Rapid methods for small farm storage surveys

Paper presented at the International Conference on Post-Harvest Technology and Commodity Marketing, Accra, November 1995

RAPID METHODS FOR SMALL FARM STORAGE SURVEYS

Julia A.F. Compton, Anthony Ofosu, Priscilla A. Magrath, Felix F. Motte, Kenneth Acquaye, Samuel Addo and Robin A. Boxall

MoFA/UK ODA Larger Grain Borer Project, Ministry of Food and Agriculture, P.O. Box 165, Ho, Volta Region, Ghana

ABSTRACT

Farm surveys are often the first step taken in identifying storage problems. As time and money for such work are generally scarce, it is important to be able to make the best use of them to get the information needed.

This paper describes some of the specific techniques and experience developed by the Ghana MoFA/UK ODA Larger Grain Borer Project for rapid storage surveys on small-scale farms.

It is argued that the following factors can critically contribute to producing more timely and relevant results:

- formulation of specific survey objectives which focus on gathering data needed for decision-making.

- use of a range of techniques to meet these objectives, including secondary data and key informants, informal surveys, case studies and participatory meetings.

- avoidance of unwitting sampling bias, using rapid techniques such as transect village walks to select farmers, along with careful timing of field visits.

- methods of sample analysis which can be used in the field, rather than the lab. Field analysis has many benefits including cost, speed, potential for increased sampling, and most importantly the greater participation of farmers and field staff in the analysis and interpretation of results.

- use of rapid and flexible techniques of analysis and presentation, in particular mapping.

Practical examples of each of these are given.

INTRODUCTION

On-farm storage accounts for the majority of grain storage in most African countries, and is becoming increasingly important as the liberalisation of agricultural markets in many countries means that the state withdraws from storage functions (Coulter and Compton 1992; Conway and Tyler 1995). Farm surveys are often the first step taken in identifying storage problems. As time and money for such work are generally scarce, it is important to be able to make the best use of them to get the information needed.

A number of publications cover general aspects of surveys and participatory rural appraisal (e.g. Carruthers and Chambers, 1981; Casley & Lury, 1981; Poate and Daplyn, 1993, PLA Notes). Here, we would like to discuss some of the specific techniques and experience developed by the Ghana MoFA/UK ODA Larger Grain Borer Project for our rapid storage surveys. We worked mainly on maize storage, but many of the problems we faced may be relevant to other commodities.

The paper discusses five different aspects of rapid surveys:

- common problems
- formulation of survey objectives
- sampling of villages, farmers and stores
- choosing survey methods, including the use of secondary data, choice of methods of sample analysis and loss assessment
- data analysis and presentation of results

COMMON PROBLEMS WITH STORAGE SURVEYS

Common problems with storage surveys, which we have experienced ourselves in the past, include:

- *surveys which take too long to analyse*, so that the next stage of the work goes ahead without profiting from the results. For example, it is not uncommon for survey analysis to be completed a year or more after fieldwork is finished.

- *survey questions which are interesting but not important*, and which take resources away from answering the important questions. For example, entomologists commonly want to identify every insect species present, while anthropologists may want detailed kinship patterns, whether or not these data are really necessary for decision-making.

- *techniques of sample analysis that are lab-based, time-consuming and expensive*, taking time and resources away from the field work. Expensive and precise lab work often leads to high sampling errors, since it limits the number of samples which can be handled.

- *frustrating data analyses which fail to show any significant relationships* because of enormous variability and correlations in the data. In some cases, an extensive survey and analysis may give no more information than a 'rough and ready' survey. For example, losses in one location may be higher than another, but no amount of survey analysis is able to tell why this is so, due to correlated factors such as climate, ethnic group, agro-ecology, store type and other practices which influence losses.

- *farmers who give incomplete or misleading information* to surveyors. Farmers often perceive surveyors as tiresome outsiders who ask a lot of personal questions, take samples of farm produce and disappear, without ever coming back with the results. This influences the quality and truthfulness of the answers they give.

- *results that do not accord with common sense.* A frequently-seen example in published surveys is that graphed average storage losses paradoxically *diminish* at the end of the season. The explanation for this is almost invariably that the only farmers' stores left to survey at the end of the season are those with low losses, as explained later.

