A practical assessment of food losses sustained during storage by smallholder farmers in the Shire Valley Agricultural Development Project Area of Malawi 1978/79 (G154)

Tropical Products Institute

G154

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Summaries

SUMMARY

An assessment of losses caused by insects and sustained by farmers who stored maize or sorghum on their farms was undertaken in the Shire Valley Agricultural Development Project area in Southern Malawi. During the survey current recommended methodology for undertaking loss surveys and for sample analysis was critically evaluated under practical conditions.

Probability procedures and stratified, random sampling methods were used to choose the farmers who participated in the exercise.

Each farmer was visited as soon after harvest as possible so that the amount of produce stored could be ascertained. Thereafter, at approximately monthly intervals local extension workers collected samples of produce for analysis and information regarding food consumption patterns from each farmer.

At each visit the extension worker had to complete a questionnaire. Some of the questions were found to be too complex for the field worker, though in general the information retrieved provided useful data.

Samples of grain were analysed for losses by determining the weight of a standard volume of grain (SVW) and comparing the extrapolated dry weight to that of a known sample. A second method, that of counting and weighing damaged and undamaged grains was also employed. Difficulties were experienced with both methods because of the relatively large variations in the results obtained and because of the low levels of loss. Significantly greater losses were recorded by the SVW method than by the count and weigh method.

Most farmers did not store their produce beyond the dry season when insect activity was low. The lack of insects was reflected in the low losses obtained, 1 – 2% for sorghum and 2 – 5% for maize. However, even those few farmers who stored through the rains did not lose a significantly greater percentage.

RÉSUMÉ

Une évaluation des pertes provoquées par les insectes et subies par les exploitants stockant le mais ou le sorgho dans leurs exploitations a été entreprise dans la zone du projet de développement agricole de la vallée du Shire dans le Malawi du sud. Pendant l'enquête, la méthodologie recommandée actuellement pour entreprendre des études de pertes et pour l'analyse d'échantillons a été évaluée de façon critique dans les conditions pratiques.

Des procédés de probabilité et des méthodes d'échantillonnage au hasard, stratifiées, ont été utilisés pour choisir les exploitants qui ont participé à l'exercice.

On a rendu visite à chaque exploitant aussi vite que possible aprés la récolte afin de pouvoir s'informer de la quantité de produits stockée. Ensuite, à des intervalles d'environ un mois des conseillers agricoles locaux ont prélevé des échantillons de produit pour analyse et ont recueilli des informations en ce qui concerne les évolutions de consommation alimentaire de chaque exploitant.

A l'occasion de chaque visite, le conseiller agricole devait remplir un questionnaire. On a trouvé que certaines questions étaient trop complexes pour le travailleur bien qu'en général les informations recueillies aient fourni des données utiles.

Des échantillons de grain ont été analysés pour déterminer les pertes en établissant le poids d'un volume standard de grain (PVS) et en comparant le poids sec extrapolé à celui d'un échantillon connu. On a utilisé aussi une autre méthode, celle consistant à compter et à peser les grains détériorés et non détériorés. On a rencontré des difficultés avec les deux méthodes à cause des variations relativement importantes des résultats obtenus et à cause des faibles taux de perte. Des pertes significativement plus importantes ont été relevées par la méthode du poids d'un volume standard que par la méthode de comptage et de pesée.

La plupart des exploitants n'ont pas stocké leur produit au-delà de la saison sèche pendant laquelle l'activité des insectes était basse. L'absence d'insectes s'est traduite par les faibles pertes obtenues, 1—2% pour le sorgho et 2—5% pour le maïs. Mais même les quelques exploitants qui ont stocké pendant la saison des pluies n'ont pas perdu un pourcentage significativement plus élevé.

RESUMEN

Fue llevada a cabo una evaluación de las pérdidas causadas por insectos y sufridas por agricultores que almacenaron maíz o sorgo en sus granjas en la zona de proyecto de desarrollo agrícola del Valle Shire en Malawi Meridional. Durante el estudio, se evaluó de modo crítico y en condiciones prácticas la metodología actual recomendada para llevar a cabo estudios de pérdidas y análisis de muestras.

Fueron usados procedimientos de probabilidades y métodos de muestreo al azar y estratificado para seleccionar los agricultores que participaron en el ejercicio.

Cada agricultor fue visitado lo antes posible después de la cosecha, de modo que pudiera evaluarse la cantidad de producto almacenada. A partir de entonces, a intervalos aproximadamente mensuales trabajadores locales de extensión recogieron muestras del producto para su análisis e información referente a los modelos de consumo de alimentos de cada agricultor.

En cada visita, el trabajador de extensión hubo de rellenar un cuestionario. Algunas de las preguntas resultaron demasiado complejas para el trabajador de extensión, si bien en términos generales la información obtenida facilitó datos de gran utilidad.

Fueron analizadas muestras del grano para determinar las pérdidas mediante el peso de un volumen standard de grano (SVW) y comparando el peso en seco extrapolado con el peso de una muestra conocida. Se empleó también un segundo método: el recuento y pesaje de granos dañados y sanos. Se experimentaron dificultades con ambos métodos debido a las relativamente grandes variaciones de los resultados obtenidos, así como a los bajos niveles de las pérdidas. Se registraron unas pérdidas significativamente mayores con el método de SVW que con el del recuento y pesaje.

La mayoría de los agricultores no almacenan su producto más allá de la estación seca cuando la actividad de los insectos es más baja. La falta de insectos se vio reflejada en las bajas pérdidas obtenidas: 1—2% para el sorgo y 2—5% para el maíz. No obstante, ni siquiera aquellos pocos agricultores que almacenaron durante la estación lluviosa registraron porcentajes de pérdidas significativamente mayores.

A practical assessment of food losses sustained during storage by smallholder farmers in the Shire Valley Agricultural Development Project area of Malawi 1978/79

INTRODUCTION

A survey of losses of produce sustained by farmers during a storage season was undertaken in the early 1970s by Schulten and Westwood. Although that survey covered the whole country very few farmers were sampled and samples were only collected twice, i.e. at the beginning and at the end of the storage season. No account was taken of the rate of removal of food from the store for consumption. The Schulten and Westwood survey attempted to produce basic information concerning the loss of maize during storage in one season; no further monitoring to determine whether storage had improved was included.

In order to make best use of manpower (extension services) or facilities (insecticides, spraying machines, etc.) it is necessary to determine how much food is lost by a farmer storing his produce on his farm. It may be uneconomic to treat the produce with insecticides if natural losses are very low; on the other hand treatments may result in considerable cash savings. Thus there is a need to obtain reliable information on storage losses in Malawi, not only for maize but for all the main crops.

In order to obtain accurate data it is necessary to obtain food consumption patterns throughout the storage season to take into consideration the declining quantities of produce in the store as the season progresses. Thus any survey should continually monitor the food stored throughout the year, farmers being visited each month. To accomplish such an intensive undertaking the area to be surveyed has to be limited. Thus rather than attempt a national survey, one of the National Rural Development Programme (NRDP) areas was chosen for investigation.

In the first year of the programme (1978/79) the Shire Valley Agricultural Development Project (SVADP) was surveyed.

In addition to providing reliable data on losses (particularly by the major grain pests *Sitophilus oryzae* and *S. zeamais*) the exercise was designed to field-test critically the available methodology for loss assessment. Consequently a large part of this report provides in detail an account of the practical experiences obtained using the techniques and modifying them in the light of the constraints encountered.

This report is subdivided into eight main sections. Following the Introduction are listed the objectives of the exercise. Then follows a short description of the SVADP area. The fourth section describes the methods and the constraints encountered especially during the initial survey. The fifth section lists the cost of the exercise. The methodology used to analyse the samples is described and discussed in relation to that currently recommended in the sixth section. Results are presented in the seventh section and discussed in the eighth section. The appendices include a log of the initial survey, the equipment used, the rainfall patterns in the valley and the crop production and topography.

OBJECTIVES

1 To obtain reliable estimates of the losses occurring in farm stored maize and sorghum during a storage season.

2 To present base-line data on which the impact of future storage recommendations and the impact of extension work can be evaluated.

3 To train staff of the Crop Storage Project (CSP) and SVADP field and laboratory staff in the methodology of loss assessment exercises.

4 To evaluate current recommended post-harvest loss assessment methodology and to suggest modifications in the light of field experience.

THE SHIRE VALLEY AGRICULTURAL DEVELOPMENT PROJECT

The Shire Valley Agricultural Development Project (SVADP) area occupies the extreme south of Malawi (*see* Appendix 1). It is approximately 250 km long and from 15 km to 120 km wide. On the east it is bordered by the Thyolo Escarpment and Shire River and on the west by the Marangwe and Matundwe ranges. The Shire River bisects the Valley eventually feeding the Zambezi River some 40 km south of the border with Mozambique. The plain is 55 – 150 m above sea level whereas some of the hill areas in the west, which are part of the SVADP area, rise to 600 m (*see* Appendix 2).

As it is so much lower than the remainder of the country, the SVADP plain is much hotter and drier than the rest of Malawi. Annual rainfall is shown in Appendix 3. The east bank area and the hilly regions have higher rainfall than the west bank valley floor area. The hill areas are relatively cool.

There are approximately 750,000 people living in the area. The valley floor is very densely populated, mostly between 75 – 150 people per square kilometre but rising to over 150 per square kilometre in the extreme south, by the Mozambique border. In the hill areas the density is less.

Maize is the preferred staple food of the population but the crop often fails because of a poor rainfall pattern. In the highland areas of the west and north and on the east bank, maize is cultivated successfully but the main staple on the valley floor is sorghum. Bullrush millet is cultivated as a secondary staple all over the valley. Other food crops grown include groundnuts, finger millet, cassava, pigeon peas and sweet potato, all being cultivated in small quantities in different localities (*see* Appendix 4).

Cotton provides the main income for many farmers. In the south, however, guar bean is the main cash crop.

There are two types of maize storage structure in the area. Most farmers in the highlands and on the east bank use the traditional Malawian cylindrical basket, the nkhokwe. On the valley floor farmers utilise their rectangular cotton stores (tchete) for storing maize. Sorghum is stored for several months after harvest on a platform, either inside the house or outside. It is then threshed and the grain put into tightly woven spherical baskets (chikwa) and stored in the house.

METHODS AND CONSTRAINTS OF THE LOSS ASSESSMENT EXERCISE

Design of the exercise

At the outset the study was designed so that the CSP staff would visit the farmers three times; at the beginning of the storage season, when the rains commenced and, finally, at the end of the season. However this was seen to be impractical because of the time commitment of the staff involved and also because in the Shire Valley there is no well defined end to the season; some farmers store their produce for

9 – 10 months whilst many empty their store within 6 months. Instead the exercise was designed so that there would be an initial intensive survey carried out by CSP staff and subsequently the farmers would be visited once each month by local extension staff. These monthly visits would continue until the farmer had consumed all his stored food. Monthly visits were chosen for two reasons. Firstly so that the farmers would not be over-burdened by visits, and secondly because farmers are normally visited once a month by an extension worker and so the loss assessment work could be combined with this visit. Originally it was considered that the collection of samples should be bi-monthly but the idea was rejected because it was felt that if one collection was omitted the gap between samples would be too great (i.e. 4 months) by which time the farmer might have run out of food. The intensive initial survey would serve four functions:

1 The staff of the CSP and SVADP would be trained in the methodology.

2 The farmers would be introduced to the exercise and would be informed of the objectives and reasons for undertaking the exercise.

3 Basic data concerning the size of the harvest and the amount stored at the beginning of the storage season would be obtained.

4 Initial samples of produce would be collected from each farmer.

The monthly visits by the field staff would have two functions:

1 To collect data on produce utilisation.

2 To collect samples of produce from the store.

Two questionnaires were designed to collect information concerning both the amount of food stored and the consumption patterns. The first was used at the initial visit only to determine the extent of the harvest and the amount of grain stored. The second questionnaire was used at all subsequent visits when the farmer (or his wife) was asked about the amount of grain removed from the store each month, the number of removals and the use to which the produce was put.

Choice of farmer

The method of selecting farmers to participate in the loss assessment exercise was stratified random sampling.

The SVADP is divided into 6 administrative areas, each subdivided into a varying number of named units, 46 in total, and each unit is composed of a number of villages.

The 6 areas differ in climate, topography and in the type of crops grown and so the first stratification was at the area level.

To determine the number of farmers to be interviewed in each area probability sampling methods were used (Harris and Lindblad, 1978). A desired accuracy of 5% was assumed for the loss estimation and the maximum range of losses expected was predicted as being 30%, so that a sampling population of 20 farmers from each area, 120 in total, was required (*see* Table 1).

Table 1

Required number of farmers

		Range of losses expected (%)								
		100	80	60	60	40	30	20	10	5
Desired	± 1%	5,625	3,600	2,025	1,046	900	506	225	54	14
Precision	± 2%	1,406	900	507	351	225	126	57	14	4
	± 5%	225	144	81	56	36	20	9	2	–
	± 10%	57	36	21	14	9	5	3	–	–

Source: Harris and Lindblad (1978)

Choosing a value for the predicted range of losses was very difficult, particularly in this situation where there was very little information regarding damage to stored produce. The choice of 30% was a compromise derived from several factors. Firstly, Schulten and Westwood (1972) indicated a maximum loss of 10% for maize stored over a season. As local maize and SV28 maize were the predominant varieties grown in the region it was assumed that the total loss would not exceed 10% as these types are very resistant to storage insect pest attack. However, in the laboratory, sorghum of mixed varieties, obtained from the SVADP appeared to be readily destroyed by grain weevils. If left for a season as much as 60% of the sorghum might be lost. However, it was necessary to consider the timing of sampling. As the season progresses the damage would be expected to increase but the difference in the level of damage or loss between one month and the next, i.e. the period between sampling occasions, would not be expected to be very great. It was assumed that the loss from one month to the next would never exceed half of the potential total loss. As the potential loss for sorghum was assumed to be 60% a maximum of 30% loss might be expected between any two months. At certain times of the year especially during the dry season there would be little or no change in the quantities of grain lost from one month to the next and so the range of losses expected was taken as 30%.

The advice of SVADP staff was sought in selecting farmers in the 6 areas. They recommended that a total of 28 units be surveyed, the choice being governed by several considerations including accessibility during the rains, accessibility by Land Rover, areas of relatively dense population and maize growing areas. The distribution of the selected units was as follows:

Area 1	6 units	Area 4	4 units
Area 2	4 units	Area 5	3 units
Area 3	6 units	Area 6	5 units

This was the second line of stratification and last point at which a specific choice would be made (*see* Appendix 5).

The uneven distribution of units within the areas created a problem regarding the numbers of farmers to be interviewed in each area. In order to spread the work load evenly throughout the units it was decided to disregard the 20-farmer limit per area. 20 farmers from each of the 6 areas could easily have been chosen if the number of units in each area had been the same. As this was not the case the calculated total of 120 sample farmers was used as the minimum requirement. By increasing the total to 140 an equal distribution of 5 farmers per unit could be achieved. The 20 extra farmers were included as reserves to replace farmers who might drop out of the exercise for reasons other than depletion of food.

Villages within the units and farmers within villages were also chosen at random. In order to achieve an even distribution of both villages and farmers in each unit, 3 villages were selected from every unit, the third being a reserve in case one of the other two was found to be inaccessible. 2 farmers were chosen from the first village and 3 from the second, i.e. a total of 5 per unit.

