

# APPROPRIATE TECHNIQUES FOR USE IN THE ASSESSMENT OF COUNTRY LOSS IN STORED PRODUCE IN THE TROPICS

by

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## Abstract

The techniques for estimating loss are not universally applicable and when an investigator is required to assess the losses in several commodities in a country there is a need for determining priorities - of the commodity to be studied and of the areas in the country where investigation should take place. An approach to this is described.

## Résumé

Les techniques d'estimation des pertes ne sont pas universellement applicables et, lorsqu'il est demandé à un chercheur d'évaluer les pertes concernant diverses autres denrées dans un pays, il est nécessaire que les données prioritaires soient définies - de la denrée à étudier et des secteurs dans le pays où les recherches doivent avoir lieu. Une manière d'aborder cette question fait l'objet d'une description.

## Resumen

Las técnicas empleadas para efectuar un cálculo de las pérdidas no son aplicables universalmente y, cuando se requiere que un investigador evalúe las pérdidas que se producen en varios productos de consumo en un país dado, será preciso determinar el orden justo de prioridades referentes al producto que ha de estudiarse, así como las zonas del país donde habrán de llevarse a cabo las investigaciones. Se describe un modo de abordar este problema.

## Introduction

The assessment of post-harvest losses need not be a difficult and expensive exercise. Much confusion has been created by debate over methodology, but the simple methods described here for estimating losses due to insects and rodents have been tried and tested by the author in the field for over eight years and have been found reliable. This is not to exclude the more complicated and comprehensive approach suggested by some (eg Harris and Lindblad, 1978; Board on Science and Technology for International Development, Commission on International Relations, National Research Council, 1978) but to demonstrate that in difficult field situations (and when funds are limited) a simple approach based on sound reasoning is a viable alternative to 'multidisciplinary teams'. Plans for vast information gathering exercises are therefore to be viewed with caution.

## A loss assessment programme

The main features of a programme to assess country losses are:

### 1. A defined scope of work

Here, it is decided whether the investigation should include

- i. All stored produce,
- or ii. only cereals and pulses,
- or iii. the main cereals.

The scope will obviously depend on the resources available. Generally, it is not necessary to examine losses in all stored produce because much of it is stored in such small quantities for such a short time that economic loss often does not occur (perishables are a possible exception). In Kenya, for example, it was concluded that losses in maize account for about 80 per cent of the losses in all food stored. It was therefore considered wise to devote most of the resources available to determining the actual extent of these losses.

## 2. A defined data base

There is a certain amount of basic data that must be obtained if a sensible figure of loss is to be arrived at, but before this can be done, the exact nature of the losses to be estimated must be defined. Although Hall (1970) has listed six types of losses, the only real loss that can be accurately measured is the loss in weight. For greater accuracy, data should be compiled on a dry weight basis by drying (such as in a ventilated oven at 130°C for one hour or a similar international standard depending on the type of produce).

Other important basic data is the amount of food remaining in the farmer's store at successive points in time between two harvests (De Lima, 1973), and in the initial period after harvest of the available surplus that the farmer may sell or otherwise dispose of (Figure 1).