FORMULATION OF SURVEY OBJECTIVES

Rapid storage surveys may be undertaken for a number of reasons. We would like to include some notes on the formulation of objectives because it is here that many surveys run into trouble. Perhaps the worst problem encountered is that some surveys do not appear to have any explicit objectives at all; only unwritten assumptions of what type of data is needed.

In order to match methods to objectives, it is important to formulate the latter as *explicitly* and *specifically* as possible. Important considerations here include:

- **Who is going to use the survey results, and when?**

- **What decisions are they going to take on the basis of the results?**

- **What type and precision of information do they need to make these decisions?**

  There is a trade-off between speed and precision. Speed of results is often more important for decision-making than precision, especially when faced with the great year to year variability of the typical farm storage situation. For example, if storage losses are of interest, is it important to know them to the nearest percent or are categories such as "none, low, medium, high' adequate for decision-making? Is the actual percentage of affected farmers necessary or can rough estimates such as 'none, few, many' be used?

  With rapid surveys, it can be useful to think in terms of 'generating hypotheses' rather than producing definitive, precise results.

- **What degree of involvement of survey farmers is necessary?**

  We feel that farmer involvement is an important element of good surveys. 'Farmer participation' is often presented as a moral issue, but it is also a practical issue in obtaining good research results. For example, interested farmers who see the point of a survey are more likely to give truthful, complete results to surveyors' questions. Any future collaboration - for example in on-farm trials or case studies - also depends on keeping farmers involved and informed from the moment of first contact with them. The way the choice of survey methods can influence farmer participation and interest is discussed later on.

A final question to ask in defining survey objectives is: are average results for the survey area really necessary? Surveys often measure such variables as 'average storage losses' and 'average proportion of farmers carrying out a certain practice'. *Representative* data is certainly needed in some circumstances, for example when the effects of a particular intervention, such as a post-harvest campaign or project, are to be measured over a given area. However, many surveys seem to take for granted the collection of *average* data without examining whether this really meets the information needs which the survey is meant to address.

To get a reliable average figure for a large survey area requires careful random sampling of villages, farmers and stores, entailing considerable cost and organisation. Random sampling, weighting villages according to their size and associated techniques (Poate and Daplyn 1993) are particularly difficult and time-consuming in areas where maps and census lists are unreliable. Moreover, year-to-year variability may mean that the painstakingly-acquired averages for one season's survey are not representative for the area when examined over a longer time scale.

It is therefore worth taking a critical look at specific survey objectives and asking whether these really require averages. It may be possible to make better use of resources by reformulating the objectives. For example, "what are average storage losses" could be reformulated more simply as "who has a problem and when"?

Example: ***Defining specific survey objectives for an impact study of a new storage pest***

To take an example from our own work, we were asked to look at the impact of a new pest, the Larger Grain Borer beetle (LGB), in southeast Ghana, and look for promising methods for its control. LGB (*Prostephanus truncatus* Horn; Coleoptera: Bostrichidae) attacks farm-stored maize and cassava chips. Although very damaging, LGB is a sporadic pest and generally only poses a problem for farmers who store maize over three months or cassava chips over one month. The first record of LGB in Ghana dates from 1989. At the time of our study, in 1993, LGB was found in about half the villages of southeastern Ghana and was still spreading through the country in a northwesterly direction.

The question of the impact of a new storage pest has been addressed by other workers and has commonly been formulated (often implicitly rather than explicitly) as follows:

> " *What are average weight losses in farm stores before and after the introduction of the new pest?* "

We saw two problems with this formulation. First, to answer it properly would require an expensive and prolonged random survey, as already stated. More seriously, it was not clear that the answer to this question would meet policy-making needs. Difficulties included the use of weight loss as the main variable, which often shows a poor relationship to value loss (see below), and the implicit assumption in the formulation that farmers passively accept losses rather than - as in real life - taking action to miminise them (Motte *et al.*, 1995).

We decided to reformulate the question as follows:

> " *For whom is LGB a real problem? Is intervention needed on behalf of these farmers?* "

The restated question was then broken down into several components, which could be addressed by different types of studies. These included:

A. Where is LGB in the region?

B. Who stores maize and cassava long enough for LGB to become a problem?

C. What levels does LGB reach in these stores? How soon in the season do losses reach an unacceptable level for farmers? What impact has LGB on store owners and households who do experience a serious attack?