Difficulties were experienced in identifying farmers since there was no up-to-date census of the SVADP at Ngabu headquarters, although lists of family heads were held at the headquarters of each area. Lists of villages in each of the specified units were obtained from the Evaluation Unit and from these lists 3 villages in each unit were chosen at random. The names of the villages were presented to a meeting of area heads of staff and the Development Officers (DO), who indicated whether they were accessible or not. Those that were not accessible were replaced by reserves.

Each DO was asked to provide a list of all the family heads in the villages chosen from his area. Most DOs submitted the list within a week. From these lists of family heads the farmers were chosen at random and then the names of farmers were sent back to the DOs. This process took one month to complete. Each DO was asked to inform the chosen farmers, through the local field staff, that they would be visited during the initial survey. Each farmer should therefore have been warned one or two days before the visit and should have been ready and waiting to be interviewed when the team arrived. In the event, many of the farmers were indeed waiting at their houses. However some had not been warned because the DOs had not received the names from SVADP headquarters and could not be found during the initial visit. It was discovered that a few farmers had moved to different villages in the valley whilst others had moved away from the area altogether. Some farmers grew no food, they just sold cash crops and purchased maize from ADMARC, others grew too little to store for more than a few weeks. For all these farmers, substitutes had to be found. In total 53 substitutes were included in the survey. This rather upset the random sampling strategy, though if many more reserves had been chosen initially this problem would have been alleviated. A substitute was chosen as being that farmer present at the time of the visit who resided closest to the original choice.

The initial survey

The initial survey had to fit in with the other activities of the CSP staff and should ideally have begun as soon after harvest as possible. Because of other commitments, CSP staff were available only in May and June. However, the times of harvest of the two crops varied; maize in March/April and sorghum from late April through until June. To be sure that most of the crop had been harvested the initial survey was conducted during the end of May and the first half of June. Field work had to be completed in 2 weeks.

In order to train the CSP staff in loss assessment methods all members took part in the initial survey. Each member spent 5 days (one working week) on the survey. One member of staff from SVADP also participated in the survey as he would be responsible subsequently for coordinating the exercise at Ngabu, the SVADP headquarters.

The CSP staff were originally divided into two teams of four men; the composition of each team would be changed from week to week. Each team should have been provided with a Land Rover and all the equipment necessary to carry out the survey. Each team would have visited and surveyed two units every day so that the survey would have lasted seven working days. However, about one month before the survey commenced it became apparent that only one Land Rover would be available. Thus the concept of two independent four-man teams was abandoned. In the event a single ten-seater Land Rover Station Wagon was used with a trailer, by one group of six CSP staff. The group was divided into two teams whilst on location. Each three-man team consisted of a Professional Officer (PO) (graduate) or Technical Officer (TO) (diplomate) to pose the questions, a TO or Technical Assistant (TA) to organise sample collection and measurement of the storage structures, and a labourer to carry the samples. During the survey the functions of the POs, TOs and TAs interchanged considerably but without any loss of efficiency.

At each unit the local field staff were collected and accompanied the CSP teams to the villages. They were instructed in their tasks and the objectives of the survey explained to them whilst travelling to the villages and during the period in which farmers were being interviewed by CSP staff.

A considerable quantity of equipment and personal effects were conveyed to the Shire Valley each week. In addition, 180 kg of shelled maize were also carried. A trailer was found to be essential in lieu of the second Land Rover since all the baggage (*see* Appendix 8) and six staff members could not have been transported in the single vehicle.

Because only one vehicle was used, it was necessary to adapt the tactics of the initial survey. Both teams would have interviewed farmers in one unit, one team working in the first village and the other team in the second village. However, at the first unit, Lulwe in area 6, it was clear that this pattern of interviewing would not work. The farmers were located far apart in the villages which were up to 12 km long and the villages themselves were many kilometres apart. This would have meant a great deal of walking for the team without transport. Instead, each team interviewed different farmers simultaneously in the same village.

The survey in each area began with a visit to the DO at the area headquarters. After a short introductory meeting the CSP team visited the first unit where the appropriate field staff joined the survey. The two villages were surveyed after which the unit staff were transported back to their headquarters. The CSP team then travelled to the next unit and repeated the procedure. In this way two or three units, i.e. 4 or 6 villages were visited each day. The survey was completed in 12 working days, taking only 2 days longer than was predicted for the two independent teams.

A log of the initial survey is given in Appendix 9.

Collection of samples from farmers

From each farmer the following samples would be collected at every visit until the food sources had been depleted:

10 maize cobs or 1 kg shelled maize
10 sorghum panicles or 1 kg threshed sorghum

Only that produce that the farmer grew and harvested himself would be evaluated. Many farmers purchase shelled maize from the marketing board (ADMARC) and store it for a few weeks until it has all been consumed. As this storage is transient it would be disregarded in this exercise.

For each commodity collected the farmer would in return, receive 1 kg of uninfested shelled maize. Thus a farmer storing and providing samples of both commodities would receive 2 kg of maize, whereas a sample of only sorghum, for example, would be exchanged for 1 kg shelled maize.

After a week of the initial survey, when many samples had been analysed, it became apparent that the 1 kg of shelled maize that was being exchanged was less than the quantity of grain from the ten cob sample. 10 cobs shelled out to between 1,200 g and 1,400 g of grain. Thereafter, to redress the balance only 8 cobs were collected.

Sorghum panicles varied greatly in size. However, none of the samples ever weighed 1,000 g and any differences were ignored during the collections.

Most farmers were happy to receive maize in exchange for either of their commodities. A few, nevertheless, would have preferred to receive sorghum in exchange for sorghum panicles and in one instance the farmer refused to participate for this reason.

In general, the farmers did not raise objections to the quantity of maize they received in exchange. This was apparent even when 10 cobs were collected and was probably due to the excellent condition of the shelled grain they received; some farmers wanted to retain the maize grain for seed.

During the initial survey each team was responsible for analysing the samples collected. It quickly became apparent that having only one vehicle during the initial survey prevented the possibility of analysing the samples whilst travelling from village to village. There simply was not sufficient room. All the maize samples were analysed during the period of the survey, either after completing each unit or more usually at night after the day's field work had been completed. This additional effort was a burden that probably could have been omitted. It was quite impractical to thresh the sorghum panicles that were collected during the initial survey and these were threshed at the Bvumbwe laboratory, after the survey had been completed. However, it took the laboratory staff several weeks to thresh all the material. It was therefore decided that panicles, collected in subsequent months, should be threshed and winnowed by the women employees of the SVADP headquarters, who were quite expert at this, as it is normally part of a woman's duties.

The results of the sample analysis were recorded immediately on a standard analysis sheet (*see* Appendix 12) but calculations of loss were all undertaken in the office at Bvumbwe.

Arrangements were made for the samples collected by SVADP staff during their monthly visits to be deposited at the headquarters of each of the respective areas. They were to be collected and transferred to SVADP headquarters at Ngabu, by the senior extension personnel. All samples were fumigated before being despatched to Bvumbwe for analysis.

The initial questionnaire

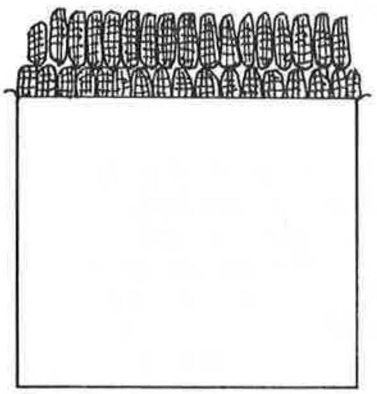
This questionnaire (*see* Appendix 6) was to provide information on the types of storage structure used and the amount and the type of grain stored by farmers.

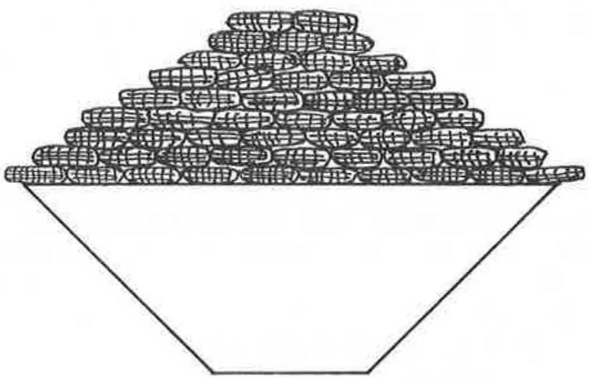
The main problem over interviewing farmers was that they were, in most cases, unable to provide a clear indication of the amount of produce they harvested and stored. Quantities of grain were frequently described in terms of baskets or cart-loads. However, after the weight of grain occupying a given volume had been determined, it was then possible to calculate the actual weight of grain in the different containers from a measurement of their dimensions.

When describing the amounts of food consumed most farmers or their wives measured in terms of numbers of baskets of produce removed.

In the SVADP area two types of baskets are used. In the north an upright basket of circular or square cross-section is common. In the south a conical basket is found. The volume of the conical basket is much smaller than that of the upright basket, but whereas the upright basket is filled to the level of the top edge the conical basket is filled so that cobs are stacked a lot higher than the upper edge. The result is that about the same quantity of maize is carried in both types of basket (*see* Figure 1). It was well into the second week of the survey before the method of filling the conical basket was realised.

Figure 1
Baskets in common use in the Shire Valley Agricultural Development Project area


The dengu
Square basket


The chitundu
Conical cotton basket

A few farmers had not completely finished harvesting when they were visited for the first time. Their stored produce was calculated from the amount of food in the store at the time of the survey and an extrapolation of that proportion which remained in the field, as estimated by the farmer.

In the highland areas two farmers had not begun to transport their sorghum from the field; there was no provision to assess this harvest in either type of questionnaire, so that this produce had to be ignored.

Monthly surveys by Shire Valley Agricultural Development Project staff

Each month, after the initial survey, SVADP staff were to visit the farmers to take samples and to complete further questionnaires.

As all areas held staff meetings during one week of each month it was originally proposed that the field staff should revisit the farmers immediately before these meetings. The samples, which could be delivered to the DOs at the meetings, were to be exchanged for further supplies of maize for exchange with farmers. Also supplies of sample bags, labels and questionnaire forms were collected as required. Samples would then be taken to Ngabu headquarters by the Chief Extension Officer. Thus all the samples from any one month would arrive at Ngabu over a period of a few days so that with an intensive effort the sample analysis could be completed in a further 2 or 3 days. However, immediately after the initial survey the system of area staff meetings was changed; the meetings took place on Saturday mornings, two units on each day. Thus to complete all six area meetings three consecutive Saturdays in each month are required. This resulted in samples arriving at Ngabu throughout the month so that sample analysis was undertaken continually.

The change in the time of area staff meetings initially caused confusion over the collections of samples by the field staff and in the sample analysis. Visits to farmers became out of phase, instead of being once a month they were often at two-weekly and then at six-weekly intervals in some instances. However, after 4 months the field assistants settled to a routine and much of the confusion was resolved.

The organisation of sample collection, supply of maize grain for exchange with the farmer, the provision of sample collection bags, labels and questionnaires was designated the responsibility of the SVADP. The TA from Ngabu headquarters, who accompanied the CSP staff on the initial survey, took charge of this operation. Four months after the initial survey this man resigned and a replacement was found. The replacement underwent a short spell of training and ran the organisation reasonably well thereafter.

At first the field staff carried out their sample collections conscientiously. Each month samples were received at SVADP headquarters from each unit. However, after the third month when the stores began to be depleted the size of some of the samples collected was very small and in some instances they were impossible to analyse.

The extension staff collected samples on the designated days at intervals of between 2 and 6 weeks during the first half of the storage year. After November, however, very few extension workers collected samples until the following January so that some farmers were not visited for up to 12 weeks. The reasons for this long gap were difficult to pinpoint precisely. It is possible that the onset of the rains made some of the farmers inaccessible. There may not have been any staff meetings held over the Christmas period so that the extension workers did not think to visit the farmers. Perhaps it was simply because it was Christmas. Fortunately most of the farmers had consumed all their grain by the end of November so that even though some farmers retained maize during the December/January period the low losses found in the samples were not greatly affected by the delay.

The recurring monthly questionnaire (*see* Appendix 7) was completed by SVADP field staff during their visits to the sample farmers, to record details of grain removed from store and its use.

There were two problems associated with this questionnaire. The first was that due to lack of time the type and format of the questions were not evaluated before the survey and secondly there was insufficient time to train thoroughly all the field staff in the techniques of asking the questions and completing the forms. Both points gave rise to some problems in interpretation of the completed questionnaire, though most of the problems were not insurmountable.

Some of the field staff on some occasions did not attempt to differentiate between the statements beginning 'How much . . . .?' and 'How many times . . . .?' The question 'How many times did you take maize from the store?' was sometimes answered in terms of a number of baskets removed.

Occasionally the quantity removed from the store and that used for beer or for feeding animals, etc., did not correlate. This was probably due to the usage of long sentences in the questions, the use of two or more part questions and the confusion between general questions and questions involving damaged produce.

The questionnaire attempted to obtain more information than the field staff were capable to accepting. In future, questionnaires to be completed by extension staff must be simpler, with a clearer format.

COST OF UNDERTAKING THE EXERCISE

In order to estimate the cost of the exercise five sections were identified. The first section involved preliminary visits to the SVADP to organise and coordinate the work involved. Also included in this section was the estimated cost of training a technical assistant at Bvumbwe for 4 weeks in crop storage laboratory techniques with emphasis on the methodology of measuring losses.

The second section was the cost of the initial survey, including cooking utensils. Section 3 provided details of the recurrent costs of the monthly surveys. Section 4 included the costs incurred in the sample analysis and Section 5 was the cost of the vehicles used during the initial survey.

All these items were costed at the time of undertaking the survey. They do not represent the costs at the time of publication of the report as an allowance would have to be made for inflation.

The costings are shown in Table 2.

DATA COMPUTATION AND SAMPLE ANALYSIS

Calculation of produce stored and food consumed each month

When making assessments of total storage losses at the farm level it is necessary to relate losses calculated from samples to the quantities of grain originally stored and the pattern of grain consumption. In the ideal situation grain would be weighed into and out of the selected stores and samples would be collected from the quantities of grain actually removed. This approach can rarely be achieved and at best estimates of grain quantities have to be made. This was the approach adopted in this survey.

As the first visits to farmers' stores were often some weeks after the grain had been put into store, estimates of the total quantities stored had to be made by questioning farmers during the initial survey. They were asked how much produce they had harvested and stored. Some were able to answer in terms of numbers of baskets but many simply did not know. The important parameter for the survey was not the actual harvest but the quantity of produce put into the selected sample store and this was estimated by measuring the volume occupied by the produce in the store and converting this volume to a standard weight using a previously determined standard volume/weight ratio.

