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# COPING STRATEGIES EMPLOYED BY FARMERS AGAINST THE LARGER GRAIN BORER IN EAST AFRICA: PRELIMINARY OBSERVATIONS

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*Abstract*

*The Larger Grain Borer, Prostephanus truncatus (Horn), has been established in East Africa for more than 15 years. During that time, recommendations have been introduced to enable farmers to combat this most destructive pest of stored maize and dried cassava. The initial control method introduced was to shell maize, treated it with an insecticidal mixture and store it in a suitable container. This procedure represented a major change for families who traditionally stored maize on the cob. Subsequently, other methods have been tried including spraying cobs with insecticide and the release of a biological control agent (in Kenya), Teretriosoma nigrescens, a histerid insect. No specific methods have been developed for cassava, farmers have simply been advised to leave the tubers in the ground for as long as possible and, therefore, to reduce the storage period. Other than an evaluation of the rate of uptake of recommendations there has not been any assessment of the efficacy of treatments used to protect maize against LGB nor the extent to which farmers are coping with this pest.*

*Surveys were conducted in six regions throughout LGB-infested areas in Tanzania: Arusha, Iringa, Kilimanjaro, Morogoro, Rukwa and Tabora to determine the extent of the pest problem, the strategies farmers are using to overcome it and the constraints they face. A total of 390 farmers were interviewed individually, between 47 and 79 in an average of four villages in each region. In these villages, group discussions were held to put the LGB and other storage problems into a general agricultural perspective and to compare the current situation to that which occurred when the pest was first introduced.*

*The results of the survey present something of a puzzle: With the exception of a minority of farmers the Tabora and Kilimanjaro survey districts, P. truncatus does not appear to have influenced production, storage and marketing outcomes to any significant degree in any of the districts surveyed. It is true that there is considerable evidence that farmers in some areas have changed their storage behavior: the key behavioural changes have been (i) a much more widespread use of ASD and, in*

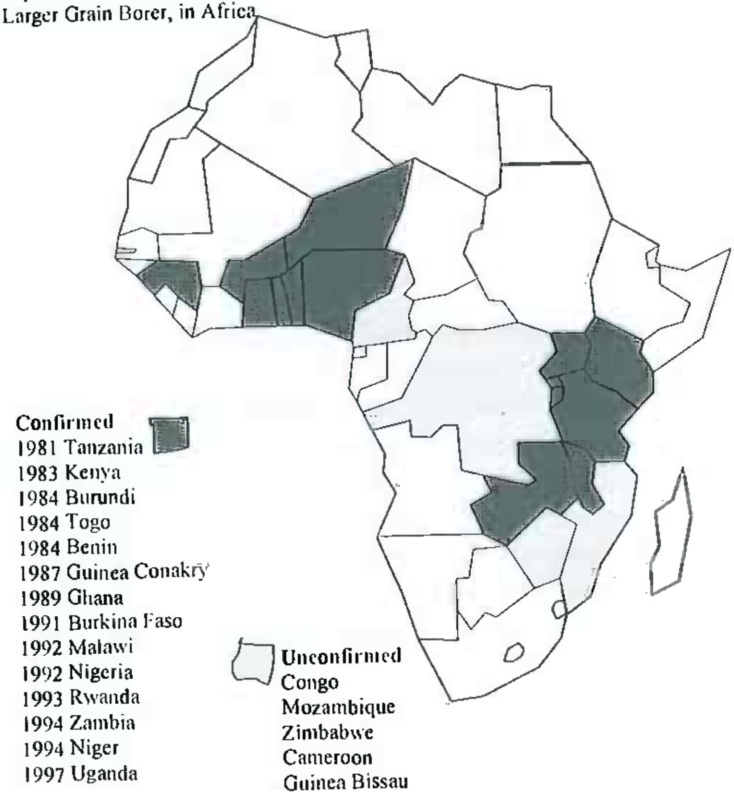
*Kilosa district Morogoro, Actellic EC; (ii) a concomitant increase in the incidence of shelling of maize (with the exception of Kilosa) and (iii) decrease in crib and platform storage. However, the changes have by no means been universal, and there are significant concerns about cost, availability and efficacy of ASD and cost and availabilty of sacks for storage. In these circumstances, it is legitimate to wonder why P.truncatus has not had more of an impact on production, storage and marketing outcomes. One possible answer is that farmers have been overestimating the difficulties that they are encountering with pesticides and sacks. This is possible, although problems with adulteration, cost and availability are well known. Another possible answer is that the use of good protection measures in the past has prevented the build up of LGB in the villages to such an extent does not cause significant damage to poorly protected grain. This seems more likely.*

