C0345

ECONOMIC MODELLING OF COCONUT BASED FARMING SYSTEMS

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Annual Report
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Table of Contents

Figures and Tables

Appendices

Abbreviations

ARI	Agricultural Research Institute (formerly NCDP and CCTP)
BEAM	Bio-economic agro-forestry modelling
CBA	Cost-benefit-analysis
CCTP	Cashew and Coconut Treecrops Project
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
DRC	Davao Research Centre
IRR	Internal Rate of Return
NCDP	National Coconut Development Programme
NPV	Net present value
NRI	Natural Resources Institute
ODA	Overseas Development Administration
PCA	Philippine Coconut Authority
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal

Exchange rates

(October 1996)

£1 Stirling = US$1.575
£1 = Philippine Pesos 41.38
£1 = Tanzania Shillings 910.52

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Special thanks are also due to Messrs Thomas and Willis of the BEAM Project, University of Wales, for their efforts in creating a spreadsheet version of the economic model.

And last but not least, the author is grateful to the many farmers and extension personnel around Davao City and Dar es Salaam, who offered a frank and willing exchange of ideas when consulted in October 1996.

SUMMARY

With regard to the economic modelling component of the project 'Coconut based Farming Systems', the following activities were undertaken between December 1995 and November 1996:

(a) Literature and software review of economic models for tree based intercropping systems; This activity was started in 1995 and continued until March 1996;

(b) Identification of potential partners to create a computer version of the economic model; in this respect, the BEAM project of the University of Wales, Bangor, was approached in May 1996;

(c) Request to PCA and CCTP for information so that modelling exercise could be started; Information was obtained in July 1996;

(d) Field visits to the Philippines and Tanzania in October 1996;

(e) Re-design of model, this was started in November 1996.

The basic principles of the economic model can be summarised as follows:

(a) The biological model, to be prepared by CIRAD, and the econmic model, to be prepared by NRI, will be linked, allowing the analysis of the profitability of coconut based farming systems and relevant projects;

(b) The software version of the model, which will be driven by Excel 5.0, mainly consists of templates for data input, and the elements where the actual analysis takes place; the link with the CIRAD model will be provided via a bio-physical template;

(c) The model allows the calculation of indicators such as Net Present Value, Internal Rate of Return, Gross and Net Margins, and Labour Requirements.

(d) The model follows the principles of partial analysis, owing to the complexity of farming systems in Africa and Asia and the fact that often only parts of a farm are dedicated to coconuts. In addition, the analysis will be based on an incremental cash-flow analysis, allowing the comparison of situations 'with' and 'without' coconut based intercropping on the same piece of land.

As for the activities to be carried out between December 1996 and the end of 1997, these include the following:

(a) Finishing of the economic model by mid 1997; this includes the preparation of guidelines for potential users;

(b) Presentation of the model to CIRAD;

(c) Linking of the bio-physical and the economic models (to be undertaken by CIRAD);

(d) Participation in end-of-project seminar where model will be presented by all collaborators to the European Commission.

(e) Training of staff of both DRC/PCA and ARI in the application of the model. The exact procedures for this need to be established. Aside from this, DRC/PCA staff are likely to require an up-grade of their computer hardware, and additional training in survey methodologies and financial appraisal.

INTRODUCTION

1. The main collaborators in this project, which is funded by the European Commission (DGXII), are CIRAD (France) who are at the same time in charge of the project co-ordination, the Philippine Coconut Authority, the Agricultural Research Institute (formerly National Coconut Development Programme, and Cashew and Coconut Treecrops Project, Tanzania), and NRI.

2. The principal objectives of the project are to:

(a) Study the overall functioning of an agrosystem comprising crops intercropped with coconut, in terms of competition for light, water, and nutrients;

(b) Develop a model for the yields of the coconut palms, the intercrops and the agrosystem as a whole;

(c) Based on yield functions, attempt to develop economic and evaluation models adapted to intercropping systems.

3. NRI's input into this project is primarily related to point (c) above, that is to develop an economic model that will be used as a tool by research and extension services to advise farmers on the profitability of coconut based farming systems.

4. This report provides an overview of the work carried out on this project by NRI during the period of December 1995 - November 1996. Based on the project activities undertaken the year before, the first part of this period was spent on a literature search, definition of model parameters, and the identification of potential partners who could collaborate with NRI in the modelling exercise. Due to their experience with similar models related to tree-based intercropping, it was decided to link with the BEAM Project (Bio-economic agroforestry modelling), which is based at the University of Wales, Bangor.

5. The second part of the reporting period was primarily spent on starting the modelling exercise, and undertaking the field visits to the Philippines and Tanzania in October 1996. During the course of the field visits, a preliminary economic model was presented to and discusssed with the respective collaborators. The feed-back obtained in the field was used to make the necessary changes on the model.

6. The report starts with an overview of the model and its principal components (situation at the end of 1996). A section on data collection will be followed by an account of the field trips to the Philippines and Tanzania. The appendices contain a bibliography, elements of the preliminary model presented to project collaborators overseas, a sample check-list for the collection of field data, and a selection of data entry forms.

THE MODEL

An Overview

7. A review of the agroforestry literature on intercropping suggested that two major approaches have been used to calculate the financial and economic effects of intercropping systems, namely cost-benefit analysis and linear (or non-linear) programming.[1] The two approaches were compared in the concept note on the methodology of the economic model, which was prepared by Sherington and Simmons, and included in the report on the project seminar in Vanuatu (5-9 December 1994) (CIRAD, 1994).

8. Further research suggested that a model based on a cost-benefit analysis (CBA) would best meet the requirements of the project, in particular since the tool would be used to advise farmers on the profitability of intercropping. As compared to linear programming, CBA is more appropriate to predict the return over the lifetime of an intercropping project. At the same time it is acknowledged that, aside from a process of trial and error, CBA does not provide an optimum solution.

9. The main features of the model are as follows: CBA is conducted on a "with" or "without" project basis. In the case of a coconut based intercropping model this would mean comparing the net costs and benefits of intercropping to mono-cropping. The latter can correspond to situations where, (a) only coconut production takes place, or, (b) other crops including tree crops, biennials, or annual crops are produced either on a mono-cropping or intercropping basis.

10. Due to the complex nature of farming systems involving agroforestry and intercropping, the model is based on partial budgeting. That is, only the part of the farm which is suitable for coconut intercropping, is analysed. Nevertheless, there may be cases where the entire farm is dedicated to coconut based intercropping.

11. The model is likely to be used in a range of Asian, African, and Pacific countries and as a result, the model cannot be tailor-made to one specific location. On the contrary, it has to be open enough to allow its use in a number of diverse farming systems including mechanised and unmechanised production. In addition, the analysis is undertaken until the point of sale. That is, aside from pre-harvest aspects, post-harvest activities such as processing of coconuts and the intercrops are also analysed.

12. Due to the life-span of coconut palms it was decided to allow for an analysis covering up to 60 years. Although most of the bio-physiscal research of this project is based on intercropping with existing coconut stands, the model also allows the analysis of the profitability of newly established stands.

