Striga.

2. Luka Dinala

Striga plots without emerged Striga. Some Alectra on Beans in plot 2. Good bean yield (1475g overall). Plot 3 has groundnut with Cercospora leaf spot. Farmer's plot appears to have had fertilizer added (!).

3. Bambo Tomato

Farmer will carry out modified kaselera to reduce termite attack on mature maize before planting second bean crop on new ridge which will also be used for next year's maize crop. ICP 9145 pigeonpea. Beans chimbamba low density untreated and mulched. Bean yield was very high (2600g).

4. Mai Muthowa

Farmer is carrying out "modified Kaselera" to reduce termite attack. Local pigeonpea planted on ridge-top. Untreated low density kaulesi beans. Good bean yield (1642g).

LINKING THE FSIPM PROJECT WITH NGOs

The Annual Project Review (October, 1996) recommended:

1. ***The Project start development of dissemination strategies***;

2. ***Linkages with NGOs be strengthened.***

DISSEMINATION STRATEGIES

Output 3 of the FSIPM Project is to "prepare and disseminate improved extension materials by both formal and informal extension networks".

Activities include: (1) developing informal extension mechanisms, in collaboration with NGOs; (2) preparing training and extension materials for extension workers (and farmers).

- How can NGOs become involved in this process ?
- What sort of materials are needed ?
- For whom ? Trainers, farmers ?
- What experiences have NGOs had of successful materials?
- What is the potential for a pilot project testing materials with NGOs

STRENGTHENING LINKAGES WITH NGOs

- IPM NGO Network meetings
- NGO participation in IPM Task Force
- Field days to demonstrate IPM interventions
- Which NGOs would like to try these or other pest management strategies ?
- Have NGOs developed IPM interventions which we could test in our project ?
- Which crops and pests are priorities in NGO working areas ?

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT

Report on Bean Commodity Team Field Visit to FSIPM Bean Trials (Chiradzulu and Matapwata)

Edited by
B. Mwale
M. Ritchie

23 February 1999

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Department Of Agricultural Research
Farming Systems IPM Project
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1.0 Background & Introduction

One of the questions regarding beans in Blantyre Shire Highlands RDP is why new varieties do so poorly under smallholder management. For the past two seasons, results of on-farm trials on beans have clearly shown that Kaulesi, a local bean variety, performed better than the other recommended varieties. It is also evident that farmers have strong preference for early maturing varieties over the late maturing ones, yet it is not clear what is being done to make more materials of such varieties available to smallholder farmers.

During the 1999 farmer field days preparation meeting held on 11th February 1999, it was agreed that the project should invite Bean Commodity Team Experts to visit on-farm bean trial sites, both in Chiradzulu and Matapwata, so that they can see for themselves how beans are performing under the smallholder intercropping systems. In preparation for the visit, a short list of questions and issues about beans arising from FSIPM Project field work was submitted to the visiting team for consideration and discussions (see Annex I)

The team that comprised of Dr R. Chirwa, Dr C.T. Kisyombe, Mr P. Mviha and Mr N. Nyirenda arrived on 22nd February from Lilongwe and we had the field visit on 23rd February 1999.

2.0 Field Programme

The members agreed to move as one team, rather than splitting as originally planned. This gave each member a chance to see the performance of beans from both sites. As a result, the wrap-up meeting was held the following day, the 24th of February.

Before leaving for the field, a short meeting was held in Dr Daudi's office where Dr Ritchie briefed the team on how beans have been performing in the two sites for the past two seasons. The team was also given copies of the results concerning beans from farmer evaluation survey of 1998 that summarises some of the bean problems perceived by farmers

We started visiting Chiradzulu sites and then Matapwata. In Chiradzulu, we visited bean fields belonging to Mai Kusala and Mai Ayimu. From Chiradzulu trial sites, we branched at Mbulumbuzi to visit Mwayi Wathu Women's Group, one of the three groups to whom we gave Kaulesi bean seed through Action Aid to see how the beans were performing.

In Matapwata, we visited bean fields belonging to Mai Muthowa and Bambo Sitima.

In the field, the team visited both Research Plots and '*Kanthu Nkako*' or Observation plots.
The whole team comprised of:

Dr J.M. Ritchie	Project Team Leader (FSIPM)
Mr B. Mwale	Ag Economist (FSIPM)
Mr D.W. Makina	Plant Nematology (Plant Protection, Bvumbwe Research)
Mr T.H.H. Maulana	TA, Entomology (FSIPM)

Dr R. Chirwa	Plant Breeder, Bean Commodity Team
Dr.C.T. Kisyombe	Plant Pathologist, Bean Commodity Team
Mr P. Mviha	Plant Entomologist, Bean Commodity Team
Mr N. Nyirenda	Plant Agronomist, Bean Commodity Team

3.0 Wrap-up

The wrap-up meeting was held in the Crop Storage Laboratory. With the exception of Dr R. Chirwa and T. Maulana, the rest of the team members that went to the field were present at the wrap-up meeting. The following summarises the discussions during the wrap-up meeting that reflect the discoveries from the field and questions arising therefrom:

- Farmers have strong preference for Kaules*i*, Chimbamba and Nanzeze over the other bean varieties. However, availability of seed for these varieties is at present a problem. Members felt a strong need to develop local capacity to produce local type seed. It was also observed that most farmers seemed not to be exposed to the other new bean varieties. New bean varieties have not been distributed in the Blantyre Shire Highlands RDP because the area is not part of the Bean Commodity Team's focus area.

- It was noted that farmers value early maturity. One farmer from Mwayi Wathu Women's Group said Kaulesi '*Ndi Mchotsa Njala*' which literally means Kaulesi removes hunger. During hunger months of January and February, farmers said they rely on quick maturing varieties like Kaulesi to cook together with pumpkins and pumpkin flowers as a main meal. However, there is still scope to promote late maturing varieties like Mkhalira and Kambidzi which farmers said are high yielding. Farmers in Chiradzulu have nicknamed Kambidz*i* as '*Kauunjika*' because it bears many pods, and hence is high yielding.

- It was observed that the current new varieties have not been developed under intercropping systems. No specific varieties have been identified as being suitable for intercropping yet. However, the situation in the field seemed to indicate that Mkhalira, Kambidzi and possibly Nagaga cope with intercropping and yield well. Therefore, members felt there was need to identify more intercroppable varieties and their agronomic practices. It was learnt that the Bean Commodity Team has, this season, mounted some on-station bean intercropping trials. But the meeting felt it would be most useful to also mount on-farm trials along side on-station trials.