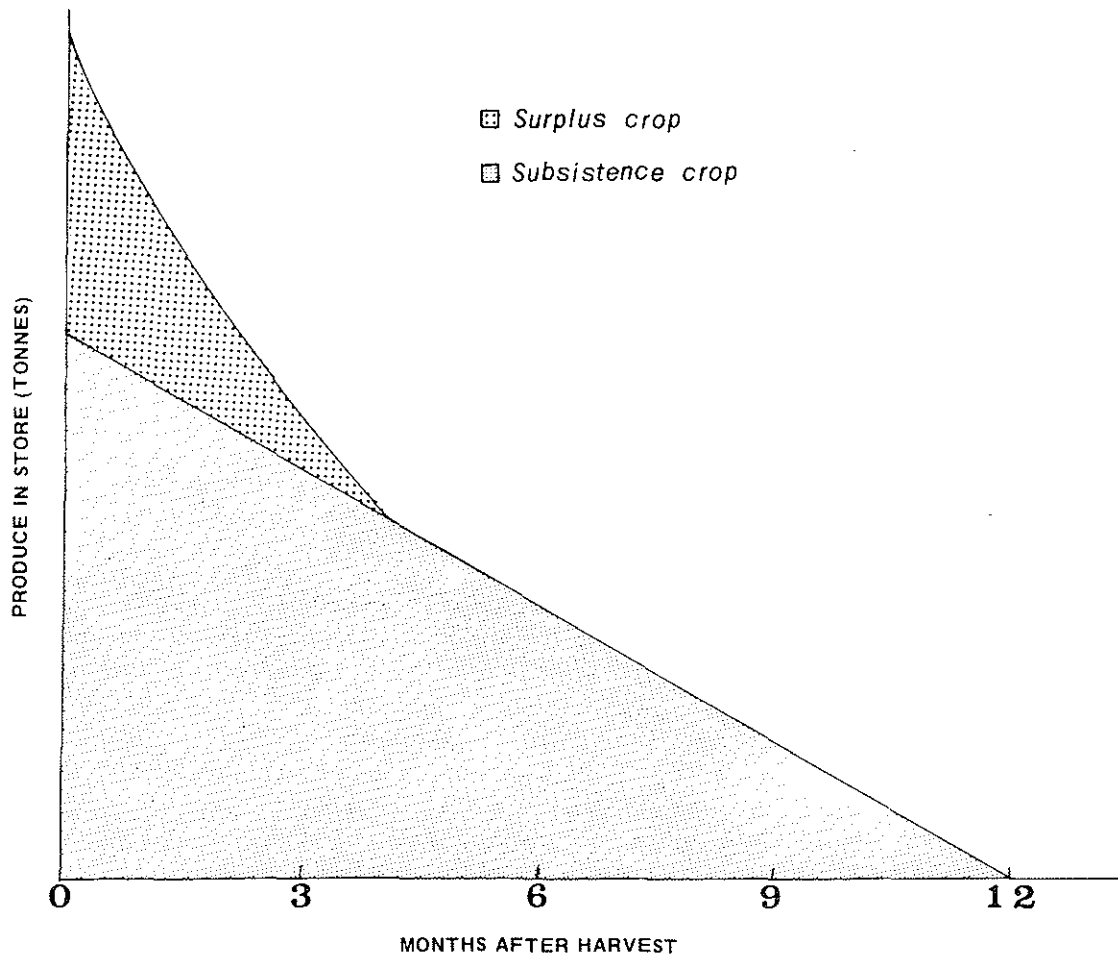


Fig 1. Pattern of consumption of harvested produce. When the surplus is disposed of, consumption is almost linear. (Modified from De Lima, 1973)

The data base for estimating losses in stored grain would therefore primarily include:

- i. A measure of weight loss due to damage from insects, rodents and fungi
- ii. An estimate of the national harvest and of the quantity of grain remaining at successive intervals between two harvests.

All other information would be of secondary importance to the exercise.

## 3. A practical framework

When an attempt is being made to quantify losses in a country it is not wise to load the programme initially with extensive socio-economics. Once an accurate loss estimate is made, further work may be justified. A practical framework is therefore important for efficiency of execution and accuracy of data (De Lima, 1975). The main aspects are:

**i. An inventory of the domains of study**

The 'domains of study' (Yates, 1971) is a term used to indicate subdivisions for sampling after stratification. It is necessary to stratify before sampling (De Lima, 1973, 1975) so that account may be taken of administrative divisions and of variations in ecology. Stratification may also be done after sampling (De Lima, 1978) when for example it is found that a certain proportion of the random sample has a special attribute, eg a proportion of the stores are treated with an insecticide. To simplify matters however, stratification may initially be done by taking into account only the political boundaries (ie provinces, districts) within a given country. Usually, these boundaries also reflect ecological, climatic and sociological differences. Areas for sampling may also be selected according to a set of priorities (De Lima, 1975) so that proportionately more work is done in areas that harvest more and store for longer periods.

**ii. A working sampling frame**

In previous (1970-71) work (De Lima, 1973) two aspects of the sampling frame were identified for each stratum:

- a. the sample of stores from the total population
- b. the sample of grain from each selected store.

A sample is some portion of a population, selected from the whole in accordance with exactly specified rules (Finney, 1972), and sampling procedures are concerned with measuring states as they exist.

**iii. A sampling procedure**

**a. Samples of stores**

In many tropical countries, selecting farmers' stores for sampling is difficult. The farming community often consists of between 70-80 per cent of the population, and while lists of villages may be available, lists of farms and farmers may not. In most of Africa 'villages' do not exist as such because each farmer lives on his own holding (or on one of his several scattered holdings). The attempt to compile such lists would require more effort than the loss assessment exercise itself and would be counter-productive.

Area and cluster sampling techniques (De Lima, 1973, 1978) are more appropriate in such situations and where time and costs do not permit even this, a 'line' sampling technique may be used (De Lima, 1978).

**b. Sampling of grain**

Some workers, eg Adams and Harman (1977) recommend the taking of samples regularly from the grain that the farmer is actually going to consume until the store is empty. However where such an intense sampling programme cannot be undertaken, ie when an estimate of loss within a store at a given point in time is required, it is necessary to sample the entire contents of the store. When sampling produce within a store it is necessary to divide the contents into sampling units in such a way that every unit has an equal opportunity of being selected.

When maize is stored on the cob or sorghum on the head, each cob or head forms a convenient sampling unit. If beans are stored in the pod or shelled, and wheat, maize, sorghum, teff, millet and other grain are stored in a shelled or threshed condition a way has to be found of dividing the produce into convenient units. Usually, only one cereal is the main staple and other cereals are less important. Pulses also are found in smaller quantities with respect to the main cereal. In practice therefore, there is an advantage in using separate sampling procedures for the larger quantities of the main cereal and the smaller quantities of the other produce.

