A REVIEW OF THE USE OF PHYSICAL STORAGE PROCEDURES IN EAST AFRICA: ASPECTS FOR IMPROVEMENT AND EXTENSION

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INTRODUCTION: In East Africa more than 80 percent of the harvested produce is stored on the farm in traditional granaries. At the subsistence level the staple crops are maize, millets and sorghums. Teff is important in Ethiopia. Rice and legumes often form an important part of the diet. In urban areas wheat is also consumed.

IMPROVEMENTS ON PHYSICAL PROCEDURES IN SUBSISTENCE STORAGE:
Various ashes and inert dusts - Mixing wood ash with grains was previously practiced in East Africa but is not common now. Generally, fairly large quantities of wood ash are required (a ratio higher than 1:5 of ash to grain) for adequate control. Wood ash, cow-dung ash, and inert dusts, although claimed to provide some control (1, 2) are generally not very effective in practical terms when compared with insecticidal dusts. Thus even at the rate of 20 gm ash to 100 gm beans, Schoonhoven (3) recorded fairly high levels of damage in the ash treated grain, even though significant reductions of the pests was obtained. The use of wood ash and inert dusts alone are therefore unlikely to be of much practical benefit but further improvements could be made when these methods are combined with other physical storage procedures like airtight containers or natural physical barriers discussed below.

Natural physical barriers - Several grain types have some form of natural cover when they are harvested. Maize is covered by a husk or sheath, beans are covered by pods, rice paddy has a husk. Usually, only a proportion of the harvest has an intact cover that will act as an effective barrier to pests. The major part of the harvest will not have the natural protective cover because of weathering and varietal effects and will have to be protected in another way. However, by proper selection a significant proportion of the harvest can be protected simply by retaining its natural cover intact. De Lima (4) has shown that approximately one-quarter of a maize harvest of hybrid grain has a sufficiently intact husk cover, to provide the stored crop with adequate protection. A trial to compare the effectiveness of the intact husk with an insecticidal treatment showed that (Figure 1) there was not much difference between the protection given to maize cobs for which the intact husk had been retained (but no further treatment given) and the de-husked cobs which were treated with a 2% malathion dust. These two treatments were far superior

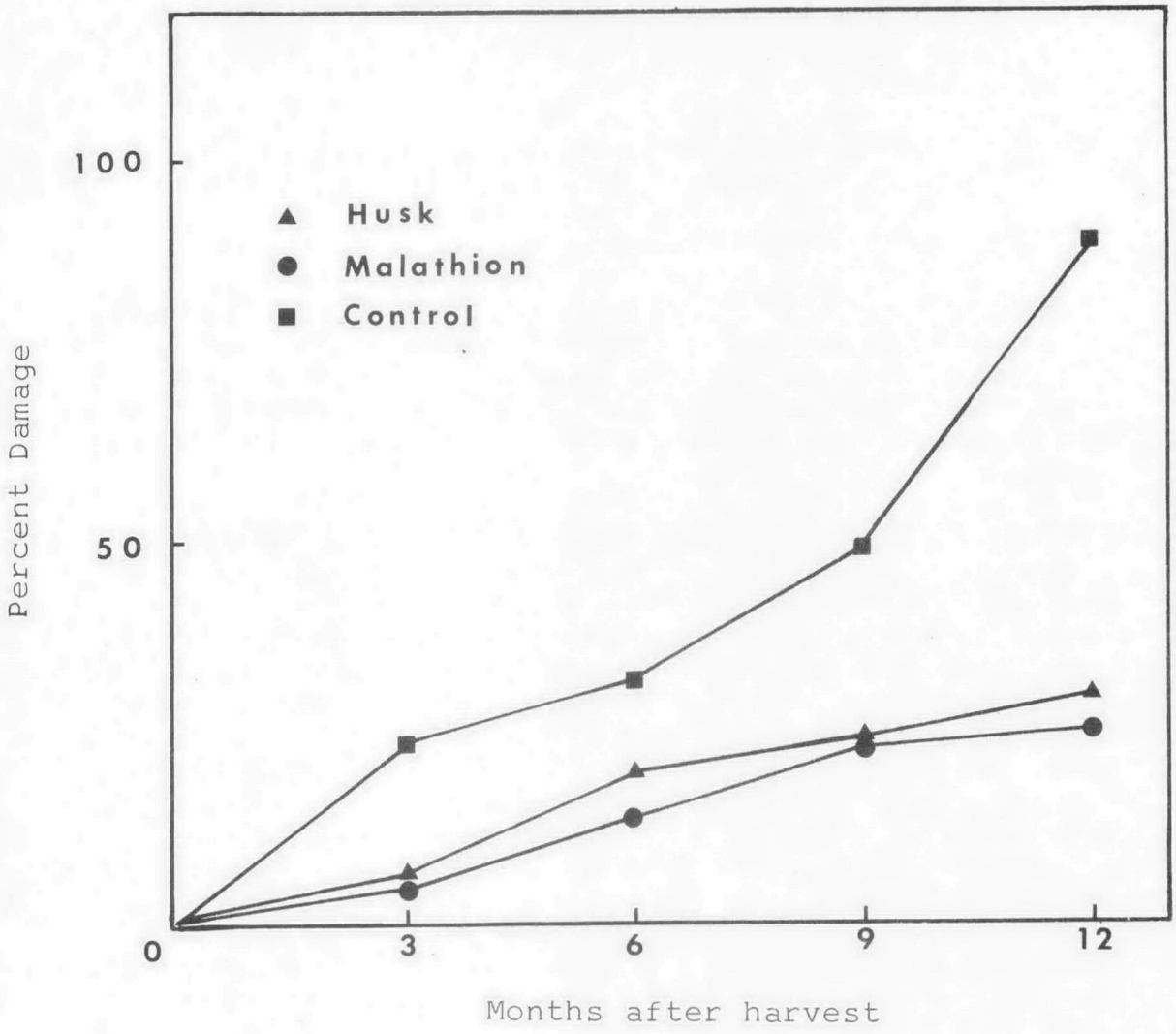

FIGURE 1. Comparative effectiveness of physical control provided by an intact husk cover on maize and an insecticidal dust on de-husked cobs (1975-76 trial in Bukura).

to the control (which was not dusted and had been de-husked). Caswell (5) has shown that the intact pod provides greater protection to the food beans it encloses and Breese (6) found that paddy with sound husk was less damaged by *Rhyzopertha dominica* and *Sitophilus oryzae*.