- It was observed that more 'new' land races are still being found, such as Nanzeze, Kankhope and Nyadanawo. Names of these land races are not standardised. It was recommended there should be proper assessment of these local land races.

- The team found '*Kanthu Nkako*' plots useful as a source of information for assessing farmer adoption or modification of practices and variety acceptance. However, there is need to distinguish genuine adoption from imitation by farmers just to please researchers.

- It was observed that farmers' knowledge on diseases was limiting. They attribute symptoms of diseases to direct effect of rainfall and look at leaf fall as a sign of maturity. The meeting recommended that Bean Commodity Team need to look at time of planting in intercropping system in different areas to minimise diseases. It was also noted early planting and good cultural practices, such as burying of trash, are important for preventing diseases and need to be encouraged. If beans are planted early, they have less exposure to initial inoculum.

- Common Bacterial Blight was the main disease observed by the Pathologist (Dr Kisyombe) in the FSIPM Project plots, in both Chiradzulu and Matapwata.

- In Mai Kusala's field, the team observed that *Alectra* is a common problem on beans. This is contrary to what CIAT has published in their recently revised manual of pests and diseases of beans, in which they indicated that *Alectra* is not a problem in Malawi. However, it was noted not much work has been done so far to assess the levels of damage and the associated loss of *Alectra* on beans. In the field, Napilira appeared to be especially susceptible to *Alectra* and Kambidzi looked less susceptible than the other varieties. The group felt the need for screening both local and newly released varieties in the Southern Malawi. An assessment study of the other bean varieties in all bean-growing areas in Malawi was also felt necessary. It was hoped the research that Mrs Mainjeni will be mounting for her MSc. in UK would be useful input into the knowledge gap that exists on the problem.

- The group observed that farmer access to information on new technologies is limiting. Most farmers do not own radios and even if they have radios, most broadcasts on agriculture are aired at wrong times. The weakness in the agriculture extension system also contributes to farmers' failure to get timely information on new agriculture technologies. To improve information flow amongst farmers, the meeting expressed the need to promote farmer to farmer communication linkages. It was strongly felt there are enthusiastic women farmer's groups who can carry out this crucial role with the assistance from Extension Agents.

- Starter pack: The team observed that Starter Pack fertiliser has also benefited beans. The effect was visible on '*Kanthu Nkako*' plots.

- The question of sustainability of the project activities was also raised. It was advised that the project's initiatives to link up with other stakeholders are aimed at partly addressing this problem. Currently, the project works hand in hand with Roots and Tubers Commodity Team, Bvumbwe Agricultural Research, on Sweet Potato; ICRISAT and Processors on Pigeon peas and recently with Action Aid who are involved in seed multiplication, in relation to beans.

- Breakthroughs: The team also wanted to know what could be take-home breakthroughs of the project at this stage. Dr Ritchie advised that it has become clear that pest management is not the major issue for smallholders in Southern Malawi. However, he noted the following as some of the positive outputs the project can point out thus far:

    - Kaulesi bean variety performed better than other varieties under smallholder intercropping and farmers showed strong preference for Kaulesi over the other recommended varieties.

    - On pigeon peas, varieties such as ICEAP 00040 and ICEAP 00020 look very promising in terms of yield and resistance to *Fusarium* wilt. Farmers like these varieties for a number of characteristics and Processors like them too because they are big seeded. However, farmers are less interested in ICEAP 00053 that also seems to be less wilt resistant.

    - On maize, 'not banking' looks promising as a control strategy for termite.

    - On sweet potato, one year results on crack-sealing shows some potential as a control strategy against *Cylas* weevil. More work is being done this season.

    - On maize again, seed dressing with Gaucho seems to be effective against whitegrub. The only problem is that the chemical is expensive.

- A question was also raised concerning the geographical coverage of the project. One member felt the project coverage is narrow and not representative at EPA, RDP and ADD levels. He felt the project should have covered more EPAs, RDPs and ADDs. In reply, Dr Ritchie reminded members that availability of resources had determined the scope of the current project. Extension staff recommended the EPAs and villages chosen for the on-farm trials. Sample sizes for trials have allowed statistically valid inferences to be drawn. The project considers its findings to be valid at EPA and RDP level. It does not claim to be representative at ADD level. However, for beans, the consistency of smallholder intercropping over large areas make it possible that the project findings are still applicable. The nearest on-farm bean programme site, by contrast, is near Dedza.

- The future of the bean programme. The meeting believed that inadequate quantities of seed are being produced from current seed production initiatives nationally. But members felt uncertain about the future structures that will ensure availability of good quality seed to farmers. At present, efforts to ensure that good quality seed is available to farmers are being made by:

  - NGOs such as, Action Aid, Concern Universal, etc. NGOs purchase already certified seed that they give to farmers to multiply. But some of the NGOs' seed multiplication programs are not sustainable in the long run due to emphasis on relief operations. Implementation of some of the programmes is weak.

  - Government programmes such as PROSCARP, SADC/ SACCAR Bean Network

  - DARTS Bean Project that produces breeders' seed

  - Action Group II of the Maize Productivity Task Force. They are responsible for producing certified seed through registered farmer groups. Farmers are registered in their own EPA by the Field Extension Worker and they later get an initial 2 to 3 day training course at an ADD Residential Training Centre (RTC) by Bean Breeders. The programme is in the process of recruiting Regional Co-ordinators for Seed Producers Associations that are just being formed. This is part of farmers' empowerment campaign. Our farmers were encouraged to register when they start making announcements on the radio.

- Although the Ministry continues to strive towards ensuring availability of quality seed to farmers, this shall only be possible through concerted efforts from all stakeholders, including smallholder farmers and the private sector.

- Overall, the team commended the project for its efforts so far done and looked forward to this year's outputs and the Project National Workshop, to be held in November this year. The Project will invite representatives of the Bean Commodity Team, the Bunda College Bean Project and Action Group II of the Maize Productivity Task Force to deliver overviews of their own findings in relation to bean development for smallholders.

Annex I

Questions and Issues Regarding Beans in Blantyre Shire Highlands RDP

- Why do new varieties do so poorly under smallholder management?
  Is it because of root competition, shading and humidity from maize crop or soil quality?