When each farmer was visited the dimensions of the store occupied by the produce were measured. In the case of the nkhokwe this was the diameter of the nkhokwe and the height of the produce in store. In the case of platforms or tchetes, the height, length and width of produce stored were measured. The volume was converted to a number of 'standard bags of cobs or panicles' by dividing by 4.5. A 91 kg

Table 2

Costs of loss assessment exercise in the Shire Valley Agricultural Development Area

	Costs in Malawi Kwacha	
Section 1 Preliminary visits, meetings and training		
Three one-day visits to Ngabu		
Training of SVADP technical assistant for 3 days		
Transport: 3 x 150 miles = 450 miles at 35 tambala (t)/mile	158	
Salary and accommodation of TA	100	
Salary of Malawian teaching staff (30 days)*	60	
Salary and expenses of expatriate research adviser*	220	
Sub-total:		538
Section 2 Initial survey		
Transport at 35 t/mile for 1 400 miles	490	
4 bags shelled maize for exchange	26	
600 paper bags	21	
Duplicating paper for questionnaires and labels	19	
Cooking utensils including Tilley lamps, plates, gas stove, etc.	164	
Salaries and subsistence while travelling*	410	
Sub-total		1,130
Section 3 Recurrent surveys		
Cost of visits of extension worker to farmer at 2 h per visit including travelling*	300	
Paper bags	97	
Maize for exchange (30 bags)	195	
Duplicating paper for questionnaires	12	
Sub-total:		604
Section 4 Sample analysis		
Experimental equipment:		
moisture meter	200	
SVW tester	40	
balance + weights	160	
sieves	22	
funnels, trays, etc.	20	
Salaries:*		
1 TA to take measurements at 20 days per month for 10 months	560	
5 unskilled women labourers for threshing sorghum for 4 working days each	20	
4 skilled male labourers to sort grain at 20 days per month, each for 10 months	960	
Sub-total:		1,982
Section 5 Transport		
Land Rover*	10,000	
Trailer*	2,000	
Sub-total:		12,000
TOTAL:		16,254

Notes: 1 Malawi Kwacha = £0.6 sterling

Items marked * would normally be incorporated into the costs of an existing project. For example the cost of the extension worker's time would already be met by the department for whom he is employed. If these items were removed from the total the cost would be reduced from K 16,254 to K 1,724.

(200 lb) hessian sack when filled has a volume of 4.5 ft^3. The approximate weight of a bag of maize cobs is 45 kg which would shell out to 35 kg. The weight of a bag of sorghum is approximately 40 kg which would thresh out to 26 kg of grain. (Unpublished data derived from trials undertaken at Bvumbwe Research Station).

A farmer's wife removes cobs and other produce from the store by filling a basket. Each month when visited by the extension worker the farmer spoke of the quantity of food consumed in terms of baskets. The dimensions of the baskets used were measured during the initial survey and the volume calculated. For baskets with a square or circular cross section an allowance of 10% extra was made to account for heaping above the top edge of the basket. The volume of the conical basket was calculated by determining the volume occupied by the cone itself and then multiplying this by 2 to allow for heaping.

The quantities of produce stored and removed for consumption could be converted to a number of baskets and so all calculations of losses were undertaken using the basket as the unit of measure.

After 2 or 3 months, farmers storing sorghum panicles threshed the produce and thereafter, stored the grain. From samples collected at the beginning of the exercise the threshing percentage was found to be approximately 65%. Thus when converting the number of baskets of sorghum grain to those of sorghum panicles the data were multiplied by 1.54.

Computation of cumulative losses

At each monthly visit the farmer was asked whether his wife had discarded any of the food removed from the nkhokwe (*see* Appendix 7). Badly discoloured grain, and grain producing noxious odours will not be eaten by the farmer and will be fed to his livestock, used for making beer or may be thrown away. Much of this type of damage is caused by fungal infestation, and some by oxidation of fats when produce is damaged by bad handling. The questionnaire elicited information concerning these types of loss, though no specific fungal analysis was attempted on the samples that were analysed in the laboratory.

Cumulative losses due to insect damage were calculated by applying the loss in the sample to the quantity of food removed from the store between each visit by the extension officer. From the sample collected the weight loss was determined (*see* Recommended methodology of loss determination in samples). This figure was then used to calculate the quantity of food that had been lost since the previous visit. The quantity lost together with the amount discarded by the farmer's wife was then expressed as a percentage of the original content of the store. The cumulative total of loss was recorded after each visit.

An example of the computation is given below:

Example: The calculation of cumulative weight loss

At the initial visit a farmer has in his store 50 baskets of cobs.

After 4 weeks 5 baskets were removed from the nkhokwe; sample collected indicated 1% loss.

Therefore quantity of food lost from that removed = **0.05** baskets

After 8 weeks another 15 baskets were removed; sample collected indicated 5% loss.

Therefore quantity of food lost from that removed = **0.75** baskets

After 12 weeks another 10 baskets were removed; sample collected indicated 10% loss.

Therefore quantity of food lost from that removed = **1.00** basket

After 16 weeks the remaining 20 baskets were removed; the final sample collected indicated a 15% loss.

Therefore quantity of food lost from that removed = **3.00** baskets

The amount of food discarded during storage, e.g. mouldy grain = **1.00** basket

Thus over the period of storage the total food loss was **5.8 baskets.**
This represented 11.6% of the original quantity of food put into the store.

No specific attempt was made to assess rodent losses. However, during the sample analysis in the laboratory signs of rodent damage were recorded (*see* Appendix 12).

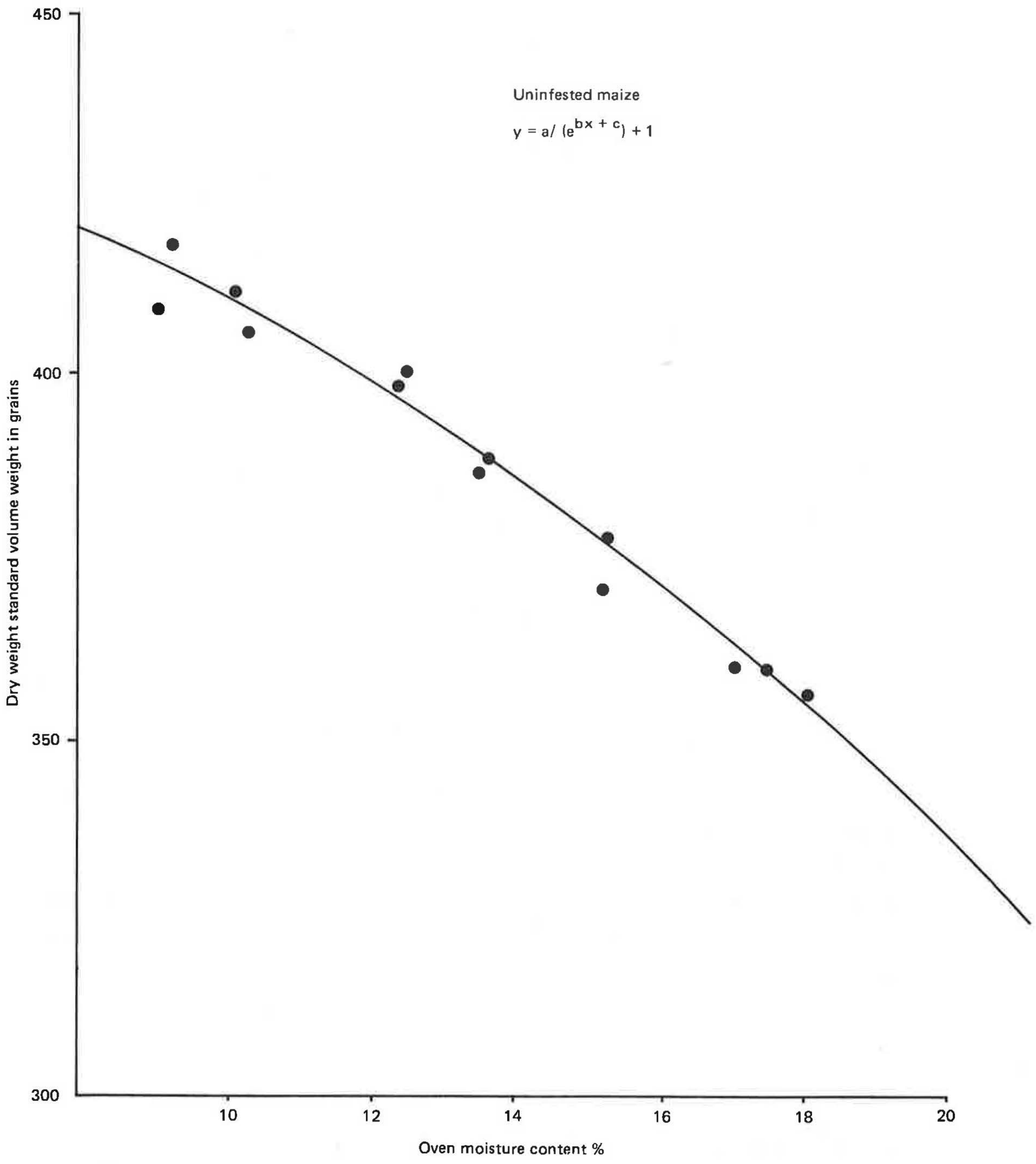
Recommended methodology of loss determination in samples

A description of the various methods that can be utilised for assessing the losses from samples of stored grain is given by Adams and Schulten in 'Post-Harvest Grain

Loss Assessment Methodology' edited by Harris and Lindblad (1978)*. Of the methods described, that utilising the weight of a standard volume of produce, hereafter referred to as Standard Volume Weight (SVW) is regarded as the most reliable. The accuracy of the SVW method was assessed in the survey and compared to a second method which involves counting and weighing damaged and undamaged grains in a sample.

For the SVW method a container with a standard volume of 2,651 cm^3 was used. Measurements of grain moisture content (m.c.) were made using a Cera moisture meter.

Figure 2
The dry weight standard volume weight of samples of local maize of different moisture contents from the Shire Valley Agricultural Development Project area



*For full details *see* REFERENCES.

The weight of uninfested grain occupying a standard volume is known to change with the moisture content of the grain and so it was necessary to establish the dry weight (DW) of the SVW at a range of moisture contents.

Before the initial survey, samples of farmer-grown local maize were collected from all areas of the Shire Valley and left to equilibrate at 27°C and 70% relative humidity for 6 weeks. After this time samples with insects present were discarded. The uninfested samples were aggregated, thoroughly mixed and then subdivided into five batches. After determining the oven m.c. of the maize bulk the batches were either dried or wetted to produce a range of m.c.s of between 9% and 18%. The SVW of each batch was measured and the results converted to a dry weight standard. The dry weights of the uninfested material were plotted against the original m.c. of the maize to obtain a baseline from which to compare all future measurements. The exercise was repeated and all of the results were plotted on a graph (*see* Figure 2). An asymtotic curve of the form:

$$y = a/(e^{bx + c}) + 1$$

was found to give a good fit to the data.

The Dry Weight Standard Volume Weight (DWSVW) was calculated for each sample of maize collected during the survey. By comparing the value of the DWSVW of the samples to that of the standard for uninfested maize at the relevant m.c., a figure for percentage weight loss was derived.

In the second (counting and weighing) method, samples of approximately 500 g were analysed. The weight loss was calculated after separating insect damaged grains from the undamaged grains and counting and weighing each fraction. The 500 g sample was derived from the grain used in the SVW method. It was divided using a Boerner divider into two equal parts, each of which was analysed separately.

The results of this analysis were substituted into the equation below to obtain the percentage weight loss.

$$\text{Percentage weight loss} = 100 \times \frac{(U\,N_d) - (D\,N_u)}{U\,(N_d + N_u)}$$

where N_u is the number of undamaged grains
N_d is the number of damaged grains
U is the weight of undamaged grains
D is the weight of damaged grains

Losses in sorghum were determined by the counting and weighing method only.

Sample analysis sheets are shown in Appendix 12.

Practical constraints in sample analysis

Maize

The SVW method. The standard volume weights of uninfested samples of approximately 1 kg of maize collected before the initial survey from five areas of the Shire Valley were measured ten times and considerable variation in the results was found (*see* Table 3).

An increase in m.c. of any sample should, theoretically, reduce the SVW measured as the density of water is less than that of the grain. The variation in the data (Table 3) was such that this feature was not always apparent. Samples of the same m.c. (14.1%), Samples B and E, had very different SVW values.

The SVW for a given commodity is known to be affected by many factors such as soil type, ambient conditions under which it is grown, variety etc., but it had been hoped that the variation in SVW would not be too great. In an earlier study (Adams and Harman, 1977) this was found to be so.

Table 3

The Standard Volume Weight of uninfested local maize from the Shire Valley

Sample	Moisture content (%)	SVW measured (mean of 10 readings ± standard error)
A	14.6	445.3 ± 5.4
B	14.1	432.1 ± 5.5
C	15.8	435.7 ± 5.5
D	15.1	445.1 ± 1.5
E	14.1	460.6 ± 2.1

The variation, however, was a major constraint in using the SVW method for determining losses in this project. It was perhaps due to the considerable variation in the grain size and in the chemical constituents which are associated with non-uniform maize types such as 'local maize'.

In view of the demonstrated variation in SVW it might have been appropriate to have prepared a baseline SVW for each individual store. However this was impracticable for two major reasons. Firstly the CSP could not afford the additional staff and time needed for such an undertaking and secondly the timing of the initial survey. It has already been mentioned that some stores were visited for the first time several weeks after the grain had been put into store and under these circumstances it was impossible to obtain a sample of grain for use as a baseline.

The method adopted was considered to be satisfactory despite the variation in SVW found because it was assumed that the variation in the maize from an individual farmer would not be great. Thus, if DWSVWs from one farm store were compared with the same initial uninfested value (from aggregate samples collected before the survey) a weight loss would be derived and perhaps a pattern of increasing weight loss with time might become apparent.

In many examples there was an obvious difference between the loss found in samples collected at the start of the survey to that found in samples collected after several months. However, the general month-to-month variations in the measurements were so large, particularly in the first 6 months of storage, in the dry season, when the losses were low, that the loss between one month and the next could not be differentiated. An example of this variation is shown in the data collected from two farmers illustrated in Table 4.

Table 4

Standard Volume Weight analysis on samples of maize obtained from two farmers in the Shire Valley

	Date of sample collection	Moisture content (%)	Reference DWSVW of uninfested maize at specified moisture content	Measured DWSVW of farmer's sample	% weight loss in sample
Farmer:	13. 6.78	13.7	386	382	1.0
E. Ngalu	15. 7.78	12.9	391	377	3.6
	9. 8.78	11.8	398	401	−0.8
	12. 9.78	11.6	399	385	3.5
Unit:	24.10.78	12.0	397	385	3.0
Saopa	6.11.78	11.7	399	374	6.3
Farmer:	12. 6.78	14.1	383	390	−1.8
W. Magalasi	5. 7.78	16.0	369	360	2.4
	6. 8.78	11.7	399	379	5.0
	9. 9.78	12.8	392	371	5.4
Unit:	16.10.78	11.7	399	383	4.0
Masanduko	24.11.78	13.5	387	372	3.9
	27.12.78	14.0	384	384	0

During the dry season, for a period of perhaps 6 or 7 months, the variations from month to month in the calculated weight losses were in some instances greater than the total actual losses that occurred. The variation was probably due to the heterogeneity of the local varieties of grain grown and stored in the area. Grain of different shape and size will produce different SVW values even when uninfested. Only a single sample need be collected at the end of the dry season; the loss during the preceding months could be computed from this sample if the quantity consumed during the period is calculated.

It is not perfectly clear as to whether this approach might be adopted when storage continues for longer periods, i.e. through the rainy season, when insect activity is more pronounced. In this survey few farmers stored through the rains, but evidence from these few farmers showed that losses were low and fluctuations high.

The count and weight method. Adams (1977) discusses in detail the inherent errors of this method. The errors were particularly apparent in the early part of the survey when the damage was low and negative values were frequently obtained.