*In these circumstances, there have to be legitimate concerns over the prospects for the future, as if adequate protection measures are not taken, P.truncatus populations will soon increase, and losses will rise. When farmers have access to reliable insecticides and adequate storage structures, the indications are that they will use them if they can afford to. The implication is, therefore, that measures be taken to tighten up the regulation of pesticides and ensure that they are more widely available. In addition, the question of cost should be considered, and if it is not tenable to reduce cost then this argues for an increased emphasis on low cost (perhaps botanical) protectants and on integrating other, less effective control measures to achieve adequate control. These issues merit further investigation.*

## 1.INTRODUCTION

The Larger Grain Borer (LGB), *Prostephanus truncatus* (Horn) was first reported as a pest in Africa nearly 20 years ago (Dunstan and Magazini, 1981). Since then, the beetle has spread throughout both East and West Africa, its current distribution being shown in figure 1.

Figure 1 Current distribution of *Prostephanus truncatus*(Horn), the Larger Grain Borer, in Africa




*P. truncatus* is a major pest of stored maize, the primary food staple of most of sub-Saharan Africa. The beetle is able to develop and reproduce in maize and dried cassava and, because of its boring activities, its is capable of damaging a large variety of commodities including other food commodities, wooden objects and drying timber, and leather. This pest can cause more than twice the weight loss in maize as would be expected from infestation by indigenous insect pests such as *Sitophilus zeamais* (Motsch.) (Dick, 1988).

Weight losses caused by *P. truncatus* were first measured in western Tanzania where farmers were found to lose a mean of 9% of their stored maize during up to six months storage (Hodges *et al.*, 1983), although some farmers lost as much as 35%. These levels of loss were derived from single spot estimates and therefore do not reflect what occurs over an entire storage season of 10 months or more. When losses were accumulated over the course of a nine month storage season in Arusha, Tanzania dry weight loss rose to more than 30% (Keil, 1988; Henckes, 1994) and similar observations have been made in West Africa (Pantenius, 1988). However, although these observations include damage to grain by all storage insect pests including *Sitophilus* spp. as well as *P. truncatus*, they do not take into account the declining quantity of grain in store as the season progresses; grain is removed both for consumption and sale. These calculated losses of more than 30% therefore grossly overestimate the real losses, caused by *P. truncatus* and other insects, farmers' suffer during the course of a storage season. The real losses suffered by farmers during the course of a storage season lay somwhere between 10% and 30% by weight.

There have been no studies on farm losses in stored cassava in Tanzania because the areas of major surplus, Mtwara and Lindi Regions, have only recently become infested with *P. truncatus*. However, studies conducted using experimental cribs shown that weight loss could rise to as much as 70% after four months storage (Hodges *et al*, 1985). Those localities in East Africa where dried cassava is stored for extended periods would be expected to suffer losses similar to those recorded in Togo where it was found that for 25 farmers, in five villages, sustained average cumulative losses of 10% after three months storage, rising to 20% after seven months (Wright *et al.*, 1993).

During a FAO extension and control campaign conducted in western Tanzania between 1984 and 1987 to help farmers cope with *P. truncatus,* losses sustained by 105 farmers in three villages were assessed during a storage season. When food removals for home consumption were taken into account the real food loss over a period of 7-9 months was less than 2% (Golob, 1988). This is no greater than losses which would normally be caused by indigenous insect pests, i.e. about 2-3% (Tyler and Boxall, 1984). These low levels were the result of farmers taking action to control *P. truncatus* by applying insecticide immediately they saw the beetle in their maize, preventing the build up of pest populations.

