Participatory and rapid rural appraisal for addressing post-harvest problems: a case study in Malawi

Marsland, N. and Golob, P.[1]

Abstract

Recent political, climatic and economic changes in Malawi have had major influences on the socio-development of farming communities in Malawi. A study was undertaken to identify farmers' needs and constraints concerning post-harvest aspects of agricultural production and marketing and to put these aspects into context with regard to other agricultural problems

Surveys were conducted in six villages in three agro-ecological zones in Central Region. Pairs of enumerators interviewed in each village: a group of women; a group of household heads who had exhausted supplies of maize (the staple food) by October/November; a group of household heads who only exhausted maize after December. Each group consisted of 5 – 10 individuals who were taken through a series of ranking exercises. In addition, the team leaders conducted semi-structured interviews with a larger group of mixed gender, age and wealth status primarily to obtain a historical perspective of the village and its agricultural development

Post-maturity problems were of less concern than those were concerned with land access, soil fertility, and prices of inputs and field pests There was a difference between the three zones in the relative importance of durable and perishable crops, though maize was the major crop for everyone. For maize, the key issues were concerned with the crop standing in the field before harvest – lack of transport facilities to haul it to the home, field pests including rodents and mammals and theft – as well as storage and marketing problems. Main storage constraints for cereals and pulses were lack of suitable construction materials for the store, and insect and rodent pests, whilst poor prices, gluts (especially for perishable crops) and unscrupulous buying agents were main concerns for farmers selling commodities.

[1] Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, U K Fax: +44 (0)1634 880066/77

Introduction

Major changes in both food security and livelihoods have occurred in Malawi over the last 10 – 15 years. Since 1980, the population has nearly doubled. Each family has less cultivable land and the land is cultivated more intensively. In conjunction with the effects of widespread deforestation, this has led to an accelerating decline in soil fertility. Although the issue of land reform has belatedly entered government and donor policy agendas, in the medium term production increases will have to come from increased yields as opposed to increased hectares. Agro-forestry initiatives are now being introduced on a national scale. However, for the immediate future at least, self-sufficiency in the staple food crop (maize) at small holder level requires hybrid varieties and fertilizer. The drought of the early 1990s, combined with certain political influences, precipitated the breakdown of the credit system some 3 – 4 years ago. Moreover, farm input prices have increased dramatically owing to the removal of input subsidies and devaluation of the Kwacha The upshot is that in the absence of handouts a smaller than ever minority of farmers are able to access fertilizers and HYVs in sufficient quantities to attain self-sufficiency. In recent years, major production deficits have been avoided only by widespread input distribution program which are probably unsustainable in the long run.

Market liberalization, drought and political change have also affected the post-harvest situation at farm level. The role of the Agricultural Development and Marketing Corporation (ADMARC) has been diminished, and private traders have come into the market place. Access to markets has been increased in some areas through private trader activity, but reduced in others owing to the closure of some ADMARC Markets. In the past, there has been a high level of dependency on ADMARC which has enjoyed various monopolies in internal and external trade, and farmers are finding it difficult to deal with the new, more liberal, policy environment. Liberalization, together with straitened economic circumstances of the 1990s, and greater perceived personal freedoms, has significant implications for post-harvest constraints and opportunities faced by Malawi's farmers

Previous studies on farm level post-maturity issues

Most farm level post-maturity studies in Malawi have concentrated on weight losses. Within these, the focus has been on a few crops only, most notably maize, either in storage or at the processing level In the late 1970s and early 1980s, Golob assessed losses in farm stored maize, groundnuts and sorghum. The studies took place in the Shire Valley Agricultural Development Project (SVADP) area in the Southern Region, and in the Lilongwe Land Development Project (LLDP) area in the central region. The results from both studies indicated that storage losses were low: in the LLDP. Average losses after 10 months storage were less than 1.5% by weight for maize and less than 1% by weight for groundnuts (Golob, 1981a), whilst in the SVADP losses were 3% or less for maize and 2% for sorghum (Golob, 1981b).

In contrast to the low levels of losses reported in these earlier studies it was widely felt that with the spread of high yielding varieties, storage losses could increase significantly. Evidence on this point is mixed. The results of a survey carried out in Karonga and Chitipa Districts in the Northern Region in 1994 indicate low weight loss figures which. reconfirm the findings from former surveys in the country (Binder et al., 1994) The mean weight loss after 9 months was 5.1%, insects were the main cause of loss, followed by moulds. Losses caused by rodents were insignificant. A key factor behind these figures was that the hybrids were either sold or consumed first, before major losses could occur. One of the interesting things about the study was that whilst weight loss was lower for maize dusted with insecticide (Actellic 2%; Zeneca) than for untreated maize, the difference was not statistically significant. raising the possibility of inappropriate application, poor quality of the chemicals or that insect damage in non-hybrids was too low to be influenced by chemical application

In contrast to the study by Binder et al , a recent nationwide study by CODA and Partners, a Kenyan Consultancy firm based in Lilongwe, estimated an average maize loss over a 6 month period of 17.7% (Anon., 1996a). The main reason for the discrepancy in the CODA and GTZ figures was that in the former study the average loss total was raised significantly by a very high loss figure for hybrid maize (62.2%) (losses in 'local' varieties were estimated as 5.2%). However, unlike previous studies, the data obtained by CODA were from single spot estimates of samples collected from farmers. These estimates do not take account of the declining amount of grain in store as the season progresses, nor of the fact that many farmers sell or consume hybrids quickly

Information on storage losses in other crops is rather limited. The most recent estimates have been produced in the CODA study. Here it was estimated that mean national level small holder storage losses in 1995 were 1.0% for rice, 46.7% for pulses, 13.3% for sweet potato, 35.7% for Irish potato, and 20.0% for groundnuts. Given the question marks over the CODA methodology, it is difficult to know how much weight should be given to these figures

Grain stored for seed on the farm using traditional methods has been found to be generally in very good condition (Wright and Tyler, 1994; Wright et al , 1995). The key criterion used to determine quality of storage was germination rates, which was in excess of 70% for the major food crops. Whilst vigor may give a truer indication of the efficiency of seed storage, it appears that traditional storage techniques are generally of high quality, although improvements are possible (Wright et al , 1995).