13. As for the number of crops to be considered per intercropping system, aside from coconuts, the model allows for two perennials, two biennials and five annual

[1] For publications consulted please refer to Appendix 1.

crops. This may seem a large number, but at the same time various intercropping combinations, leading to a relatively large number of crops, are likely to occur during the lifetime of a 60 year project. In addition, there are often two or more growing cycles per annum in coconut growing areas, i.e. at least two annual crops can be produced on the same plot of land.

14. Three sets of indicators can be calculated by the model:

(a) Net Present Value, Internal Rate of Return, Benefit-Cost Ratio and Pay-back period;

(b) Gross and Net Margins, of any given project year (i.e. between 1 and 60);

(c) Labour requirements. This is primarily a comparison of "with" and "without" coconut intercropping and related changes in labour demand.

15. As for (a), these are standard indicators of project appraisal and well documented in relevant handbooks (e.g. Gittinger, 1982). The Net Present Value, which is often considered the most straightforward discounted cash-flow measure, corresponds to the present value of the incremental net benefit. The calculation of NPV requires the identification of an appropriate discount rate (i.e. often the real interest rate). At the same time, the NPV does not give the return on the investment, it only shows whether or not an investment yields a return higher than the discount rate.

16. Contrary to this, the Internal Rate of Return (IRR) indicates the exact return on an investment. By definition, the use of the IRR as discount rate leads to a situation where the net present value of the incremental net benefit stream of the project equals zero.

17. Benefit-Cost-Ratios are obtained by dividing the present value of the incremental benefit stream by the present value of the incremental cost stream. Ratios exceeding 1 would indicate a profitable project at a given discount rate.

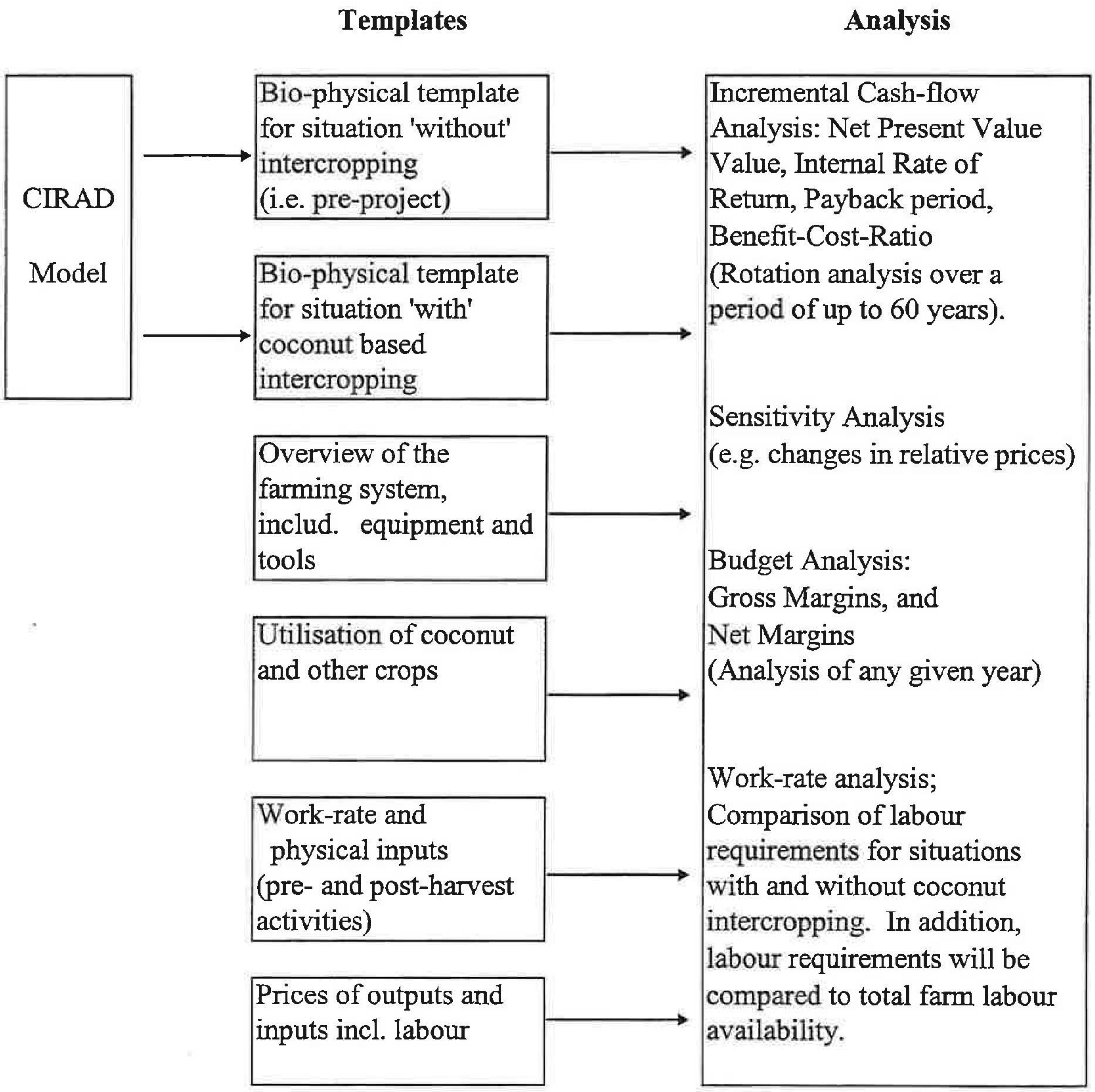
18. The Payback-period corresponds to the length of time it takes to recover the original investment. In other words, it is the period from the beginning of the project until the incremental net benefits reach the total amount invested in year zero.

19. As for (b), gross and net margins can be calculated for any given year. The model allows a specific year to be selected, indicating relevant values. Due to the nature of the farming system the calculation of fixed costs may not always be straightforward. Usually, farm implements and equipment are used across the farm and as a consequence it can be difficult to attribute exact fixed costs to the production of a particular crop.

20. As for (c), the third set of indicators is primarily related to changes in labour requirements and the identification of potential shortfalls in family and hired labour.

On the one hand, labour requirements of family members including men, women, and children are calculated. On the other hand, where required, hired labour in the form of men or women, can equally be accounted for. It was decided to omit hired child labour from the calculations for political and ethical reasons. Hired child labour is either discouraged by the relevant government or it is difficult to draw an exact line regarding age limits.

Figure 1: Overview of economic model of coconut based farming systems



21. Figure 1 provides an overview of the economic model and its various elements. The latter primarily consist of templates for data entry and the analysis of financial indicators and labour requirements. The bio-physical templates are directly fed by the corresponding CIRAD model. At the same time, the bio-physical model can also be fed 'manually' if other intercropping options, beyond what is analysed by the CIRAD model, would be considered. These other options may include crops different from the CIRAD bio-physical model or a different period of analysis. It is

understood that by feeding the bio-physical model manually, it will become difficult to fully take into account the dynamic aspects of an intercropping system.