D. What factors appear to influence LGB levels?

E. What ideas and experience do farmers have about control measures? What actions do they take to limit losses? Are these actions sucessful in solving the problem to the farmers' satisfaction without the need for outside intervention?

SELECTION OF VILLAGES, FARMERS AND STORES

Selection of farmers and stores to be surveyed often gives trouble to survey planners.

Random or purposive selection?

The first question to be addressed in selection is whether a random sample is necessary or not to attain the objectives.

To return to the example of our own preliminary survey above, questions A: *Where is LGB?* and B: *Who stores for a long period?* could have been tackled by a large random survey. However, we needed the answers quickly, within 2-3 months, in order to move on to developing control options. They were therefore addressed largely by surveys of agricultural extension personnel, combined with our own observations in a limited number of villages. (The problem of collecting and analysing 'hearsay' data from informants is discussed below.)

In our village visits, we actively searched for people with an LGB problem (purposive selection) as well as visiting a few randomly selected farmers. A random survey of a few farmers per village might well have missed the LGB problem altogether, since in many areas LGB was still at low levels. Similarly, a random survey of villages, unless very extensive, would probably have missed the fact that the pest is concentrated along maize trading routes.

Random surveys are frequently not the best ways to tackle questions such as C: *How does LGB affect the household economy?*, D: *What factors affect LGB levels?* and E: *What action are farmers taking and is it enough?* above. If a storage problem is sporadic, as in the case of LGB, it is quite likely that a random survey will only turn up a small fraction of farmers who are affected, so that much of the data is effectively wasted. For example, in an earlier rapid LGB survey in Togo (Compton 1991) only about half of the villages surveyed had LGB, and the others contributed little to the understanding of this pest problem. We decided to address these questions through intensive long-term case studies in a few villages with relatively high levels of LGB (Magrath *et al.*, forthcoming), and by participatory meetings with small groups of affected farmers.

If the effect of different storage factors on losses is of interest, it is worth thinking in advance about possible correlated factors and designing the survey to disentangle these. To cite a commonly-encountered example, store types often vary according to region of the country. If the effect of store type on storage losses is to be discerned, it is important to have enough samples from more than one store type *in the same region* to permit analysis. Otherwise, a random survey followed by multiple regression analysis is likely to tell you something like "losses are lowest in mud silos in the savannah zone", a conclusion you might have reached without the benefit of the survey! In this case, a very rapid survey to generate the hypothesis that mud silos are better than other store types, followed by farmer interviews to elicit their benefits and disadvantages, and possibly replicated trials to test the hypothesis, might have been a better option than an extensive random survey.

In sum, a purposive selection of villages and farmers can be better than a random one for tackling some questions, provided there is no need to make generalisations over all farmers in the area, and that the non-random nature of the sample is clearly stated in the survey report.

Minimising unwitting bias in selection of farmers

Problems due to selection of 'volunteers' and the use of extension staff

Nevertheless, it is clearly important not to *unwittingly* bias the sample, as is frequently done. The most common error both in random surveys and in participatory meetings is to rely on extension staff to select farmers. This virtually always results in the selection of the better-off farmers in the village. For example, in one village surveyed in Togo (Compton 1991), a 'random sample' selected by the extensionist came up with the chief, the chief's brother, the chief's nephew, a teacher from the local primary school and the vet! Unfortunately, most examples are not as flagrant as this and the researcher may not be aware of any bias. Even when extensionists are specifically asked by the researcher to select poorer farmers, women and other frequently-missed groups they may have a hard time. In one of our study villages, 90% of an extensionist-selected sample were men, while in a 'transect walk' through the village (see below) about one quarter of stores belonged to women.

Volunteers who turn up for 'participatory meetings' are also likely to be the more leisured classes of the village: the old and young, some underemployed men, plus a sprinkling of prominent citizens who come out of courtesy or in hopes of future projects following the survey.