Maize has been the focus of studies of processing losses. Mtimuni and Cusack and also Ninje in the early 1980s found that around 40% of the weight of the original maize grain were lost during local processing into refined white flour. Ninje further reported that when corrected for crude extraction rate, the crude protein and energy losses in processing came to 45% and 55% respectively of the processed grain (studies quoted in Anon , 1995).

Studies on weight losses do not necessarily reflect the impact of post-harvest problems on the farm family. None of the studies take into account the end use of the grain nor the socio-economic factors or conditions which influence a farmer's decision regarding crop disposal and the actions required to maintain quality The introduction of structural adjustment policies and agricultural input and product market liberalization in particular has disrupted the equilibrium of the traditional post-harvest system The implications of grain market liberalization have been studied by Coulter (1994), Tyler and Harding (1994) and Tyler and Bennett (1995) One of the major issues arising from this work is the effect of the reduced influence of parastatals in purchasing and distribution of small holder crops, and the concomitant encouragement of private traders. Of particular influence here is the loss of the guaranteed market for grain surplus shortly after harvest, which had previously relieved the producer of storage and quality maintenance problems (Tyler and Bennet, 1995). The implication of such changes is that methods of conserving grain safely on the farm take on a new importance.

Objectives of the study

Almost all the studies conducted to identify post-maturity problems have concentrated on producing a quantitative assessment of the magnitude of the problems. Very few attempts have been made to gain farmers' perceptions of the salient issues. This is a particularly important need in the context of the significant economic, political, demographic and social changes that have taken place in the country over the last 10 – 15 years. It was in this context of change that

it was felt necessary to undertake a broadly focused pilot study using participatory methodologies. The main objective of the study was to identify the key constraints in post-harvest operations for important food security crops (as identified by the farmers themselves).

This paper describes the approach and methodology employed to accomplish the objective of the study A detailed explanation is provided as this type of approach is novel to post-harvest investigations. The paper also provides an overview of the responses obtained from farmers and a perspective of the problems in the Central Region of Malawi.

Methods

The study was conducted in the Central Region of Malawi Six villages were selected with the aim of providing a flavor of the key issues and concerns in each of the major agro-ecological zones in the central region. It was felt that this would be a large enough sample to allow identification of key researchable constraints, indicative of each zone, through offering windows into regions (Chambers, 1983).

The two villages visited in the plateau zone were around 60 km apart, one to the north and the other to the south of Lilongwe and both about 1000m above sea level. Situated on the Lilongwe plain, they experience a tropical continental climate, with a mean annual rainfall of between 800 and 1000 mm, and a mean annual temperature of 18 – 22℃. Latosols, strongly leached acid soils, cover most of this area, although seasonally waterlogged hydromorphic soils are found locally in *dambos*. This area forms part of the main maize and tobacco grow belt that stretches from north of Liwonde in the south to Mzimba in the north.

In the central region, the rift valley zone consists of the lakeshore plain. With an altitude of 470 – 600 m above sea level, it is hotter than other parts of the central region (22 – 24℃ as the annual mean) and the soils are generally better (calcimorphic alluvial and hydromorphic predominating). It can also be wetter: historically, mean annual rainfall has ranged from 1500 – 2500 mm. Millet and rice is commonly grown here (as well as maize), and cotton is an important cash crop for many farmers. The two villages visited in this zone were fairly close to one another in Salima District.

The high plateau/mountain zone consists of areas where the altitude exceeds 1500 m and the climate, particularly the low temperature (mean annual temperature 15 – 18℃), is the dominant environmental influence. Rainfall is typically 1000 – 1500 mm and the soils are generally either shallow stony lithosols on the slopes or humic ferallitic soils on the plateaux. One village was located in the Dedza highlands, near to the Lake Malawi escarpment, and the other on the Ntcheu plateau. This part of Malawi is known for its temperate horticultural crops and Irish (European) potatoes.

Village	Location	Zone
Bwetu	30 Km North of Lilongwe, Lilongwe District	Plateau
Chimango	30 Kms South of Lilongwe, Lilongwe District	Plateau
Mikuju	12 Kms South of Salima, Salima District	Rift Valley
Mpunga	9 Kms South of Salima, Salima District	Rift Valley
Kalilombe	4 Kms South East of Dedza, Dedza District	High Plateau
Kadzakalowa	15 Kms North of Ntcheu, Ntcheu District	High Plateau

Survey design

The survey was conducted by two teams of seven people, who had been trained in the field of participatory and rapid rural appraisal (PRA/RRA) techniques Each team spent a week visiting villages, a day in each In addition to stratifying the survey sample by agro-ecology, it was also necessary to capture intra-village socio-economic and gender issues. To cover these, each team split into pairs, with each pair working with one of three focus groups. (a) A women group; (b) A group consisting of heads of those households which exhausted supplies of staple food (maize in all cases) by or before October / November; (c) A group consisting of heads of those households which exhausted stocks of staple food (maize) after December.

This division into groups b) and c) enabled the separation of poorer farmers from more wealthy farmers. The time to which stocks of staple food ran out was the starting point for group definition; this was modified as necessary after discussion with the local extension staff.

Each group consisted of 5 – 10 individuals. Participants were taken through a series of ranking exercises to produce diagrams of tables which were then discussed to gain further insights into key issues, problems and solutions. In addition, team leaders conducted semi-structured dialogues with a large group of people including men and women of all ages and wealth status in order to produce a historical perspective of agriculture within the village and to gain an insight into the relative importance of problems that occurred once the crop in the field reached maturity.