- What can be done about this?
  Sole crop beans? (Farmers unwilling)
  Alley crop alternate ridges?
  What work has been done with farmers on this?

- Farmers clearly prefer early maturing varieties. What has been done to make available more material of such varieties?

- What did earlier surveys of farmer preference show?

- Has any attention been given to *Alectra* resistance in beans for smallholders? What is known from elsewhere on this?

- New varieties are all bush types. What work has been done on climbers and semi-climbers?

- Farmers can gain some advantage with e.g. Kaulesi by using old pigeon pea sticks to stake the beans or grow them up maize plants. What work has been done on potential yields from these techniques?

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

SUMMARY REPORT OF A VISIT TO THE FSIPM PROJECT BY ICRISAT REGIONAL PIGEONPEA PROGRAMME STAFF

17 MARCH 1999

by

Mark Ritchie

Ministry of Agriculture and Irrigation
Department of Agricultural Research
Farming Systems IPM Project
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Introduction

The visit was arranged to allow the ICRISAT personnel to observe the performance of the pigeonpea varieties supplied to FSIPM by ICRISAT in on-farm trials. After visits to fields belonging to Mai Chisanga and Bambo Pambhala in Mangunda Section of Matapwata EPA, a short wrap-up meeting was held at Bvumbwe. The main points of discussion are given below.

Visitors

Dr Said Silim (Agronomist), Dr Ade Freeman (Socio-economist), Dr R.B. Jones (Technology Transfer Specialist), ICRISAT, Nairobi.

Discussion points

The main observations were: that the plots were very well looked after by the farmers; all varieties were growing well though the medium duration varieties will flower later than they would be under Kenyan conditions. Budding could be expected from three weeks time. ICEAP 00053 is suffering badly from wilt as is ICP 6927, one of the medium duration varieties. None of the medium duration varieties are regarded as *Fusarium*-resistant.

It was discovered that the variety ICEAP 00020 which was supplied to the project by ICRISAT was replaced accidentally by ICEAP 00040. It was subsequently found that wrongly-labelled seed had been supplied by ICRISAT to the multiplication farms sponsored by the Dhal Millers Association who passed it on to FSIPM (R. Jones, pers. comm.).

ICRISAT staff explained that they regard the results of the Mangunda and main pigeonpea variety trials as making a major potential contribution to the evidence in favour of official release in Malawi. ICRISAT is keen to weed out less suitable varieties and supply only those which farmers regard as valuable. It was interesting to find that Bambo Pambhala had kept seed of only two varieties, ICEAP 00020 and ICEAP 00040 from last year. ICRISAT was interested in information from the Kanthu Nkako plots on how farmers plant pigeonpeas in their own fields (split by gender). So far no local names have been given to the new varieties. We should ask our farmers for some sugestions. In Tanzania ICEAP 00020 is called "lipstick" because of the red mouth-like hilum.
Action point: FSIPM to follow up other farmers on use of last year's seed and Kantu Nkako pigeonpea spacing.

ICRISAT personnel indicated their interest in attending the Project Final Workshop at the end of November to present their vision for development of pigeonpea as a smallholder crop in Malawi and participate in discussion of project findings.

It was noted that farmers may need to be invited to two open days to see medium duration varieties in June and long-season varieties in August. At such field days it would be advantageous to have small bags of seed available to sell to farmers. **Action point: FSIPM to check for source of clean seed.**

There was some discussion of the need to give farmers in Malawi access to improved seed of Chickpeas and cowpeas.

It was agreed that the FSIPMP should contact Dr Eli Minja to look at aerial pests at time of flowering of medium duration (May/June) and long duration (July/August) varieties.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT

Report on Project Familiarisation Field Visit by Some Members of Project Steering Committee

B. Mwale

M. Ritchie

15 December 1998

Ministry of Agriculture and Irrigation

Department Of Agricultural Research

Farming Systems IPM Project

Bvumbwe Research Station

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Introduction

At the seventh meeting of the Steering Committee of the Farming Systems IPM Project, it was agreed that the project should invite members of the Steering Committee to visit the project field sites with Project staff in order to meet farmers and view the trials on farmers' fields. The familiarisation field visit took place on Tuesday, the **15th December 1998**. Eighteen members, comprising of project staff and representatives from the Project Steering Committee and Field Extension staff participated in the field familiarisation visits.

Field Programme

The team was divided into two groups. One group went to Magomero village in Matapwata EPA while the other team was in Lidala Village, Mombezi EPA

The Magomero group visited **Striga Trial(in Mai Kalonga's field)**, **Termite Management Trial (Mai Kusala's field)** and **Pigeon Pea/Bean Variety Trial (Mai Muthowa)**. Those who went to Lidala visited **Pigeon/Bean trial belonging to Mai Ayimu** and a **Whitegrub Trial for Mr Charles Sapanga**.

The members in the two groups comprised of:

A Magomero Team

Dr A.T. [illegible]audi	Project Manager (FSIPM)
Dr Mark Ritchie	Project Team Leader (FSIPM)
Mrs G. H.M.Thaulo	Senior Crop Protection Officer- Department of Crop Production, LL3)
Mr C.B.K. Mkandawire	Field Supervisor(Pest Management-FSIPM)
Mr P. Kapulula	Research Assistant (Social Anthropology-FSIPM)
Mr B.A.B. Kapereta	FA, Matapwata EPA
Mr D.Z. Mkwamba	TA- FSIPM
Mr H. Mputeni	TA- FSIPM
Mr V. P. Bondo	Evaluation Supervisor- Thyolo RDP
Mr H. Gwenembe	DO- Matapwata

B Lidala Team

Ms Julie Lawson-McDowall	Social Anthropologist (FSIPM)
Mr B. Mwale	Ag Economist (FSIPM)
Mr D.W. Makina	Plant Nematology (FSIPM)
Mr T.H.H. Maulana	TA, Entomology (FSIPM)
Mr E.R. Shawa	TA, Pathology (FSIPM)
Ms Chancy Chanza	M Sc. Student, Bunda College
Mr H. Thaulo	ADO, Mombezi EPA
Mr D.E.S. Kadalinga	TA- Lirangwe

Wrap-Up

After the field visit, members were given light lunch then a Wrap-Up meeting was held in the Bvumbwe Conference Room. At this meeting members made the following comments/observations:

- Linkage and involvement of Extension Workers in the project is critical. The good technologies which the project is developing would just lie on the shelf if the agents for delivering that technology are not aware of the technology and do not even know how it was developed. Only if the Extension Staff are part of the learning process shall they be confident to pass that information to the farmers who are the end-users.