In storage surveys, the unwitting selection of larger farmers is likely to lead to overestimation of average amounts stored, length of time in store and losses. For example, the average store size of a sample of volunteer farmers contacted though the extension worker in one of our case study villages

In storage surveys, the unwitting selection of larger farmers is likely to lead to overestimation of average amounts stored, length of time in store and losses. For example, the average store size of a sample of volunteer farmers contacted though the extension worker in one of our case study villages was about 1.5 tonnes of maize, while stores on a 'transect walk' in the same village ranged around 0.5 to 1 tonne. The extensionist-selected farmers stored for a median period of about 7 months and suffered estimated value losses in store of about 10-20%, while the 'transect' farmers stored for the most part less than 5 months and had much lower losses in consequence. Of course, many storage specialists may have an undeclared interest in showing storage losses to be as great as possible!

The transect walk - a useful technique for farmer selection

A technique we have found very useful in the selection of farmers for rapid surveys is the semi-random 'transect walk'. At its simplest, this means walking a straight line through the village and surveying all farmers encountered along this line. If the village is large, a linear sample of every second, third, fourth etc. household encountered on the walk can be taken to make up the desired sample size. However, to assure a representative sample, it is important to pre-survey the village with a knowledgeable person before embarking on the walk, plan the route to include different types of farmers, and do a preliminary stroll along the planned route to count the number of households and calculate the sampling fraction. Without these preliminaries, the transect walk is liable to miss certain types of farmers altogether. For example, in one of our first attempts we missed an entire ethnic group congregated in a part of the village outside the transect. Farmers in satellite hamlets or isolated homesteads may also be missed. Finally, it is important to time the transect walk to meet farmers at home, especially in a single-visit survey. During the day the more assiduous farmers are likely to be away in the fields.

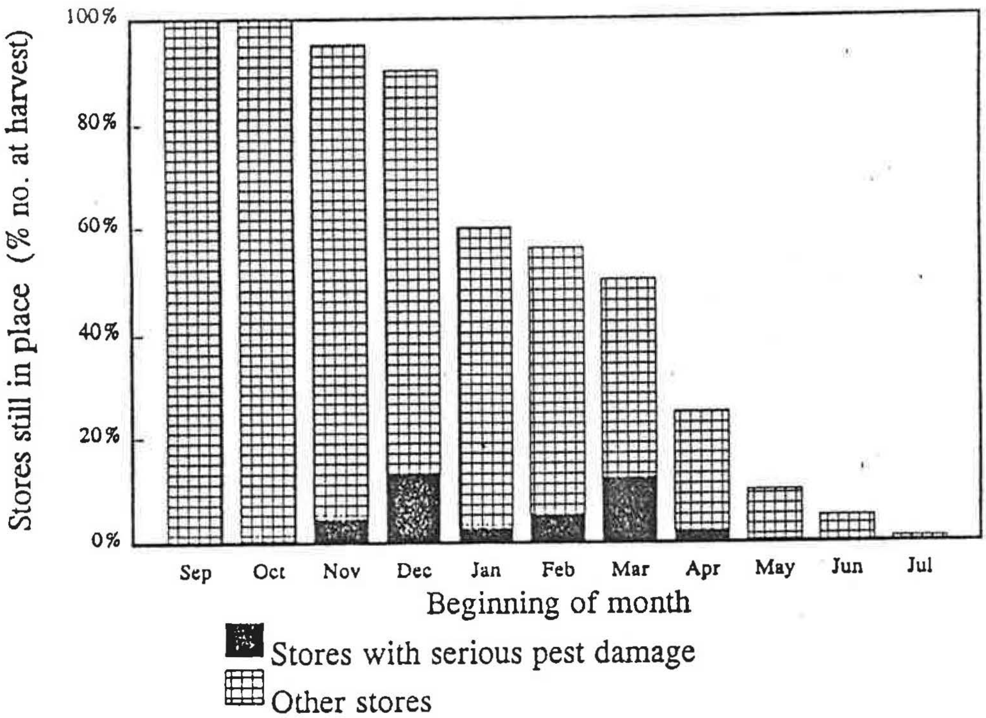
Survey timing

Seasonal timing is a particularly critical issue for farm storage surveys. This is due to the variation in the date that farmers dismantle their stores, and the fact that serious pest damage almost always leads to stores being dismantled early, followed by rapid consumption or sale. This contrasts with pre-harvest crop surveys in which farmers have no option but to leave their crop in the field until harvest-time, whether it is damaged or not.