Village introduction

Gaining the confidence of farmers takes time and generally the more contact between the villagers and the survey enumerators the better. In this particular survey shortage of time was a particular constraint but despite this it was important to obtain valid information from farmers which was not skewed by their preconceptions In order to achieve this, it was made clear to the large group of villagers who attended the meeting at its inception that they would not receive any handouts or inputs as an immediate result of the meeting But they was visiting in order to learn from their experiences, i. e. they, the farmers, were the teachers.

The introduction took about 20 minutes to complete Thereafter, villagers broke into the groups described above and four component sessions were then facilitated by the study teams These components and approximate timings were as follows:

1. Crop listing and ranking (30 minutes);
2. Post harvest crop operations (including gender divisions) (1 hour);
3 Post-harvest constraints (5 – 6 hours);
4. Evolution of storage systems (1 – 1.5 hours).

Components 1 to 3 were carried out with the three focus groups. Component 4 was carried out with the large group which included older people.

Crop listing and ranking

Firstly, groups were asked what crops are grown and for what purpose, i. e. either for food, sale or both A simple matrix was then drawn on the ground or on a large sheet of paper and the group asked to rank each crop in terms of its contribution towards household food security (example A).

Example A

CROP	RANK
Local Maize	1
NDDF Tobacco	3
Beans	2
Sweet Potatoes	5
Cow peas	6
Groundnuts	4

Post harvest operations

On the basis of the rankings done in component 1, the five most important crops in terms of food security (excluding tobacco) were selected for further investigation. The group was asked to list every operation undertaken from the time that a crop is mature until the time the crop is sold (including taking the crop to market) or consumed (example B) After each operation, they were asked about responsibilities for undertaking the operation, i. e who is responsible for carrying out the operation: men or women or both, and were children involved (example B)? If both men and women were involved, who did most of the work, the man or the woman? Was labor hired for the task, or was just family labor used?

Example B

OPERATION	RESPONSIBILITY
Drying whilst still planted	Children (to scare off monkeys etc.)
Stooking	Men
Transporting to home	Women and men
Drying	Women
Threshing/shelling	Women
Winnowing	Women
Bagging	Women
Putting in nkokwe	Men and women
Pest control	Men
Removing from nkokwe	Women
Processing	Women
Marketing	Men usually

Post harvest constraints

The most important crop was revisited (example A) and the gender relevant operations for that crop was considered one by one For each operation, the group was asked whether they face any problems in the course of carrying out the operation (example C).

Example C

1 LOCAL MAIZE (Poor men's group)

Operation	Problem	Problem	Problem	Problem	Problem
Drying	Monkeys	Human theft	Insects		
Stooking	Monkeys	Human theft	Insects		
Transporting	Distance from home	Losses	Cost(ox cart)		
Crop Protection	Insect damage	Rodent damage	Mould	Theft	Rain damage
Marketing	Transport to market	Low prices			

After they listed all the problems they face for that particular operation, they ranked the problems This task was repeated for each operation and finished with the final operation, usually marketing (figures in parentheses in example D below) This *direct matrix ranking* was drawn on the ground or on a large sheet of paper.

Example D
1 Local Maize (Poor men's group)

Operation	Problem	Problem	Problem	Problem	Problem
Drying	Monkeys (1)	Human theft (2)	Insects (3)		
Stooking	Monkeys (2)	Human theft (1)	Insects (3)		
Transporting	Distance from home (1)	Losses (3)	Cost(ox cart)(2)		
Crop Protection	Insect damage (1)	Rodent damage (2)	Mould (4)	Theft (3)	Rain damage (5)
Marketing	Transport to market (2)	Low prices (1)			

After problems occurring in the various operations were ranked, the group were reminded of all the problems that they had ranked as number one for this crop They were then asked to pick out the most important problem of all the number ones (*preference ranking*) (letters a – e in the example E) This was then repeated for the second most important problems, then for the third most important and so on.

Example E
1 Local Maize (Poor men's group)

Operation	Problem	Problem	Problem	Problem	Problem
Drying	Monkeys (1) [c]	Human theft (2) [d]	Insects (3) [c]		
Stooking	Monkeys (2) [c]	Human theft (1) [d]	Insects (3) [a]		
Transporting	Distance from home (1) [e]	Losses (3) [d]	Cost (ox cart)(2) [e]		
Crop Protection	Insect damage (1) [a]	Rodent damage (2) [a]	Mould (4)	Theft(3)[b]	Rain damage(5)
Marketing	Transport to market (2) [b]	Low prices (1) [b]			

In example E above, the ranking for the most important or main problems was: 1a) Insect damage (crop protection); 1b) Low prices (during marketing); 1c) Monkeys (whilst the crop is drying); 1d) Human theft (whilst the crop is in stocks in the field); 1e) Distance from home (when transporting the crop from the field). In the same example, the ranking for second most important problems was: 2a) Rodent damage (crop protection); 2b) Transport to market (during marketing operations); 2c) Monkeys (whilst crop is in stocks); 2d) Human theft (whilst the crop is drying); 2e) Cost of ox cart hire (for transporting the crop from field to home)

The most important main problem (insect damage in example E) was then revisited and the group asked why it was the most important, and what solutions, partial or total, they could devise to overcome the problem. This was repeated for the next most important main problem, and then for the remainder of the main problems. This process was repeated for all the second most important problems and then for the third most important. The groups were then asked to compare the most important second problem (rodent damage in example E) with the list of main problems (*pairwise ranking*) to ascertain where this second problem fitted in Again, they were asked to consider appropriate solutions to this most important second problem. After they attempted this, they were asked to compare the most important third problem with the list of main problems to identify where the most important third problem fitted. This stage was completed orally in order to avoid complicating an already cluttered matrix still further.

After all the rankings were completed for the most important crop, the process was repeated for the second most important crop and then for the third crop and so on, until all five crops were completed.

Results

Post-maturity problems in perspective

In each village visited, farmers were asked to give an overall ranking of agriculturally related problems. This allowed the importance of the post-harvest problems investigated in the study to be put into a broader perspective. The results of this exercise revealed that pre-maturity constraints to household food security were viewed as being more important than post-maturity constraints. Out

of seven ranked classes of constraint, four were production related and three were post-production related. Table 1 summarizes the results:

Table 1. Important agricultural problems: farmers rankings.