Comparison between SVW method and the count and weigh method. Before the survey began five samples of maize from different units in the Shire Valley were put into uncovered containers and left for 5 months. Each sample was then divided into an uninfested fraction (which had no visible insect emergence holes) and an uninfested fraction (with no obvious signs of insect damage). The grains in each fraction were counted and weighed, and the percentage weight loss calculated. The DWSVWs of the uninfested fractions were measured and the fractions recombined. The DWSVWs of the recombined samples were then measured and the percentage weight loss calculated from the difference between the two DWSVW measurements (*see* Table 5).

Table 5

The weight loss of five samples of maize stored for 5 months analysed by different methods

Sample No.	Percentage loss of weight	
	Calculated using SVW	Calculated by counting and weighing grain
1	1.0	0.3
2	4.3	−0.3
3	3.2	0.9
4	1.7	1.5
5	11.1	7.4

The count and weigh method consistently gave lower losses than the SVW method. With low levels of infestation the count and weigh method is subject to greater error than the SVW method. Preferential infestation of large grains by the insects as well as larvae hidden inside the grain accentuate the lower loss figures found in the count and weigh method.

It is probable therefore that the SVW method provides a more realistic impression of the losses occurring in farm stores, a conclusion Adams and Harman (1977) also reached. However during this survey it was frequently found that the percentage loss in samples calculated by the SVW method were greater than the percentage of grains actually damaged. The reasons for this anomaly are not clear but must be due to the chemical or physical nature of the grains; grains different in composition would have different weights so that heavy grains when damaged might still weigh more than undamaged light grains. Table 6 demonstrates the different densities of the grains used in the five samples mentioned above.

It would be expected that the weight of insect damaged grains would differ from one grain to the next, being dependent on not only the moisture content of the

Table 6

The dry weight of maize grain from five samples obtained in the Shire Valley

Sample	Moisture content (%)	Weight of uninfested grain (mg/grain)	No. of grains to fill SVW container	Weight of insect damaged grain (mg/grain)	No. of grains to fill SVW container
1	9.5	366	1,091	339	–
2	11.3	416	899	419	892
3	9.6	386	990	373	–
4	10.0	414	882	407	890
5	9.3	463	–	498	683

grain but also the number of emergence holes found. The weight of uninfested grain also differed quite markedly between samples and this must be due not only to the possible weight difference caused by the harbourage of internal infestation (internally infested grains counted as sound grains), but also to the chemical nature of the grains themselves. Clearly, the 'local' maize was by no means an homogenous 'variety' like a standard hybrid, even though it gave the outward appearance of being so, particularly as regards grain size.

At the termination of the survey a comparison was made between the loss as measured by the SVW method to that calculated from the count and weigh method on each sample collected. A statistical analysis using a paired sample t-test was carried out on 260 sets of data. There was a mean difference of 2.53% between the two methods with the SVW method giving the higher estimates of loss. With a standard error of differences of 0.239 the estimates obtained using SVW method were found to be significantly greater ($P < 0.01$) than those obtained using the count and weigh method.

Sorghum

When extension staff were asked to bring 10 panicles of sorghum from a farmer in their particular area before the start of the survey they produced a total of 40 panicles from 4 farmers which comprised 19 obviously different varieties. Indigenous sorghum in the Shire Valley is very variable in size, colour and chemical composition. So that an SVW analysis might be undertaken, the grains were graded into two sizes. However, even uninfested grain of similar size of different varieties produced quite different SVWs, as shown in Table 7.

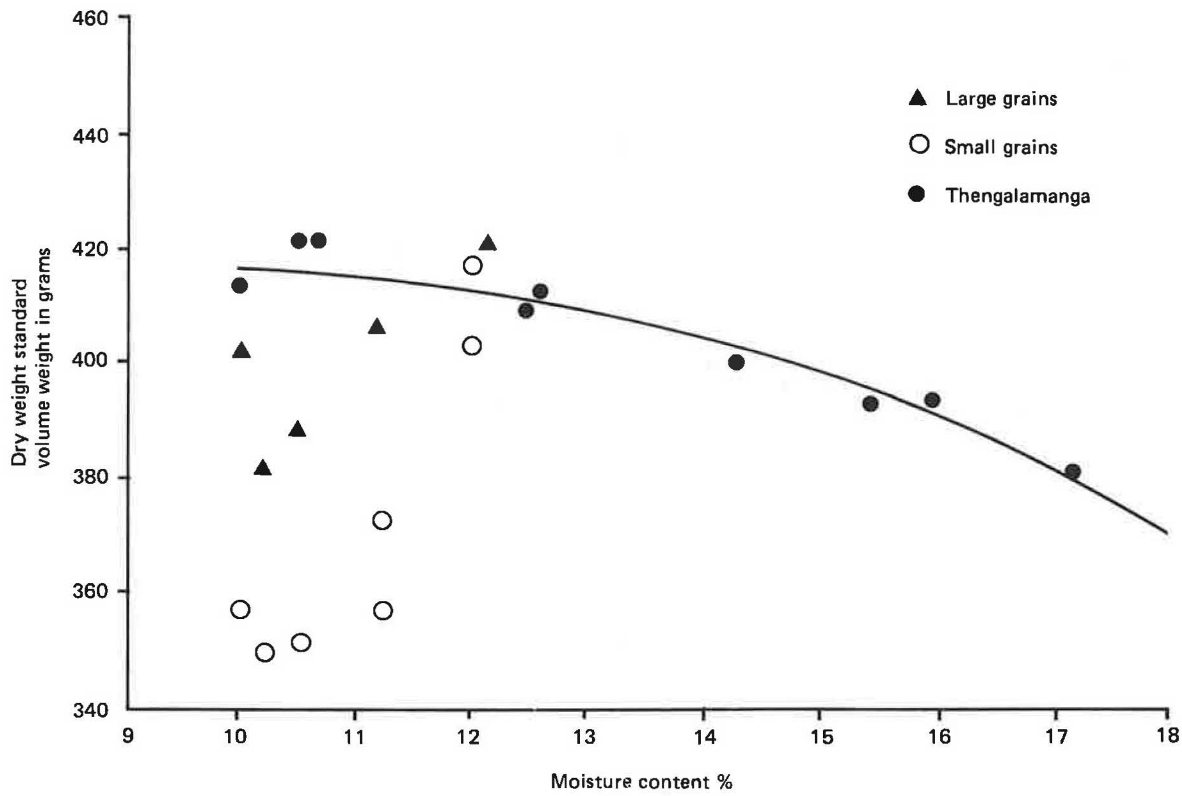
Table 7

The Standard Volume Weight of graded uninfested sorghum varieties

Variety	Moisture content (%)	SVW	
		Grade A	Grade B
Thengalamanga	12.1	478	457
Serena	12.1	475	474
S77W9	10.2	425	387
Segaleone	10.5	432	391
PN3	10.0	446	395
PN8	11.2	456	400
Nega White	11.2	–	417

Figure 3 illustrates the data in Table 6 graphically after extrapolation to a dry weight equivalent. Included in this graph is a standard curve, drawn by eye, from data derived from uninfested Thengalamanga sorghum. Even over the small range of m.c. measured it is clear that there was a wide dispersion of results. It was not practical to use the SVW method with a baseline derived from aggregate samples of all varieties nor indeed from aggregate samples of the same variety. The SVW method could have been used if it had been possible to obtain a baseline for each

Figure 3
The standard volume weight of graded sorghum varieties converted to a dry weight equivalent



store but this was not practical for the same reasons given for the investigation of maize losses.

Sorghum losses were therefore assessed by counting and weighing samples of approximately 1,000 grains. As well as the errors mentioned by Adams and Harman (1977) other errors occurred. In particular, human error was possibly very significant as it is a very tedious task to sort small sorghum grains.

The sample size was restricted to 1,000 grains because of the shortage of time for analysis and to reduce the tedium of sorting. However, 1,000 grains only weigh approximately 30 g and errors may have been introduced when the fractions were weighed, particularly the infested fractions in the early part of the survey when damage levels were low. Duplicate examinations were made on all samples.

RESULTS

From the farmers interviewed, 83 stored maize and 85 stored sorghum. In the following tables it will be noted that the total number of farmers do not always amount to the maximum numbers recorded. Some farmers were unable to remember the month in which they harvested so that the duration of storage could not be calculated. For a small number of farmers the losses could not be calculated because they consumed all the produce before the first samples were collected. These points perhaps emphasise the need to begin field work early, at the time of harvest or immediately after; however it has been explained earlier (*see* Methods and constraints of the loss assessment exercise) why this was not possible in this survey.

Maize

Month of harvest

Maize was harvested predominantly over a three-month period; the majority of farmers harvested in April. This is at least a month earlier than when farmers harvest maize in the rest of the country.

Table 8

Number of farmers harvesting maize each month in each area

Area	January	February	March	April	May	June
1	–	1	10	9	2	–
2	–	–	3	7	3	–
3	–	1	3	9	4	–
4	–	–	6	3	–	–
5	–	–	–	1	3	–
6	–	–	1	8	1	–
Total:	–	2	23	37	13	–
Percentage of total:	–	2.7	30.7	49.3	17.3	–

Quantity of maize stored

Table 9 illustrates the quantity of maize stored during the 1978/79 season:

Table 9

The quantities of maize stored by farmers in each area

Area	Number of bags of cobs						
	0–9	10–19	20–29	30–39	40–49	50–59	60+
1	4	4	5	5	4	1	1
2	4	1	4	1	2	–	1
3	3	7	6	–	1	–	–
4	7	1	–	2	1	–	–
5	3	1	1	1	–	–	–
6	2	5	–	2	2	–	1
Total:	23	19	16	11	10	1	3
% of total:	27.7	22.8	19.3	13.3	12.1	1.2	3.6

As 1 bag of maize grain (91 kg) is equivalent to 2.5 bags of cobs (35 kg) then 70% of the farmers stored less than the equivalent of 12 bags of grain. The mean family size of the farmers interviewed was 3 adults and 3 children. In order to feed a family of this size for a year 16 bags of maize grain would be required. Thus most families ran out of maize well before the following harvest as is illustrated in the following section. In order to sustain the family the farmer sold cotton or guar beans to ADMARC and purchased maize with the cash received.

Duration of storage

Most farmers had harvested their maize by the middle of April. The large majority were unable to store food to the beginning of the rainy season which began in the latter part of November, some 36 weeks later. Table 10 illustrates that 75% of the farmers finished their maize by the onset of the rains.

Table 10

Duration of storage period of maize by farmers in each area

Area	Storage period in weeks										
	0–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40+
1	–	–	–	–	2	5	4	5	1	1	8
2	–	1	–	1	–	2	1	4	2	1	2
3	–	–	–	–	–	3	4	3	4	1	4
4	1	–	–	–	–	2	1	2	2	–	1
5	–	–	–	1	–	–	1	2	–	–	–
6	–	–	–	–	2	2	3	1	1	–	1
Total:	1	1	–	2	4	14	14	17	10	3	16
Percentage of total:	1.3	1.3	–	2.5	4.9	17.0	17.0	20.7	12.2	3.7	19.4

Maize loss sustained

The mean loss of maize sustained by all farmers in the SVADP was 3.2 ± 3.4% standard deviation (SD) calculated by the SVW method and 1.8 ± 3.5% SD calculated by the count and weigh method.

Table 11 summarises the data obtained for each area individually. Tables 12 and 13 demonstrate the amount of loss sustained related to the period of storage.

Table 11

The total loss in weight of maize (including discarded grain) by the termination of storage in each area

Area	No. of farmers	Percentage weight loss (mean ± standard deviation)	
		SVW method	Count and weigh method
1	23	2.5 ± 2.2	1.3 ± 1.8
2	12	2.1 ± 1.6	0.7 ± 1.0
3	17	3.8 ± 5.5	2.4 ± 5.1
4	8	3.6 ± 2.6	1.8 ± 2.6
5	4	4.3 ± 3.0	1.5 ± 2.1
6	8	4.8 ± 6.0	4.0 ± 6.8

The losses calculated by the SVW method were significantly higher than those calculated by the count and weigh method (cf. p. 17). However the losses were low, the maximum calculated being less than 5%.

As the losses were very low they were independent of the length of storage. Thus in Table 12 there was no significant difference between the loss calculated up to 24 weeks storage and that sustained by farmers who stored for 40 weeks. Even the onset of the rains had no effect on the losses.

Table 12

Loss of maize (including discarded grain) related to length of storage period

Duration of storage (weeks)	Number of observations*	Percentage loss of food consumed (mean ± standard deviation)	
		SVW method	Count and weigh method
10–20	56	1.4 ± 2.6	0.7 ± 1.9
21–24	27	3.3 ± 4.6	2.2 ± 4.4
25–29	31	3.1 ± 3.1	1.6 ± 2.9
30–34	18	2.3 ± 1.1	1.0 ± 1.1
35–39	7	1.3 ± 1.5	1.1 ± 1.1
40+	9	1.7 ± 2.0	1.7 ± 2.5

Note *Number of observations made on all samples up to that period indicated. As the storage period increased so the number of observations (samples) decreased. The increases after 25 and 40 weeks were because some farmers failed to provide samples in the immediately preceeding period.

Table 13

The storage period as related to the loss of maize that occurred

Percentage weight loss (including discarded grain)	SVW method		Count and weigh method	
	No. of farmers	Storage period weeks (mean ± standard deviation)	No. of farmers	Storage period weeks (mean ± standard deviation)
Up to 0.1	1	40.0	14	28.0 ± 7.6
0.2 – 1.0	27	30.4 ± 8.6	38	28.6 ± 6.9
1.1 – 2.0	8	32.8 ± 4.9	6	33.7 ± 7.5
2.1 – 3.0	15	30.4 ± 5.1	5	28.2 ± 3.7
3.1 – 5.0	7	27.6 ± 6.5	3	36.0 ± 5.3
5.1 – 10.0	12	29.8 ± 6.2	3	26.5 ± 3.5
10.1 +	2	26.5 ± 4.9	3	24.7 ± 4.7

On fourteen occasions losses greater than 5% were recorded (*see* Table 13). This was because the farmers concerned (all in areas 5 and 6) had discarded some of the grain removed from their nkhokwes. This grain may have been badly discoloured due to fungal damage. Little evidence of rodent damage was recorded in samples analysed in the laboratory.

Sorghum

Month of harvest

Most farmers harvested in April or May (*see* Table 14).

Table 14

Number of farmers harvesting sorghum each month in each area

Area	January	February	March	April	May	June	July
1	–	–	1	4	6	2	–
2	–	–	2	3	8	–	–
3	–	1	3	5	9	4	–
4	–	–	1	2	4	–	–
5	–	–	–	9	4	–	–
6	–	1	–	5	8	3	–
Total	–	2	7	28	39	9	–
Percentage of total	–	2.3	8.3	32.9	45.9	10.6	–

Quantity of sorghum stored

After harvest most farmers left their sorghum unthreshed on raised wooden platforms outside the house, to dry and to await threshing after they had harvested their cotton. The amount of sorghum harvested is shown in Table 15. The quantities are expressed in bags of grain, the data being derived from calculations of the volumes occupied by the panicles as described in the previous section on Data computation and sample analysis.