The problem is illustrated in Figure 1, which shows a typical pattern of maize storage in a village in our study area, from a simplified model based on case study data (Magrath *et al.* forthcoming). There are three main periods when village farmers dismantle their stores in order to make maize sales: before Christmas and at planting season, to meet cash needs, and finally in the lean season, when the highest prices are obtained. If farmers notice pest damage in their store, it is likely that they will take it down at the first opportunity and sell the maize, especially during these three periods. Thus, a month or two after a store moves into the 'seriously damaged' category it is likely to disappear from the graph. It can be seen that highest losses are likely to be observed in early December and March, and that visits late in the season (June) may actually record lower losses in the few remaining stores. However, the worst-affected farmers in Figure 1 are those who were forced by pest damage to take their stores down very early (around November), and these may be missed altogether by a later survey.

It is fairly easy to get a rough idea of the type of information shown in Figure 1 through interviews with key informants. This is an important preliminary step in planning single-visit or few-visit surveys, both to get the maximum amount of information, and to make note of the likely direction of any biases in the results.

Figure 1. The problems of timing survey visits:
Example village pattern of maize storage



Source: model based on unpublished data from Ghana.

DATA ANALYSIS AND PRESENTATION OF RESULTS

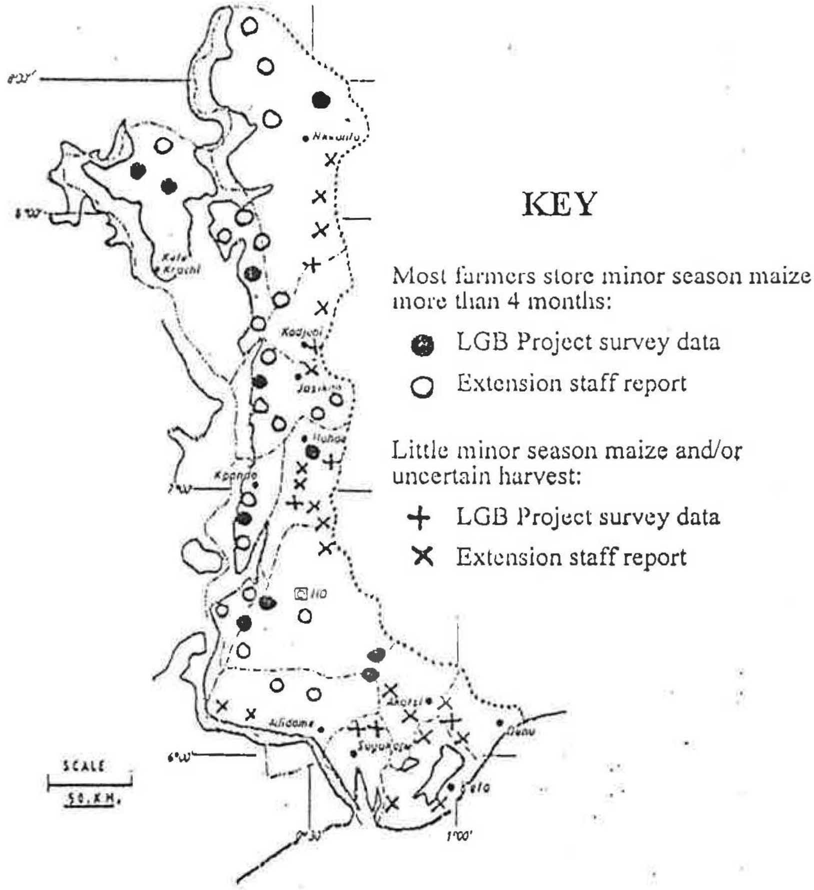
Data analysis and presentation is discussed here before survey methods, because it needs to be planned as part of survey methodology, and decisions (conscious or unconscious) made at an early stage about analysis can have considerable impact on survey methods and results.

For example, the presentation of data as tables of percentages or averages, which is the most common practice, presupposes random selection of villages and farmers, as mentioned above, if the results are not to be misleading. This means of presentation also makes it very difficult to incorporate secondary data, or data of questionable reliability, into the results.

