ECOLOGY AND THE INTEGRATED CONTROL APPROACH UNDER TROPICAL CONDITIONS

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INTRODUCTION: In most tropical countries more than four-fifths of the harvest is stored for subsistence in traditional granaries. The remaining 20 per cent is generally stored in large scale warehouses in urban areas and is handled by national grain agencies. The ecological conditions for pest development vary widely under these two contrasting conditions of storage and there are important differences between the pest fauna.

THE INTEGRATED CONTROL APPROACH: The study of the ecology of the pest complex in each situation is of special importance in the context of integrated control. Way (1) states that integrated control is "nowadays usually defined as involving the compatible use of a combination of appropriate methods of pest control." With growing crops in the field, integrated control in the above sense has found several applications and has resulted in less dependency on the use of chemical pesticides. In stored produce however, there are several difficulties to be overcome, the main one being that of the economic injury level. In affluent countries one insect in a packet of rice could be considered a pest at the economic injury level if the packet is rejected. In tropical countries especially in the rural areas there is a higher threshold of tolerance to insects in stored produce and to insect damaged grain. De Lima (2) estimated economic damage in subsistence storage by considering the cost of the insecticide treatment and the amount of grain that would be saved by its use.

CHEMICAL WITH PHYSICAL STORAGE METHODS: Physical barriers like the husk cover in maize, the pod cover in beans and the husk on paddy are often able to protect grain from damage by insects. It is necessary however that these physical barriers be intact but since only a fraction of the harvest normally has suitable physical protection, the rest of the harvest needs to be preserved by chemical or other means. A study of the pest population on maize with a poor husk, a good (intact) husk and without a husk showed (Fig. 1) that the intact husk was significantly able to protect the maize from pest damage. A comparison of chemical control to de-husked cobs (Table 1) showed that the intact husk with fumigation was as effective as fumigated de-husked cobs treated with a chemical dust in preventing damage to maize grain.

VALUE OF PARASITES IN STORAGE: In rural storage the possibility exists for the use of natural parasites for control of the pest

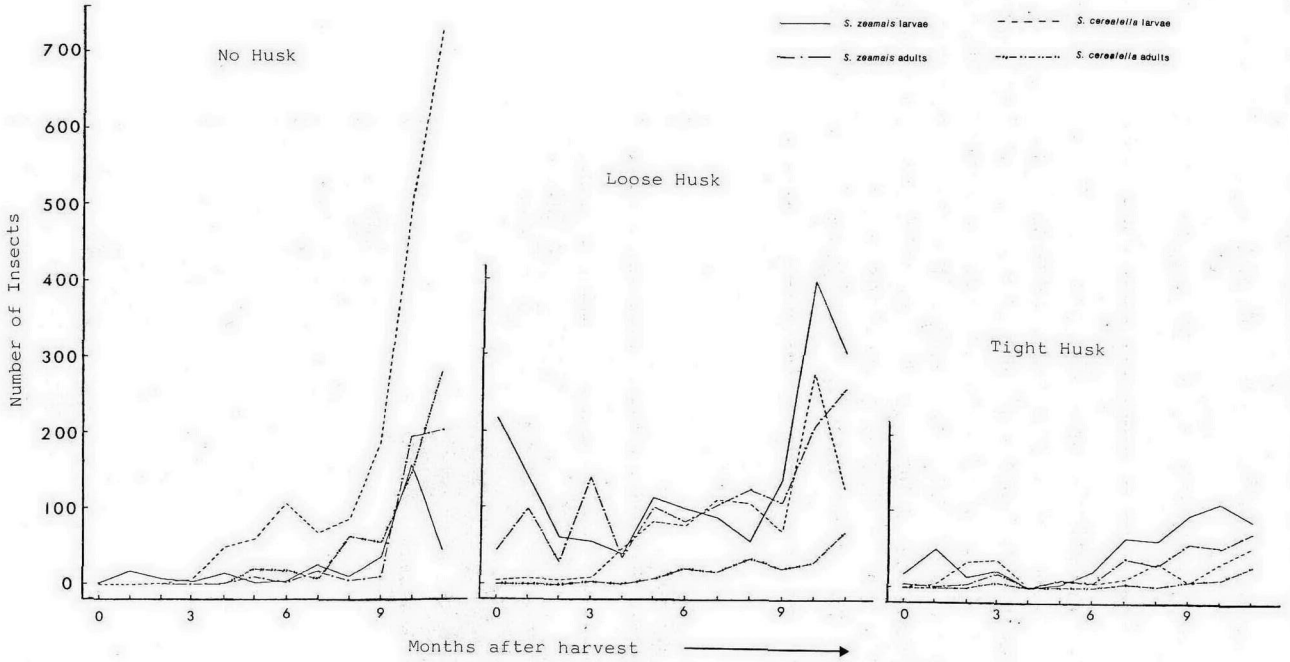

FIGURE 1. Control of damage to maize grain by use of the natural cover to physically exclude insect pests (1973-74 trial in Kitale).

TABLE I. Damage to maize in an insecticidal dust and fumigant trial in the 1976-77 storage season in Njoro (mean ± damaged ± standard error).