When Tanzanian farmers first became aware of the magnitude of the problem caused by *P. truncatus* they tried very many procedures to control it, including spreading grain in a thin layer to use the heat from the sun to drive away or kill the beetles, subjecting infested cobs to heat and smoke above the kitchen fire, and spraying cobs with DDT or endosulphan. None of these methods were effective and when it was demonstrated that the pyrethroid, permethrin, would control *P. truncatus* very easily farmers readily adopted the recommended method of shelling their grain and applying permethrin 0.5% dust to the grain (Golob, 1991). This method (later modified by replacing the insecticide with a cocktail containing permethrin and pirimiphos-methyl) represented a major change to traditional storage practice because maize was normally stored on the cob. In West Africa, farmers were much more reluctant to shell their maize and methods were devised to enable them to treat maize on the cob (Boxall and Compton, 1996), including: sprinkling water based insecticide solutions on to the husk leaves; subjecting the wooden storage platform to intense heat; replacing infested timbers used in the store; raising the temperature of the cobs in the store by covering them with polythene sheeting; and removing any infested cobs, grain or other crop residues. Similar suggestions for treating both cobs and grain were produced in Kenya (Giles *et al.*, 1995) and the application of permethrin sprays to husked cobs in Tanzania was found to be very effective in preventing *P. truncatus* damage as long as the treatments were applied soon after harvest, before the pest becomes established in the maize (Golob and Hanks, 1990).

Biological control of *P. truncatus* by releasing a natural enemy, the histerid beetle *Teretriosoma nigrescens*, was first attempted in Togo, West Africa (Biliwa *et al.*, 1992) and subsequently in Kenya (Giles *et al.*, 1996). This method does not require intervention by farmers and so its effectiveness is independent of such problems related to misuse of chemicals during application, non-availability of chemicals when most required and incorrect timing of treatments. However, because farmers are not really involved in the release of the predator they are unlikely to appreciate the effects on the pest population and loss reduction, if these occur. Initial studies on the impact of the predator have concentrated on observing its spread and the effects on loss reduction in experimental maize stores (Borgemeister *et al.*, 1997). It is too soon to evaluate impact on farms. Furthermore, continued use of insecticide alongside biological control is likely to nullify the effects of the predator in some circumstances as this beetle is more susceptible to the chemicals used to control *P. truncatus* than the pest itself (Golob *et al.*, 1994). *T. nigrescens* has not yet been released in Tanzania though there are plans to do so (it would not be surprising if the beetle had already become established from Kenya).

Despite these alternative strategies, in East Africa in particular, the extension services have concentrated on the simple recommendation of shelling maize, treating it with Actellic Super Dust (ASD) and storing it in an appropriate container (e.g. Golob, 1991). At the time *P. truncatus* became established in Tanzania, maize was mostly stored for home consumption, on-the-cob and husked. The exception to this occurred in Arusha Region where maize has long been regarded both as a food and cash crop.

There have been no specific recommendations developed to control infestations in stored dry cassava. Farmers have been exhorted to leave their crop in the field as long as possible to circumvent damage during storage.

The survey which is the subject of this paper was conducted to determine the ways farmers have coped with the *P. truncatus* problem in Tanzania during the last two decades. The only other study of this type was conducted during the FAO control campaign during 1986 and 1987 (Golob, 1991) during a period when the control recommendations were being actively promoted. Since that time, the extension services in Tanzania have been under severe financial constraint and the effort to promote good storage practice has declined markedly.

## II.METHODS

The study was conducted four villages in seven districts spread over six regions except in Mpanda district, Rukwa Region where widespread flooding allowed access to only three villages (table 1). In the text, regional names are used to designate the villages and districts where the survey was conducted because they are commonly used to designate localities and are recognised as such by the population of East Africa, whereas districts and villages may not be. Furthermore, although *P. truncatus* occurs in other districts in some of the regions, those in which the survey was conducted are representative of other areas of the regions which are infested.