A technique that we have found very useful in survey analysis and presentation is *mapping*. Apart from the obvious advantages of showing exactly where particular storage problems and practices are located, maps are flexible tools which are able to incorporate different types and qualities of data. In our preliminary survey of LGB, we created composite maps built up from data from our own village visits as well as interviews with extension staff and other sources. An example is shown in Figure 2. Sources were colour-coded (black and white is used in the Figure), giving a visual impression of the likely reliability of different data points. It was comparatively easy to spot and check anomalous results. We used manual mapping, but new Geographical Information Systems software is a powerful tool where available. Maps are excellent tools for generating hypotheses and are better than tables of results for illuminating geographically correlated factors, such as the example of store type and region given above.

In the example in Figure 2, a clear pattern emerges from the addition of the secondary data that would probably not have been clear had we relied on the few points from our own survey data alone. That is, the east and the far south of Volta Region apparently store little minor season maize, while much of Central-Northwest Volta Region stores minor maize for long enough to be at risk of LGB (see above). Overlaying this map with a map of current LGB incidence in the region gave us an idea of likely target areas for LGB work in minor season maize.

Figure 2. Example of the use of mapping to show patterns and incorporate secondary data: Minor season maize storage in Volta Region, Ghana, 1993.



Now that computers are widely available to researchers, an important decision is whether to use them for survey analysis or not. Although we use computers a lot in our work, our experience is that computer data entry and analysis can be very time consuming. There is no point in saving time in a rapid field survey only to spend twice as long in front of the computer! Sometimes a simple manual tally, with a spreadsheet package used to graph the summarised data, can give a quick result, as was done with some of our surveys of extension staff. Generating hypotheses from the survey data - a common objective of surveys - can often be done without computer analysis, and the latter can give a spurious impression that the results are more "scientific". Often, the time devoted to the computer analysis could more profitably be spent in the field, discussing hypotheses with farmers and getting their feedback. Computer analysis is most appropriate where very large amounts of data are involved or where it is planned to add further data to a database in the future.

CHOOSING RAPID SURVEY METHODS

Using 'soft data' : secondary data and key informants

Storage surveys rarely cover unexplored territory, but sometimes the survey reports read as if they do! Many surveys make little or no use of information already available about the study area. Often, this is because the use of secondary data is limited by the choice made on data analysis and presentation, as discussed above.

Mapping lends itself to the use of secondary data. As well as its other advantages, mapping is very quick and facilitates immediate checks of doubtful answers.

For example, we have used regular surveys of agricultural extension workers to produce maps of changing maize storage practices and LGB problems in the region. A brief multiple-choice questionnaire containing general categories such as "none, few, many" farmers is used. Extension workers are asked to fill in a questionnaire for their own village, or any village they know very well, during one of their regular monthly meetings. Results are mapped during the lunch break and any doubtful or anomalous answers are checked, then the maps are presented to the whole group and discussed later the same day. This approach generates a lot of enthusiasm as well as apparently quite reliable data, and heightened interest in this pest problem has produced better results over time. Two important points are: not to ask questions that respondents are unlikely to have sufficient knowledge to answer well, and to strongly encourage the use of the "don't know" option when respondents are unsure.

Commodity traders are another under-utilised source of information. We have found participatory meetings with maize traders very useful in exploring the impact of LGB on the quality and quantity of traded maize.

Sample collection and analysis

Nearly all storage surveys involve some type of sample collection and analysis, and decisions taken about analysis can have a profound impact on the nature of the survey. For example, a costly lab analysis limits the number of farmers surveyed, increasing sampling errors. The risk of sample deterioration before analysis may also lead to surveyors rushing back to the lab, rather than sitting down for a relaxed chat with the farmer.

An important question when planning sample analysis is: *how precise does the method need to be*? There is an obvious trade-off between precision, coverage and speed. We feel that many surveys over-emphasise analytical precision. Commonly, precise and time-consuming lab analysis is matched with imprecise or biased sample collection. Bias can arise not only at the level of farmer selection, but at the level of the store: few store types allow samples to be taken at all levels of the produce, and not many farmers are be happy to go along with the suggestion of de Lima (1978), quoted in Boxall (1986) to take a random sample by breaking down the entire store! Samples are normally taken from the surface of the produce, which may be more or less infested than the bulk. There is little surveyors can do about this, except to lower their expectations of precision and - ideally - to undertake supplementary work to find out the likely direction and magnitude of sampling bias.