Constraint	Class	No. Of villages in which the constraint was mentioned	Overall rank
Input prices	Pre-maturity	5	1
Field pests and diseases	Pre-maturity	4	2
Land access and land productivity issues*	Pre-maturity	4	3
Post maturity handling problems	Post Maturity	4	4
Marketing problems	Post-maturity	3	5
Storage pests	Post-maturity	3	6
Labor costs and availability	Pre-maturity	2	7

* Encompassing: soil erosion, poor rains, poor access to upland and dimba (seasonally waterlogged hydromorphic soils)

Farmers were encouraged to take an overall and general view of constraints to household food security When asked to focus specifically on post-maturity problems, the frequency of problem identification increased, and this is reflected in subsequent tables in this paper This does not, however, invalidate the results in table 1, as the focus of the questioning leading up to this table was much broader If the focus had been on production problems then the frequency of problem identification for these problems would have increased also.

For a significant proportion of farmers, the severity of production problems resulted in short storage periods (i. e. under 3 months) and small amounts of marketable surpluses. In this sense, there is a link between alleviation of production problems and the relevance of post-maturity interventions for household food security: the importance of post-maturity problems and, therefore, the impact of post-maturity interventions on food security will be magnified to extent that production problems are successfully tackled.

Main food security crops

Table 2 indicates the main food security crops grown in the three agro-ecological zones. There are clear differences in the importance of the different crops and some, such as cowpea are more important as food crops in one zone but have a greater marketing value in another. These results are very much in line with what is already known about the differing importance of various crops in the three agro-ecological zones. In addition, the results illustrate the universal importance of 'local' – i e. non-hybrid – maize as the main staple food. Whilst hybrid maize is also consumed, it is not seen as being of such central importance to food security as local maize. Beans – probably the second most common ingredient in the diet of most rural Malawians – are widely grown However, they are seen to be much less important in the plateau villages than in the other two zones. This can be explained to some extent by the high profile of tobacco as a cash crop: there is less need for farmers in these areas to grow beans as they can buy them using the proceeds from sales of tobacco. Of the six villages visited, the level of commercialization of agriculture is lowest in the lakeshore villages. Here, the food function of important food security crops is more evident than in the other villages. A final point to note is the importance of horticultural crops in the high plateau villages.

Table 2. Main food security crops: farmers rankings[1].

Plateau[2]		Rift Valley[3]		High Plateau[4]	
Rank	Food/Cash	Rank	Food/Cash	Rank	Food/cash
1. 'Local' maize[5]	F	1. 'Local' maize	F	1. 'Local' maize	F
2. Tobacco	C	2. Beans	F / C	2. Beans	F / C
3. Hybrid maize	F / C	3. Rice (Mpunga)	F / C	3. Horticultural crops[6]	F / C
4. Groundnuts	F / C	4. Sorghum (Mikuju)	F / C	4 Hybrid maize (Kadzakalowa)	F / C
5. Soya beans	F / C	5 Sweet potatoes	F / C	5 Irish potatoes (Kalilombe)	F / C
6. Beans	F / C	6. Cassava	F / C	6. Finger millet	F
7. Cowpeas	F / C	7. Cotton (Mikuju)	C	7 Soya beans	F / C
8. Sweet potatoes	F / C	8. Tobacco (Mpunga)	C		

Note: Where crops are used for both cash and food (F / C) bold type face signifies the main function of the crop Thus (F / C) means that the main function is food Where there is no bolding the food and cash functions are roughly equal in importance Names in ( ) refer to specific villages

[1] These ranks are derived from aggregation of focus group assessments in each village. Through the process of aggregation, some variation between and within villages is lost

[2] Other crops mentioned included: Vegetables (F / C); Cassava (F / C); Irish potatoes (F / C)

[3] Other crops mentioned included: Sesame (F); Cowpeas (F / C); Vegetables (F / C)

[4] Other crops mentioned included: Finger Millet (F); Wheat (F); Pigeon peas (F) and Sorghum (F)

[5] It is difficult to talk of purely local maize in many areas in Malawi today, much of the 'local' maize is the product of crossing with various types of improved varieties, this has affected both yield and storage characteristics Farmers, however, always refer to this non-hybrid maize as 'local'

[6] The most important crops in this category are: tomatoes, onions and cabbage, although rape, okra, Chinese cabbage and carrots also figure

Key problems and issues identified for food security crops

The following sections give details on the types of problem faced in the villages visited for each of the key food security crops (excluding tobacco). Several issues were raised in relation to each crop. These are grouped under three headings: pre-storage; storage and post-storage. The pre-storage period begins at the point of crop maturity and finishes when it is put into store. This period may last as long as two or three months, if the crop dries slowly and if the farmer fails to find transport to carry the crop away from the field. In Malawi, this period commonly includes a time when maize is cut and stooked in the field, as well as the threshing or shelling and winnowing operations. The post-storage period includes processing activities once the grain has been taken out of the store, as well as marketing activities. Storage itself is conducted using a variety of containers including the traditional woven bamboo basket-the 'nkokwe', especially for maize stored on the cob, and jute or polypropylene sacks.

Maize

As well as the ubiquitous 'local' varieties, the main hybrid varieties planted by smallholders are MH16, 17 and 18 and NSCM 41. MH12 is also used. Planting takes place at the onset of the rains which normally start between October and December. Harvesting of early maturing hybrid varieties can take place as early as February or March, but in most areas in Central Region, April, May and June harvesting is more common. Although maize is harvested in a variety of ways, the following sequence of events is typical if not universal. At maturity the crop is normally left to dry in the field, the plants are then cut and stooked, before being transported back to the home, to be stored either in the nkokwe or in bags. Most farmers store their maize in the nkokwe. This structure generally lasts for 2 – 5 years, although repairs, undertaken around harvest time, are necessary on a yearly basis, as is construction of the roof. After removing from storage, maize destined for consumption by the household is shelled and then processed into 'nsima' (maize patties) Marketed maize is left unshelled until being either transported to the local ADMARC market or is bought by private traders.