- In Rukwa, Mpanda district is the only one which has suffered significant *P. truncatus* in both maize and cassava. The highlands of Sumbawanga district are major producers of maize but this area has not been infested. The lakeshore littoral of this district is much poorer and produces a lot of cassava which has been heavily infested with the beetle in the past. However, access to this area is extremely difficult even under normal weather conditions and were impossible during this survey.
- Iringa Region, around Iringa town, has very sporadic, light infestations which intensive control campaigns during the 1980s kept very much under control. Only in the 1990s has the infestation spread to farms in areas located close to Lake Malawi.
- Kilosa district, close to Ilonga village, was one of two initial focii of *P. truncatus* infestation in Morogoro Region (the other being Morogoro town) and the area surveyed is representative of the other infested sections of the region.
- Tabora Rural district is a major tobacco producing area and, climatically, is similar to much of central-west Tanzania. The survey was intended to be carried out in Urambo district but extensive flooding prevent this happening. Urambo is also a tobaco producing area but is more lightly populated than Tabora Rural. The other district which is heavily infested, Nzega, relies on cotton as its cash crop. In all three districts, storage practices have traditionally been the same; maize storage on-the-cob, stored on a variety of platforms or in cribs.
- In Arusha the survey was to have been conducted in two districts, Babati and Moduli, but the latter had to be ommited because of adverse weather conditions.
- The two districts in Kilimanjaro Region, Hai annd Mwanga are close to Mt Kilimanjaro and experience high rainfall, though this declines to the south. The southern district, Same, has not suffered the same level of infestation as the other two.

Table 1. Villages which participated in the study

| Region | District | Village |
|---|---|---|
| Iringa | Iringa | Kiwere |
| | | Mgera |
| | | Nzihi |
| | | Chamdindi |
| Rukwa | Mpanda | Songambele |
| | | Mnyaki |
| | | Ikolongo |
| Morogoro | Kilosa | Rubeho |
| | | Msingisi |
| | | Ukwamami |
| | | Ihenje |
| Arusha | Babati | Mamire |
| | | Chasimba |
| | | Singe |
| | | Dareda |
| | | Riroda |
| Kilimanjaro | Mwanga | Lembeni |
| | | Mwembe |
| | Hai | Rundugai |
| | | Magadani |
| Tabora | Tabora Rural | Isikizya |
| | | Magiri |
| | | Inala |
| | | Itonjanda |

Note: In Rukwa Region severe local flooding prevented access to many villages and only three could be visited during the survey.

The districts and villages were chosen on the basis of known *P. truncatus* infestation. Each survey team of four enumerators spent two days in each village. In each village, rapid rural appraisal (RRA) techniques were used to understand farmers perceptions of post-harvest problems, within a more general context of livelihood and food security strategies. This was complemented by a market traders checklist and a questionnaire sample survey administered to 390 individual farmers (between 47-79 farmers per district). Sample survey questions focused on both maize and dried cassava production, storage and sale. One of the key areas was an investigation of the impact of LGB on production, storage and marketing outcomes, and the impact of extension messages on how to deal with the pest. This was looked at by comparing the current situation with the situation at the time when LGB first became established in villages (around 15 years ago).

## III.FOCUS OF THE PAPER

*Objectives:*

(i).To assess the role played by *P. truncatus* in determining changes in production, storage and marketing of the maize crop during the period between the first reports of *P. truncatus* in the country and the current time, a period of more than 15 years.

(ii).To assess the factors determining the role played by *P. truncatus* in these stages of the commodity system, in particular the impact of insecticide treatment.

*Hypotheses:*

(a)In comparison to the time when *P.truncatus* became established, the role of crop production in household food security strategies today is not significantly different.

(b) Farmers perceive maize and cassava to be as important to their household food security today as they did 15 years ago.

(c) Quantity of maize and cassava harvested has decreased, and farmers perceptions of the importance of these crops has fallen because *P. truncatus* is forcing farmers to switch out of the crop.