A related question is: *how many variables to measure*? As stated earlier, surveyors frequently find themselves collecting more data than they can easily analyse. It is vital to distinguish the important from the merely interesting, at the planning stage.

Finally, it is our contention that *sample analysis should take place in the field, not the lab*, wherever possible. Field analysis has a number of important advantages, including:

- speed of analysis, which increases the number of stores that can be sampled, reducing sampling errors;

- no losses of samples in transit and the lab

- instant results which can be followed up on the spot

- no need to take samples away or pay farmers for them. This may be a critical consideration for national research programmes, most of which have severe budget restrictions.

- most important, farmers and field staff can work together on analysis and interpretation of the results. Farmers can see the point of the work and are often stimulated to come up with hypotheses or proposals for experiments. Field staff too feel more involved and responsible, reducing the chances of fraudulent (Poate and Daplyn, 1993) and poor quality results.

Our project has been using rapid field methods for assessing losses and insect numbers in stored maize (Compton, forthcoming). This has been combined with supplementary lab work to assess the validity and precision of results produced by these methods.

Loss assessment methods

Nearly all storage surveys involve some element of loss assessment. The method chosen to measure losses should reflect the farmers' perception as well as that of the researcher.

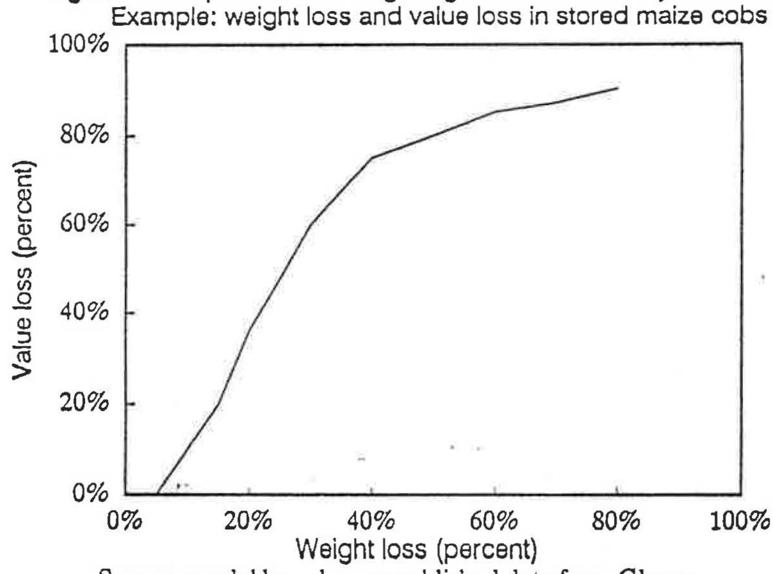
For example,

- *few surveys attempt to measure loss in value*, even though this is the important variable from the farmers' point of view.

- *weight loss, a frequently recorded variable, is often not well related to value loss*, especially where sales are by volume.

  Figure 3 shows one example of the relationship found in practice. This model is loosely based on data collected from market traders valuing damaged maize from stored cobs in our project studies. In this example, value losses are insignificant until weight losses reach about 5%, then increase rapidly. We have not collected enough data yet to know whether the relationship really follows the roughly sigmoid curve shown, or whether this curve would hold for other situations; the point here is that weight and value loss may vary greatly.

Figure 3. The problem of using weight loss as a survey variable.
Example: weight loss and value loss in stored maize cobs



Source: model based on unpublished data from Ghana.

- *the unit of analysis should be that of the farmer.* For example, losses in stored maize should be looked at on a cob basis as well as a grain basis. A total loss of one cob may be perceived differently by the farmer than a slight loss spread over many cobs.

- *quality loss is not always reflected in price.* For example, maize contaminated with fungal toxins may not be marked down in price unless its colour or odour is affected. Thus, in spite of the health risks, farmers may see little economic incentive to adopt mould-reducing technology.

- *much of the economic loss may come from early disposal of the commodity,* as discussed above. Any loss assessment method which does not take this into account risks undervaluing losses.

We have found it very helpful to work with commodity traders and farmers to value damaged stored maize in their terms (Compton *et al.*, 1995). Based on this, we have developed a rapid assessment method which seems to give a fair prediction of value loss due to pest damage in stored maize cobs (Compton, forthcoming).

