ASSESSING FOOD LOSSES AND THE SOCIO-ECONOMIC CAPACITY FOR IMPROVEMENTS THROUGH STATISTICAL SURVEYS

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Abstract

Accurate preliminary information on the nature of food losses helps to design field surveys with greater precision for qualitative and quantitative estimates.

The practical relevance of such data is enhanced through proper stratification of the sample to obtain social and economic data.

Social data helps to plan extension programmes to reduce food losses. Economic analysis helps to determine the best loss reduction strategies to introduce into the extension package.

Finally, a properly conducted field survey can also provide new information to design experiments to reduce food losses.

Examples of such surveys in Africa and Asia are given to illustrate these concepts.

1. Introduction

Sixteen years ago at the '1st International Working Conference on Stored Product Protection', I presented a paper on 'The conduct of field infestation surveys and the economic use of their results' (De Lima, 1975). The scientific and philosophical basis given in that paper for postharvest field work continues to hold true today.

In this paper I will summarize a total of 21 years experience in the conduct of postharvest surveys in a number of developing countries.

To be successful, field surveys must be used as diagnostic tools to quantify problems and direct efforts to solutions based on social, economic and scientific realities.

Therefore, before undertaking a postharvest field survey in a developing country one must have some idea of the problem, its socio-economic setting, the possible technical solutions available and finally the extension strategies that may be planned to improve the delivery of a package of improved postharvest practice to the target population. In essence the requirements are qualitative observation, quantitative estimation and model building of socio-economic and loss data for possible solutions through a synthesis that contains all relevant information. The final product must be an improved extension package to the farming community.

2. Major Postharvest Survey Situations

In this paper I will summarize the successful use of postharvest surveys in four major situations.

(i) as an adjunct to a national agricultural census to assess food losses and identify reduction strategies (Swaziland);

(ii) to develop a strategy to introduce better postharvest techniques to newly settled agricultural areas (Zambia);

(iii) to assess losses and determine an extension package of improvements in a traditional socially closed society (Pakistan);

(iv) to identify the boundaries of a new quarantine pest, to evaluate its spread and assess the effectiveness of control measures (Kenya).

The above situations encompass the likely problems one may encounter in a developing agricultural economy ranging from semi-arid irrigated systems to temperate rain fed conditions.

3.1 The Postharvest Survey as an Adjunct to the National Agricultural Census

The annual agricultural survey has been in progress in most countries over the past three decades and is usually based on two or more comprehensive agricultural censuses initiated at 10 year intervals. There is much statistical information available on which to design a sampling frame for specific postharvest needs. Under the FAO Prevention of Food Losses Programme (FAO/PFL) 1975-1985 the approach was to gain as much information as possible to obtain a reliable national estimate of food losses. In Kenya, I found (De Lima, 1979) that the national frames (with sample probability proportional to population size) were too complex and counter-productive (for postharvest studies) in terms of cost of obtaining the sample versus the information gained. I therefore developed a series of sampling programmes using stratified area and cluster techniques at the district level to obtain provincial and national estimates. This experience illustrated the difficulties that occur in virtually every large country with a variety of geographical, physical, environmental, economic and social attributes.

In small countries it is far easier to obtain national estimates based on the national frame.

In Swaziland the sampling frame is properly stratified with regard to physiographic differences and level of agricultural development. The population is socially stable and the homestead is the basic unit for enumeration of agricultural data. The size of enumeration areas is determined by the number of homesteads and residents in each. In a study over two seasons 1980-1982 (De Lima, 1983) a sub-sample of 90 enumeration areas (EAs) was selected at random from a

national total of 552 EAs. Stratification was done according to physiographic region and administrative district and according to level of agriculture. The sample size was fixed and so the number of enumeration areas was determined by the size of homesteads within each sub-stratum. Thus the enumeration areas were selected with probability proportional to the number of homesteads. In this way a total of 900 homesteads was obtained for sampling.

The estimate for the characteristic 'x' for block 'j' of sub-stratum 'i' of stratum 'h' was given by the formula:

$$\bar{X}_{hij} = \frac{N_{hij}}{n} \sum_{k}^{n} X_{hijk}$$

where X_{hijk} = value of the characteristic 'x' in homestead 'k' of block 'j' of sub-stratum 'i' of stratum 'h'.

N_{hij} = total number of homesteads in block 'j' of sub-stratum 'i' of stratum 'h'.

n = number of sample homestead for sample block.

The data was analysed using analysis of variance to separate variation between homesteads sub-strata and strata. Total postharvest losses of 22.7% were recorded for 1982 and 16.15% during 1982. The lower 1982 figure was because a smaller harvest was obtained due to drought conditions. The precision of the sample estimates in both years was better than 0.25%.