(d)Uptake of hybrid maize varieties has been adversely affected due to increased susceptibility of these varieties to *P. truncatus* in comparison with traditional varieties.

(e)The length of time that maize and dried cassava is stored has fallen, as farmers sell early to avoid *P. truncatus* damage.

(f)*P. truncatus* represents a major problem for farmers and they are unable to cope with it.

(g)Owing to problems with insectides and sacks, the problems caused by *P. truncatus* are likely to increase in future.

## IV.RESULTS AND DISCUSSION

### (i) Role of Crop Production in Household Food Security Strategies

In each village visited, farmer groups were asked to rank household food security strategies in order of importance. This was done in order to place the importance of LGB damage to maize and casava in context. If it was clear that crop production was much less important in certain areas than 15 years ago, then this would clearly have an implication for the impact of LGB on food security and level of well-being: ie LGB would be relatively much less important than 15 years ago.

Farmers came up with several categories, which have been grouped for the purposes of analysis. The groups are as shown in Figure 2 : crop production; livestock; trading activities; unskilled income generating activities (IGAs) and skilled IGAs. The figure indicates that there have been no major changes in livelihood strategies at an aggregated level (ie all 24 villages taken together). At the village level, the picture is much the same: whilst in some areas, off-farm IGAs have become more important (eg in the Morogoro villages), crop production remains the most important livelihood activity, followed by livestock in almost every case. In the light of this, hypothesis (a) is accepted: on the evidence collected it looks like crop production is no less important to houshold food security than it was 15 years ago.

### (ii) Farmers perceptions of importance of maize and cassava.

Whilst crop production in general may be as important to household food security as it was in the past, what of the importance of maize and cassava within this? Has the importance of these crops decreased? If it has, then this is an *a priori* indication that the potential impact of LGB on livelihoods will have fallen. In order to investigate this, farmer groups were asked to rank the importance of these crops relative to other crops and to compare these rankings with the situation 15 years ago. Figures 3(a) and 3(b) present the results on a region by region basis.

Figure 3(a) indicates that only a very small proportion of the groups (one group each in Iringa and Morogoro) felt that maize had fallen in importance. Figure 3(b) indicates that the picture is quite different for cassava. Here, out of a total of 47 farmer groups interviewed, 13 stated that cassava had decreased in importance and 11 felt that it had increased. Of the districts surveyed, cassava has only ever been important in Tabora Rural and Mpanda (Rukwa).

In the light of these findings, hypothesis (b) is also accepted: on the evidence collected it appears that both maize and cassava – in those areas where this has historically been an important food security crop - are as important to houshold food security as they were 15 years ago.

### (iii) Influence of LGB on Production, Storage and Marketing Outcomes

*Context:*

The period since LGB became established in Tanzania has seen major changes in the provision of agricultural services. Since agricultural market liberalisation was introduced, government subsidies for agricultural inputs have been removed and insecticides, including ASD, have risen in price. In addition, the reduced role of government control over agricultural marketing has placed increased emphasis on the quality of on-farm storage of grains (Tyler and Bennet, 1993)[1]. During the 1990's,

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[1] The key point here is the loss of the guaranteed market for grain surplus shortly after harvest due to the closure of rural primary buying points, which had previously relieved the producer of storage and quality maintenance problems (Tyler and Bennet,

production of maize has been particularly influenced by adverse climatic conditions, mostly drought. The impact of LGB on the maize commodity system in Tanzania has been conditioned by these factors.

*Production levels:*

Farmers interviewed individually were asked to give estimates of maize production in recent years in both "normal" years (ie when the crop was not affected by drought) and in years when rainfall has been lacking (figures 4a and b). In drought years almost all of this maize is stored for home consumption (figure 5b). Not surprisingly, in "normal" years a greater proportion of maize is sold immediately after harvest. At the district level, in Babati district (Arusha) the mean number of bags sold immediately was estimated to be equal to over 40% of that stored for one month or more after harvest. In villages in the other regions the mean proportion of sales to stored grain is lower, though hybrid sales appear to be equal to upwards of 40% of stored hybrid volumes in the Kilimanjaro, Morogoro and Iringa districts (figure 6a).