The Bio-physical Template

22. The bio-physical template allows the creation of a number of intercropping combinations over a period of up to 60 years. The maximum number of crops to be combined in the model is as follows:

- Coconut
- 2 Perennials
- 2 Biennials
- 5 Annuals (in 2 seasons)

23. The elements of the bio-physical template include the following:

- Area dedicated to one crop (trees/ha in the case of coconut)
- Yield
- Fertiliser inputs
- Year code

24. There will be two almost identical bio-physical templates for, on the one hand, the situation "without", and on the other hand the situation "with" coconut based intercropping.

25. The area per crop is to be indicated on a per hectare basis. In the case of coconut it is expressed in terms of trees per hectare and in the case of perennial crops it can be expressed either on a per tree or a per hectare basis. The model should allow to create the combinations of intercrops which are likely to be encountered in any given year of the project. For example, one hectare of land intercropped with coconut palms, one perennial, and two annual crops (i.e. one in season A, and one in season B) could be expressed as follows:

1 Hectare = 100 Coconut palms + 0.5 ha Perennial-1 + 0.3 ha Annual-1 + 0.3 ha Annual-2.

26. In a next step, this information plus that on yields and physical fertiliser inputs can be linked to the templates containing information on labour requirements, other physical inputs, and price data. The combination of the information can be used to calculate the financial indicators and labour requirements for one hectare intercropped. In a final step, this can be multiplied by the entire area considered for intercropping in order to obtain indicators such as the total gross margin or total labour requirements.

27. Yield figures are expressed in kg per hectare. In addition, by-products are considered. In the case of coconut, there is a column for the volume of timber (m^3/tree).

28. As for fertiliser inputs, two columns for two different types of fertiliser are considered to be sufficient in the bio-physical template.

29. And finally, the year code has to be seen in relation to the year in the life cycle of coconut palms, perennials, and biennials[2]. Distinction will be made between the following four categories of years:

- First year (establishment year),
- Early growth,
- Normal year,
- Final year.

30. Each of the years has different characteristics and as a consequence pre- and post-harvest input requirements differ correspondingly. Again, for each crop and year category different input templates have to be filled in. Obviously, for biennial crops, only the establishment and final year will have to be considered.

31. The bio-physical template in Appendix 2 was taken to the Philippines and Tanzania for demonstration. Although it has been modified in the meantime, it provides an idea of how the bio-physical template is structured.

Data Collection Templates

32. These are called data collection templates due to the fact that they are not actually linked to the bio-physical model to be provided by CIRAD. These templates, which will have to be filled in manually, are designed for collecting the financial and work-rate data for the intercropping system.

33. The data collection templates cover the following main points (see Figure 1):

- Overview of the farming system,
- Utilisation of coconut and other crops,
- Work-rate and physical inputs,
- Prices of outputs and inputs, including labour.

34. The overview of the farming system will have to be provided in the 'Home Page', which covers basic information such as farm size, intercropping area, farm labour availability and credit (if applicable).

35. A separate page will be dedicated to the utilisation of coconut. This is due to the many products and by-products potentially resulting from coconut processing. The following products will be listed: Fresh nuts, copra, dessicated coconut, and coconut oil. By-products to be primarily made from the outerparts of the nut include: Charcoal, powder, and coir. The amount of by-products obtainable is conditioned by the principal coconut product to be produced. Figure 2 provides an overview of the products and by-products obtainable from coconuts.

36. Aside from nut related products, there are also by-products from the coconut tree itself such as timber and leaves. These will be allowed for in the bio-physical template.

[2] By definition, annual crops do not require this distinction.

Figure 2: Coconut utilisation; main products and by-products

(percentage figures are examples only)

Main products	%	By-products	%
Fresh nuts	20	Charcoal	15
		Powder	0
		Coir	30
Copra	40	Charcoal	90
		Powder	10
		Coir	0
Dessicated coconut	25	Charcoal	80
		Powder	10
		Coir	50
Oil	15	Charcoal	40
		Powder	30
		Coir	40
		Copra-cake	100

NB: - By-product percentages do not have to add up to 100%. In some cases no by-products are produced or used. Only the production of charcoal and powder preclude production of the other.

- Generally coconut oil is manufactured from copra, however in the template it is important to record what is sold by the farmers.

Other 'non-nuts' by-products:

Timber
Leaves

37. The data forms for work-rates and physical inputs are required for the scenarios presented in Table 1 below. It is assumed that different data forms are required for situations 'with' and 'without' coconut based intercropping. As already indicated, the situation 'without' coconut based intercropping can mean pure coconut stands on the one hand, or agricultural mono/poly-cropping without coconuts.

38. Data forms for pre-harvest activities are on a per tree basis in the case of coconut and other perennials, and on a per hectare basis in the case of annual and biennial crops. The post-harvest activities are recorded on a per tonne basis.

39. As already explained in relation to the bio-physical template, 'years' correspond to the year in the production cycle of a particular crop. In the case of perennials, these may include up to four years: i.e. for establishment, early growth, normal, and final.

40. The data forms for workrates and physical inputs cover primarily the following headings[3]:

- Month,
- Agricultural operations,
- Family labour, time (men, women, children),
- Hired labour, time (men, women),
- Animal power,
- Machine power,
- Tools (descriptive),
- Physical inputs (type, quantity, unit).

41. The work-rate data on a monthly basis allows on the one hand a comparison of family labour requirements for situations before and after the introduction of coconut based intercropping, and on the other hand a comparison of family labour demand and supply. Due to the fact that children of a certain age are usually involved in family farm work, it has been considered useful to include them in the analysis. At the same time, as mentioned above, it was decided not to include children under the category of hired labour.

42. In addition to manual labour, animal and machine power are included in the data forms. As for the units for work-rate data, these are 'minutes per tree', 'hours per hectare, and 'hours per tonne of produce'.

43. Based on the information above, Table 1 provides a summary of potential scenarios for input data forms. For the 'farming systems' category, it is important to distinguish between the situations 'with' and 'without' coconut based intercropping. It is assumed that labour and other input requirements will not be the same for the two scenarios, hence the existence of two data forms for the same category.

44. Another major element of the templates is on prices for inputs and outputs. On the output side this obviously includes the major commodities produced by the intercropping system, but also the various coconut products and by-products. Input price data will be on physical inputs and labour.

45. As for land tenure arrangements, which can negatively affect the returns to farmers, the template can handle the allocation of a proportion of a crop to the owner of the land. As a result, the benefits to the farmer net of levies due to landownership can be directly analysed by the model.

[3] Examples of forms for work-rate and bio-physical data are presented in Appendix 2.

Table 1: Data forms and possible scenarios

			Farming Systems		
Crops	Years	Post or pre-harv.	Coconut based Intercropping	Pure Coconut	Without coconuts
Coconuts	Establishment	pre	x	x	
	Early growth	pre	x	x	
	Normal	pre	x	x	
		post	x	x	
	Final	pre	x	x	
		post	x	x	
Perennials	Establishment	pre	x		x
	Early growth	pre	x		x
	Normal	pre	x		x
		post	x		x
	Final	pre	x		x
		post	x		x
Biennials	Establishment	pre	x		x
		post	x		x
	Final	pre	x		x
		post	x		x
Annuals	(Per season)	pre	x		x
		post	x		x

DATA COLLECTION

46. Three sources of information will have to be considered in gathering the data for the economic model. As a first step, it is important to make adequate use of already existing material in the form of published and 'grey' literature. Secondly, expert advice has to be sought where appropriate. Steps one and two need to be complemented with information to be obtained directly from farmers.