When undertaking post-harvest operations in a household, someone has to make decisions (*decision making power*) and someone has to do the work (*responsibility*). It is well known that both men and women are involved in decision making and responsibility, and they may be joined by their children and / or other family members when undertaking certain operations. Interestingly, during the fieldwork, perceptions differed quite markedly between women and men as to their respective share of *responsibilities* and *decision making power*. All the groups of women interviewed felt that they, the women, were responsible for most of the operations, whereas the men were more inclined to feel that the division of *responsibilities* was more equal. Similarly, women were inclined to report that they had *decision making power* over certain operations which the men believed were in the control of men! Despite this, there were some commonalties, for example on perceptions of the *responsibilities* and *decision making power* over processing (women) and nkokwe-making (men).

Maize was cited as a key food security crop by each farmer group in each village. At the aggregate level (over all villages and all groups) pre-storage problems predominated, followed by storage problems. Figure 1 presents the responses in more detail.

The chart combines responses for hybrid and non-hybrid maize. Local maize was mentioned in all villages and hybrid maize was mentioned in three villages by four separate groups. Marketing problems and damage to the crop from weevils in storage was relatively more important for hybrid than for local, reflecting the poorer storage characteristics and greater likelihood of sale of hybrid varieties. In other respects, the responses for hybrid and non-hybrid were broadly similar.

Taking hybrid and non-hybrid together, it can be seen that the three most commonly mentioned problems were all pre-storage: theft, rat damage and invertebrate field pests. Weevil damage during storage was the most frequently mentioned storage problem (mentioned by six of the farmer groups). Post-storage problems were mentioned less

frequently than these pre-storage and storage problems. Processing problems i.e. distance to maize mills (mentioned exclusively by women in relation to local maize) and marketing problems (by better-off men in relation to hybrid maize) were ranked as one of the top three problems in three cases each. The key marketing problem was perceived cheating by the marketing board, ADMARC. Farmers complained that they felt that ADMARC officials were tampering with the equipment used to weigh the maize being bought.

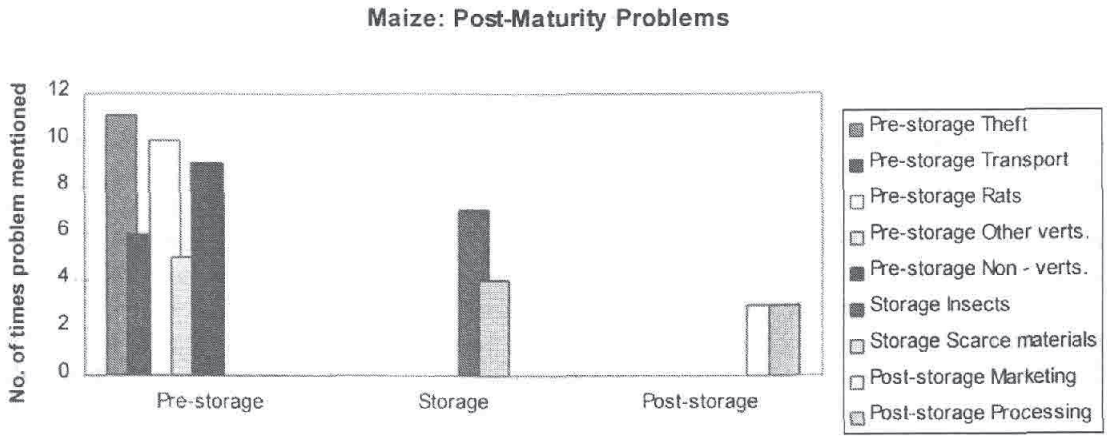

Fig.1. Maize: Most Important Post-Maturity Problems.

Focusing on storage, the fieldwork illustrated that there are distinct seasonal patterns not just in utilization of food but also in perceptions of utilization and losses. It appears that people's perceptions of losses are also related to the use of the crop. Cultural celebrations such as weddings and festivals take place soon after harvest, a lot of food is consumed and some is wasted, thrown away for dogs and pigs. More generally, from harvest in May up until about August, people consume possibly more than is required (there is a popular belief that people are not satisfied if there are left-overs on the plate after a meal). As the year progresses, more and more people run out of food, theft increases, and pest attack increases on the diminishing stock of stored grains and legumes. Farmers' perceptions of loss also change. They become more sensitive to the levels of loss.

In addition, it appears that perceptions of loss are also influenced by end use. For example, in Chimango village (Lilongwe district), the perception of loss was greater if maize was used for sale than if it was used for consumption, because, even if weeviled, farmers argued that they could still make nsima (although it would not taste as good), whereas weight loss would mean lower market prices. In addition, it was noted that if the germ is eaten then the crop will not germinate thus leading to a big loss in terms of seed. However, it can still be eaten. If the endosperm is attacked then the farmers noted that it could still be used as seed and food. On this basis, even though weight loss might be the same, the farmers perceived the germ loss as more important than the endosperm loss. The key point is that perceptions are related to the functional uses of the grain.

Other cereals

Other cereals were of some importance to household food security in the Salima and the mountain villages. In Mijuku village, Salima, rice was regarded as a cash and food crop by all focus groups. Theft came out clearly as the most important problem with respect to this crop. In Mpunga, women regarded sorghum as a food crop, whereas the men tended to see it as both food and cash. Several of the post-harvest problems for sorghum in this village were due to pests either in the field (birds, rodents, livestock) or when the crop was drying on the platform at home (termites, weevils, rodents and poultry). As in other villages, lack of oxcarts for crop transport increased crop losses in the field and scarcity of materials made platform construction difficult. In the high plateau villages, sorghum and finger millet were rated of some importance. Sorghum was rated as third most important food security crop by the women's group in Kalilombe village, Dedza, and finger millet was viewed as being of moderate importance in both Kalilombe and Kadzakalowa village, Ntcheu. Field pests caused the biggest problems for these crops; birds, livestock and poultry attacked the crop whilst it was still in the field. In addition, losses arose from shattering during winnowing.