Table 15

Quantity of sorghum grain stored by farmers in each area

Area	Number of bags stored					
	Up to 1.0	1.1 – 2.0	2.1 – 3.0	3.1 – 4.0	4.1 – 5.0	5.1+
1	4	4	–	2	1	2
2	1	2	1	5	–	4
3	5	2	4	2	3	6
4	5	1	–	–	–	1
5	2	2	–	1	1	7
6	–	3	3	2	3	6
Total:	17	14	8	12	8	26
Percentage of total:	20.0	16.5	9.4	14.1	9.4	30.6

Duration of storage

Nearly 70% of farmers stored their produce for less than 28 weeks. Most farmers had consumed all their produce before the onset of the rains in November.

Table 16

Duration of storage period of sorghum in each area

Area	Storage period in weeks									
	0–3	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	35+
1	–	–	2	1	5	1	2	1	–	1
2	–	–	1	3	3	1	1	2	1	1
3	1	–	2	1	2	1	4	4	2	5
4	–	3	2	–	1	–	–	–	1	–
5	–	2	1	1	2	1	–	4	1	1
6	–	–	4	2	5	2	3	1	–	–
Total:	1	5	12	8	18	6	10	12	5	8
Percentage of total:	1.2	5.8	14.1	9.4	21.2	7.1	11.8	14.1	5.9	9.4

Sorghum losses

The mean loss of sorghum for all farmers sampled at the termination of storage was 1.7 ± 0.5% (SD). Table 17 illustrates the losses sustained by area.

Table 17

The loss in weight of sorghum (including discarded grain) by the termination of storage in each area

Area	No. of farmers	Percentage weight loss (mean ± standard deviation)
1	12	1.2 ± 1.9
2	14	1.7 ± 2.2
3	19	1.2 ± 1.0
4	7	0.3 ± 0.7
5	13	2.1 ± 4.5
6	15	3.4 ± 4.6

The loss of sorghum was low in all areas. The duration of the storage period was limited though this did not appear to affect the loss as Table 18 demonstrates. Even farmers storing sorghum through the rains did not lose 2% of their crop. There was no significant difference between the loss that occurred in any of the periods shown in Table 18. However, some farmers did lose in excess of 5% by weight of their original produce (*see* Table 19).

Table 18

Loss of sorghum related to length of storage period

Duration of storage (weeks)	Number of samples stored and analysed	Percentage loss of food consumed (mean ± standard deviation) including discarded grain
9–13	55	0.4 ± 0.8
14–20	32	1.7 ± 3.1
21–24	25	2.0 ± 3.7
25–29	16	2.4 ± 4.2
30–34	12	1.9 ± 2.0
35 +	7	1.5 ± 0.7

The relatively high losses in Table 19 were from areas 5 and 6 and were due to farmers discarding some of the grain which had been removed for consumption. The losses measured by the count and weigh method (i.e. insect losses) were not greater than those in other areas. The reasons for discarding grain were not recorded but it may have been due to fungal damage and discolouration. The eight farmers suffering more than 5% loss (*see* Table 19) were recorded as having stated that they had discarded grain. However the question may have been misinterpreted and the grain may have been simply fed to animals rather than thrown away. No evidence of rodent damage was recorded.

Table 19

The storage period as related to the loss of sorghum including discarded grain

Percentage loss in weight	No. of farmers	Storage period in weeks (mean ± standard deviation)
Up to 0.1	23	10.8 ± 5.8
0.2 – 1.0	26	23.1 ± 8.0
1.1 – 2.0	15	30.0 ± 9.5
2.1 – 5.0	8	21.3 ± 9.2
5.1 – 10.0	6	19.9 ± 9.3
10.0 +	2	22.2 ± 7.4

DISCUSSION

Survey methodology

The stratified random sampling technique was efficient until the random choice was made. Probably the same spread of results would have been obtained if a single cluster of farmers had been used rather than two clusters (Atkins, personal communication). Thus all the farmers could have been chosen from one village in a unit rather than from two. This type of selection would have allowed a greater choice of farmers with consequently many more randomly chosen reserves and this would have overcome the problem of selecting replacements. Interviewing farmers from only a single village would have saved considerable time in the initial survey which may well have been completed within 10 days, i.e. 2 working weeks.

The initial survey achieved its objectives but could have been more streamlined and, therefore, efficient. It is considered important that initial survey teams should be highly mobile and uncluttered. As little equipment should be carried as possible, and all analysis should be undertaken in a laboratory. By the third week the survey completed two units each day by 14.00 hours after commencing at 08.00 hours, whereas during the first week the working day began at 07.30 and finished at 17.00 hours.

In order to carry out successfully the series of monthly visits to farmers a great deal of effort and coordination was required. The local extension organisation was very large and operated through four or five hierarchical levels which made transmission of decisions and messages rather slow and cumbersome. Samples collected from farmers were left out at the units for several weeks and maize for exchange and questionnaires often did not reach the extension worker in time. Future studies in this area might be simplified if fewer visits to farmers to collect samples were made. From the experience of this survey it is suggested that in future studies, once the initial survey has been completed, visits should be made once before the onset of the rains and then at intervals of about 6 weeks. This survey clearly demonstrated that during the dry season damage levels remain low and under these conditions a large number of sample collections is not justified. A check on the consumption pattern should be made at the time of sample collection using a questionnaire in order to establish the quantity of food removed during the dry season, and the pattern of consumption through the rains until the store is emptied.

By reducing the number of samples collected from the farmer a considerable monetary saving would be made in the cost of produce for exchange and in the wages paid to casual and skilled assistants who undertake the analysis. Furthermore, the organisation of the exercise would be simplified and the achievement of the objectives facilitated.

The exercise has demonstrated the need for straightforward questionnaires for use by extension staff. Difficulties arose in this survey because some of the questions were not fully understood by the extension staff and farmers.

A new questionnaire, producing the same information, has been designed and used for another similar exercise carried out in the Lilongwe area. This questionnaire was pre-tested (unlike the first) in a small number of units and, after evaluation of the completed forms, was modified accordingly. For any future survey of this nature it is essential to pre-test and evaluate questionnaires before use in order to isolate and remove inconsistencies.

Sample analysis

The calculated quantity of food stored in the nkhokwe, tchete or on the platform was relatively accurate although occasionally widely different from the quantity the farmer stated he harvested. Even though baskets of different shape and size were used in the area, the quantity placed in them on different occasions was remarkably constant, being restricted by the conformation of the basket itself and by the wife of the farmer, who knew how much the basket could contain. Possibly the largest source of error was in the number of baskets of produce removed from the store. This was not always consistent or regular, because produce would be removed for paying wages, donating gifts, making beer and feeding animals as well as for home consumption. Several farmers had finished their produce when it was calculated that they should have had several baskets remaining. Subsequently, upon enquiry, the farmers were found not to have mentioned some of the produce which they sold, possibly because they feared visits from the taxman. The only means by which these problems would be overcome is by on-the-spot invigilation, which for practical purposes is not possible. The experience of this survey has shown that an error of the order of 10% must be allowed for the quantity of produce removed over the whole storage period.

Because the distribution of insect pests within the store is non-uniform any two samples removed from the store can exhibit widely different amounts of damage. Thus part of the fluctuation found in the loss analysis from month to month would have been due to differential infestation throughout the store, particularly when the infestation was low. However, the variation was heightened by the methods of determination themselves — the SVW method exhibited quite marked variations in measurement even on uninfested samples — particularly with non-uniform produce as was grown by farmers.

The problems of assessing losses are discussed in detail by Adams and Harman (1977) but little emphasis is placed upon the problems associated with the SVW method for use in a practical situation when using an aggregate baseline sample.

With a uniform variety of maize, such as SR52, the SVW method may well produce replicated results having a low coefficient of variation. However, this was not the case in SVADP where farmers' maize was primarily indigenous, being flinty maize with some improved characteristics derived from varieties that have been recommended and tried over the last few years, in particular synthetic varieties SV28 and SV37. The grain was heterogenous and consequently affected the SVW measurements of loss as well as calculations derived by counting and weighing grains. Almost all farmers in Malawi grow and store this local-improved maize. Where hybrids are grown they are sold immediately after harvest for cash. Thus wherever loss assessment is attempted this same problem with the SVW method will occur. At higher loss levels the SVW method, like the count and weigh method, is likely to be more accurate. However, it remains to be seen whether such losses, i.e. in excess of 10% in a sample, do occur in Malawi.

The sources of error associated with the counting and weighing method of assessing losses have also been discussed by Adams and Harman (1977). In this exercise it was found that when the percentage number of damaged grains in a sample was less than 5% the weight loss was 24.8% of the damaged value. However, there was a large variation in this figure as is illustrated by the high standard deviation of 13.8. Similarly, for damage values in excess of 5% the loss represented 22.1 ± 12.3% of the damage. Thus the variation tended to make the individual loss values achieved by this method suspect. This is in line with the findings of earlier studies (Adams and Harman, 1977). Loss cannot simply be related to a straight damage assessment using the count and weigh method. One has to keep in mind the major limitation of the method, that of hidden infestation. Individual figures will have a high variation but as long as the variance is quoted then a pattern might emerge which would still be useful.

The level of losses in maize and sorghum

Despite the inconsistencies that occurred in the sample analysis it was clear that very small losses occurred in both stored maize and sorghum; 3.2% for maize as measured by SVW method (and 1.8% by the count and weigh method) and 1.7% for sorghum measured by the count and weigh method.

Maize

Cob maize in Malawi is infested during storage by various insect pests, the most common being *Sitophilus zeamais* Motsch. and *Sitotroga cerealella* Olivier. Experimentation has demonstrated that it is only during the rainy season (i.e. between November and March) that damage by these pests becomes significant; before the rains the grain is too dry to support development of the insects.

Maize would be expected to exhibit low damage levels when stored up to the beginning of the rains and this was shown to be the case in the Shire Valley. The protection of the flinty, resistant grain was enhanced by the tight husk, which extended well over the tip of the cob, effectively reducing pre-harvest infestation by the pests to negligible levels.

Most farmers had finished their maize or had very little left to consume by the onset of the rains. The damage to maize stored through the rainy period did increase in some instances. Even though weight losses in individual samples of 5% and above were recorded this was at a time when very little grain was left in store. Consequently these losses did not represent a very large proportion of the total crop stored. In areas where more grain is stored for longer periods, for example in the Lilongwe area, the increased rate of development of insect pests during the rains might cause more substantial losses to the food stored.

The losses in maize sustained by farmers in the Shire Valley are likely to remain negligible unless there are changes in farming conditions. If, for example, farmers start growing and storing hybrid and composite varieties such as MH12 and UCA on a large scale, much more insect damage will occur. These higher yielding varieties have poor husk sheathing and are, therefore, more easily infested before harvest by storage pests than local maize; the grain is inherently more susceptible to insect damage. If more maize is stored through the rains, allowing a substantial development of insect populations, the losses might become much more significant, particularly if hybrids and composites are stored.

Sorghum

Sorghum is a relatively susceptible commodity to insect attack and could become heavily infested before harvest as it does not possess a protective husk like maize. In the SVADP the predominant storage pest of sorghum is *Sitophilus oryzae* L., the rice weevil, but like the maize pests this insect only became obvious after the onset of the rains. During the dry season farmers suffer little loss.

Farmers in the Shire Valley harvest their sorghum when it is hot and dry. Results of the survey showed that there was no insect damage at harvest, nor during the first two months of storage, when the sorghum is usually left unthreshed on raised platforms. In July and August, whilst it is still dry, the produce is threshed and the grain placed in a tightly woven grass basket, the chikwa. This basket is relatively insect-proof so that uninfested sorghum placed inside it will remain undamaged as it will only be subjected to a very low infestation pressure. Even if stored through the rains the losses will remain very low.

If infested grain was put into the chikwa then the sorghum would become very heavily damaged in a short time and the only remedy would be to apply insecticide to the grain. However, none of the 85 farmers had grain which was heavily infested when it was placed in the chikwa.

Economic considerations

An economist's approach to loss is to consider the consequences which arise from a loss being incurred and to compare these with the results of measures required to reduce the loss. This entails expressing, normally in monetary terms, the inputs required to reduce the loss (i.e. cost) and the amount of commodity saved (i.e. benefit). The common procedure is a cost/benefit analysis but other methods may be used.

At the farm level, loss prevention will be undertaken because either the reduction in losses which can be achieved is sufficiently dramatic to induce farmers to make the necessary expenditure to achieve the reduction, or because governments actively encourage a loss prevention programme. From which source the initiative stems depends on the size of loss and how the loss is viewed. In the discussion below the economic evaluation of loss prevention is viewed firstly from the farmer's viewpoint and then from the national viewpoint, and in relation to loss levels occurring in the survey area only.

There are several ways, used singly or combined, in which losses can be reduced, such as improvements to traditional storage structures, introduction of modern structures made of metal or concrete and application of insecticide. The first two are of limited application at present in the survey area, so further discussion concerns application of insecticide only. Addition of insecticide to cobs of high-yielding hybrid maize varieties has been shown to result in large savings of grain in the SVADP area. Losses were reduced after 6 months of storage from above 25% to 5% or less by the addition per bag of cobs of 80 g of 2% Actellic (the locally available insecticide).

However, farmers in the SVADP area store only traditional varieties and do not apply insecticide to these, hence there is no estimate of the amount by which losses are reduced by the incorporation of Actellic into the storage system. The cost/benefit approach, where cost of insecticide is compared with value of grain saved, cannot be done. Thus, a slightly modified approach is used which identifies the amount by which losses must be reduced in order to recoup expenditure on insecticide.

Average losses in the survey were estimated at 1 – 2% for sorghum and 2 – 5% for maize. Total elimination of weight loss cannot be achieved under farm conditions and the amount by which weight loss could be reduced by Actellic application is assumed to be between 1% and 4% for maize and 1% for sorghum of the original weight of produce stored.

The farmer's viewpoint

Costs. The optimum rate of application of Actellic to maize to prevent insect damage and thereby weight loss is two sachets (80 g of 2% dust) per bag of cobs and to protect sorghum panicles one sachet. The cost of a sachet of Actellic is 14 tambala (t) and therefore the cost of treating a bag of cobs is 28 t and a bag of sorghum is 14 t. Insecticide would be applied by the farmer and the value of time spent should be included in the cost; however the farmer's own labour is assumed to have in fact a negligible opportunity cost and is excluded from the calculations.

Benefits. A bag of maize cobs is equivalent to 35 kg of shelled maize and a bag of sorghum panicles is approximately 40 kg of threshed sorghum. The quantity of grain saved per bag and its value at different levels of loss reduction, between 1 – 4% for maize and 1% for sorghum, are shown in Table 20. Cereal production in this area is in deficit and when stocks have been used up maize is brought from ADMARC. Thus to convert grain saved into a monetary value the price used is that at which maize is bought.

Table 20

Potential weight of grain and cash saved by farmers treating produce with Actellic

Percentage weight saved of original quantity stored	Maize		Sorghum	
	Weight kg	Value t	Weight kg	Value t
1	0.35	3.5	0.4	4.0
2	0.70	7.0	–	–
3	1.05	10.5	–	–
4	1.40	14.0	–	–

Evaluation. From the above table it can be seen that the value of grain saved, 14 t for maize and 4 t for sorghum, never exceeds the cost of the insecticide, 28 t and 14 t respectively. Thus from the farmer's viewpoint use of insecticide cannot be justified.