Time after treatment	Fumigation only	Fumigation + intact husk	Fumigation + malathion dust (10 ppm)	Untreated control (de-husked)
6 months	8.34± 1.04	1.83± 0.69	4.62± 1.30	37.60± 6.73
12 months	66.45± 3.46	18.37± 3.34	23.89±11.68	90.22± 2.10

population if these parasites are effective. This is because the subsistence farmer would tolerate some damaged grain as would occur due to dependence on biological control. Unfortunately insect parasites are generally ineffective and exert little control over the pest population. The percentage parasitism recorded in an ecological study on the pest fauna in traditional stores was extremely low and the parasites were not able to effectively control the host species. Figure 2, gives some

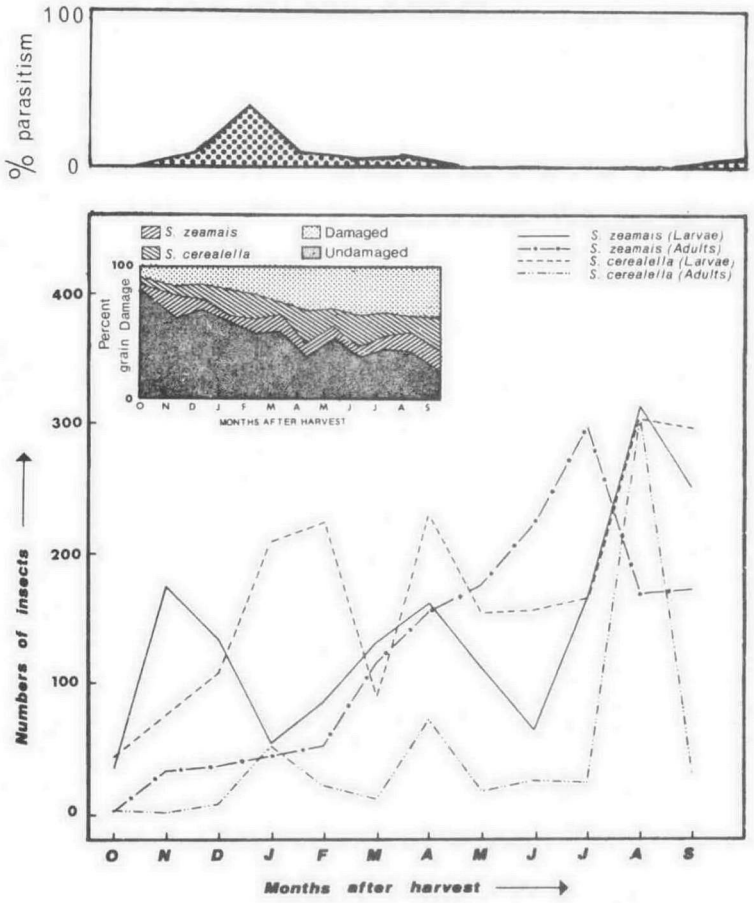

FIGURE 2. Effect of parasites on the development of a pest population in maize grain (1973-74 in Kisii).

information in one of the places, Kisii, where the highest levels of parasitism were recorded, and it was seen that even there the parasites were not able to reduce the pests and the proportion of the grain destroyed was extremely high. A search through the literature likewise fails to reveal any evidence of economic control from parasites in stored produce.

INTEGRATED CONTROL POSSIBILITIES IN LARGE SCALE STORAGE: As mentioned earlier, the possibilities for integrated control in large scale stores are difficult to achieve in the true sense of the definition of "integrated control." Thus, Way (1) indicates that pesticides should be introduced into the integrated control context only when necessary to avoid predictable economic damage and should be used to complement and supplement other methods when these cannot keep pest populations below economic injury levels.

In an urban situation where one bean weevil or one damaged bean constitutes economic injury, most store managers and grain boards will view with skepticism suggestions on integrated control especially if the definition involves cost of control versus (value of) loss in weight of produce due to pest damage.

So what is there to offer? I believe that in the scientific field (as opposed to the commerce of stored produce) we can look at the entire storage network in a country and consider the options. For example we can consider that one fraction which will be consumed fairly quickly, that is within 3-4 months after harvest, needs only to be fumigated while another fraction needs to be treated with an insecticide as well to suppress re-infestation because it will not be needed until the 5th month after harvest. For grain that will be stored for more than one year before being consumed we may consider the possibilities of storing under hermetic conditions.

In Kenya, hermetic storage in semi-underground "Cyprus" bins has proved to be an extremely effective way of preserving a "famine reserve" for 3 years or more with little dependence on the use of pesticides. The economics of handling grain in this way also make the storage of grain very worthwhile from the national point of view (3).

Other areas where possibilities exist for integrated control in large scale stores are to combine the release of synthetic pheremones from traps which also contain an insecticide to kill attracted adults (4). There are also advantages in introducing aeration to cool the produce and thus reduce the rate of pest development (5). This, however, may not be entirely economical (often because the grain is sold to the consumer at a controlled price) and so would have to be limited to very valuable commodities like coffee (6).

DISCUSSION: Good store hygiene is of vital importance under any circumstances and cannot be too strongly stressed under tropical conditions. Combining chemical control with the physical control

of natural barriers like the intact husk is important under substistence storage conditions as this may mean less expenditure on chemicals and also less insecticide in the farmers' diet. Plant breeders should take note of the benefits of an intact husk and pod and include such characteristics in the breeding programme.

More use may be made of synthetic pheremones, as these are developed, to serve as an early warning guide for store managers. In some situations possibilities exist for using micro-organisms to control stored-product pests but these are likely to be viewed with caution by the general public and applications may have to be limited to surface sprays and to the store fabric. There appears to be limited possibility for introduction of biological control by use of insect parasites and predators. Possibilities exist for the use of ionising and non-ionising radiations to control storage pests, especially in more valuable commodities. Within the next 15-20 years there is considerable scope in the tropics for improved control by combining chemical control with the development of physical barriers for the saml l scale farmer and for rationalising chemical control with the use of controlled and inert atmospheres in large scale storage.

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