Only in the Tabora and Rukwa districts did more than 12 farmers from the sample cultivate cassava (figure 7). Although cassava is generally regarded as a drought resistant crop, during drought years production decreases significantly (figure 8a). In Tabora, equal quantities are both stored and sold in "normal" years but in drought years it is mostly retained for home consumption (figures 8b and 8c). In Mpanda district in Rukwa, cassava is only produced for home use whatever the quantity produced.

*Role of P. truncatus in maize and cassava harvests*

In villages in Mpanda district (Rukwa) and Kilosa district (Morogoro), very high percentages of farmers stated that there had been a significant reduction in the quantity of maize harvested, however, this has *not* been induced by *P. truncatus*. Indeed, very few farmers in any of the districts visited mentioned that production had been influenced by the pest (figure 9). Most farmers interviewed said either that there had been no change in quantity of maize harvested in comparison to 15 years ago (Arusha, Kilimanjaro, Tabora) or that harvest had reduced but this had been due to factors other than LGB (Morogoro and Rukwa). In Iringa, the picture was more complicated with roughly 40% of farmers saying that there had been no change, 30% saying that there had been a decrease (not due to LGB) and the remainder stating that there had been an increase.

In Tabora, 70% of farmers said their cassava productioin had not changed since *P. truncatus* was first introduced (figure 10). However, in Mpanda more than three quarters of farmers had decreased production during this period, primarily because of a decline in soil fertility (44%) but also because of perceived damage by insects (probably includes other pest damage, particularly CMV) (17%).

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1993). One of the implications of such changes is that methods of conserving grain safely on the farm take on a new importance

*Role of P.. truncatus in the choice of maize and cassava varieties*

The majority of farmers are currently cultivating the same varieties now as they were 15 years ago (figure 11). Those farmers who are using different varieties, especially in Morogoro, are doing so because improved varieties have become available. There are now several international seed companies developing and distributing maize seed in Tanzania, whereas before 1990 seed was only available through the Tanzanian Seed Company, a parastatal organisation. New varieties, particularly hybrids, have been developed particularly for the high potential areas of the Southern Highlands (Iringa, Rukwa, Mbeya and Ruvuma Regions) and Arusha, though opportunistic farmers in other areas where rainfall is adequate also cultivate them as a cash crop. HYVs are more susceptible to insects, including *P. truncatus* during storage, but this has not induced farmers to change varieties except in Kilimanjaro.

Most farmers in the Tabora and Rukwa districts, the main producing areas within this survey, have not changed varieties (figure 12) and those that have have been influenced by factors other than pest damage.

*Role of P.truncatus in duration of storage and volume of sales at farm level*

Figure 13(a), (b) and (c) indicates the length of time after harvest that farmers have maize in storage on farm. Looking across all regions, figure 13(b) shows that farmers exhaust stocks of maize between 8 and 10 months after harvest in a "normal" year. In a drought year this reduces to between 5 and 6 months.

Figure 14 shows that at least 50% of farmers stated that there had been no change in the duration of maize storage in comparison with 15 years ago. In Babati district (Arusha) and Iringa district, 80% of farmers stated "no change", in Mwanga and Hai taken together (Kilimanjaro), 65%, and in in the remainder, around 50%. In Kilosa (Morogoro) and Mpanda (Rukwa), 30 - 40% of farmers stated that there had been a decrease due to non -LGB reasons (most commonly a reduction in production). It was only really in theTabora and Kilimanjaro that a significant minority of farmers attempted to avoid the effects of *P. truncatus* by reducing storage and so curtailing the potential period of exposure of maize to the pest: 25% of farmers in Tabora and 15% of farmers in the Kilimanjaro had taken such action. Unsurprisingly, also in these districts some farmers had increased the quantity of maize sold due to *P.truncatus*. (figure 15). Lower percentages of farmers in other districts had also taken this action (less than 10%).