- Realising that it is practically difficult to involve Extension Staff in every activity that the Project is doing because of tight work schedules for both the Project and the Extension Staff, it was proposed that the Extension Workers should at least be invited to group meetings with farmers such as Bean/Pigeon Pea/Maize Harvests, group evaluations as well as field days. Such meetings are not only informative but also educative.

- In general, members found what the project is doing with farmers very interesting. In seeing what farmers are actually doing, members felt more educated about the project than they had previuosly through reading reports or attending meetings.

- Farmers' innovativeness and research-mindedness was quite appealing to the members. Much as farmers are trying to learn from the Research team, there are also a lot interesting things that Researchers/Extensionists can learn from farmers.

- Specific to the field, it was observed that farmers' own plots were doing better than the Research plots. Essentially, research plots were planted later than farmers' own plots. In some cases, farmers' own plots were already weeded while the research plots were not. Members expressed fear that the difference in planting may give wrong impressions to some farmers who may think that what they are doing is much better than what the research team is doing.

- However, it was indicated that the research team will be mounting a weeding compaign, starting the 16th December, 1998. The Field Extension Workers were also requested to assist in sensitising and advising farmers to weed their fields on time.

- It was also noted that farmers like to apply fertiliser late, usually six weeks after planting, so that they can see their maize green at cob development, yet the most critical time is the early stages of plant growth. There is need for more demonstrations on fertiliser timing. The Extension Staff may want to pick up from the Project's Fertiliser timing trials, one application at two weeks after planting and the other at four weeks after planting.

- On the part of farmers, they felt encouraged by the visits and hoped that the team shall visit them again in the later stages of crop development.

FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

FIELD TRIAL FAMILIARIZATION VISIT

WEDNESDAY 15 DEC 1998

SUMMARY OF FSIPM TRIALS 1998/99

All formal trials are researcher designed and farmer managed trials with randomized treatments set within the context of the dominant maize/pigeonpea/bean intercropping system, with the exception of the Striga management trial in which beans are replaced by other legumes. Some of the formal trials are complemented by farmer designed and implemented observation plots. In addition to researcher data collection from formal trials, both these and the observation plots are being jointly monitored by researchers and farmers through regular individual and group meetings leading to individual and group assessment of effectiveness of treatments.

Termite management trial

Testing effects of banking vs kukwezera weeding on the level of attack by termites on mature maize. Also examining seed priming vs no seed priming as a means of speeding up maize development to avoid late termite damage. Four plots per farmer (12 farmers) with all combinations of the two treatments on each farm.

Whitegrub management trial

Testing effect of seed dressing with gaucho vs no seed dressing to reduce damage due to adult and larval whitegrubs. Also testing incorporation of Tephrosia (vs no Tephrosia) on whitegrub numbers and damage. The formal trial was augmented by giving farmers a small quantity of gaucho to mix with their own seed and plant in their preferred manner.

Pigeonpea varietal resistance for Fusarium wilt management

Testing effectiveness of new varieties of pigeonpea against Fusarium and in terms of improved yield. This trial is implemented on the same plots as the following trial, with four varieties on each farm. Farmers have also been given a series of up to eight varieties to assess under their own management. A separate group of farmers in Mangunda EPA (see Sweet potato trial, below) is also assessing pigeonpea varieties for the second year.

Bean varietal resistance/tolerance to bean stem maggot (BSM) and other pests.

Testing effectiveness of new varieties of beans against BSM and in terms of improved yield. This trial is implemented on the same plots as the previous trial, with four varieties randomised on each farm. Farmers have also been given a series of eight varieties to assess under their own management.

Striga management trial

Testing practicability and effectiveness of fertilizer, trap crops and green manures (cowpeas, Tephrosia, and Crotalaria) for reducing the incidence and severity of witchweed, *Striga asiatica*, in maize. The 6 farmers have 10 sets of four plots between them and have also been given a series of trap crops (groundnut, soya, cowpea, Crotalaria ochroleuca, Crotalaria pallida, Mucuna) to assess under their own management.

Fertilizer timing and green manure trial

In response to farmers' intense interest in (and disagreement with) researcher recommended fertilizer timing, a trial has been set up with 22 farmers to compare fertilizer application at two weeks and four weeks after planting. The trial also examines the effect of combining planting of a green manure (either *Crotalaria* or *Tephrosia*) in farmers' plots with the fertilizer treatments.

Crotalaria observation plots

A series of four pairs of plots in one of which Crotalaria was grown in 1997/98 and will be grown again in 1998/99, while the other had no legume added.

Bean variety *Alectra* observation plots

Three sets of small farmer-designed variety patches featuring four varieties known to have varying susceptibility to the legume witchweed, *Alectra vogellii*. These will be compared for the incidence of mature *Alectra* attached to the roots at bean harvest.

Sweetpotato weevil (*Cylas*) management trial

This trial will be implemented from January in Mombezi EPA with 12 resource-poor smallholders and in Mangunda EPA with a slightly less disadvantaged group (5 farmers) who tested the technique in 1997/98. The treatment compares sealing of soil cracks vs no sealing for control of tuber damage by *Cylas* weevils.

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FARMING SYSTEMS INTEGRATED PEST MANAGEMENT PROJECT

FIELD DAY FOR PROJECT STEERING COMMITTEE AND TECHNOLOGY CLEARING COMMITTEE
22 –23 MARCH 1999

Edited by

B. Mwale
J.M. Ritchie
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6 April, 1999

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1 Introduction

A Field Day was held for the Project Steering Committee and some members of the Technology Clearing Committee on the 22nd March 1999. Visits were made to on-farm trials (OFTs) for *Striga,* Green Manure, Termite, Whitegrub, Pigeon Pea Wilt and Sweet Potato Weevil.

The purpose of the Field Day was to give the members an opportunity to visit the farmer trials in the field and appreciate what the project was doing on the ground so that they could relate what they normally read in the project's reports and papers. Members of the Project Steering Committee had also specifically requested for this chance at their last meeting. In the past two seasons, the Project Steering Committee had been following what the project was doing mainly through written reports.