The surveys showed that most of the losses were in the highland region where higher rainfall gave better crops but delays in harvesting also resulted in postharvest losses in the field when the second rains (in the biomodal rainfall zones) caused field rotting. The socio-economic surveys showed that harvesting was delayed because the menfolk were away working in the mines or in urban employment. The women could not harvest on their own and depended on children for assistance. They therefore waited for the school holidays before harvesting. These problems were discussed during the socio-economic surveys and it was found that by a small alteration in the school term i.e. by giving the two-week school holidays in early April rather than at the end of the month the major losses due to field rotting of the crop would be eliminated.

The extension package was also improved by targeting women and school children. Women are not fully literate and alternative extension messages were required. For school children the inclusion of better postharvest methods as a unit in the agricultural activities curriculum was found to be most valuable.

3.2 Postharvest Surveys in Newly Settled Agricultural Areas

In the majority of african countries post-independance rehabilitation of the rural population has meant the establishment of 'settlement' schemes on land previously alienated by european farmers for extensive methods of farming with indigenous people providing labour and having squatter status. The settlement schemes became the first base of a socio-economic rehabilitation process and very often resulted in a mixture of tribal groupings especially in areas where administrative districts cut across tribal boundaries. The schemes are often partly funded by external aid for infrastructure development, and over the past 20-25 years various input strategies have been developed to provide for "integrated rural development". An important aspect of most schemes has been the introduction of new food storage and handling techniques. The need for new postharvest techniques had its origin in the development and extension of new agricultural methods that results in production of different commodities from what was traditionally handled. Large volumes of harvest also mean that the traditional structures are not of sufficient capacity. In many cases newly settled people do not have access to the materials needed for traditional postharvest techniques because the prior extensive european farming cleared the land of much natural vegetation.

A good example is the agricultural development programme in Zambia. Here a number of integrated agricultural development projects are administered by the Government through the assistance of development agencies in each of the country's provinces. The introduction of greater inputs resulted in higher production and therefore the need for better postharvest practices.

A series of improved postharvest technologies were developed over the years but a major problem was to determine the appropriateness of each to climatic conditions and the socio-economic responses of individual farmers. The requirements were to evaluate the results of the new techniques after they had already been in place for 3-4 years prior to the survey.

After examining a large number of farms it was found that the best results would be achieved by grouping fixed sets of the most effective innovations into replicates for climatic social and economic variables (De Lima, 1983). The results fitted a multi-variate analysis of variance model and subsequently gave good comparisons between the different postharvest methods. This enabled an extension programme to be developed to suit the needs of the farmers in a specific integrated rural development area.

An extension package of measures could be developed to integrate the best aspects of each technology with the economic capacity of the individual farmer. The results also demonstrated that extension messages needed to be group

specific i.e. some aspects of postharvest operation were handled by men and others by women.

3.3 Postharvest Surveys in Traditional Socially Closed Societies

Postharvest surveys in the traditionally closed societies of the Middle-East and Western Asia are more difficult to achieve than elsewhere. This is specially apparent when socio-economic questions must be answered as part of the data requirements for food loss assessment and for developing a package of extension measures to reduce losses. A series of surveys carried out in Pakistan (De Lima 1985) may perhaps serve as a model for similar work.

Wheat, rice and maize are the major food crops in Pakistan. Seventy two percent of the wheat crop is produced in the Punjab province comprising approximately five million hectares and producing eight million tonnes from 2.5 million farms. The Crop Reporting Service (CRS) undertakes an extensive sampling programme in a selected sample of 1,010 villages to enable annual crop forecasts to be made. This statistical sample has been developed over a number of decades and has an accuracy of 0.05%.

Preliminary surveys were undertaken in irrigated and rainfed areas to determine the sample design most suitable for accuracy in obtaining food loss data. A precision of 0.1% was set and a multistage stratified random sample frame established. The preliminary data established the number of samples required and the stratification procedure to be followed to achieve the accuracy desired.

For the unirrigated area three strata were used: 5 ha and less; 5-10 ha and above 10 ha. For the irrigated area four strata were used: less than 2.5 ha; 2.5-5 ha; 5-10 ha and above 10 ha. Fifteen farm households were selected at random from a CRS list for each village and made proportional to the number of farmers in each strata. In each strata a random number table was used to select the total number of farmers required. Additional samples were taken for non-response cases etc.

The formula used for selection of farmers within each stratum was:

$$N_h = \frac{N_h \times n}{n}$$

where N_h = sample size in stratum 'h'.

h = 1, 2, 3 (unirrigated area)
h = 1, 2, 3, 4 (irrigated area)

n = sample size = 15
N_h = size of stratum 'h'
N = population size

When the full scale surveys were undertaken, 15 households from each of 32 villages, from the CRS sample were required to be sampled at monthly intervals. the final results (De Lima 1985) gave an estimate of 3.8% postharvest loss. The precision of estimates was 0.1%. The results were excellent and with a small compromise in accuracy (as against the full CRS sample of 1,010 villages) sufficient data was obtained to validate the loss assessment estimates as well as provide a reliable socio-economic analysis of the population in terms of the kinds of postharvest responsibilities of male and female members of the household, the decision making roles and the persons to whom improved postharvest methods should be targetted.