47. At this point, no attempt will be made to go through all the details of information required. This is already covered in the various sections on the model and in the Appendices providing samples of checklists and data forms.

48. It is suggested that data collection methods should concentrate on Rapid Rural Appraisal techniques. In particular, semi-structured interviewing is likely to be of use to obtain information at farm level. Interviews may be held with groups of farmers or individuals depending on the circumstances. There may be cases where only one farmer needs an analysis of his/her coconut growing area.

49. If the survey has to cover a larger number of farms, it is important to follow the stratification rules outlined in most RRA manuals. The stratification criteria will depend upon the conditions prevailing in the study area. For example, if a region consists of different farming systems or agro-ecological zones this has to be adequately taken into account in the sample. At the same time a balance needs to be struck between villages with and without market access.

50. There may also be cases where within one village different farmer groups have to be interviewed. This may include small-scale farmers on the one hand, and larger scale ones on the other one. Depending on cultural circumstances, it may sometimes be necessary to have separate interviews with women farmers and men.

51. Given the working conditions in the field it is likely to be more useful to collect the data through an RRA in the first place, and use a second step, preferably in the office, to put the information into the computer model. Often, the information originally collected in the field will not be in the right form to be used in the model and as a consequence conversions are necessary.

52. Appendix 3 provides a sample check-list for data collection, which was developed in Tanzania, but with minor modifications may also be used in other countries. The check-list also includes points which are not directly required for the economic model but which are nonetheless important for the understanding of the farming system under consideration.

53. If required, manuals on Rapid Rural Appraisal can be provided by NRI. The manuals provide an overview of issues, techniques, and tools to be considered when doing an RRA.

VISITS TO THE PHILIPPINES AND TANZANIA

Activities Leading to the Visits

54. Prior to the visits to the Philippines and Tanzania, both PCA and CCTP were approached to send data on coconut farming systems in their respective country to NRI to allow the start of the modelling exercise. This data was supplied to NRI by July 1996. Based on this, a preliminary economic model was designed by NRI in collaboration with BEAM, University of Bangor, and taken to Davao City, Philippines, and Dar es Salaam, Tanzania. The Excel 5.0 based spreadsheet programme was mainly created by BEAM and primarily consisted of the various data collection templates.

55. The following paragraphs provide an overview of the various activities undertaken during these visits, and the main findings.

Visit to the Philippines

Assignment

56. Mr Nick Fereday (Marketing Systems Economics Group, Social Sciences Department) visited the Davao Research Centre (DRC) of the Philippine Coconut Authority between 4 - 12 October 1996. He worked primarily with Mr Rogaciano Margate, Head of Agronomy and Soils Division, and Ms Manet N Eroy, who is a Science Research Specialist.

57. Mr Fereday's activities included:

(a) Discussion of the economic model and the preliminary templates with Mr Margate,

(b) Field visits to coconut growing areas around Davao City in order to interview farmers and test data collection procedures,

(c) Intensive training of Mr Margate and Ms Eroy in financial analysis and Windows applications (in particular Microsoft Excel 5.0) and survey techniques.

Findings on the farming system

58. The most common coconut based intercropping systems in the Davao City area include banana, maize, coffee, cocoa and fruit trees such as mango and *durian*. Nevertheless, coconut monoculture remains widespread. On the other hand, fruit trees appear to be gaining in importance relative to coffee and cocoa. In fact there is evidence that some farmers are removing the coconut palms as the fruit trees mature. Fruit trees aside, there is usually only one intercrop at a time.

59. In Davao most coconuts are planted in a 10m*10m sequence giving 100 trees per hectare. 100 mature tall coconuts take up 0.2ha leaving 0.8ha for intercrops. As a result it was suggested that the model should include a land use template to show effective areas under each crop.

60. As for the different periods in the lifespan of a coconut palm, in addition to the years (establishment, normal, final) already identified in the model, it was observed that early growth years required inclusion. This would reflect the period when intercropping would not be feasible due to the creation of excessive shade by the coconut palm canopy.

61. Harvesting of nuts is undertaken every three to four months. Copra is by far the most important coconut product in the Philippines followed by charcoal. Other products include fresh coconuts, coir and timber.

62. With regard to risk and the subsistence and cash crop balance, most farmers view the coconut intercropping system primarily as a source of income. In addition to their coconut stands, most farmers will be growing rice and vegetables on other plots for their subsistence. Copra, cocoa and coffee are all sold for cash though there is some home consumption of corn.

63. Data for inputs such as fertiliser and pesticides are readily available from 'best practice' guides and the Fertiliser and Pesticide Authority who have a local monitoring office in Davao City. As for farmgate prices, the PCA Davao Regional Office have a price monitoring section. All copra, regardless of water content, is bought at the same price. There appeared to be minimal grading at the farmgate.

64. Data for labour requirements may be difficult to collect. Labour can either be family based, hired manual or hired manual plus animal (for ploughing, transporting). In addition, activities may be gender specific and hired labour may be costed either by piece-work or on a daily basis.

65. Costs for tools are not straightforward to assign because they are used for more than one crop and also for other activities.

66. Land tenure arrangements in the Philippines can affect the returns to farmers. Most farmers are tenants and have to pay varying proportions of the sale value of copra to the owner of the land. Usually the sale of the intercrop is not included, although this may vary depending on the location. Tenants often have to seek permission if they want to plant fruit trees or other perennials.

67. In addition to the collection of general data, Mr Fereday gathered farming systems data for a model budget. The sources of information included secondary literature, expert advice, and two field visits to farming areas around Davao City.

Conclusions

68. During the course of his stay, Mr Fereday identified three potential constraints to the successful implementation of the 'economic modelling' part of this project:

(a) The Davao Research Centre lacks staff with a background in economics, and as a result, there is no familiarity with financial appraisal;

(b) the level of computer literacy is limited, in particular in relation to Windows based applications; in addition there is a lack of computer hardware.

(c) the team has only limited experience with farm survey work, in particular with regard to informal methods such as Rapid Rural Appraisal. In fact, most of the research is done on-station.

69. As a consequence it was suggested that a more comprehensive training be provided to DRC officers in three areas, i.e. financial analysis, computer applications (in particular Excel and Windows), and survey techniques. The amount of time needed to do this would be of the order of two to three weeks. Additional funds would be required to carry out such an assignment.

70. For the model as such, it was suggested that significant changes would have to be made to the data collection templates if they were to be used by DRC. With regard to the analysis and indicators, given that most farmers already have existing mature coconut stands, the question was raised whether or not partial budgeting alone would meet the information requirements.

71. Other points discussed included future changes of commodity prices, the inclusion of livestock in the model, and a financing component (i.e. loans and payment periods). It was suggested that the model should allow the assessment of future relative price changes of intercrops. Given that raising of livestock such as cattle is quite common around Davao City, DRC were interested to include a livestock component in the model but did not see it as a top priority. Although a financing component should be included in the model, it may not be applicable in all circumstances.