The average duration of storage for cassava is less than one month, very few farmers store for longer (figure 16). Most farmers have not changed the duration of storage except in Tabora Rural where there was usualluy no stated reason for the change although 25% admitted reducing the period because of the presence of *P. truncatus*.
*Summary*

In all the villages surveyed, *P. truncatus* has had no real impact on maize production outcomes at farm level. Impact on storage and marketing outcomes has been more evident, but even here behavioural change has been restricted to a minority of farmers in two regions, Tabora and Kilimanjaro. Taking all regions together, then, hypotheses (a), (b) and (c) are unsupported by the survey evidence. This poses the question: do farmers actually regard the pest as a major problem, and if so, are they able to deal with it ?(hypothesis (d)).

Cassava production has been relatively low during the period under question and *P. truncatus* has had no impact on the production lrevles or on the quantities stored and sold. However, its presence in Tabora Rural has caused a quarter of the farmers interviewed to reduce the duration of storage although this is usually short (less than one month) in any case.

### *Is P.truncatus still regarded as a problem?*

*LGB in the context of major agricultural problems*

In order to put the importance of LGB in context, farmers in groups were asked to rank the main agricultural problems they faced, comparing the current situation to that when LGB first became established. Figure 18 presents the results.

The figure indicates that at the aggregate level (ie all districts taken together) the number of times that a specific mention of LGB was ranked first most important is considerably lower for the present time than for 15 years ago. In fact, the position of LGB as the first ranked problem fell in all districts except those in Kilimanjaro (where it remained high) and Morogoro where it remained low. At the same time, the number of times that LGB was ranked as second or third most important agricultural problem has risen somewhat, so that the number of times that LGB has been ranked as one of the top three most important agricultural problems has reduced only modestly. In comparison to other agricultural problems however, the importance of LGB (as measured by the number of "top three" rank scores) has reduced considerably when compared to 15 years ago. This is probably a reflection particularly of the greater opportunities now for income generation as shown by the much greater concern for marketing issues and for adding value by processing (figure 18).

*LGB in the context of other storage problems*

Taking all villages together, farmers perceive LGB to be almost as important a problem today as when the pest first became established. Figure 19 illustrates this by showing the number of times that LGB is ranked first second or third most important storage problem today by farmer groups, and comparing this with the ranks for 15 years ago.

Disaggregating, Figures 20 and 21 show the importance of LGB in surveyed districts. Figure 21 shows that at least 50% of farmers in districts surveyed still regard *P. truncatus*, as being the main storage problem for maize stored for own consumption -

and in Tabora and Kilimanjaro the figures are much higher: 85% and 92% respectively. In relation to cassava, Figure 22 shows...........

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32.It thus appears that P.truncatus is percieved as a major problem in relation to stored maize (hypothesis f). **WHAT IS THE SITUATION W.R.T CASSAVA? INSERT TEXT HERE**. The next question is: to what extent are farmers dealing with the pest?

*Coping strategies for P.truncatus*

ASD is regarded as the main method of protecting maize during storage in all regions surveyed except for Morogoro (figure ..), where less than half the farmers use this chemical through choice. Many in this region spray diluted Actellic emulsifiable concentrate. This chemical is similar to ASD but it does not contain the pyrethroid component, permethrin. Although *P. truncatus* is particularly susceptible to permethrin it will also succumb to Actellic (pirimiphos-methyl) particularly during the first months after grain is treated. In Morogoro there has been a decline in the duration of storage (figure 6) and it is likely that application of Actellic alone will be sufficient to provide protection against insect pests, including *P. truncatus*. Other chemicals are used as storage protection particularly where there is a need to apply insecticide to cash crops such as cotton and tobacco during the production period. These chemicals are often very cheap or even provided free by companies buying the harvested product. However, without exception, these chemicals which include thiodan and DDT, are all far too toxic to apply to grain which is to be consumed. Some farmers still subject their maize to heat and smoke by placing cobs in layers or heaps above the kitchen fire. This is an established traditional practice which is effective in controlling most storage pests but has very limited effect against *P. truncatus*. Other traditional methods are also still used, including mixing maize with leaves of various plants such as tobacco, applying ash from the kitchen fire or from burnt animal dung. None of these methods effectively controls *P. truncatus* by itself.