For the Technology Clearing Committee, it was also an opportunity for them to see some of the upcoming technologies which the project might propose to the committee for clearing and release.

2.0 Field Programme

The field day attracted a total of eight participants from Project Steering Committee and Technology Clearing Committee (**Appendix 1**).

The team had a full day visiting trials and a wrap-up meeting was held the following day. At a welcoming meeting the Project Manger reminded the team that the Project would officially phase out in September 1999. From September 1999 to March 2000, members of staff would only concentrate on documenting the research work that had been carried out during the life span of the project. He also advised that there would be an end of project workshop sometime in November where some of the technologies that the team members were to see in the field would be presented. Thus, the Field Day was the only chance the members would have to see the work that the project was carrying out on the ground before the end of project workshop.

The participants visited farmers in Kambuwa and Magomero villages, Nansadi Section, and Pindani Village, Mangunda Section, both in Matapwata EPA, now part of Thyolo RDP.

A schedule for the field day is provided in **Appendix 2.**

2.1 Field activities

2.1.1 Termite Management Trial – Kambuwa Village

The first visit was to Bambo Kamoto's field where the project was testing the effect of *kukwezera* instead of banking to reduce loss of yield due to termite damage without unacceptable loss of maize. *Kukwezera* is a special weeding technique whereby the farmer pulls soil on top of the ridge without burying the weeds. The farmer shakes off the weeds by hand and throws them away. Banking is believed to encourage termite damage. Since termites feed on the weeds which are buried during banking and in the process cut down the maize stalks in banked field, *kukwezera* may reduce termite damage.

Of the four plots, two were banked and two not banked. One of each pair also had maize seed soaked overnight in water before planting. Seed priming is believed to speed up germination and result in earlier harvest, reducing damage by termites.

Farmer's comments: The team walked around the plots in the trial led by Bambo Kamoto who was explaining what he was doing in the trial. Of the four plots, two plots were banked while the other two were not banked. Bambo Kamoto also indicated that two plots were planted with maize seed that was primed. Seed that is primed germinates fast and, therefore, may escape termite damage. Bambo Kamoto indicated Seed Priming is something that he had been doing before, though not as a termite control strategy. Apparently, all the four plots had no termite damage regardless of whether the plot was banked or not. Bambo Kamoto thought no termite damage was observed this season because of too much rain and that the termite mound in his field was not active. No alates came out of the mound this year.

When asked how he has dealt with the termite problem in the past, Bambo Kamoto said that he used to bank his maize field early. Killing the termite queen was something that he had tried before but members observed that there are associated social conflicts with killing the mound because alates can be a source of a highly prized relish or a source of cash income.

Visitors' comments:

- One drawback to the practice of kukwezera was that the plots had evidently too many weeds. One other problem of kukwezera that the project observed, in other similar trial plots belonging to other farmers' fields, was lodging of maize due to wind.
- Some members of the visiting team also wondered whether one-week difference in germination between seed that is primed and that is not primed would really, in any way, affect the level of termite damage. It was advised that one advantage of seed priming was that the maize crop is more vigorous and tough and, therefore, may resist lodging from termite attack. In addition, there is also expected to be a slight increase in yield by priming maize seed.
- The issue of washing fungicide off maize seed that was primed was considered not to be a major a concern.

2.1.2 Green Manure plot with Crotalaria – Magomero Village

Members also visited the Green Manure plot with *Crotalaria* in Mai Esther Rabichi's field. Mr Rabichi briefed the team about what was done in the trial. Essentially, half of the plot had fertiliser applied two weeks after planting and the other half had fertiliser applied four weeks after planting. One plot that received fertiliser early and another one that received fertiliser late had also *Crotalaria* planted in it as a source of green manure. However, *Crotalaria* was planted two weeks after maize had already been planted (at first weeding).

Farmers' comments

On the plot performance, Mr and Mrs Rabichi observed that maize in the plots where they applied fertiliser late performed better than where they applied early. Mr Rabichi thought poor performance on the plot where they applied fertiliser early could have been the result of continuous rains that led to fertiliser leaching. Mai Rabichi also appreciated the **90cm** spacing that was used in the trial because it led to bigger cob development. When asked whether she ever heard about the 90cm spacing before from Extension Staff, she said that the Field Assistant in the area was only involved in Land Husbandry.

Visitors' comments

- The type of soil in the field was sandy and that might have contributed to poor performance in the plots where fertiliser was applied early, due to leaching.

- How would the project isolate the effect of fertiliser from *Crotalaria* on maize yield? It was advised that the benefits of *Crotalaria* usually are apparent in the second year when soil fertility is improved by uprooting the plants and burying them in the furrow where the farmer would make ridges for the next planting. The four plots are arranged so that each fertilizer treatment occurs once with and without *Crotalaria* so that effects can be distinguished.

2.1.3 Whitegrub Trial – Magomero Village

In Bambo Gomani' field, the trial was testing the effect of seed dressing with Gaucho in reducing whitegrub (locally known as *Kangawo* or *Matono*) population and damage. In the trial, all eight subplots were fertilised but four of them had also *Tephrosia* incorporated in them. *Tephrosia* was incorporated not only as source of green manure but also to test its efficacy in reducing whitegrub population and damage. *Tephrosia* is believed to have some toxic effects against pests. Gaucho was used in only four plots. Two plots, which were used as control plots, had neither Gaucho nor *Tephrosia*

Farmers' comments

Mai Gomani said whitegrub is their major pest problem in their field. However, low soil fertility is also a great concern for increased agricultural productivity.

Visitors' comments

- Maize performed better in the subplots where *Tephrosia* was incorporated than in the plots without *Tephrosia*. The effect of *Tephrosia* on whitegrub compared to that of Gaucho should be seen after harvest when samples will be taken in the plots. Poor performance of maize was also apparent in the control plots.

2.1.4 Green Manure (*Tephrosia*) Trial – Magomero Village

Another Green Manure trial with *Tephrosia* that was visited was in the field of Mr and Mrs Mangochi. As in Mai Rabichi's field, there were four plots in this trial. Half of the plots (plot 3 & 4) had early fertiliser application while the other half (plot 1 & 2) received fertiliser late. Two of the plots (Plot 4 and Plot 1) had also *Tephrosia* planted in them. The *Tephrosia* was planted at the same time as maize.