Visit to Tanzania

Assignment

72. Mr Ulrich Kleih (Marketing Systems Economics Group, Social Sciences Department) visited the Agricultural Research Institute (ARI, formerly NCDP and CCTP) at Mikocheni, Dar es Salaam, from 21 - 28 October 1996. He was joined by Mr Terry Thomas of the BEAM Project (University of Wales), who was able to combine his visit to Tanzania with another study tour to East Africa.

73. Following a meeting with Dr Allois Kullaya, Director of ARI, Messrs. Kleih and Thomas primarily worked with Ms Grace Chipungahelo, Head of Agronomy Section, her colleague Mr A Ngereza, and Mr E Simbua of the Farming Systems Research Section.

74. In detail, the activities carried out include the following:

(a) Discussion of the economic model and the preliminary templates with Dr Kullaya and a group of coconut specialists at ARI;

(b) More detailed presentation of the model to a team of 4 agronomists and farming systems researchers;

(c) Visits to Mkuranga field station and coconut farmers around Dar es Salaam;

(d) Short training of Ms Chipungahelo, Mr Ngereza and three other ARI staff in financial appraisal and survey techniques;

(e) Visit by Messrs Thomas and Simbua to Zanzibar to gather information on the island's intercropping systems;

(f) Discussion involving Ms Chipungahelo, and Messrs Ngereza, Simbua, Terry and Kleih, of the various elements the model should exactly include and data collection procedures;

(g) Final presentation of the findings of the visit to the Director of ARI and a group of coconut specialists.

Findings on the farming system

75. Tanzania's coconut based farming systems are quite complex and can be characterised as follows[4]:

(a) Traditional coconut growing systems, where farmers continuously take new land under cultivation planting coconuts and other treecrops together with annual food crops in the first 5 - 6 years. Subsequently, the field is left for treecrops only owing to the shade of treecrops not allowing further planting of annual crops.

(b) System characterised by expansion of coconut production in non-traditional areas but with limitation on the availability of land; farmers may in some cases already have a few palms around their house and are expanding or starting coconut growing by planting palms into the fields originally dedicated to food crops. Spacing of palms and other treecrops for permanent intercropping is the critical issue in this system.

(c) System characterised by expansion of coconut and ample land, but also constraints of labour and capital. The average farm size is only half as big as in the other two systems. Most of the land is cropped every year and often in each rainy season. Trees like citrus and bananas are gradually replacing coconut trees.

76. The principal crops encountered in the three systems is summarised in Table 2.

Table 2: Tanzania, Importance of crops for home consumption and cash income

Food Crops	System A	System B	System C
Rank :1	Cassava	Maize	Cassava
2	Maize	Cassava	Maize
3	S/Potato	Banana	Rice
4	Cowpeas/Rice	Rice	S/Potato
Cash crops			
Rank: 1	Citrus	Citrus	Coconut
2	Coconut	Coconut	Citrus
3	Cashew	Cassava	Mango
4	Pineapples	Rice	Pineapple/Cashew

77. Some of the common characteristics of small holder farming systems in coconut growing areas of Tanzania include the following:

- Small size of the holding (1 - 3ha),

4 Largely based on CCTP information prepared prior to the visit.

- A limited capacity of the active labour force per household (2 -3 people), with women bearing the bulk of the workload,
- Mean number of people per household ranging from 6 - 10,
- Low technical standard of soil cultivation (hand hoe) resulting in small arable acreage per household,
- Extremely low use of fertiliser, chemicals, and improved seeds,
- Off-farm labour is rarely employed,
- High proportion of subsistence production, maize and root crops being the main food crops,
- Huge diversity of treecrops,
- High planting density per unit area and as a result many trees per farm,
- Minimal animal husbandry.

78. The coconut area per farm varies between 0.9 and 2.7 hectares. This corresponds to 60 - 90% of the farming area. The average planting density is between 61 - 75 palms per hectare. The number of other trees on the farm varies between 86 and 145. The area occupied by annual crops is of the order of 1.0 - 1.4 hectare per farm. This corresponds to 30 - 70% of the total farm area.

79. The parts of Tanzania where coconuts are grown generally experience bi-modal rain patterns with a long rainy season from March to August (*masika*) and a short rainy season from November to January (*vuli*).

80. As for data on coconut based intercropping systems in Tanzania, the Farming Systems Research Section of ARI have carried out extensive surveys in the past and as a result there is a wealth of information available in the form of published and un-published reports.

Conclusions

81. The Tanzanian coconut based farming systems are quite complex and as a consequence it will be a challenge to capture all related aspects in the economic model. The presentation of the preliminary model and the ensuing discussions have shown that extensive modifications were necessary to have a more streamlined final product.

82. In particular, it was decided that only a partial analysis was possible, i.e. not the entire farming system would be considered but only the area where intercropping actually takes place.

83. Other areas where modifications were recommended included the utilisation of coconut. It was concluded that this aspect needed expansion in the model allowing for the multitude of main and by-products potentially obtainable from coconuts.

84. As for the aspect of labour patterns it was concluded that as far as possible, these should be analysed on a monthly basis distinguishing between male, female, and children.

85. With respect to data collection it was decided that informal methods such as Rapid Rural Appraisal should be used as much as possible. This information should complement data obtained from secondary sources and expert advise. Data forms were left with ARI to be completed during a four-month period following this visit.

86. Following discussions of the form of data entry, ARI staff suggested that the bio-physical model, which is being developed by CIRAD, and the economic model should use similar templates in order to avoid confusion.

APPENDICES

Appendix 1: Bibliography

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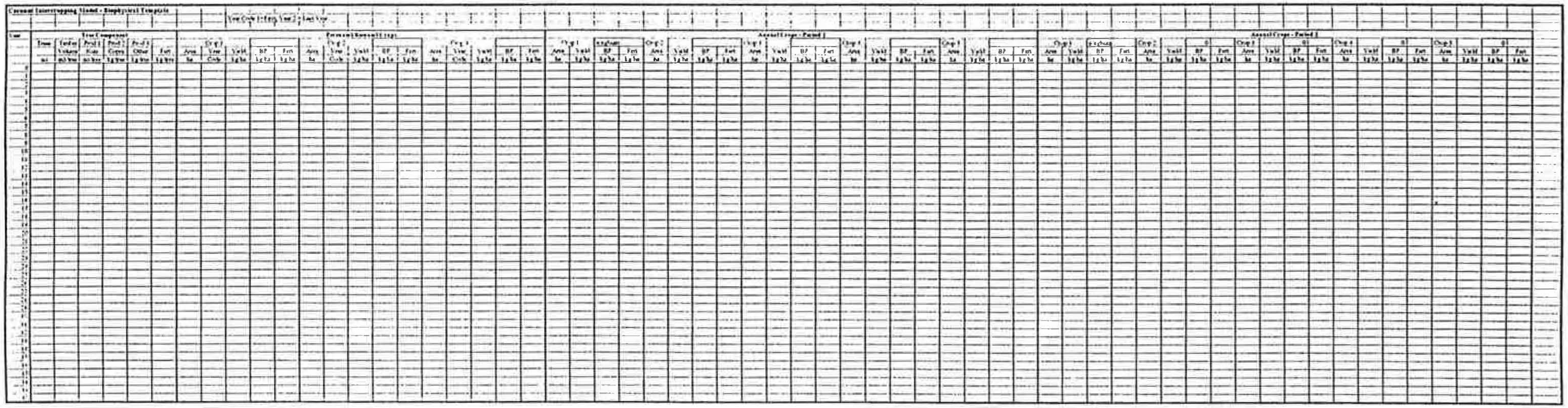
Appendix 2: Selection of provisional templates taken to the Philippines and Tanzania for discussion

NB: Following discussions at ARI and DRC/PCA, it was decided that these templates required extensive modifications.