If grain is stored in bulk and is completely accessible (to a sampling probe or similar device) there may be no need to divide the bulk into smaller units. Otherwise, all the grain in the store has to be made accessible for sampling by physically emptying the store. The contents of the store sampled in this way would be disturbed and so a store once sampled, would not be selected again for sampling. De Lima (1978) found this technique of sampling without replacement very convenient in his studies.

**iv. A laboratory routine**

Once adequate field samples are obtained they must be handled by a set procedure to reduce variability of results. The way the samples are handled will obviously depend on the methods used to determine the loss. Adams and Harman (1977) classified the techniques used to determine loss in weight into volumetric, gravimetric and indirect methods. They suggested that the volumetric method employing a bulk density technique was the most appropriate for their situation but De Lima (1978) found this method too variable, besides requiring a great deal of 'base-line'

work also subject to unlimited variation. Since other workers have subsequently advocated the bulk density technique without themselves having had the benefit of field testing it is necessary to emphasise the shortcomings. The bulk density of a cereal varies with the variety, moisture content, and whether or not an insecticidal or other dust (or ash) has been used. The extent of damage and type of damage (insect or fungal) also has an effect on the weight/volume ratio of the sample. In the absence of standard instruments for taking bulk density readings variations due to 'packing' occur. Thus if one wishes to estimate the loss of maize and there are six hybrid and two-three non-hybrid varieties the amount of 'base-line' work is enormous and not entirely justifiable. When a farmer does not know what hybrid he used and when the 'hybrid' is several times removed more variations occur.

De Lima (1978) found that loss could be more accurately determined by examining each sample intensively by dissecting individual grains to determine the loss caused by each pest species and establishing a loss profile. The large amount of work that this entails can be brought within bounds by reliable sub-sampling. Sub-samples not dissected are retained for subsequent cross-checking of results from dissected sampled and for determination of other parameters eg moisture content by an oven method. This method of estimating loss in a sample also overcomes the errors caused by use of the 'gravimetric' methods common in francophone Africa.

#### 4. A coherent synthesis of the data

The estimates of loss made for each sample in the laboratory have to be related to the farmer's store from which the sample was extracted. Similarly information from the sample of farmers in each stratum have to be brought together to provide loss estimates at district, provincial and finally the national level in the country (Figure 2). At each stage an analysis must be made of the errors and of the variance of the estimates. By proper treatment of the data greater accuracy can be achieved and when a final re-combination of all the information is carried out the overall picture will be considerably more accurate.

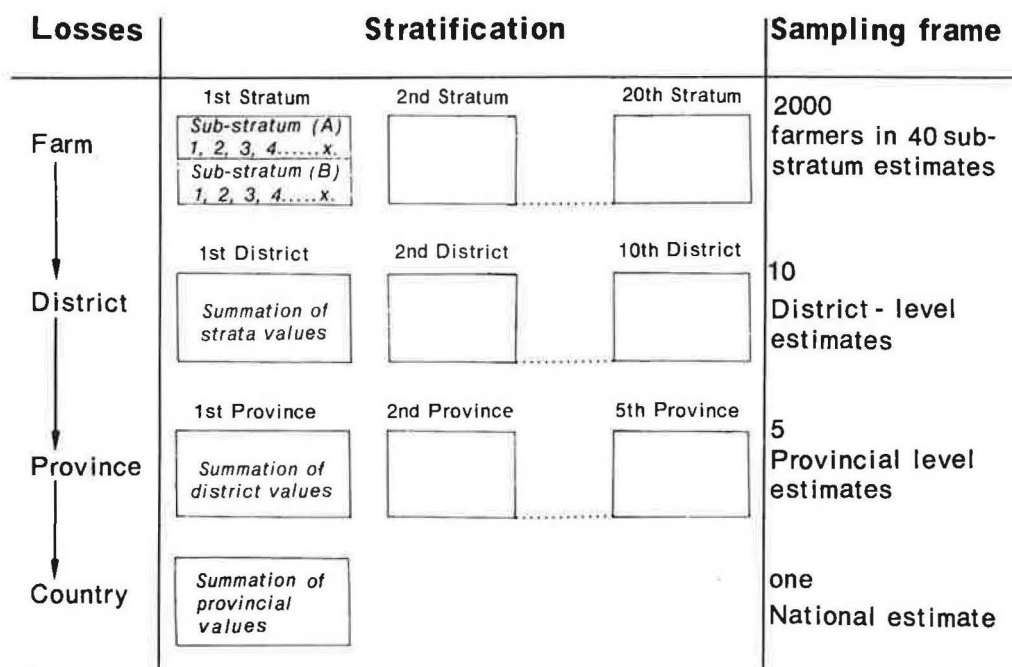


Fig 2. Stages in the estimation of country losses.

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