Farmer's comments

Unlike in Mai Rabichi's field, Mr Mangochi observed that maize in the plots that had early fertiliser application performed better than the ones with late fertiliser application.

Visitors' comments

The team also observed that the trial was not well looked after. The plots had a lot of weeds and were banked late. Mr Mangochi acknowledged the late weeding and banking because he had been busy with business during the time of weeding and banking. His wife could not manage to carry out all the operations alone. Members encouraged him to work hard so that other farmers can also learn from him.

2.1.4 *Striga* Trial – Magomero Village

In Simeon Magomero's field, the team visited the *Striga* trial. Six of the eight subplots had a legume in them, two each with *Crotalaria,* Cowpeas and *Tephrosia that* can act as trap crops for *Striga* and can be green manure as well. One of each pair of subplots had fertiliser and one plot had neither fertiliser applied nor legume planted in it.

Farmer's comments

Commenting on the problem, Mr Magomero said *Striga* had always been a big problem in his field, resulting in poor maize yield. Before the trial, Mr Magomero said he used not to have a good maize crop stand as was seen in the trial. He also said that *Striga* incidence appeared to be lower than the time the project started, three years ago. He was grateful for the work that the project brought to his field. When asked what control strategies he has learnt through the project, Mr Magomero mentioned use of fertiliser and trap crops like soya, groundnuts, Mucuna and Nseula.

Visitors' comments

- Why did the Technical Team not mark quadrats to verify S*triga* intensity in the *Kanthu Nkako* plots as they did in the trial plot? It was advised the main constraint was time factor because of so much work that has to be done by the technical team. Again, it was noted that *Kanthu Nkako* plots were left at the farmer's own discretion in terms of management. Striga incidence is extremely patchy and the areas of each trap crop are of different sizes, making comparative sampling of Striga very difficult. The project was mainly just observing what the farmer was doing in the Kanthu Nkako plot and assessing how the farmer adapts the strategies being tested under his or her own conditions.

- Participants were struck by the performance of maize in the plot where *Tephrosia* was incorporated. The effect of *Tephrosia* as a source of green manure was quite visible in this plot. Members felt in a wet year, like this year, *Tephrosia* would have an advantage over fertiliser because most of the fertiliser might have easily been washed away due to leaching.

2.1.5 Pigeon pea Variety Trial and Sweet Potato Crack-sealing Trials – Pindani Village

2.1.5.1 Pigeon pea Variety

In Mai Chisanga's field, the team first visited a Pigeon Pea Variety Trial against *Fusarium* wilt. The same four varieties tested last year were repeated in this trial. These varieties included ICEAP 00040, ICEAP 00020, ICP 00053 and ICP 9145. These four are long duration maturing varieties. ICP 9145 functions as a local check. The four varieties were chosen at the farmers' trial planning meeting. However, Mai Chisanga also planted three medium duration pigeon pea varieties, namely ICEAP 00068, ICEAP 00073 and ICP 6927 which were provided by the ICRISAT Programme in Kenya, plus one reputed local medium maturity variety known as Chilinga. The medium duration varieties and one replicate of long duration varieties were sole-cropped, while a second replicate of the long duration varieties were intercropped with maize.

Maize and pigeonpea were planted on the same day. Fertiliser (23:21:0+4S) was applied at four weeks after planting.

Farmer's comments

The varieties that were planted as sole crops had more branching than did those grown as intercrop. Especially, ICP 9145 had more branches than the other three varieties. Mai Chisanga felt those that were grown as sole crops should yield higher than the intercropped stands.

When asked the variety that gave high yield last year between ICP 9145 and ICP 00053, Mai Chisanga said that ICP 9145 had a better yield than ICP 00053.

On ratooning pigeon peas, Mai Chisanga said it is difficult to practice that system because of shortage of land. She also doesn't practice crop rotation because of the same land shortage problem. As a result, she realises low yield of pigeon pea every year.

Visitors' comments

- Mai Chisanga rated the yield of ICP 9145 higher than that of ICEAP 00053. This was contrary to the findings of the farmer evaluation of the OFT just before harvest in 1997/98. The FSIPM team suggested that Mai Chisanga might not recall properly the variety that performed better than the other last year because she completely lost all her pigeon peas. What she could remember was based on what she saw in Mr Phambala's field where a group farmer evaluation of the pigeon peas was conducted. However results of yield measurements from the 1997/98 trial do in fact show a higher average yield for ICP 9145 than for ICEAP 00053. The project intends to hold another farmer evaluation of the pigeonpeas this season to seek farmer perceptions about individual variety performance.

- So far, ICP 00053 looked more susceptible to *Fusarium wilt* than the other three varieties.

- Ridge spacing in the plot was greater than the recommended 90 cm and visitors wondered whether that was intentional. It was advised ridge spacing in the trial was farmer's own practice.

2.1.5.2 Sweet Potato Crack-sealing

On Sweet Potato Crack-sealing against *Cylas* weevil, Mai Chisanga advised the members that the trial was conducted for the second time. She was happy with the trial because from last year's trial results, she was convinced that crack sealing helps reduce sweet potato weevil damage.

- Asked whether crack sealing was really economic if she had to take into account the cost of hiring labour, Mai Chisanga said she got more money than what she spent after selling the sweet potatoes.

With crack sealing, she said yield was high and most of the sweet potatoes were not damaged. Last year, she got 8 bags of about 70 Kg which were sold at approximately K 120 each.

- Asked whether she knew any other strategies for controlling sweet potato weevil, Mai Chisanga said planting and harvesting sweet potatoes early sometimes helps. She said planting early helps because most of the cracks are sealed by rains, hence the weevil does not have a chance to enter into the tubers. If sweet potatoes are harvested early, they are also less exposed to the weevil than if they overstay in the field. However, she said planting sweet potatoes with first rains is usually difficult because farmers are busy with maize or they do not have planting materials.

- Close to the OFT was another bigger field planted with sweet potatoes Mai Chisanga had got during the Rapid Seed Multiplication Course that the Project organised in liaison with Roots and Tubers Section sometime last year. These varieties included Cemsa, Mugamba and Tainon 57. She indicated to have shared the planting materials of these varieties with about **19** other farmers. Ten of those farmers were given seed as payment after assisting her with weeding but the rest were given the planting materials free. However, she did not seal cracks in that big field because she was busy with meetings of various kinds. Given some spare time, she would seal the cracks in that field.