NB: This is an overview of the provisional bio-physical template. Details are on the following two pages.

Coconut Intercropping Model - Biophysical Template

Year Code 1=First, Year 2 = Last Year

Year	Tree Component						Perennial/Biennial Crops																								Annual Crops - Peri	
							Crop 1					Crop 2					Crop 3					Crop 1		sorghum		Crop 2				Crop 3		
	Trees	Timber Volume	Prod 1 Nuts	Prod 2 Copra	Prod 3 Other	Fert	Area	Year Code	Yield	BP	Fert	Area	Year Code	Yield	BP	Fert	Area	Year Code	Yield	BP	Fert	Area	Yield	BP	Fert	Area	Yield	BP	Fert	Area	Yield	BP
	no	m3/tree	no/tree	kg/tree	kg/tree	kg/tree	ha	Code	kg/ha	kg/ha	kg/ha	ha	Code	kg/ha	kg/ha	kg/ha	ha	Code	kg/ha	kg/ha	kg/ha	ha	kg/ha	kg/ha	kg/ha	ha	kg/ha	kg/ha	kg/ha	ha	kg/ha	kg/ha
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d 1									Annual Crops - Period 2																			
	Crop 4				Crop 5				Crop 1		sorghum		Crop 2		0		Crop 3		0		Crop 4		0		Crop 5		0	
Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha	Area ha	Yield kg/ha	BP kg/ha	Fert kg/ha

BEAM/NRI Coconut Intercropping Model
Data Collection Template

This template is designed for collecting the financial and workrate data for a coconut intercropping system. The template can accommodate information on the coconut component, three perennial or biennial intercrops and five annual intercrops. There are three elements in the template.

1. "Home Page" - This page can be accessed by clicking on the "Home"button in any of the other pages. It contains three schedules to be filled in: one relating to the farm and local units; one relating to farm labour availability on a monthly basis through the year, and one relating to the sale value of and home consumption of the crops and their by-products. A fourth panel contains buttons allowing instant access to the other pages in the workbook.

2. Tree and Crop Cost Pages - For the the trees and perennial and biennial crops there are three pages for each: one for the establishment year one for a normal cropping year and one for the final year. In each page there are two schedules. The first allows the user to enter the physical inputs to the system in any unit required and their unit costs. The second is designed to schedule the labour requirement for the tree or crop. In the case of annual crops there are two cropping periods in each year.

3. Summary Page - This page summarises the data entered by the user on other pages and is the input sheet for the economic models.

Home Page

Summary Data

Item	units	value
Farm	name	1
Currency Unit	name	tsh
Area Unit	name	ha
Area Units/Ha		1
Farm Size	(ha)	3
Home Labour Cost S	(tsh/day)	2
Hired Labour Cost S	(tsh/day)	3
Home Labour Cost P	(tsh/day)	2
Hired Labour Cost P	(tsh/day)	3
Hours per person day	(ha)	8

Farm Labour Availability

Month	Standard days/mth	Premium days/mth
1	250	10
2	312.5	12.5
3	337.5	13.5
4	412.5	16.5
5	350	14
6	375	15
7	325	13
8	450	18
9	300	12
10	400	16
11	425	17
12	450	18

Crops Consumption and Value

Crop Code	Staple Code	Crop Name	Farm Use kg/annum	Sale Value (tsh/kg)
C	n	Timber		0.5
Cm1	s	Coconut	19	1
Cm2	n	Copra	18	2
Cb1	n	Other	17	3
P/B1m	s	P/B1m	16	4
P/B1b	n	P/B1b	15	5
P/B2m	n	P/B2m	14	6
P/B2b	n	P/B2b	13	7
P/B3m	s	P/B3m	12	8
P/B3b	n	P/B3b	11	9
A1m	s	A1m	10	10
A1b	s	A1b	9	11
A2m	n	A2m	8	12
A2b	n	A2b	7	13
A3m	s	A3m	6	14
A3b	n	A3b	5	15
A4m	s	A4m	4	16
A4b	n	A4b	3	17
A5m	n	A5m	2	18
A5b	n	A5b	1	19

Credit

Amount/Annum	0
First Year	1
Last Year	5

Click on Button to Access Appropriate Page

- Title
- Coconut Establishment
- Coconut Normal
- Coconut Final
- Per/Bi 1 Establishment
- Per/Bi 1 Normal
- Per/Bi 1 Final
- Per/Bi2 Establishment
- Per/Bi 2 Normal
- Per/Bi 2 Final
- Per/Bi 3 Establishment
- Per/Bi 3 Normal
- Per/Bi Final
- Annual 1
- Annual 2
- Annual 3
- Annual 4
- Annual 5
- Summary

Tree Crop - Establishment Year

Home

fertiliser tsh/unit	6

Physical Inputs				Monthly Labour Requirement		
Name	Rate	Unit Cost	Total			
	unit/tree	tsh/unit	tsh/tree	Month	Standard	Premium
input 1	1	0.5	0.5		days/tree	days/tree
input 2	2	0.4	0.8	1	8	1
input 3	3	0.3	0.9	2	8	1
				3	8	3
			0	4	8	3
			0	5	8	3
			0	6		
			0	7		
			0	8		
			0	9		
			0	10		
			0	11		
			0	12		
Total			2.2	Total	40	11

Tree Crop - Normal Year

Home

fertiliser tsh/unit	6

Physical Inputs - per tree

Name	Rate	Unit Cost	Total
	unit/tree	tsh/unit	tsh/tree
input 1	1	0.5	0.5
input 2	1.1	0.2	0.22
input 3			0
			0
			0

Physical Inputs - per nut

	unit/nut	tsh/unit	tsh/nut
1	0.1	0.01	0.001
			0
			0
			0
			0
			0
Total/tree			0.72
Total/nut			0.001

Monthly Labour Requirement

Month	Tree Operations Standard	Tree Operations Premium	Harvest Operations Standard	Harvest Operations Premium
	days/tree	days/tree	mins/nut	mins/nut
1	8	1	8	1
2	8	1	8	1
3	8	3	8	3
4	8	3	8	3
5	8	3	8	3
6				
7				
8				
9				
10				
11				
12				
Total	40	11	40	11

Tree Crop - Final Year

Home

	fertiliser tsh/unit	6

Physical Inputs - per tree

Name	Rate	Unit Cost	Total
	unit/tree	tsh/unit	tsh/tree
input 1	1	0.5	0.5
input 2	1.2	0.3	0.36
input 3	1.3	0.1	0.13
			0
			0
Physical Inputs - per nut			
	unit/nut	tsh/unit	tsh/nut
			0
			0
			0
			0
			0
			0
Total/tree			0.99
Total/nut			0