It was found that postharvest activities involving harvesting and drying involved the menfolk and was done through contract hiring of mechanical harvesters and dryers. Some sun drying was also done but this occurred after the crop was taken to the home courtyard at which stage it became the entire responsibility of the womenfolk. As the women were not permitted to come into contact with the predominantly male extension workers postharvest techniques were related 'second-hand' through male household members. The socio-economic survey identified this aspect as the main reason for the lack of progress in better postharvest techniques in the household. Studies conducted by female socio-economists showed that the womenfolk were keenly interested in better postharvest methods and requested the supply of either female extension agents or video training programmes which could be viewed at women's group meetings.

An extension package of measures was developed for field trial with attention being given to the correct use of phosphine in metal containers as an improvement on the practice already in adoption by some progressive farmers.

3.4 Postharvest Surveys of New Quarantine Pests

In 1978 a new postharvest pest *Prostephanus truncatus* was introduced into Tanzania from Central America. First records indicated that it has arrived in food shipments that were not satisfactorily disinfested. Over the next ten years the pest rapidly spread throughout the country and into neighbouring countries of Rwanda, Burundi and Kenya. Separate infestations were recorded in Benin, Togo and Ghana.

The major problem associated with containment and control of the pest was to identify the locus of each infestation and move to eradicate it. This did not work in Tanzania, because no predictive base was built into a survey strategy to determine dispersal of the pest through human or natural means.

In Kenya a limited outbreak occurred along the Tanzania-Kenya border in the Taveta district in 1983. Early efforts at eradication were unsuccessful and the pest was recorded in villages further inside the country crossing a semi-arid

"buffer" zone. The problem was to determine why this was happening and to develop a strategy for action.

It was immediately clear that a complete census of the affected areas along the Tanzania-Kenya border was required. Accordingly a questionnaire survey of every household was carried out to determine the source of their produce, previous history of Prostephanus infestation, effectiveness of control methods, transfer of produce to other areas. In addition the cross-border trade was also monitored and experiments were carried out to determine the effectiveness of the existing treatments (De Lima, 1988).

The survey methodology was a complete census because the areas of out-break were relatively small. The study showed that cross-border trade was common because of price differentials and higher value of the Kenya currency. Movement of infested produce to inland towns was traced through the supply of maize to children studying in high school and to men and women from the outbreak area carrying maize to urban areas where they were employed. Because of the cheaper maize in the infested area supply of the crop to relatives in villages further inland was common. In addition several small traders were also involved in cross-border transport of the infested produce to small farms and some districts where maize shortages existed. Sales were made on village and district market days.

The experimental trials with the recommended chemicals demonstrated their ineffectiveness for eradication. The major problem was that as dilute dusts the chemicals were rapidly diluted further by the large amount to grain flour produced by the 'boring' activity Prostephanus. Shelling maize did not limit the problem. Doubling the dose was only marginally effective.

These results demonstrated that strict quarantine legislation was necessary. An educational campaign was required to alert the public about the spread of the pest into the high production areas. The only pest control method found effective was fumigation with phosphine or methyl-bromide.

4. Conclusion and Discussion

Properly conducted statistical surveys will continue to be a requirement of all postharvest development programmes for monitoring, evaluation, surveillance and intervention strategies. Surveys need not be large or expensive. It is important to determine the precision required in sampling and the amount of error that is acceptable. Stratification reduces the amount of work involved and also leads to a better understanding of the population being surveyed. The inclusion of social and economic criteria in a survey will enable a more sensible analysis of the information as well as assist in developing a targetted approach in the development of extension and training programmes and in reviewing the effectiveness of previous programmes. Finally surveys enable a field evaluation of the effectiveness of control measures

already in use and allow better experiments to be designed for field testing.

5. References

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ETUDES STATISTIQUES SUR L'EVALUATION DES PERTES EN NOURRITURE ET LA CAPACITE DU CONTEXTE SOCIO-ECONOMIQUE A L'AMELIORER.

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Résumé

L'information préliminaire exacte sur la nature des pertes en nourriture est nécessaire pour préparer les études sur le terrain avec une plus grande précision pour les estimations qualitatives et quantitatives.

La valeur de ces données est nettement améliorée en cumulant et en combinant des enquêtes d'ordre économique et social.

Les données sociales aident à faire des programmes de développement plus complets pour réduire les pertes de nourriture. Les analyses économiques aident à déterminer les meilleurs stratégies de réduction des pertes à introduire dans les services de développement.

Finalement, un essai au champ bien conduit peut aussi fournir de nouvelles informations pour concevoir des expériences de réduction des pertes.

Des exemples de tels essais en Afrique et Asie ont été donnés pour illustrer ces concepts.