- Members were impressed with what Mai Chisanga was doing and encouraged her to continue working hard and it was hoped other women would follow her example.

2.1.6 Pigeon pea Variety Trial and Sweet Potato Crack-sealing Trials

In Bambo Phambala's field, members saw the same trials as in Mai Chisanga's field. He was one of the five farmers that were doing the same trials as in Mai Chisanga's field in Mangunda.

- On the Pigeon Peas, Bambo Phambala pointed out it was too early at that point to indicate which variety is better than the other. Individual variety performance would best be judged later after harvest. However, he was impressed with the pigeon peas stand in the sole cropped plots. Like in Mai Chisanga's field, the pigeon peas that were planted as sole crops had more branches than those intercropped with maize. Particularly, Bambo Phambala observed that pigeon peas in plot 2 (ICEAP 00020) and plot 3 (ICEAP 00053) had more branching than the other plots. In future, he thought he would try to reserve some few ridges for pigeon pea sole cropping because he expects to get high yields from those plots.

- He was also impressed with the performance of maize (MH18) in the plot. He did not expect that much better yield with one fertiliser application. He said he was used to applying fertiliser twice. He said he would keep seed from the maize harvest for next season.

- On sweet potato trial, Bambo Phambala said that he did not know at first that sealing cracks helps prevent sweet potato damage. He was convinced after they harvested the sweet potatoes from last year's trial.

- However, his concern for both Pigeon Peas and Sweet Potatoes was finding a market for the produce. He said that last year he could not manage to sell all his sweet potatoes because of problems of finding market for them. Members encouraged him and not to get worried with market because there were a lot of potential buyers who could come and buy their produce as long as they were of reasonable quantities and good quality.

3.0 Wrap-up

3.1 Termite management

The termite problem is complex and more of a social issue where conflicts arose if farmers valued income from flying ants (alates) more than damage to maize from termites. This might occur when termites came from mounds on fields belonging to other farmers. The surest way to deal with termites is to kill the termite queen but often owners of these mounds are unwilling to destroy their mound. Technical knowledge and recommendations might help reduce such conflicts. Some strategies (early banking, monitoring of mounds for alates) do not involve conflicts.

The situation is also variable in terms of whether the farmer gets a timely warning about termite damage. Farmers might already have banked by the time termites start damaging the crop. Damage may also vary according to the rainfall pattern experienced in that particular season.

Unfortunately, it was observed there are no technical recommendations for termite management at the moment. The project's trial output would undoubtedly be a valuable input in coming up with recommendations for termite control for small farmers. Members recommended the project to submit to the Technology Clearing Committee a proposal on termite control strategies, preferably before the beginning of the next crop season. Dr Mtukuso promised to send Dr Ritchie the guidelines for the proposal to the TCC. The proposal should among other things include:

- All technical data related to the trial for the past three seasons
- An economic analysis of the trial
- Draft Chichewa leaflet for farmers and Extension Staff describing options and circumstances for termite control.

3.2 Fertiliser Timing

Following farmers' comments that applying fertiliser at emergence (as in last year's trials) was too early for the maize to give a good yield, the FSIPM project mounted a fertiliser timing trial in 1998/99. Farmers who apply fertiliser once indicated that they do so just before maize tasseling, a time that was not acceptable to the project because at this late stage cob production is already pre-determined and the fertiliser does not produce more yield. Applying fertiliser at four weeks after planting was a compromise between farmers and the project staff after a series of trial implementation planning meetings.

Farmers responded eagerly to one fertiliser application that was practised in the trial. Was this passed to farmers as an IPM strategy? Some felt that early fertiliser application could be an IPM strategy because it boosts plant growth early enough and the crop can withstand the pressure of diseases and pests.

Why was expensive, low analysis fertiliser (23:21:0+4S) used instead of cheaper, high analysis fertiliser? 23:21:0+4S is not the most appropriate fertiliser where nitrogen is limiting. It was indicated that for research purposes, 23:21:0+4S has been used since the start of the project to allow fair comparison between plots, farms and years. Any deficiency of Phosphorous or Sulphur is thereby remedied, eliminating some inter-farm differences.

The reality for smallholder farmers is that they cannot afford enough fertiliser because of the continued increases in prices. Therefore, the question is when should a farmer apply the little fertiliser she or he can afford? The role of research and extension to address this question cannot be avoided. Farmers adopt technologies that fit their own system regardless of whether that technology is recommended or not recommended by scientists.

Farmers' response to 90 cm. spacing might be an example of the problems faced by our Agricultural Extension System. Extension coverage is still limited to 30% of smallholder households.

3.3 *Striga*

Farmers still do not know the full biology of *Striga*. This limits use of simple methods. On use of trap crops, members first questioned availability of seed of some of the trap crops such as *Tephrosia* and *Crotalaria*. In response, it was advised that farmers could plant *Tephrosia* as hedges from which they could prune the biomass for incorporation and that there are also wild species of *Crotalaria* that can also be incorporated in fields with *Striga* problems.

Dense planting is not possible with the local Mucuna as an intercrop. The local Mucuna has a habit of pulling down maize. The bush types could, perhaps, be the most appropriate ones but the problem is that they are not locally available.

Members wondered also whether banking damages *Crotalaria*. The group also felt the need to characterise the *Crotalaria* species that farmers can use as trap crops.

Striga is mainly seen on soils that are well drained, leached and gravelly.

As with the Termite Trial, members recommended the project to submit to the Technology Clearing Committee a proposal on *Striga* control strategies, preferably before the beginning of the next crop season. The proposal should among other things include:

- All technical data related to the trial for the past three seasons
- An Economic analysis of the trial
- Draft Chichewa leaflet for farmers and Extension Staffs on all possible combination of strategies, old or new/ short term or long term for controlling *Striga*.

3.4 Whitegrub

It was noted that Gaucho is effective against whitegrub but the chemical is expensive for smallholder farmers. About 125 gm of the chemical cost US $ 41.5. In the region, it is only in Kenya and South Africa where you can find maize seed already treated with Gaucho. However, it was indicated that the Company that manufactures the chemical in South Africa is working on a new formulation that would be less expensive than it is at the moment.

The Ministry of Agriculture and Irrigation may wish to explore purchasing the chemical under the Japan's Grant Aid, KR2, where some chemicals are already purchased. Particularly, there may be need for direct application of Gaucho to Composite maize seed. If that works, there would be need to control the price of maize seed treated with the chemical so that it is still affordable to Smallholder farmers.