Monthly Labour Requirement

	Tree Operations		Harvest Operations	
Month	Standard	Premium	Standard	Premium
	days/tree	days/tree	mins/nut	mins/nut
1	7	1	8	1
2	8	1	8	1
3	8	3	8	3
4	8	3	8	3
5	8	3	8	3
6				
7				
8				
9				
10				
11				
12				
Total	39	11	40	11

Perennial Crop 1 - Normal Year

fertiliser tsh/unit	6

Physical Inputs

Name	Rate unit/ha	Unit Cost tsh/unit	Total tsh/ha
input 1	5	6	30
input 2	4	1	4
input 3	3	6	18
			0
			0
			0
			0
			0
			0
			0
			0
			0
Total			52

Monthly Labour Req

Month	Season 1 Standard days/ha	Season 1 Premium days/ha
1	8	1
2	8	1
3	8	3
4	8	3
5	8	3
6		
7		
8		
9		
10		
11		
12		
Total	40	11

Annual Crop 1

fertiliser tsh/unit: 6

Physical Inputs				Monthly Labour Requirement				
Name	Rate	Unit Cost	Total	Month	Season 1		Season 2	
	unit/ha	tsh/unit	tsh/ha		Standard	Premium	Standard	Premium
input 1	5	6	30		days/ha	days/ha	days/ha	days/ha
input 2	4	1	4	1	8	1		
input 3	3	6	18	2	8	1		
				3	8	3		
			0	4	8	3		
			0	5	8	3		
			0	6				
			0	7			7	2
			0	8			7	1
			0	9			7	4
			0	10			7	1
			0	11			7	1
			0	12				
Total			52	Total	40	11	35	9

BEAM/NRI Coconut Intercropping Model
Annual Economic Model

This Model is designed to synthesise the information from biophysical and the financial and workrate data templates and present the information on the budgetary position and labour availability for any year of the rotation. There are eight pages of information in the model.

The Home Page This page allows the user to specify three factors: which year of the rotation they wish to evaluate; the proportion of coconut to be used for copra production, and what length rotation they require. The page also contains the two main summary information tables relating to the performance of the system for the specified year. The first of these "Summary Labour Profile" shows the labour availability for each month of the year and the net position as a result of the monthly labour demand. The second of these "Summary Financial Budget and Self Sufficiency" shows the gross and net margin figures for each of the crops, any resultant cash income and the percentage self-sufficiency of staple crops. There are also buttons which allow easy access to the other pages.

Farm Budget Pages These three pages provide a more detailed breakdown of the information summarised in the Home page. Farm Budget Pages 1 and 2 describe individual crops in terms of the yields, values and self-sufficiency ratios of the crops themselves and their byproducts. In the case of the annual crops a seasonal breakdown is included. Farm Budget 3 contains a detailed breakdown of labour demand for each crop on a monthly basis throughout the year in comparison with labour supply.

Graphics Pages These two pages describe the monthly labour supply and demand graphically in order that a clearer picture of possible conflicts and their causes may be identified.

Biophysical and Summary Template Data Pages These two pages summarise the information from the two data collection templates.

Home Page

Options	
Year for Analysis	15
% Nuts Processed for Copra	70
Rotation Length	40

Summary Labour Profile

Month	Standard Demand	Net Available	Premium Demand	Net Available
no	person/days			
1	276	**-26**	29	**-19**
2	266	**47**	29	**-17**
3	266	**-156**	88	**-75**
4	266	**147**	88	**-72**
5	266	**84**	88	**-74**
6	35	**340**	0	**15**
7	40	**285**	2	**11**
8	59	**161**	1	**17**
9	40	**260**	5	**7**
10	40	**60**	1	**15**
11	40	**60**	1	**16**
12	35	**415**	0	**18**
Total	**1630**	**1675**	**333**	**-158**

Summary Financial Budget and Self Sufficiency

Name	Gross Margin	Labour Cost	Net Margin	Cash Income	% Self Sufficiency Staples
Coconut	10068.00	3472.00	6596.00	11976.24	100.00
per/bi 1	-8.32	488.80	-497.12	0.00	n/a
per/bi 2	0.60	5.10	-4.50	0.00	3.57
per/bi 3	0.00	0.00	0.00	0.00	n/a
first	-18.00	218.00	-236.00	0.00	20.00
second	7.93	215.60	-207.67	0.00	0.40
f	25.50	78.50	-53.00	0.00	31.08
g	-1.32	37.20	-38.52	0.00	52.50
h	25.43	69.60	-44.17	4.50	100.00
Total	**10099.83**	**4584.80**	**5515.03**	**11980.74**	**51.26**

