METHODS OF ASSESSING LOSSES IN STORED FOOD PRODUCTS

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ABSTRACT

The need for reliable estimates of losses in stores due to insect pests is emphasized. Situations in which losses occur are outlined. Major categories of losses are considered. Sampling framework and methods of estimating losses are discussed.

Keywords: *loss category, loss estimation, loss methodology.*

INTRODUCTION

This paper is written to draw attention at all levels of government departments, officials, farmers and the public to the great importance of losses in food due to insect pests and that reliable estimates of losses in store are required. Figures commonly quoted have ranged from a 10 percent worldwide loss of cereals in store, 35 percent for grain losses in India after harvest to 46 percent for sorghum losses in Nigeria (Scrimshaw 1978). Such figures, according to Spensley (1982), often quoted and requoted, are usually little more than guesses. Reliable assessment techniques might prove these figures to be over-estimates rather than under-estimates. A number of recent studies at subsistence farmer level (see Boxall and Gillett 1984. Tyler and Boxall 1984 and Evans 1987 for references) point to levels of loss of the order of about 5 percent or less. The report of the First Regional Grain Conservation Seminar held in 1978 in Lusaka, Zambia stressed an urgent need for more precise studies on losses during and after harvest in terms of their magnitude, nature, and point of occurrence. The methods of measuring losses during and after harvest and during the various processes of marketing need to be standardised, at least regionally. Such studies are essential for the development of rational and viable post-harvest loss management programmes. The term pest used in this paper refers to insect pests.

Detecting Insects in Stored Produce

Before starting loss assessment studies, it is necessary to have a knowledge of the pest species occurring in the produce. the following stages may be present in the commodity:

1. Living adults
2. Dead adults
3. Living larvae
4. Dead larvae
5. Living pupae
6. Dead pupae
7. Eggs

The identification of pest species requires specialist knowledge. With the correct name, it should be possible to know its biology and behaviour and whether or not secondary pests will be able to infest the produce in store. Methods for detecting insects in stored produce have been described by Ashman *et al.* (1970).

Detection of insects may be combined with a preliminary survey, which may often help to clarify pest problems and give information on where most losses occur (Freeman 1978).

Situations in Which Losses Occur

This has been discussed by Harris (1978). Post harvest grain losses are caused by insects, rodents and birds, during harvesting, transport, storage and processing of the produce, on government and commercial farms, during distribution, wholesale and retail handling and in the household itself.

Harris and Lindblad (1978), in their manual on Post-Harvest Grain Loss Assessment Methods, rec-

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ommend a three-step procedure for making loss assessments and decisions on the feasibility of intervention, control or prevention:

1. Obtain an overview of the whole post-harvest system.

2. Make a rapid on-site appraisal that will focus on the potentially significant losses, the "peaks" in the system.

3. Study specific losses and methods of loss reduction and prevention.

The factors to be considered in any rapid on-site appraisal are as follows:

(a) Moisture content of the produce and outside.
(b) Length of time and temperature of holding.
(c) Local quality and quality control.
(d) Type of bins or other storage structure.
(e) Standard of sanitation in the store.
(f) Presence or absence of any trading quality factors.
(g) Use of pesticides and the technical standard of their use.
(h) Evidence of insect and rodent damage in grain: the kinds and amounts of insects, their frass and webbing exit holes and rotten kernels, or kernels damaged by rodents and presence of their excrements.

Mechanical Losses in Handling or Processing

In the tropics, storage over extended periods of time without reasonable control of temperature and moisture and without sound rotation of the produce in store may result in serious losses due to pests.

The Nature of Loss

Attempts to categorise losses have been reviewed by Howe (1965). Parkin (1956) divided losses into two categories: (a) a general estimate, or an informed expert guess; (b) an estimate based on actual measurements, however crude, of loss in weight or quality of produce.

Hall (1970) recognized the following major categories of loss:

(i) Weight Loss

This is a physical loss of substance, as shown by loss of weight or volume, caused by insects, rodents or other pests. Such a loss can easily be accounted for and quantified. However the following points ought to be noted:

a. Where there is sale by volume, especially in rural areas, such a loss may remain undetected.

b. In large scale trading, when there is adulteration with inert materials, weight loss may appear greater.

c. Increase in moisture content due to the activity of some insect pests may also show as a loss when dried.

(ii) Loss in Quality

Various commodity and marketing boards, for example the Cocoa marketing Boards in West Africa, have specific criteria which permit values to be placed on certain aspects of quality. The presence of insects, their remains, their excreta, damage and moulds obviously lower the quality of the produce.