Some members felt the need to look at the health risks of the chemical, particularly if used in dambo fields.

If *Tephrosia* proves to be effective against whitegrub, it would be an alternative cheaper source for controlling whitegrub especially for Smallholder farmers who may not afford Gaucho. The trial will provide useful information at the end of the season.

3.5 Pigeon Pea

On pigeon peas, members again raised the issue that Mai Chisanga did not feel ICEAP 00053 had a better yield last year than ICP 9145. It was advised that ICEAP 00053 suffered a lot of wilt last year but was regarded as giving better yields than ICP 9145 according to scores that five farmers made during evaluation. In fact analysis of yield results has shown that Mai Chisanga was correct (see section 2.1.5.1, above).

Farmers needed to be encouraged to rotate pigeon peas to get high yields and avoid built up of nematodes.

With regard to release of pigeonpea varieties, ICRISAT has brought in a lot of plant material but what was holding release of those varieties? ICRISAT intends to submit its proposal to the TCC, through Dr Hastings Soko, the Pigeon Pea National Co-ordinator. The project intends to submit its results through that office as a contribution to the national results. However, members felt the project could submit its own proposal direct to the Technology Clearing Committee, just as the case with termites, sweet potatoes, *Striga* trials.

Members doubted the potential of ratooning pigeon peas for smallholder farmers because of shortage of land and because it encourages build up of nematodes.

2.6 Sweet Potato

There is need to conduct an economic analysis of the trial in terms of profitability and economic number of times farmers could be expected to seal the cracks.

Early planting as a strategy for controlling sweet weevil was proposed but the problems that most farmers face are availability of planting materials and competition for labour with maize operations. The potential for rapid seed multiplication might require further exploration in this regard. However, it was observed later planting could also be advantageous in high rainfall areas. Under high rainfall, tuber development starts late because mostly the crop concentrates on vegetative growth.

The course on Rapid Seed Multiplication that was offered to the five farmers in Mangunda last year seemed to have paid off. Mai Chisanga already indicated to have assisted 19 other farmers with the sweet potatoes she was given to multiply using rapid seed multiplication technique. Early planting of sweet potatoes would also be advantageous for food security reasons for most smallholder farmers.

Visitors observed that correct ridge spacing was not followed in the Sweet Potato trial. The ridges looked far apart and they advised that DAR guidelines should have been followed. However, it was advised that spacing of ridges was farmers' own practice.

3.7 Dissemination of messages

It was observed most of the trial farmers seemed to be bypassed by field Extension Staff in the area. In Mangunda, the Field Assistant, Mr Kanyika, was openly challenged to disagree with the farmer that he had never come to advise him on any day nor did he meet other farmers in blocks.

Apparently, in the three villages, there were no blocks through which Extension Staff have contact with farmers. Members felt Extension Staff might in future use FSIPM farmer research-groups as points of entry for Extension-farmer contacts. If required, the project could provide to Extension Staff a list of all farmers it has been working with from which they could choose farmers they would like to work with after the project phases out.

Some members felt the project had given wrong advice on fertiliser application. One farmer (Phambala) had expressed satisfaction because he believed that one fertiliser application was enough to get high maize yields. It was felt that the trial would have been more meaningful if there was another experiment to test 2 times fertiliser application so that the farmer could have made a good comparison. However, members were advised to distinguish demonstration from an experiment on the farm. The project used a single application because many (if not most) resource poor farmers are already doing that. This was not a recommendation, but a realistic context in which to conduct an on-farm pigeon pea variety experiment, intercropped with maize. It was emphasised that farmers will adopt technologies that they perceive to be appropriate, whether they are recommended or not.

Appendix 1: List of Participants

Visitors

1	Dr A.P. Mtukuso	Deputy Director of Department of Agricultural Research and Technical Services
2	Mr J.C. Mbalule	Deputy Director of Agricultural Extension Services
3	Mr K.M. Chavula	Deputy Director of Crop Production
4	Mr E.E.J. Mlangali	Blantyre ADD
5	Mr E.F. Nyozani	Development Officer, Mombezi EPA
6	Mr D.S. Kadalinga	Field Assistant, Lirangwe, Mombezi EPA
7	Mr Kanyika	Field Assistant, Mangunda Section

FSIPM Project

8	Dr A.T. Daudi	Project Manager, FSIPM Project
9	Dr J.M. Ritchie	Team Leader, FSIPM Project
10	Dr A. Orr	Farming Systems Economist, FSIPM Project
11	Mr B. Mwale	Agricultural Economist, FSIPM Project
12	Mr H. Mputeni	TA, FSIPM Project
13	Mr B. Mkandawire	Field Supervisor, Pest Management, FSIPM Project
14	Mai D. Saiti	Field Supervisor, Socio-Economics, FSIPM Project
15	Mr N. Nsanjama	Officer-In-Charge, Bvumbwe Agricultural Research

Wrap-up meeting

16	P. Kapulula	Research Assistant, FSIPM Project
17	Mr Kamangira	CURE

Appendix 2: A Schedule for Project Steering Committee and Technology Clearing Committee Field Day

09.00 a.m.	Depart for Kambuwa
09.30- 10.15 a.m.	At Bambo Kamoto's Termite Trial field and discussions with the farmer
10.15- 10.40 a.m.	At Mai Rabichi Green Manure (Crotalaria) Trial field and discussions with the farmer
10.40- 11.05 a.m.	At Bambo Gomani's Whitegrub trial field and discussions with the farmer
11.05- 11.30 a.m.	At Bambo Mangochi Green Manure (Tephrosia) Trial Field and discussions with the farmer
11.30- 120.00 noon	At Simeon Magomero's Striga Trial Field and discussions with the farmer
12.00 noon	Depart for Luchenza
1.00- 2.00 p.m.	Lunch at Luchenza
2.15- 3.00 p.m.	At Mai Chisanga's Pigeon Pea and Sweet Potato Crack-sealing Trials plus discussions
3.00- 3.45 p.m.	At Bambo Phambala's Pigeon Pea and Sweet Potato Crack-sealing Trials plus discussions
3.45 p.m.	Depart for Bvumbwe
4.30 p.m.	Arrive at Bvumbwe
Following Morning	Wrap-up meeting