Click on Button to Access Appropriate Page

Title Page

Graphic 1 Standard Labour

Farm Budget 1 - Coconut and Perennial/Biennial

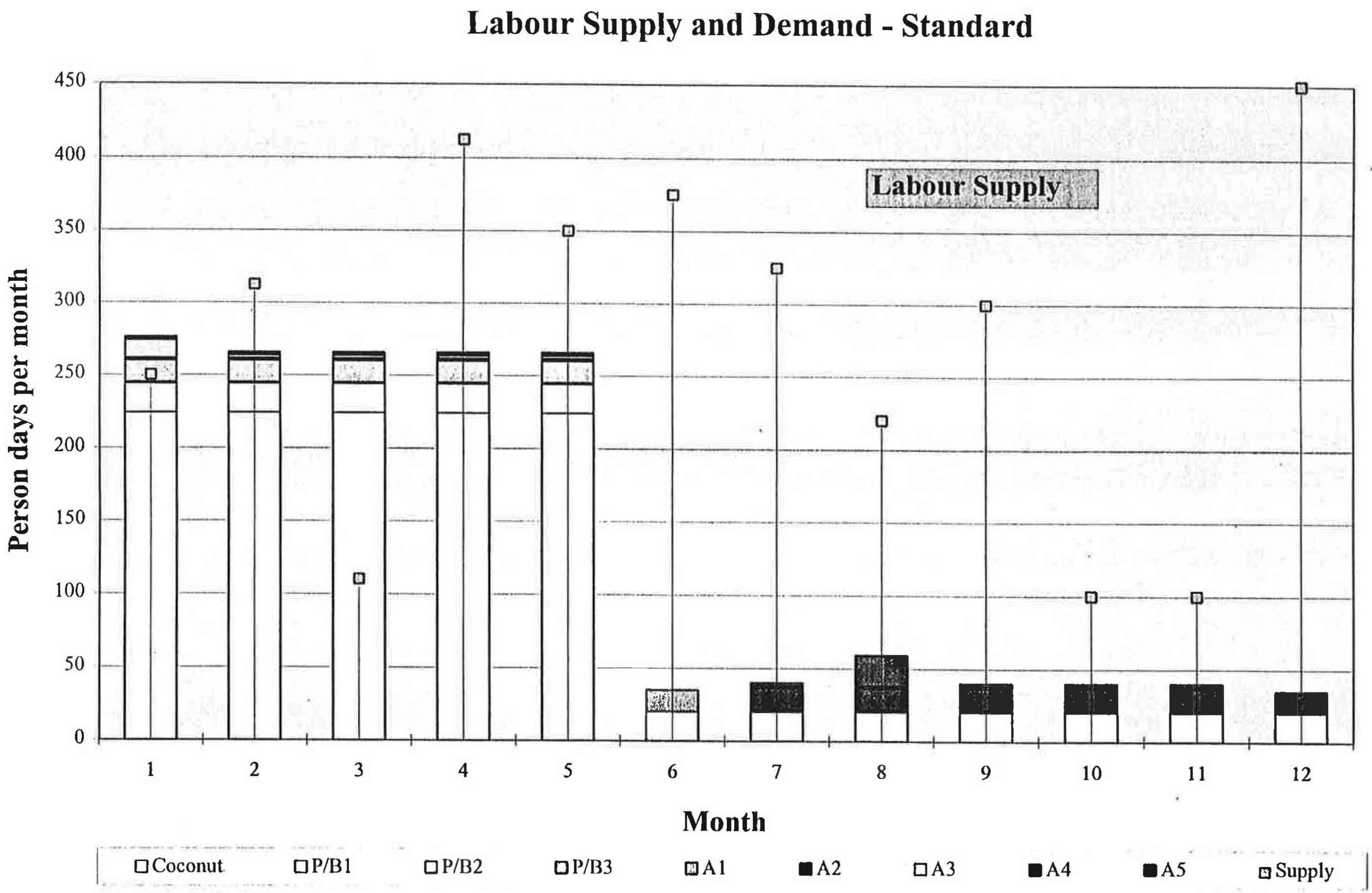
Graphic 2 Premium Labour

Farm Budget 2 - Annual Crops

Biophysical Data

Farm Budget 3 - Labour Supply and Demand

Summary Template Data


Labour Supply and Demand - Standard
Labour Supply
Person days per month
450
400
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
Coconut
P/B1
P/B2
P/B3
A1
A2
A3
A4
A5
Supply

HELP 1

SUMMARY DATA

This area is for specifying base data on the farm and local units. For labour costs there are two possible types of labour. Standard (S) and Premium (P). It is assumed that most labour will be standard in that it can easily be undertaken by most members of the farm family. The Premium labour is where specialist skills commanding a premium price are required for a particular task.

FARM LABOUR AVAILABILITY

This area is for scheduling the total labour availability for the farm for each month of the year.

CROP CONSUMPTION AND VALUE

Crop Code This code refers to the crop as specified in the biophysical output. C is the coconut, P/B refers to the perennial or biennial crops and A to the annuals. The suffixes m and b indicate maincrop and byproduct respectively

Staple Code This indicates whether the output is a staple food crop. If it is a staple then the letter "s" should be entered, otherwise the letter "n" should be entered.

CREDIT

Where the farm is liable for the repayment of credit, the amount payable per annum should be entered here, in addition to the first year and last years in which the repayments must be made.

Appendix 3: Check-list for Rapid Rural Appraisals

ECONOMIC MODELLING OF COCONUT BASED FARMING SYSTEMS

CHECKLIST FOR RRA TO COLLECT DATA FOR MODEL

General information

- Location
- Agro-ecological zone, seasons, site characteristics
- Market accessibility
- Farming system
- Household size (M, W, C)
- Other important facts

Farming system information

- Farm size
- Number of plots
- Plot sizes
- Crops grown per plot
    - Perennials, biennials, annuals
    - Rotations
    - Sequences
- Motivation to grow crops (cash, subsistence, other)

Detailed information on coconut plot

(i.e. plot where coconut production already takes place or could potentially be included)

Plot size

Proportion of plot occupied, per crop

Per month, starting with the 1st month of the agricultural calendar, identify:

- Each operation <u>per crop</u>
- Resources employed
    - Family labour (days/area or minutes/tree)
        - Men
        - Women
        - Children
    - Hired labour (days/area or minutes/tree)
        - Men
        - Women
    - Animal draft power (days/area)
    - Motorised machinery (hours/area)
- Physical inputs
    - Type
    - Quantity/area or tree

Units

In the case of post-harvest activities identify in the same manner:

Labour requirements
Animal draft power requirements
Machinery requirements
>> On the basis of time/quantity, time/nut, or time/other unit.

At the end, information should be available on all pre- and post-harvest operations (i.e. until the point of sale) related to the crops grown on the "coconut plot".

If there is more than one season, this will reflect on annual crops grown (i.e. 2 or more crops grown on the same piece of land in one year).

In addition, in the case of tree crops, aside from a normal year, also try to obtain the same type of information on establishment, early growth and final years. Information for biennials will cover establishment and final year (i.e. up to 24 months).

Yields

Crop yields (e.g. bags per area)
Tree yields (nuts or fruits per tree)

Products

Main products and by-products per crop
Utilisation (e.g., % of nuts sold fresh or processed into copra or oil)
Conversion ratios (e.g., kg of copra/nut)

Price information

Outputs (in particular, prices for crops grown on coconut plot)

- Coconuts and coconut products
- Tree crops
- Staple crops

Inputs

- Resources
  - Hired labour (Men, Women)
  - Hired animal power
  - Hired machinery
- Physical inputs
  - Seeds, fertiliser, etc.

Prices should reflect what farmers actually have to pay for inputs or what they receive for their produce. In the case of home consumption, the principle of opportunity cost should be applied (i.e. how much what the farmer have to pay to obtain the same product).

Discussion with farmers of pros and cons of intercropping with coconuts

Appendix 4: Selection of data entry forms

Coconut, Normal Year **Pre-harvest activities** **(per tree)**

Months	Operations	Resources							Tools	Physical inputs		
		Family labour			Hired labour		Animal Power	Motorised Machinery	(descriptive)	Type	Quantity	Unit
		Men Minutes	Women Minutes	Children Minutes	Men Minutes	Women Minutes	Minutes	Minutes				
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

DATA FORM **ECONOMIC MODEL OF COCONUT BASED FARMING SYSTEMS**

Coconut, Normal Year **Post-harvest activities** **(per tonne)**

Months	Operations	Resources							Tools	Physical inputs		
		Family labour			Hired labour		Animal Power Hours	Motorised Machinery Hours	(descriptive)	Type	Quantity	Unit
		Men Hours	Women Hours	Children Hours	Men Hours	Women Hours						
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

DATA FORM **ECONOMIC MODEL OF COCONUT BASED FARMING SYSTEMS**

Annual crop: **Pre-harvest activities** **(per hectare)**

Months	Operations	Resources							Tools	Physical inputs		
		Family labour			Hired labour		Animal Power	Motorised Machinery	(descriptive)	Type	Quantity	Unit
		Men Days	Women Days	Children Days	Men Days	Women Days	Days	Hours				
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

DATA FORM **ECONOMIC MODEL OF COCONUT BASED FARMING SYSTEMS**

Annual crop: **Post-harvest activities** **(per tonne)**

Months	Operations	Resources							Tools	Physical inputs		
		Family labour			Hired labour		Animal	Motorised	(descriptive)	Type	Quantity	Unit
		Men Hours	Women Hours	Children Hours	Men Hours	Women Hours	Power Hours	Machinery Hours				
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												