CONCLUSIONS

In this paper, we discuss some of the problems frequently encountered in on-farm storage surveys and argue that the following factors can critically contribute to producing more rapid, timely and relevant results:

- formulation of specific survey objectives which focus on gathering data needed for decision-making. It is often useful to think in terms of generating hypotheses rather than producing definitive, precise results.

- use of a range of survey techniques to meet these objectives, including secondary data and key informants, informal surveys, case studies and participatory meetings. Extensive random surveys are slow and difficult and should be used only when strictly necessary to achieve the objectives. Purposive rather than random selection of respondents can be useful in some cases.

- avoidance of unwitting sampling bias, using rapid techniques such as transect village walks to select farmers, along with careful timing of field visits.

- use of methods of sample analysis which can be carried out in the field, rather than the lab. Field analysis has many benefits including cost, speed, potential for increased sampling, and most importantly the greater participation of farmers and field staff in the analysis and interpretation of results.

- use of rapid and flexible techniques of analysis and presentation, in particular mapping. Standard techniques of computer analysis such as multiple regression are time-consuming, vulnerable to correlations between explanatory factors, and may give a spurious impression of scientific accuracy.

In our view, post-harvest scientists have a major responsibility for improving farm survey design and implementation. There is an increasing and laudable tendency to employ socio-economists in survey work. However, even if the socio-economist is experienced in rapid farm surveys (not always the case), s/he can be handicapped in survey design by the data requirements put forward by technical colleagues. Notably, insistence on precise laboratory techniques of sample analysis can severely limit the scope of the survey and the possibility of informal interaction with the farmer, as discussed above.

Post-harvest scientists could help, firstly, by accepting some sacrifices in 'scientific accuracy' in order to get more rapid and wide-ranging survey results. Secondly, they can perform a valuable role by looking at storage losses from the point of view of farmers and commodity traders, and trying to relate these perceptions to objectively measurable physical aspects of the stored commodity. Finally, post-harvest scientists can use their laboratory resources to develop rapid methods of sample analysis which can be used in the field.

REFERENCES

Boxall, R.A. (1986) *A critical review of the methodology for assessing farm-level grain losses after harvest.* Report of the Tropical Development and Research Institute G191, viii + 139 pp.

Carruthers, I. and Chambers, R. (1981). Rapid appraisal for rural development. *Agricultural Administration* 8, 401-422.

Casley, D.J. and Lury, D.A. (1981) *Data collection in developing countries.* Oxford: Clarendon Press

Compton, J.A.F. (1991) *Survey of farm storage of maize and dried cassava, Central Region, Togo; February-March 1991.* Natural Resources Institute Report R1773, xi + 90 pp. Chatham, UK: Natural Resources Institute.

Compton, J.A.F. (forthcoming) *Rapid assessment methods for small farm maize storage work.*

Compton J.A.F., Magrath P.M., Motte F.F., Gbedevi S.R., Addo S., Ofosu A., Boxall R.A., and Semakor S.K. (1995) *The role of maize traders in developing and promoting new maize storage technology in Eastern Ghana.* Paper presented at the 11th Meeting of the African Association of Insect Scientists, 6-11 August 1995, Yamoussoukro, Cote d'Ivoire

Conway J.A. and Tyler P.S. (eds.) (1995) *Practical Implications of Grain Market Liberalization in Southern Africa: Proceeedings of a workshop held in Harare, Zimbabwe, 18-20 October 1994.* Chatham, UK; Natural Resources Institute. viii + 194 pp.

Coulter, J.P. and Compton, J.A.F. (1991) *Liberalisation of cereals marketing in Sub-Saharan Africa: Implementation issues.* Marketing Series 1, Chatham, UK Natural Resources Institute.

Motte, F.F., Feakpi, R. and Awuku, M. (1995) *Farmer experimentation in small-scale maize storage. Experiences from Volta Region in Eastern Ghana.* (These proceedings).

PLA Notes (Notes on Participatory Learning and Action) Thrice-yearly journal. London, International Institute for Environment and Development.

Poate, C.D. and Daplyn, P.F. (1993) *Data for agrarian development.* Cambridge University Press, Great Britain, x + 387 pp.