The national viewpoint

This evaluation considers how the country as a whole is affected. To the country the cost of reducing losses is the foreign currency paid to buy imported inputs plus the opportunity cost of the internal resources used, such as the resources used to distribute inputs and the provision of services, e.g. extension services.

The benefit is that either less grain is imported to feed the population or more grain becomes available for export. In both cases the Government has extra foreign currency at its disposal. The value of imported inputs, or imported or exported grain, is calculated using import and export prices (border prices) rather than internal prices.

Costs. The c.i.f. price of Actellic is 100 t for a kilogram of 2% dust and therefore the cost of insecticide is 8 t for maize and 4 t for sorghum. To this has to be added the opportunity cost for packaging and distributing Actellic, together with the opportunity cost of time spent by officers in the extension services in training farmers in the use of Actellic. Since the time required by extension officers for training farmers would be small and is therefore assumed to have a negligible opportunity cost, it is excluded from the calculation. From the national viewpoint, opportunity cost of internal resources are lower than market values. For the purposes of this evaluation it is assumed that the economic value of small sachets of Actellic for sale at farmer level is double the border price of bulk imports.

Benefits. Malawi is normally self-sufficient in maize and exports surpluses. Countries to which Malawi has exported are neighbouring countries, the Netherlands and Japan. When exporting, Malawi has to compete with other sources of supply, especially the USA and Argentina. Exports to neighbouring countries make the highest f.o.b. prices as for these destinations Malawi can obtain better prices as transport costs are lower than for her competitors. For March 1980 the f.o.b. price is calculated as K160 a tonne. The value of maize saved is shown in Table 21.

Losses to sorghum from insect damage, are extremely small and do not warrant the use of Actellic. The economic cost of Actellic, 8 t, exceeds the value of grain that would be saved, 6.4 t.

Evaluation. It can be seen from the above table that if loss can be reduced by more than 3%, benefits exceed costs. Using the information in Table 21 in relation to the

Table 21

Value of weight of maize saved

Percentage grain saved	Maize	
	Weight kg	Value t
1	0.35	5.6
2	0.70	11.2
3	1.05	16.8
4	1.40	22.4

losses sustained by 72 farmers in the sample, only 12 (17%) using the SVW method and 8 (11%) using the count and weigh method sustained losses due to insect damage at or above a level which would justify (from the national viewpoint) protective measures being taken.

Conclusion

The use of insecticide cannot be justified from the farmer's viewpoint for either sorghum or maize; loss would need to be in the order of 10% for maize and 5% for sorghum, which only requires 40 g of Actellic dust per bag, before the application of insecticide can begin to be justified. This assumes that the relative prices of Actellic and maize remain the same.

From the national viewpoint, use of insecticide can be justified on maize at lower levels of loss — in this area an average of 4—6%. The large differential between border and internal prices for maize results in a loss reduction programme becoming beneficial to the country well in advance of benefitting the farmer.

Not until the majority of farmers sustain high losses does a national campaign to reduce losses become worthwhile. Where the number of farmers sustaining high losses is low, identifying these farmers cannot be done by survey and a full census covering all farmers is needed. The cost of such a census would be prohibitively expensive; its cost would probably nullify the value of any grain saved. The alternative of a national campaign to increase the use of Actellic would encompass all farmers, the few who from the national viewpoint would benefit as well as all those who would not. The combined cost of the campaign plus the Actellic, would probably be greater than the value of the grain saved.

While at present the use of Actellic from the national viewpoint cannot be justified, losses only have to increase on average by around 3% and then the use of Actellic would be worthwhile. With resistance to insect infestation possibly becoming less as cross-fertilisation of traditional and improved varieties occurs, an increase in loss of 3% could become a reality.

If in the future losses rose to 4—6% or more but were not sufficiently large (i.e. 10% or more) for farmers to take the initiative and start to use the insecticide, then a positive incentive would be needed to encourage the farmers. One incentive that might be considered is to subsidise the price of Actellic. However, such a subsidy would have to be pitched at a level which would achieve a quite dramatic benefit, as farmers would be unlikely to respond unless the value of grain saved exceeded the cost of Actellic by a considerable margin.

CONCLUSIONS

Loss assessment methodology

1 The exercise was time-consuming and often tedious. It is vital that the limitations in the capabilities of all the personnel involved in the exercise, including the farmers themselves, should be taken into account, during the planning phase. Too much work should be avoided.

2 Time could have been saved and better utilised if a single large cluster sample had been obtained from each unit. Certainly the importance of practical constraints in meeting farmers must exert a strong influence on the sampling theory when the participants are being chosen. To eliminate the haphazard selection of substitutes during the visits, additional reserves must be chosen and forewarned.

3 The initial visit to the farmers must be made as soon after harvest as is possible to facilitate the calculation of consumption patterns, when the farmer is acutely aware of the size of the harvest.

4 The design of the exercise, an initial visit followed by visits at monthly intervals, instills a routine into the farmers and the staff collecting material. This design should in general be adopted, though to reduce the work load of the laboratory staff it should be possible in the SVADP to restrict the collection of samples to the end of the dry season and then through the rainy season. Thus a programme for future studies in the SVADP should be as follows:

(i) An initial survey to be conducted as soon after harvest as possible to gather information concerning the total amount of produce stored and to collect initial samples for analysis.

(ii) A second survey to be undertaken at the onset of the rains in November to gather information concerning the amount of produce remaining in storage and to collect a second sample for analysis. This visit would serve to calculate the quantity remaining in store, the sample would act as a check on the initial sample collected.

The utilisation of the food prior to this visit is of little consequence because the losses can be assumed to be very low and immaterial.

(iii) Monthly visits to commence one month after the second survey, to collect information on consumption patterns and to collect samples for analysis. These visits to be terminated when the stores have been emptied.

(iv) The exercise should be completed by May when the final samples of any remaining produce should be collected. A maximum of eight samples would, therefore, be collected from each farmer.

5 Samples should be check analysed by both the SVW and the count and weigh method because each is subject to high variation, certainly when losses are low. Maize samples from the SVADP were particularly heterogenous as a result of interbreeding with very many varieties which have been introduced into the area in preceding years. This heterogeneity led to SVW values for loss which fluctuated from month to month. SVW determinations were invariably higher than estimates obtained by counting and weighing grain because the latter method omitted losses due to internal infestation, a problem amplified when losses are low.

To improve estimates obtained with the SVW method a base line graph of uninfested material should be produced for each farmer. Without drastically reducing the sampling population this is not practical. The best estimate of loss using the SVW method is obtained by comparing the monthly changes to a value calculated from the analysis of the initial sample, the initial loss being regarded as zero. The accuracy of the SVW method would increase in areas where the produce stored is relatively homogenous, for example, when a specific hybrid variety is stored whose grains are of a standard size, shape and weight.

The count and weigh method misinterprets loss because it does not account for insect choice preference of different sizes or type of grain nor for hidden infestation. As a result this methods tends to underestimate losses. The advantage of this method is that base-line data do not have to be produced. Both methods tested suffer from different problems. As most farmers grow and store local, non-uniform varieties, the best estimate of loss can be achieved by analysing samples using both methods.

Losses in the Shire Valley Agricultural Development Project area

The losses sustained by farmers who stored maize or sorghum were very low. Losses were low because:

(a) The duration of storage was short. Most of the produce was completely utilised before or just after the onset of the rainy season. During the dry season there were very small populations of insects present, not in sufficient numbers to create much damage. If more produce was stored through the rainy season then the losses might become substantial.

(b) The type of local maize grown and stored by the farmers is naturally resistant to insect pest attack. This maize is quite different to the much higher yielding hybrid and composite varieties which are more susceptible to pest damage, that are currently recommended for cultivation. In time interbreeding with these improved varieties will produce less-resistant local maize, when losses will be markedly greater than they are at present.

Unless specific agricultural inputs which might influence storage conditions, such as widespread introduction of hybrid varieties, are introduced into the area it would not be profitable to undertake loss assessment exercises, on any one particular crop, at regular intervals. However, the potential profileration of improved varieties demonstrates the need to evaluate any new variety under local storage conditions to confirm that losses would not be incurred. Samples of produce could be collected from selected farmers each year to determine in the laboratory changes in the susceptibility to insect infestation (Dobie, 1974).

Training local personnel

Collaboration by staff of the SVADP was generally very good. The short on-the-job training was not entirely satisfactory as it was difficult to estimate the comprehension of the personnel. However, as there were more than fifty field staff involved it would not have been practical to give them a longer, formal training course. To improve the understanding of instructions the questionnaire, in particular, must be simplified.

By the end of the three week technical course the SVADP staff member had a good understanding of storage problems and techniques. He trained his own unskilled staff in the handling of samples as they arrived for analysis. The analytical work, as a result, was carried out efficiently and accurately.

CSP staff were all capable of organizing and undertaking similar exercises elsewhere. However, the data collection compilation and interpretation presented problems that they were not capable of handling. It required specialist expertise to manipulate and utilise the data.

REFERENCES

ADAMS, J. M. (1977) The evaluation of losses in maize stored on a selection of small farms in Zambia, with particular reference to methodology. *Tropical Stored Products Information,* **33,** 19—24.

ADAMS, J. M. and HARMAN, G. W. (1977) The evaluation of losses in maize stored on a selection of small farms in Zambia with particular reference to the development of methodology. *Report of the Tropical Products Institute, G109,* xi + 149 pp.

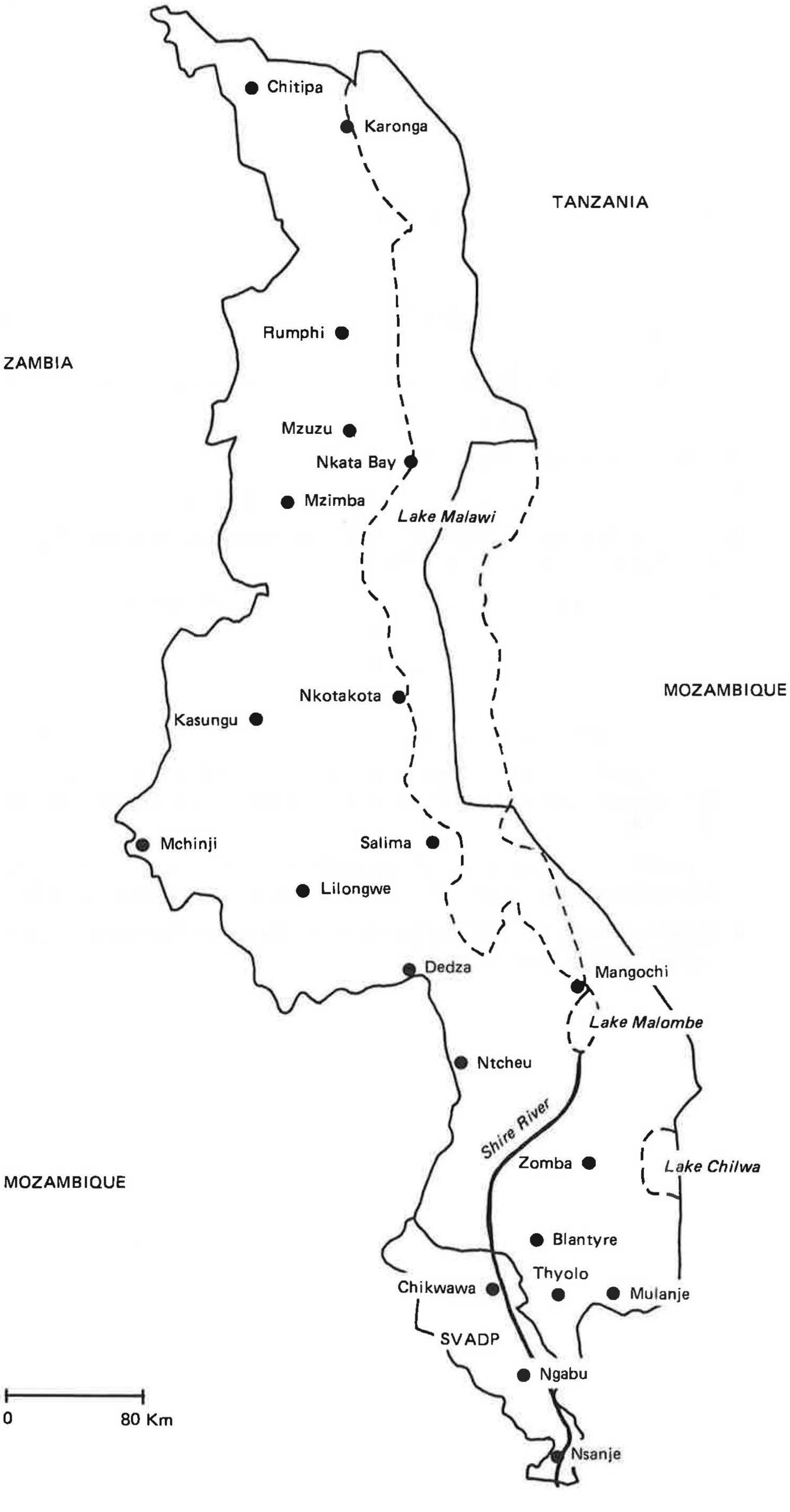
DOBIE, P. (1974) The laboratory assessment of the inherent susceptibility of maize varieties to post-harvest infestation by *Sitophilus granarius. Journal of Stored Products Research,* **10,** 183—197.

HARRIS, K. L. and LINDBLAD, C. J. (eds.) (1978) Post-harvest grain loss assessment methods. Washington DC, USA. American Association of Cereal Chemists, xii + 193 pp.