Legumes

Legumes of one sort or another are regarded as being important food security crops in all of the villages visited during the survey (Table 1). In the rift valley and high plateau villages, the key legumes are beans, whereas in the two Lilongwe villages, groundnuts and soya beans assume a fairly high profile, with beans and also cowpeas being mentioned.

Beans were found to be used mainly for food, in contrast to soya which was regarded as more of a cash crop, at least as far as men were concerned. Groundnuts generally appeared to fall somewhere in between beans and soya on the food-cash continuum. After being dug up, beans, typically, are dried in the field before being transported back to the household where the drying continues. The crop is then threshed and stored, either in bags, the nkokwe or clay pots. The beans may or may not be protected against insect damage, although most of the groups interviewed in the survey indicated that they did protect the stored crop. The threshed crop is removed and winnowed before consumption or sale.

Post harvest operations for groundnuts are generally similar to those for beans although there are two key differences. The first is that groundnuts, unlike beans, are commonly stooked after uprooting which can exacerbate the risk of theft and insect and rat damage. Secondly, the process of removing the unshelled nuts off the plant is considerably more arduous than removing beans from their pods, and is regarded as time consuming and tedious by most farmers.

Whilst the operations for soya are basically the same as for beans, threshing and winnowing the crop is much more unpleasant due to irritation of eyes, lungs and skin by tiny hairs that fly off the plant.

In terms of responsibilities and decision making power, as was the case for maize, there were some clear differences in perceptions between male and female focus groups. Taking all post-maturity operations for all three crops together, women felt that they had at least as much decision making power as men. In contrast, whilst they accepted that there were several operations where there was joint decision making power, men felt that in general they had a higher level of decision making power than women. This was especially true for groundnuts and soya, but less true for beans. This may be because beans are more universally regarded first and foremost as a food crop.

Notwithstanding these general differences in perception between men and women, all groups accepted that men were responsible for and took decisions over store construction and women were responsible for and took decisions over processing In addition, women agreed with men that they (the men) were more likely to make the decisions over marketing of crops.

Taking an overall view encompassing all three legumes, pre-storage problems accounted for 49 of the 70 responses; storage problems accounted for 11, and post-storage problems (marketing) accounted for 10. Table 3 gives more details.

Table 3. Post-maturity problems in legumes (Number of times particular types of problem were ranked as important).

Crop	Pre-Storage						Storage					Post-Storage	
	Theft	Transport	Rats	Other verts.	Non-Verts	Rotting in field	Other	Rats	Theft	Insect dam.	Scarcity of mats.	Mkting	Processing
Beans	3	1	1	3	6	4				4		4	
G. nuts	8	2	1	5	3		3	4	2		1	4	
Soya	2			3	1		3					2	
Total	13	3	2	11	10	4	6	4	2	4	1	10	–

Scarcity of mats – scarcity of materials for nkokwe construction.

Problems with beans were at their worst in the field after harvest and before storage. It is here that vertebrate and invertebrate field pests are active, where theft occurs and where rotting and sprouting takes place. All this suggests that the length of time that the crop is left to dry in the field after uprooting should be examined further, and ways of drying at the homestead should be investigated. Insect attack (weevils and termites) in storage was also a problem, mentioned by six farmer groups drawn from three of the survey villages, and ranked as an important problem by four of the groups. In terms of marketing, farmers complain about low prices. This is a function of the timing of sales, which are at their peak immediately after harvest, when cash is needed.

For groundnuts, like beans, the majority of problems fell in the pre-storage category. Within this category the main areas of concern were theft (easily the most frequently mentioned problem) and losses from vertebrates (mainly dogs). Within the other categories, rat attack in storage was also mentioned by some of the focus groups, as were low prices and cheating at ADMARC at the time of marketing. The low prices are caused by high sales after harvest.

Farmers complained of lower than expected prices for soya at ADMARC markets, arguing that they had been led to believe that soya prices would be higher in 1996 than they were in 1995. Their expectation induced a response which increased supply, whilst demand for the crop actually contracted. The government is trying to encourage the growing of soya for family consumption. However, as most

men tend to view it as a cash crop, the sharp reduction in prices may result in a switch away from the crop in the next growing season. As with groundnuts and beans, problems occurred in the field due to theft and livestock damage. In addition, several farmers complained of coughing and itching whilst threshing of the crop

Root crops

Of the three root crops covered in the study, sweet potato is the most widely grown, mentioned in all villages by all but three focus groups It was ranked as an important food security crop only in Salima, however, where it was used for both cash and food. Cassava is also widely grown. Like sweet potato, however, it was regarded as important only in Salima where it was used as both a cash and a food crop.

Being a temperate crop, Irish potatoes were grown widely only in the mountain zone villages. In Kalilombe village the crop was ranked as important to household food security for all groups, in contrast to Kadzakalowa where it was of minor importance. Only the better-off in Kalilombe regarded Irish potatoes as a cash crop, whereas other groups in the mountain villages grew the crop for cash and food or for food only

After lifting, cassava is typically transported back to the home. Processing or marketing begins almost immediately owing to the rapid deterioration of the crop after it has been removed from the ground. In the Salima villages, processing involves peeling and drying before bagging in sacks and is carried out by women. Men are responsible for marketing, whilst the arduous process of digging up and transporting the crop is done by the whole family. Women have decision making power over processing whilst men make the marketing decisions.

In contrast to cassava, sweet and Irish potatoes can be stored. After harvesting, sweet potatoes are typically stored in a pit (*nkhuti*), and may be protected with ashes. In the Dedza village, storage of Irish potatoes was effected through the use of a raised platform (*thandala*). The gender division of decision making power and responsibility appeared similar to that for cassava.

Table 4. Post-maturity problems in root crops (Number of times particular types of problem were ranked as important by focus groups).