Semi-hermetic storage - Semi-hermetic conditions are obtained in traditional underground pits in Ethiopia. Boxall (7) was able to suggest improvements in the storage methods. He compared various linings for the under-ground pits: matting and straw; polyethylene sheets or sacks and concrete lining or a combination of these barriers. These linings reduced damage due to moulds by restricting and preventing the ingress of water over

a period of 4 months and also resulted in less damage due to insects and rodents.

Gourds are often used as receptacles for storage of beans, sorghums and millets. Insects breed well in these containers and damage to the grain stored within is often severe. Loss in this situation is especially important from the nutritional view-point because the grains stored in these containers are a scarce commodity often preserved for the use of nursing mothers. McFarlane (8) examined some gourds used in Kenya (empty dry fruit cases of *Lagenaria cineraria* and related curcurbits) and showed that by treating the external surface of the gourd with linseed oil or varnish, the oxygen permeability was greatly reduced and the container could be used as a semi-airtight receptacle if well-sealed at the neck.

IMPROVED PHYSICAL PROCEDURES IN LARGE-SCALE STORAGE: Of the physical storage procedures available for practical use on a large scale under tropical storage conditions, the use of controlled atmospheres provides the most promising approach for improved storage at low cost. Naturally induced inert atmospheres are among the easiest to achieve in large air-tight structures.

Hermetic storage - In Kenya, seventy hermetic ("Cyprus") bins were constructed to hold approximately 100,000 tons of grain as a famine reserve (Figure 2). Over the past 10 years during

Figure 2. The "Cyprus Bins" - semi-underground hermetic structures. Each bin can hold approximately 1,500 tonnes of grain.

which these structures have been in use, several long-term trials have been conducted to test their effectiveness. The rate of depletion in the oxygen level depends largely on the presence of a pest population. Thus in the absence of a pest population (or its presence at very low levels) the amount of oxygen in a bin would tend to remain the same for a long period of time (Table I).

TABLE I. Storage of maize in the "Cyprus Bins" under hermetic conditions.

Bin no.	Length of airtight storage months	Infestation level insect/kg live/dead		% oxygen
Kitale				
1	33	0.1	5.6	9.25
5	32	-	2.2	8.75
13	32	-	-	8.25
31	21	-	-	10.00
32	21	-	-	17.00
35	21	-	-	12.50
37	21	-	-	10.25
Nakuru				
3	34	0.2	0.3	4.75
4	37	-	-	2.45
9	33	-	0.48	4.05
12	39	-	-	3.20
24	38	-	-	3.00
27	32	-	-	3.20
28	39	-	-	3.60

In the early management of the bins, filling and emptying was done with the help of pneumatic conveyors which caused a fair amount of breakage as as a result the high concentrations of dust and broken grain at certain points in the bins caused heating. Subsequently chain conveyors were installed and their use resulted in negligible breakage and no heating over a two year trial period and in a further two years of routine use.

Of the 70 bins built for use in Kenya, 40 are in Kitale and 30 are in Nakuru. At each site, one-third of the bins are emptied and filled every year so that grain remains in each bin for a maximum period of 3 years. In cases where the grain has remained longer no deterioration has been observed. Several bins were emptied in 1974-75 after a 3 year period of storage and overall weight losses were established as 2.48%. This works out

to approximately 0.8% per year. This overall loss figure includes losses due to grain destroyed by heating or mould, losses due to dust extraction in the clean-up process, losses due to classification of grain as undergrade and losses due to non-estimatable causes like respiration. Losses due to pest damage were negligible. In comparison it should be noted that losses in conventional large scale storage are generally in the region of 2% per annum. Operational costs (including labour, fabric repairs, pest control etc.) were also extremely low and over the 1972-76 period worked out to approximately K£ 0.3 per ton (0.6 U.S. $) for the 4 years period.

Aeration and cooling - In the high altitude areas of Kenya the temperature conditions are sufficiently low to permit cooling of produce for better storage. Stirling (9) was able to show that under general storage conditions of coffee, which are moderately warm, it would be advantageous to ventilate the coffee at appropriate humidities. He developed an automatic control circuit for a ventilation system and showed that under cool dry ventilated conditions parchment coffee could be stored for at least 12 months with negligible woodiness appearing in the cup liquor.

DISCUSSION: One of the most important physical storage procedures that needs special emphasis in the tropics is cleanliness in storage. Good hygiene and proper store construction to minimise harbourage for pests and to enable easy cleaning will go a long way towards preserving the stored grain from unnecessary damage.

Under present storage conditions in developing countries some of the storage receptacles which are already in use as hermetic or semi-hermetic containers could be further improved. In large-scale storage more care and consideration could be given to appropriate store design of conventional stores to promote cooling by aeration.

In many countries consideration needs to be given at the national planning level to the storage of grain as a famine reserve, and for such a purpose the low cost hermetic structures - the "Cyprus Bins" have proved their worth.

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