Whilst ASD is used widely, several farmers expressed concerns about cost, availability and quality. Perceptions of the efficacy of ASD require some interpretation. What can be said categorically is that it was only in the two districts in Kilimanjaro that a sizeable minority of farmers (20%) categorically stated that ASD was not effective against LGB (Fig...). In discussions with farmers, however, it became clear that concerns about the efficacy of ASD were more widespread. To some extent, this is due to improper application, either by reducing the dosage or by treating maize on-the-cob rather than grain. There is also, however, a real problem in some areas with adulteration. **CONCRETE EVIDENCE ON THIS EITHER FROM THE SURVEY OR ELSEWHERE?.**

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**Paragraph on availability: Need to analyse data and produce table or chart**

In order to use ASD effectively, maize must be shelled before treatment. As shelling was never a traditional practice in most regions of Tanzania this activity necessitates a change in the type of storage container used. The survey found evidence that storage structures in some areas have changed between the time LGB was introduced and the current time. Fifteen years ago most families stored maize cobs in cylindrical cribs located outside the house or on platforms in the roof eaves above the kitchen fire or outside the house, the latter being used for drying as well as for storage (figure ..). In Iringa district and Kilosa district (Rukwa), many farmers have since switched to storing in sacks made from jute, hessian or woven polypropylene (figure ...). In the Tabora, Kilimanjaro and Arusha, there are still many farmers who use platforms and who therefore store mainly maize on the cob. There appear to be two reasons for this. First, there has always been some unwillingness to take action to prevent LGB problems by shelling and treating until insects are actually seen in the maize (Golob,1991). Thus many families store maize on-the-cob on platforms before shelling later in the year when the insect becomes apparent and putting the grain into sacks. Second, sacks are expensive and not always easy to obtain. As an illustration of cost, farmers in Iringa complained that in order to buy 10 gunny bags to store their harvest, they are forced to sell 1 – 2 bags of maize.
CAN WE GET FIGURES FROM THE SURVEY ON VIEWS ON COST AND AVAILAIBILITY OF BAGS?

## V.CONCLUSION

38.The results of the survey present something of a puzzle: With the exception of a minority of farmers the Tabora and Kilimanjaro survey districts, *P. truncatus* does not appear to have influenced production, storage and marketing ***outcomes*** to any significant degree in any of the districts surveyed. It is true that there is considerable evidence that farmers in some areas have changed their storage behavior: the key behavioural changes have been (i) a much more widespread use of ASD and, in Kilosa district Morogoro, Actellic EC; (ii) a concomitant increase in the incidence of shelling of maize (with the exception of Kilosa) and (iii) decrease in crib storage. However, the changes have by no means been universal, and there are significant concerns about cost, availability and efficacy of ASD and cost and availabilty of bags for storage. In these circumstances, it is legitimate to wonder why *P.truncatus* has not had more of an impact on production, storage and marketing outcomes. One possible answer is that farmers have been overestimating the difficulties that they are encountering with pesticides and bags. This is possible, although problems with adulteration, cost and availability are well known. Another possible answer is that good protection measures in the past have prevented the build up of LGB in the villages to such an extent where the pest can cause significant damage to poorly protected grain. This seems more likely.

In these circumstances, there have to be legitimate concerns over the prospects for the future, as if adequate protection measures are not taken. *P.truncatus* populations will soon increase, and losses will rise. When farmers have access to reliable insecticides and adequate storage structures, the indications are that they will use them if they can afford to. The implication is, therefore, that measures be taken to tighten up the regulation of pesticides and ensure that they are more widely available. In addition, the question of cost should be considered, and if it is not tenable to reduce cost then this argues for an increased emphasis on low cost (perhaps botanical) protectants. These issues merit further investigation.

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