Crop	Pre-Storage					Storage			Post-Storage	
	Theft	Transport	Rats	Other verts.	Non-verts.	Rotting in field	Scarcity of materials	Insects	Processing problems	Mkting problems
Cassava(a)	3	2	1	3	1	1		1	2	
S. pots (b)									2	3
I. pots (c)		2			2					3

Key: (a) Responses from Mijuku village, Salima; (b) Responses from Mpunga village, Salima; (c) Responses from Kalilombe village, Dedza

Pre-storage problems predominated for cassava in the Salima villages. As with other crops, a key factor appeared to be the length of time that crops were left in the field after maturity. Theft, livestock attack and rotting were all mentioned as issues in the pre-storage period, as was the cost of ox carts to transport harvested crops to the home Transport difficulties were a factor behind the length of time that crops remained in the field, and were often caused by theft of work oxen needed to pull oxcarts owned by farmers. At the storage stage, weevil attack was highlighted as a problem in one of the villages, and at the post-storage stage, livestock damage during processing was mentioned in both villages as an issue of some concern.

Sweet potatoes were mentioned by women in one of the Salima villages, for them the major problems occurred during processing, when shortages of water and firewood made cooking difficult, and marketing because of lack of transport (ox carts) and money to pay market fees.

In relation to Irish potatoes in the Dedza village, marketing problems were the main concern. The basic issue here was low prices, caused by timing of sales and high levels of competition from Mozambican farmers just over the border. During pre-harvest operations, insect damage to crops in the field, damage caused by climate, and transport difficulties were mentioned, and in relation to storage the main difficulty was availability of materials for construction of the storage structure (*thandala*).

Horticultural Crops

The key horticultural crops grown in the central region are tomatoes, cabbages and onions, with rape, Chinese cabbage, mustard and okra also widely grown. The crops are normally grown on *dambos* (seasonally waterlogged hydromorphic soils). In all the villages visited during the pilot, farmers grew some or all of these crops, although the importance of the crops in terms of household food security varied widely. It was in the mountain zone villages that horticultural crops assumed most importance. Tomatoes in particular were ranked highly (3rd or 4th) in Kalilombe

(Dedza), whilst in Kadzakalowa (Ntcheu), onions and/or cabbages and/or tomatoes together were ranked as either third or fourth most important food security crops.

After lifting and transporting back to the home, onions may be dried and stored or they may be marketed immediately. In contrast, cabbages cannot be stored easily and must be marketed. Tomatoes can be dried and stored for home consumption, but since they are grown predominantly (although not exclusively) as a cash crop in the villages surveyed, most of the crop is marketed as soon as it has been harvested. It appears that men take all the important decisions with respect to post-harvest operations for these crops (and even the women's groups agree on this!), probably because in these villages they are very important cash crops. It is not altogether surprising that most of the problems raised by farmers are related to marketing. Table 5 illustrates this.

Table 5. Post-maturity problems in horticultural crops in mountain villages (Number of times particular types of problem were mentioned by focus groups).

Non-marketing related problems			Marketing related problems			
Transport from field to home	Rotting in storage (onions)	Rotting	Losses through pest attack	Lack of market outlets	Transport bottlenecks	Low prices
3	1	3	4	3	2	3

Key marketing related issues included low prices (due to seasonal supply gluts which have been exacerbated over the last few years by Mozambican produce coming onto local markets); lack of physical marketing outlets; transport bottlenecks in getting produce to markets; rotting at market and whilst waiting for transport to market and; pest damage to produce (rats, insects, maggots and birds).

In addition to these marketing problems, considerable losses occurred due to overripening at harvest time. This was caused or exacerbated by bottlenecks in transporting crops from the field. This was a particular problem in Kadzakalowa, where the hilly terrain made use of ox carts difficult. Some farmers attempted to get around this problem by selling crops at the field.

As noted earlier, onions are sometimes stored. Farmers attempt to cure the bulbs, characteristically by tying the tops of bulbs in bunches and hanging them on a horizonta pole. However, rotting can be a problem and this was certainly the case in Kadzakalowa, where farmers requested assistance on how they could preserve their onions better.

Discussion

The study was organized around a simple conceptual framework which sought to delineate the basic influences on smallholder post-maturity commodity systems. Figure 2 sets out the framework.

Farmers considered constraints to production to be of major importance though significant problems did occur at several stages once the crop was mature. The following table summarizes farmers' views on the key post-maturitv constraints for each crop.

Many of the critical post-harvest problems for cereals and legumes occur during the period after maturity when crops are drying in the field. Thorough drying is essential if crops are to store well, yet the practice of leaving the crops in the field substantially increases the chances of theft and losses due to vertebrate and invertebrate attack. It appears, therefore, that there is a need for research to look into low or no-cost technologies which can dry crops effectively but minimize the chances of theft and pest attack.

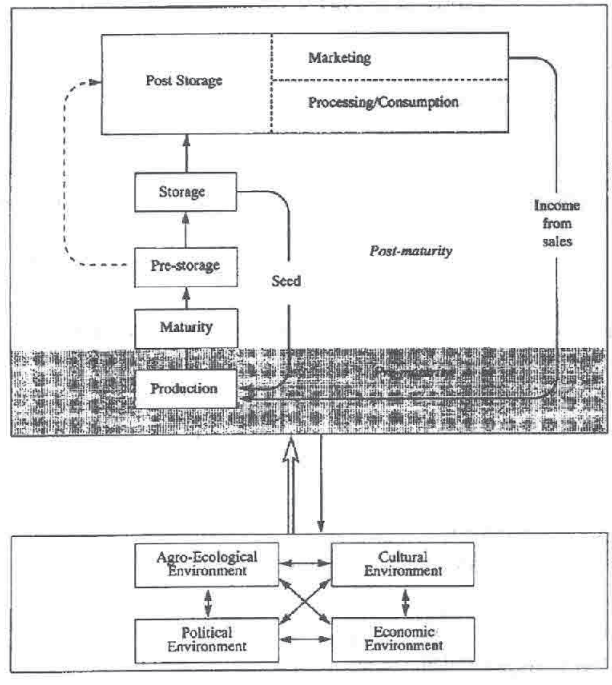

Fig. 2. Conceptual Framework for Smallholder Post-Maturity Systems.