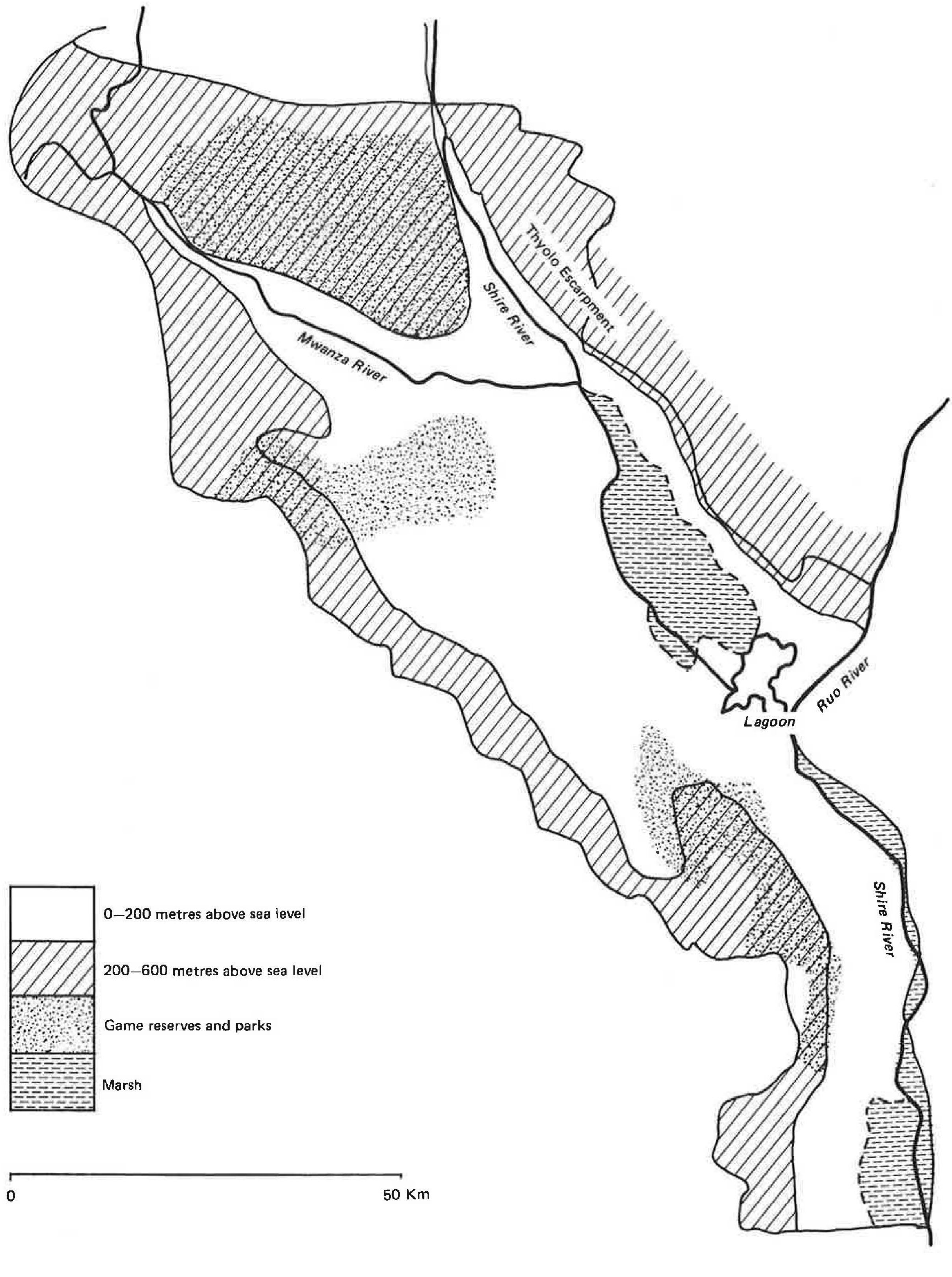
SCHULTEN, G. W. and WESTWOOD, D. (1972) Grain storage project, Malawi. Final Reports. 1969–1972. Lilongwe, Malawi: Ministry of Agriculture and Natural Resources.

Appendices

Appendix 1
Location of the Shire Valley Agricultural Development Project area in the Republic of Malawi



Appendix 2
Topography of the Shire Valley Agricultural Development Project area



APPENDIX 3

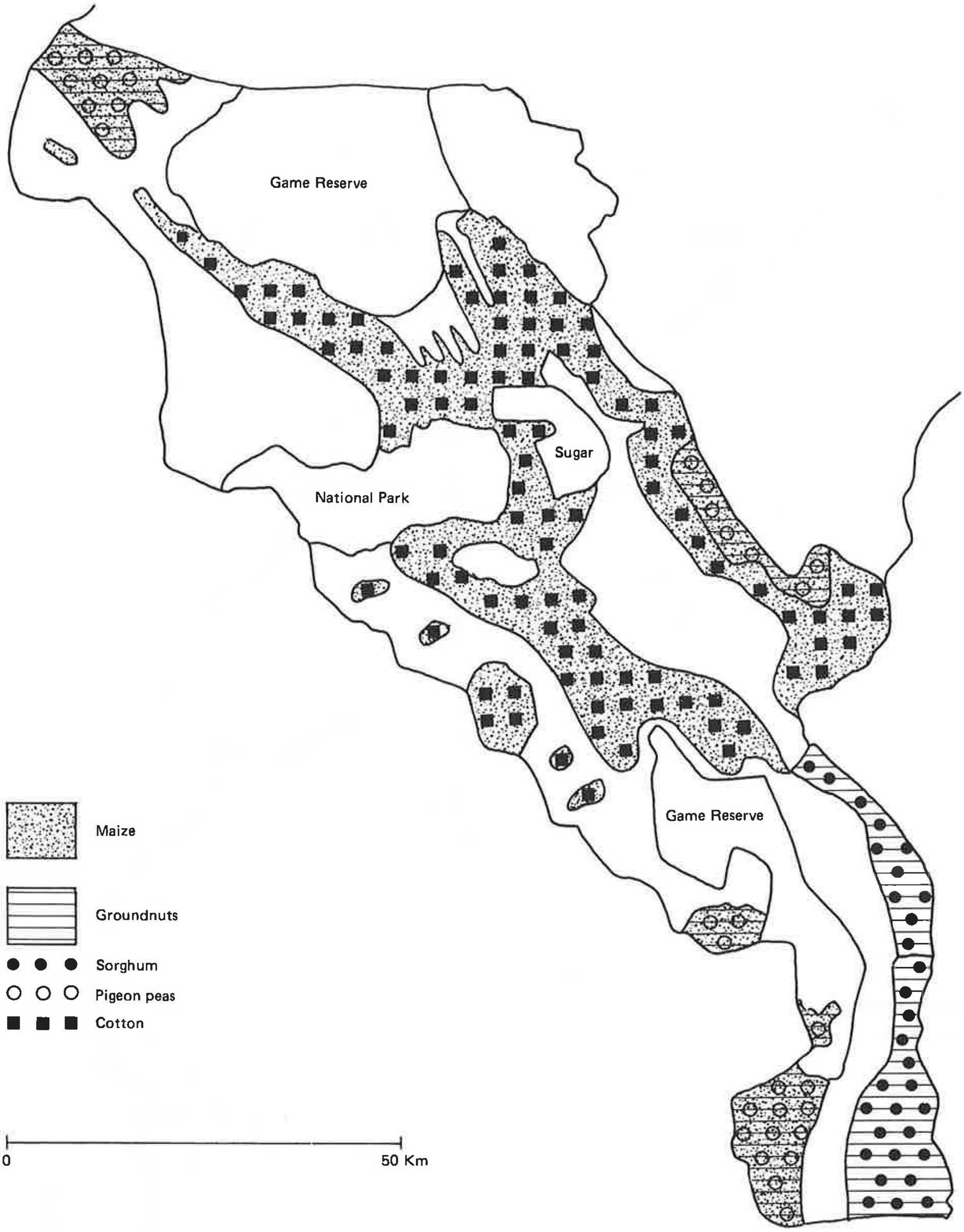
Table A

Annual rainfall in the Shire Valley

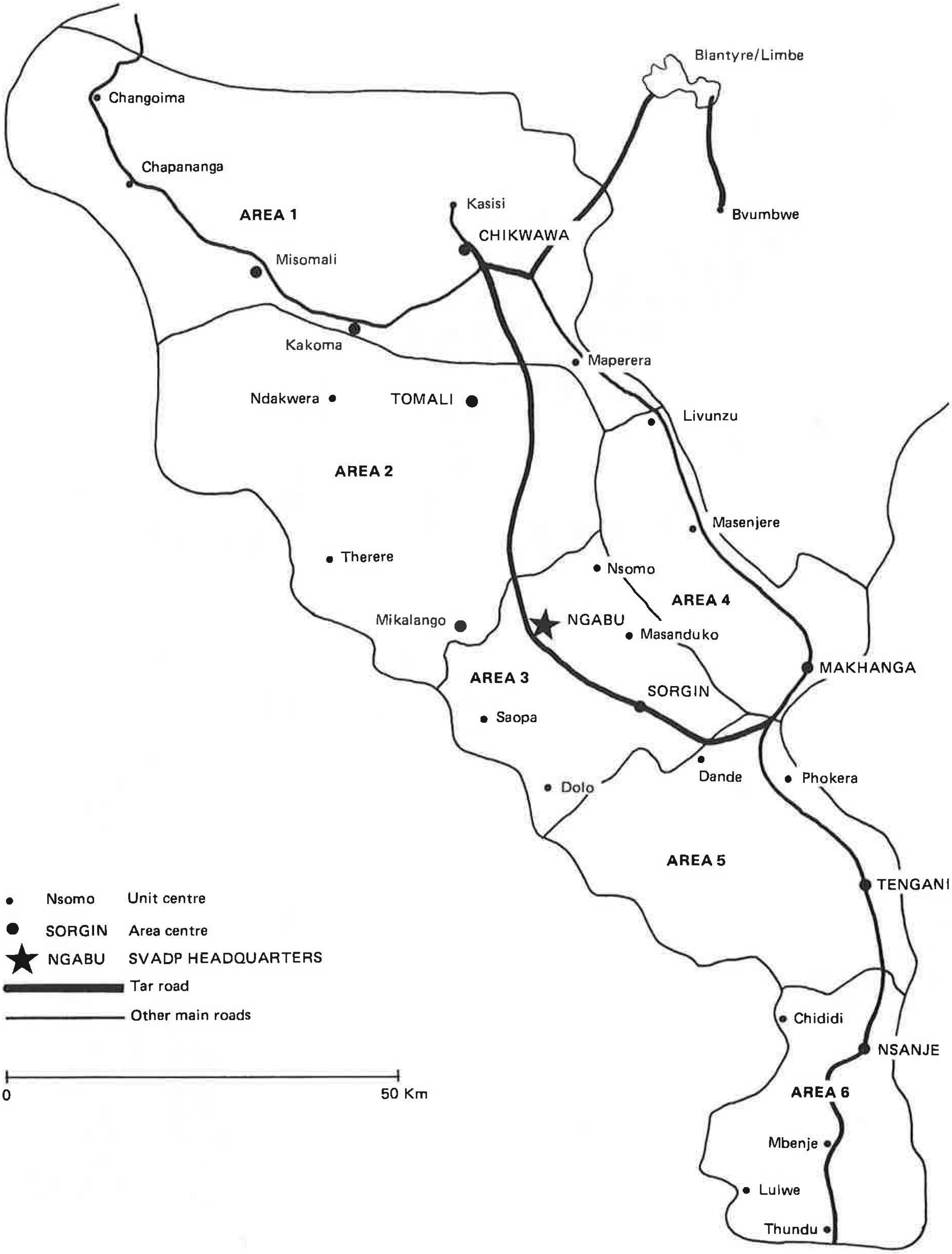
(mm)

Year (Oct/March)	CHIKWAWA Area 1	TOMALI Area 2	NGABU Area 3	CHIROMO Area 4	TENGANI Area 5	NSANJE Area 6
1972/73	544	543	665	651	547	743
1973/74	830	709	719	753	718	1,014
1974/75	505	460	449	584	581	646
1975/76	979	876	805	918	584	935
1976/77	733	640	723	632	595	743

Appendix 4
Crop distribution in the Shire Valley



Appendix 5
Unit centres in the Shire Valley Agricultural Development Project area



APPENDIX 6

Initial questionnaire. Crop loss assessment survey, Shire Valley Agricultural Development Project, June 1978

1 Date of interview. . . . .
2 Name of farmer. . . . .
3 Village. . . . .
   (a) Unit . . . .
   (b) Area . . . .
4 Do you grown maize? Sorghum?
5 What other crops do you grow?. . . . .
6 How many people do you feed? . . . .
   (a) Adults. . . . .
   (b) Children . . . .

Maize

7 When did you harvest your maize this year? . . . .
8 How much did you harvest?
   (a) Local. . . . .
   (b) SV28. . . . .
   (c) Other . . . .
9 Where are you storing your maize? . . . .

   Cobs Shelled

10 Since filling your store how many times have you removed cobs (shelled grain) for consumption? . . . .
11 How many cobs (shelled grain) have you removed at each occasion?
   . . . .

Sorghum

12 When did you harvest sorghum this year? . . . .
13 How much did you harvest?
   (a) Local. . . . .
   (b) Other . . . .
14 Have you threshed your sorghum? .if not when will you thresh it?. . . . .
15 Where are you storing sorghum heads (panicles)? . . . .
16 Where will you store threshed sorghum?. . . . .
17 Since harvest how many times have you taken sorghum for food? . . . .
   . . . .
18 How many heads (grain) have you taken on each occasion? . . . .
   . . . .

Insecticide

19 Have you treated any of your produce with insecticide?. . . . .
   If YES, specify . . . .

Measurements of relevant structures

1 Basket – Used for bringing produce to store or for taking produce for food preparation etc.
   Length. . . . . .Width . . . .
   Height. . . . .
   or Diameter. . . . . Height . . . .
2 Nkhokwe – Diameter. . . . . Height of cobs . . . .
3 Chete – Area occupied by produce. . . . .
   Length. . . . . .Width . . . . Height. . . . .
4 Chikwa – Diameter (approx. average) . . . .
   Height. . . . .

5 Platform — Area occupied by produce. . . . .
Length. . . . . .Width . . . .
Height. . . . .
6 Other structure : . . . .
7 Volume of produce : . . . .

APPENDIX 7

Monthly questionnaire for farmers. Crop loss assessment survey, Shire Valley Agricultural Development Project, 1978/79

1 Date of interview. . . . .
2 Name of farmer. . . . .
3 Village. . . . .(a) Unit . . . .
(b) Area . . . .

Maize

4 Since my last visit how much maize have you taken out of your store?
. . . .
5 How many times did you take maize from the store? . . . .
6 Did you sell any of the maize? (a) to ADMARC. . . . .(b) Locally. . . . .
If YES, how much. (a) to ADMARC. . . . .(b) Locally. . . . .
7 Was any of the maize damaged? . . . .
How much did you (a) Throw away. . . . .(b) Use for beer. . . . .
(c) Feed to animals . . . .(d) Use for food . . . .
8 Was all the rest of the maize used for consumption?. . . . .
If not, what did you do with it? . . . .
and how much did you use? . . . .

Sorghum

9 Is your sorghum threshed or unthreshed? . . . .
10 If unthreshed (a) How many heads have you taken since my last visit for consumption, or any other reason?. . . . .
(b) How many times have you taken heads since my last visit for consumption or any other reason? . . . .
11 If threshed (a) How much grain have you taken since my last visit for consumption or any other reason? . . . .
(b) How many times have you taken grain from your store since my last visit for consumption or any other reason?. . . . .
. . . .
12 Were any of the heads or the grains damaged? How much of the damaged grain did you (a) Throw away . . . .(b) Feed to animals. . . . .
(c) Use for beer . . . .(d) Use for food . . . .
13 Did you use any that was not damaged for beer making? . . . .
If YES, how much?. . . . .
14 Did you sell any sorghum? . . . . If YES, where to? . . . .
and how much?. . . . .
15 Did you do anything else with the sorghum (for example, pay labourers, use for gifts)? . . . .

Actellic

16 Have you used Actellic on any of your produce? . . . .
17 What produce are you using it on? . . . .
18 How much are you using on your produce? . . . .