(iii) Nutritional Loss

Feeding by pests may reduce the nutritional value of the produce. For example, fungal damage and the consequent production of toxins, such as aflatoxin, will make the product unfit for human consumption. The presence of insects and their remains may cause customers to reject the produce for fear of nutritional hazards.

(iv) Loss of Seed

Seeds are usually stored with extra care because they affect future food supplies. However losses due to pest infestation, excessive respiration, fungal diseases and inadequate or inappropriate control measures may still occur.

METHODOLOGY

De Lima (1979) stated that the scope of any loss assessment studies should be clearly defined. It should be decided whether all the stored produce or part, some section, category (some kind of it) is to be sampled to measure the extent of losses. The actual process of assessing losses will vary according to the individual situation but usually involves the following.

The Survey

An initial survey should be carried out to select an area in which to measure losses, and to select farmers and stores from whom the samples of produce will be taken. Such surveys usually provide a general idea of the problems involved.

The Sampling Framework

Sampling Stores

For the choice of farmers and stores recognised statistical procedures should be followed. De Lima (1979) suggested the use of a 7 x 7 Latin Square, superimposed over a map of the area surveyed to select sample stores. Area and cluster techniques (De Lima 1973, 1978) are more appropriate in cases where villages do not exist and each farmer lives on his own holding. Where cost does not even permit the use of these techniques, a line sampling technique may be employed (De Lima 1978) using a vehicle and stopping at fixed distances along a road. Sampling and its limitations are discussed by Zarkovich (1965, 1966) and others (e.g. Harris and Lindbald 1978).

Sampling of Grain

For sampling grain, Adams and Harman (1977) recommended intense sampling programmes such as taking samples regularly from the grain that the farmer is actually going to consume until the store is empty. However, where such a programme cannot be undertaken it may be necessary to divide the contents of the store into sampling units in such a way that every unit has an equal opportunity of being selected (De Lima 1979).

As practical examples given by De Lima (1979), 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, or wheat, maize, sorghum, millet and other grains are stored in a shelled or threshed condition, a way has to be found of dividing the produce into convenient units. However, if grain is stored in bulk, is completely accessible, and a sample divided or similar device can be used, there will be no need to divide the bulk into smaller units.

The Estimation of Loss

Although it would be ideal to base losses on the reduction in weight, nutritional or other quality, loss of seed or in practice, it may be necessary to confine studies to weight loss only, if facilities are limited.

The methods used to determine the loss have been classified by Adams and Harman (1977) as follows:-

i Volumetric
ii Gravimetric
iii Indirect methods

They suggest that the volumetric method, involving the weighing of a standard volume of sample and comparing it with the same volume of visibly damaged grains, was the most appropriate in the small farmer situation. However, De Lima (1978) criticized this method.

i. The method is too variable and requires a great deal of base-line data.

ii. The bulk density of a cereal varies with the variety moisture content, and whether or not an insecticidal dust or ash has been added.

iii. The extent and type of damage due to insects or fungi affect the weight/volume ratio of the sample.

iv. Without the use of standard instruments, variations in bulk density readings occur due to 'packing'.

De Lima (1978) advocated the intensive examination of each sample by dissecting individual grains to determine the loss caused by each pest species in order to establish a loss profile.

The Thousand Grain Mass (TGM) Method

The basic principle of this method considers that when an entire lot of grain is weighed before and after being attacked by insect pests or some other causative agent, the percentage loss of mass is easily calculated by using the formula:

$$\frac{m_1 - m_x}{m_1} \times 100 = \%$$

where m is the grain mass before attack and m is the grain mass after attack. Mass is the dry matter weight.

In this method the sample taken from the lot must be representative. This means that if a lot consists of 30% large grains, 50% medium and 20% small grains, these properties should be found in a representative sample. Similarly if 10% of the grains in the lot are damaged this percentage of damaged grains should also be found in the representative sample. The authors of this method (Proctor and Rowley 1983) believe that the method is based on sounder principles than any methods previously developed.

Synthesis of the Data

De Lima (1979) stressed that the estimates of loss made for each sample in the laboratory must be related to losses in the farmer's store from which the sample was taken. Information from the samples of farmers in each stratum have to be brought together to provide overall loss estimates for the district province or region and finally at the national level for the whole country. Clearly there is a need for further research on loss assessment methodology and practical methods allowing rapid appraisals to be made at the farm level are required (ECA and ICIPE 1988). Location specific studies also need to be carried out (Gahukar 1994).

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