From the point of view of security and management, the optimal solution is probably to dry crops at the home. However, the fieldwork revealed that transport can be a

critical constraint. Moreover, lack of physical space at home may be another constraint which restricts the potential for effective drying. Rapid moisture reduction can be achieved by removal of husks/pods and drying on ventilated platforms or in well-ventilated stores, but this will invite further pest attack unless protectants are used. Moreover, the introduction of new structures may be constrained by shortages of locally available construction materials unless alternative and sustainable sources of material can be found.

One possible way forward would be to look into the introduction of drying cribs, which have low requirements in terms of construction materials and which might work alongside the traditional nkokwe. It may be feasible to consider one store type for short-term storage perhaps a smaller store which facilitates drying, and another for longer periods. Improved cribs have been developed, introduced and extended, with varying degrees of success, in Nigeria, Kenya, Benin, Cameroon, Ghana, Tanzania, Uganda and Zambia (Tyler and Harding, 1994).

Table 6. Post-maturity constraints for important food security crops: Farmers views.

Crop Type	Crop	Areas[2]	Pre-storage	Storage	Post-storage
Cereals	Non-hybrid maize	All	Theft; rats; insect field pests; transport	Weevil attack during storage; shortage of construction materials.	Distance to maize mills
	Hybrid maize	All	As above	As above	'heating' at ADMARC; low prices
	Rice	Rift	Theft		
	Sorghum	Rift, Mountain	Field pests; (insects, rodents, livestock)	Scarcity of construction materials	
	F. Millet	Mountain	As above; shattering		Shattering during winnowing
Legumes	Beans	Rift, Mountain	Theft; insect field pests	Insect attack	Low prices
	G nuts	Rift, Plateau	Theft; insect field pests	Rats	Low prices, 'cheating' at ADMARC
	Soya	Plateau	Theft; livestock damage		Low prices
ROOT CROPS	Cassava	Rift	Theft, livestock, attack, rotting, transport	Weevil attack	Livestock damage during processing
	S. potatoes	Rift			Processing difficulties (water and firewood); transport to market and market fees
	I. potatoes	Mountain	Transport, insect damage	Shortage of construction materials	Low prices
HORT. CROPS	Tomatoes	Mountain	Transport		Low prices, crop deterioration, transport
	Cabbage	Mountain	Transport		As above
	Onions	Mountain	Transport	Rotting	As above

[2] This column denotes where the crop is an important food security crop It may be grown in villages in other zone, but is not regarded as important for household food security by farmers in those villages

Assuming that technically effective structures can be developed, their impact on reducing losses will be influenced, possibly quite heavily, by the alleviation of transport bottlenecks from the field to the household. Moreover, even if theft and pest damage are low during the drying period, difficulties in transporting crops from the field to the household means that crops may be left longer than they need to be, thus resulting in damage and theft to the well dried crop. In addition to drying technologies therefore, there is an argument for research into appropriate transport technologies.

Scarcity of materials for construction of nkokwes came up

as a problem in the fieldwork in several of the villages, both during the formal ranking exercises and during more informal discussions. Some attention to the problem of scarce construction materials could pay dividends in relation to encouraging uptake of improved storage structures, and such attention is in any case likely to become increasingly pertinent for construction of the traditional nkokwe in the context of the high rates of deforestation in Malawi.

The fieldwork highlighted the fact that farmers' perceptions of maize losses may not correspond with scientific estimates. The actual levels of storage losses were not quantified in the study, and as noted in the introduction, estimates of actual levels of loss can vary considerably (vis. Binder, 1994 versus CODA 1996). Notwithstanding this, the results of the survey indicate that insect and/or rodent damage are regarded by farmers as issues for certain crops. Moreover, in the context of (i) grain liberalization, which increases the likelihood of longer on-farm storage, and (ii) confirmation of the arrival of the *Prostephanus truncatus* (Horn), the Larger Grain Borer in Malawi, an argument for further research into storage improvements to improve pest control is strengthened.

There were problems with perishable crops which need to be addressed. It is clear that farmers growing onions would benefit from better storage technologies such as those outlined by Brice et al. (1997). Two of the key problems faced by vegetable farmers are that all the crops mature at the same time thus there are seasonal gluts in supply: and tomatoes and cabbages in particular stay fresh for limited periods only. Thus there is a case for introducing new varieties that mature earlier/can be harvested earlier/ have better storage characteristics.

For those farmers forced to sell a large proportion of their crop, particularly cereals, soon after harvest to honor debts built up over the course of the season and/or to meet pressing problems such as school or hospital fees and non-food expenditures, the introduction of inventory credit may provide another option. Although experience in other sub-Saharan countries with inventory credit has been mixed (Coulter, 1994), it may, however, represent a way a way forward. Inventory credit, by allowing farmers to retain a greater proportion of their crop in the immediate post-harvest period, can boost incomes by allowing sales to proceed later on in the season when prices are higher. Experience has implied that there are certain factors which can have a great bearing on the likely success of inventory credit. However, no detailed research has been carried out in the Malawian context to test for the suitability of this system for smallholders.

Conclusion

These issues can be tackled in various ways, however, the key to success will be relevant to the actual situations faced by resource poor smallholders. It is for this reason that a focused and integrated program of adaptive research and development *in situ* at the village level is the preferred implementation model. A systems approach to post-maturity constraints should be adopted, drawing on the conceptual framework used for this initial RRA. A village focused program would build on the results of the current study to: deepen understanding of identified constraints; identify any additional constraints; introduce appropriate techniques to overcome the constraints; initiate trials to assess efficacy of the solutions; assess the socio-economic viability of improved technologies; encourage the uptake of these technologies using resources of the government extension services and NGOs; and monitor and evaluate uptake and efficacy.

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