APPENDIX 8

Equipment taken on initial survey on Shire Valley Agricultural Development Project, crop loss project, May/June 1978

Item		*Comment*
4	clipboards	2 only required
2	metal trunks for small items of equipment and questionnaires, etc.	1 only required
500	monthly questionnaires for distribution to SVADP field staff	
150	initial survey questionnaires	
500	sample analysis sheets	
1000	labels for samples, half for distribution to SVADP field staff	
2000	paper bags, 50 to be left with each unit with 500 spare	
491	kg of shelled maize divided into 1 kg and put into paper bags, 100 kg to be carried each week	
3	Tilley lamps and spare mantles	Many spare mantles to be taken as they are very fragile
4	packets of mosquito coils	
2	aerosol insecticides	
1	mortar and pestle for threshing millet	Unnecessary
1	Boerner divider	Unnecessary
3	handshellers	2 only required
5	plastic trays	
4	(minimum) hessian sacks for threshing sorghum	Unnecessary
2	tally counters	Unnecessary
1	stapler	
1	large plastic funnel	
1	standard volume tester	
2	spring balances	Unnecessary
1	Avery zero balance and weights	
1	Kongskilde moisture meter	Unnecessary
1	Burrows Insto moisture meter	
2	sets of sieves	1 set only required
12	universal tubes containing Pampels fluid	Unnecessary
1	pair scissors	
2	rolls Lassotape	
20	small polythene bags	
2	tape measures	
1	roll mutton cloth	
1	large plastic washing-up bowl	
1	aluminium milk jug	
1	tin opener	
6	plastic saucers	
3	metal teaspoons	
2	aluminium saucepans with lids	
1	enamel kettle	
1	enamel teapot	
6	metal knives	
6	metal forks	
6	metal dessertspoons	
6	tin plates	
2	small paraffin stoves	
1	gallon paraffin	
1	bottle washing-up liquid	

APPENDIX 9

Extracts from log of the initial survey undertaken by the crop storage project staff

This material serves to exemplify the practical problems and constraints that were encountered and which therefore had a direct bearing on the survey.

Date: 3 May 1978

I visited SVADP headquarters to explain to the six area heads-of-staff the aim and objectives of the loss assessment exercise. Each Development Officer (DO) had been requested to bring 10 maize cobs and 10 sorghum panicles to the meeting. Five of the DOs brought maize and four brought sorghum.

The samples were required for:

(a) determining the variability of the produce,
(b) determining standard data for uninfested produce, i.e. SVW at different moisture contents for different varieties.

The Evaluation Unit produced lists of villages in all the units from which I chose those to be sampled. I presented the names of the villages to the DOs. Each was asked to send to Ngabu a list of names of family heads of the chosen villages within seven days.

Date: 11 May 1978

My second visit to Ngabu. This time to deliver to the Chief Extension Officer (CEO) seven bags of shelled maize for distribution to the areas.

Areas 1, 2 and 5 had returned the lists of farmers names. From these, individuals were chosen to participate in the survey. It was left to the Evaluation Section to choose the farmers in the other areas when the remaining lists were received. I arranged with the Assistant Evaluation Officer to pass the completed list of chosen farmers to the CEO who would pass the names to the relevant DOs. In this way the farmers could be warned in advance of the survey.

To make certain the DOs had understood our discussions of 3 May I had prepared a handout for them detailing the survey and their part in it (*see* Appendix 10). These handouts I left with the CEO for distribution.

Date: 25 May 1978

I received the completed list of farmers from Ngabu.

Date: 26 May 1978

Phoned the CEO SVADP. He assured me that all the maize had been distributed to the areas and that the names of the farmers had been given to the DOs. The Training Officer said a second Land Rover might be available, however it is too late to alter the arrangements for the initial survey.

Date: 29 May 1978

Left Ngabu at 07.00 hours, about 3 miles from Nsanje, headquarters of area 6, we (the Land Rover) got stuck in a deep water/mud patch. It took the team and twelve nearby villagers 45 minutes to get us on our way again. It took a further 1 hour and 5 minutes to cover a distance of 11 miles on route to Lulwe.

The first thing I did after being introduced to the unit staff was to explain the itinerary. After a very short discussion we decided to change the tactics of the survey. Rather than one team interview all the farmers in one village and the other team the farmers in the second village, both teams would operate simultaneously in the same village. This course of action was taken because the farmers were well-dispersed within each village, the very first pair of farmers were 5 miles apart in the same village. Even so, we had a great deal of walking to do as some farmers were not accessible by Land Rover, only on foot. Obviously, the DO had a different idea of accessibility to me.

Sorghum was grown in this unit but nobody harvested it. Lulwe was different in this respect to all other units, the late harvest being due to a cooler climate resulting from the higher elevation.

Left Lulwe at 14.30 hours, very late. Began interviews in Thundu at 15.00 hours. The farmers in Thundu expected us around noon. Because of this one of the five chosen farmers did not wait and so was unavailable. Another farm was inaccessible; it required a 3 mile walk and it was nearing darkness. Two substitutes were interviewed instead. The substitutes were in the same village as the men they replaced, being those who lived nearest to the farmers they replaced. The same criterion for choosing substitutes was used on all other occasions.

Left Thundu at 16.20 hours, arrived back at Nsanje at 17.15 hours, just as it started to get dark. Found all the Tilley lamp mantles were broken. There was no electricity in the training centre so found it impossible to do any sample analysis.

Date: 30 May 1978

Everybody up at 05.15 hours. Spent next hour looking for the Land Rover keys. Turned up eventually in Mtimaukanena's pocket. Left Nsanje about 07.30 hours.

The first unit, Chididi, is situated in the western hills above Nsanje. Took 55 minutes to travel 13 miles to the unit headquarters. Fortunately, the villages and farmers were not too far apart, only had to walk half a mile up hill and cross a small stream. Had to find another replacement in the village, the farmer had returned to Mozambique.

Finished Chididi at 11.50 hours and arrived at Mbenje at 12.15 hours. At the first village everybody was out in their gardens, so had to go to second village and then return. Eventually, finished at Mbenje unit at 14.30 hours and completed Nsanje unit by 16.00 hours.

This evening the team analysed all the maize samples collected so far and finished about 20.00 hours. It is obviously impractical to attempt any threshing and winnowing of sorghum during the survey, these will have to be left until we return to Bvumbwe.

Date: 31 May1978

Set out for Tengani, area 5 headquarters. In the first village both original choices had to be substituted, the first choices were a man who grew no food and an extremely old woman.

After completing the units in area 5 we travelled across the Shire River and stopped at Makhanga training centre in area 4. On arrival we unpacked the Land Rover and found that several of the bags containing samples had burst. Fortunately, most of the samples were recovered and identified; however two or three had to be discarded. It was unfortunate that we used paper bags for sample collection, but there were no plastic bags available in the country when they were required.

Date: 1 June 1978

Started the survey in area 4. The DO had not received names of the farmers! None of the farmers had been warned so most were unavailable. Many substitutes had to be found. The DO sent the names of farmers to be interviewed on 2.6.78 to the respective unit headquarters. This was the first major error by the extension service at Ngabu headquarters, though we managed to overcome it.

Date: 5 June 1978

The first village in Changoima was 12 miles away over hilly road and the two farmers lived 8 miles apart in the village. Both farmers were away even though they had been warned of our visit. Two substitutes were chosen. In the second village all the farmers were attending a funeral so a substitute village was chosen. The village chosen was the closest to the one which was the original choice. Many of the farmers in this unit had not transported all their maize from the farm to their nkhokwes.

At one unit in area 6 none of the farmers had been warned although the unit supervisor was aware of our visit. We had to select alternative villages and farmers. The unit supervisor was inebriated and attempted to select his friends; he was the first and only one we encountered in the SVADP who was neither interested nor bothered.

Date: 6 June 1978

At the first unit Misomali, all the chosen farmers were waiting for us — very encouraging! In this unit farmers use both tchetes and nkhokwes for storage, a transition area. Maize is stored in the nkhokwe and sorghum in the tchete. After cotton is harvested the sorghum is threshed and the grain is stored in the chikwa.

A novel problem occurred in this unit. The first farmer interviewed had three wives and each wife and the farmer himself had a nkhokwe with maize. Maize is drawn from each of the wives' nkhokwes and when finished the farmer uses his. It was impossible to sample each nkhokwe as this would have complicated the sampling by the field assistants. Eventually one of the wives' nkhokwes was chosen and this one will be sampled regularly.

One farmer in Kakoma unit after passing the time of day with us and answering the questionnaire for 30 minutes decided that he wanted his sorghum exchanged for other sorghum rather than for maize. This man had his nkhokwe full of maize and didn't want any more. We had to choose an alternative farmer but this was difficult as the others in the village were aware of the argument and objected for the same reasons. We eventually did manage to find a substitute. This was the only occasion this problem was encountered.

Today we decided that 10 cobs in exchange for 1 kg of maize was not a fair exchange. From this day on we collected only 8 cobs from each farmer.

Date: 7 June 1978

One village in Maperera unit did not have the farmers that were listed in the returns, they lived in a different village several miles away. It took a long time to allay the suspicions of the farmers we chose as alternatives. After about one hour they agreed to participate. Elsewhere our substitutes were very willing, though it is clear that a few individual farmers do not like being selected from an entire village. If perhaps a large proportion of a village was interviewed the willingness to cooperate would have been more obvious than it was when only 2 or 3 were interviewed.

Date: 8 June 1978

Two farmers in Ndakwera unit were blind. They lived on a settlement scheme in Kadinga village. Despite their affliction they were self-reliant to a very great extent and produced excellent maize, sorghum and cotton crops.

Whilst at Ngabu took opportunity to check up on delivery of the bags of maize to the various area headquarters. Area 1 had not received any maize. The CEO said he will deliver it tomorrow.

Date: 9 June 1978

Continued the survey of area 2. In Therere unit one village was located at the end of a 2.5 mile walk through bush. A substitute village was chosen.

Date: 13 June 1978

First day of survey. After completion of two units the survey should have finished with Ngabu unit. However, after much searching and time wasting, we were unable to find any staff from this unit. Thus this unit will be omitted from the survey.

Date: 14 June 1978

Called in at Ngabu headquarters to clear up the problem of the missing maize. Eventually it was discovered that the maize had been delivered to area 4 by mistake.

APPENDIX 10

Information and instructions for Development Officers, Shire Valley Agricultural Development Project, concerning storage loss assessment survey, 1978/79

1 The survey will be undertaken by Crop Storage Project, Bvumbwe, during the course of the 1978/79 storage season.

2 An initial visit will be made in May/June 1978 to selected farmers throughout the SVADP by the CS Project. Then at one monthly intervals the DA/TAs will make visits to the same farmers to collect samples and fill in a questionnaire.

3 Visits by DA/TAs will continue until all this season's crops are finished.

4 The information will be collected by the Crop Storage Project and the amount of food loss occurring over the period will be calculated.

5 The DOs must ensure that the unit staff regularly visit the farmer. It is no good if visits are missed out.

6 The DA/TAs must collect 1 kg (2.2 lb) sorghum and 10 maize cobs each visit. In exchange for this produce the DA/TA will give the farmer 1 kg of shelled maize for each commodity taken.

7 The DO must make sure that the DA/TAS visit their farmers one or two days before the monthly area headquarters meetings. At the meetings the units should give the samples and completed questionnaires to the DO who will pass them on to Mr. Anthuachino for delivery to Ngabu. The DO will be issued with polythene bags which will be given to the DA/TAs for sample collection.

8 The DO must make sure that each unit has 10 kg of shelled maize every month to be used for exchange with the farmer's commodity. It may be that this maize could be distributed a month before the next sampling, at the area headquarters meetings or it could be distributed to the units a few days before the farmers are visited. As the year progresses the units will require less than 10 kg because the farmers will begin to run out of food.

9 The TA/DAs should not collect shelled maize from farmers that has been purchased from ADMARC. The visits must be continued until all the home grown produce has been used up, this will vary from farmer to farmer.

10 Week beginning 9.5.78 shelled maize will be delivered to Ngabu (Mr. Anthuachino) for distribution to each area. This maize will be used for the first visits by the DA/TAs. More maize will be provided by the Crop Storage Project as the year progresses. The following number of bags will be distributed to each area initially:

Area 1 (6 units to be visited)	1 bag	— 1 bag should last 1 visit plus
Area 2 (4 units)	1 bag	— 2 bags should last 3 visits
Area 3 (6 units)	2 bags	— 1 bag should last 1 visit
Area 4 (4 units)	1 bag	— 2 bags should last 3 visits
Area 5 (3 units)	1 bag	— 1 bag should last 2 visits
Area 6 (5 units)	1 bag	— 1 bag should last 1 visit plus

11 Each DO must inform Ngabu when shelled maize samples are diminishing so that additional grain can be purchased and stocks maintained.

12 Each DO must supply lists of family heads of the villages in the units in his respective area. The list of villages is appended. Names of farmers should be returned to Mr. Anthuachino at Ngabu during the week beginning 8.5.78.

13 The Crop Storage Project will choose from the lists of names 5 farmers from each unit to be visited, 2 from one village and 3 from the other.

14 The names chosen will be sent to the DOs.

15. The DO must make sure that the unit staff ask the chosen farmers if they will cooperate in the survey and tell them on what day they will be visited by the Crop Storage Project so that they are in the village when the visits take place. The dates on which the Crop Storage Project will visit each unit is appended.

16 Unit staff should not take samples from the farmers before the visit by the Crop Storage Project.

17 The unit staff must tell the farmer that the survey is to find out how much stored food is lost during storage and to find a way to reduce losses.

18 If DA/TA is on leave or cannot for any reason visit a farmer, the DO must make sure the farmer is visited by an alternative member of staff.

19 It would be appreciated if the DO and relevant DA/TA accompany the Crop Storage Project staff on these visits.

APPENDIX 11

Instructions for Development Assistants/Technical Assistants, Shire Valley Agricultural Development Project, crop loss assessment survey, 1978/79

1 The DA/TA must visit all the farmers he is responsible for once each month, the day before the monthly area headquarters meetings.

2 He should collect 10 maize cobs or 1 kg (2.2 lb) of maize grain and about 1 kg of sorghum; what he collects will depend on what the farmer has in his store.

3 In replacement, for the maize and sorghum he should give the farmer 1 kg of shelled maize for each commodity taken.

4 He must, therefore, go to each farmer with 2 kg of shelled maize.

5 The cobs or panicles of sorghum must be taken straight from the store or from that which has just been removed from the store for consumption but is still unthreshed. If the farmer is storing threshed commodities then the DA/TA should collect these.

6 The cobs or panicles of each farmer must be placed in separate bags.

7 A label must be placed in each bag giving the name of the farmer, village, unit, area and the date of collection. The labels will be provided.

8 The DA/TA must fill in the questionnaire for each farmer.

9 The questionnaires and samples must be returned to the unit headquarters.

Each DO must take all the samples to the area headquarters on the day of the monthly area meeting.

APPENDIX 12

Sample analysis sheet, Shire Valley Agricultural Development Project, crop loss assessment survey, 1978/79

Date sample collected .... Date of analysis ....
Farmer .... Village .... Unit ....

Maize

1 Any sign of rodent damage? Yes No If YES, specify
....

2 No. of cobs .... (3) Variety......... (4) Total weight of cobs.........
5 Weight of shelled grain .... g (b) Weight of sieving ....

7 Moisture meter used: Cera (C) Insto (I) Kongskilde (K)

8 Moisture content (m.c.) (a) ..... % (b) ..... % (c) ..... % Mean m.c...... %
9 Corrected m.c.. .... %
10 SVW (a)..........g (b) .... g (c) .... g Mean SVW..........g
11 Corrected dry weight SVW ....g
12 Weight loss of sample (CF standard) .... %
13 Cumulative weight loss (accounting for monthly removals)................ %

Sorghum

14 Any sign of rodent damage? Yes No If YES, specify ....

15 If UNTHRESHED, No. of heads........21 No. of varieties ....
16 Weight of heads......................22 Weight of threshed grain ....g
17 If THRESHED, weight of sample ..... g 23 Weight of fine sievings.........g

18 M.c. meter type (C) (K) (I)

19 M.c. (a)......... % (b)......... % (c) .... % Mean m.c. .... %
20 Corrected m.c.. .... %

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