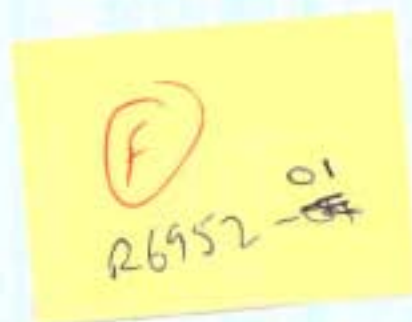


THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF AGRICULTURE AND CO OPERATIVES

*FARMER COPING STRATEGIES FOR POST HARVEST PROBLEMS WITH
PARTICULAR EMPHASIS ON THE LARGER GRAIN BORER.*

REPORT OF A WORKSHOP



AUGUST, 1999
PLANT PROTECTION DIVISION
P.O BOX 9071
DAR ES SALAAM

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REPORT OF A POST HARVEST WORKSHOP ON FARMER COPING STRATEGIES FOR POST HARVEST PROBLEMS WITH PARTICULAR EMPHASIS ON THE LARGER GRAIN BORER.

1. INTRODUCTION

The national 2025 Vision on Food, Agriculture and the Environment, underlines the desire as the world enters 21st century for Tanzania to have an agricultural sector that ensures food security and eradicates malnutrition; protects the environment; is remunerative and thus alleviates poverty; **reduces wastage by improving the transportation, storage and processing of agricultural products** and one that stimulates and responds to demand.

"The policy goals of the Tanzanian food security programme are ensuring **adequacy of food supplies, maintaining safe supply stability** and securing access to available supplies by all consumers according to their nutritional needs" (*Comprehensive Food Security Programme Vol.1, Ministry of Agriculture 1992*).

The central position of storage in food security is implied in both the national vision and the food security policy goals.

However, crop storage in Tanzania has a long history of problems, of which post harvest crop losses due to insect pests and poor post harvest crop handling in general is the most pressing.

Generally, prior to 1980s, estimates of post harvest losses caused by pests were averaged at between 2-5% for maize in a storage season. Maize is the primary food staple of Tanzanians.

In Tanzania, the majority of agricultural producers are small scale farmers. These farmers are estimated to store between 70- 80% of their cereal harvest maize and other cereals in household stores. The stored crop is managed within the limits of their social, cultural and economic setting.

Like in most developing countries, small farmers have limited access to resources. In storage, the required resources of which they have limited access includes inputs like chemical protectants, improved store fabrication materials and skills, storage management technology, information to enhance decision making etc. This being the case, the challenge of protecting stored products at farm level is immense.

Since early 1980's the problem of storage of maize and cassava staples was amplified by the invasion of a notorious foreign pest, the Larger Grain Borer (*Prostephanus truncatus*) popularly known as Dumuzi. The pest is endemic to Central America, and it was accidentally introduced into Tanzania and identified

in 1980. It is believed to have been introduced into Tanzania through trade and most probably through maize aid imports.

In the advent of LGB, maize and cassava losses increased threefold compared to losses caused by the traditional storage pests before the 80's. For instance, weight losses in maize stored for 6 months have been found to exceed 35% compared to 2-5% prior to LGB invasion.

Although LGB was first noticed in Tabora, the beetle spread from one region to another year after year, and by 1993, the beetle had spread to all regions of Tanzania to neighboring countries. Countries of Africa infested todate includes, Kenya, Uganda, Togo, Benin, Zambia, Burundi, Nigeria, Bukina Faso, Malawi, Niger, Ghana, Nigeria and Guinea.

The food security aspect has thus become a world wide concern, necessitating concerted efforts by all post harvest stakeholders to control the pest.

Research and extension has been fundamental to the LGB control efforts, and farmers are integrating the recommendations into their social and cultural setting to cope with the LGB and other storage pests.

2. BACKGROUND TO THE WORKSHOP

LGB continues to extend its range across Africa, and has drawn wide attention and prompted control action from a multitude of stakeholders. Workshops and conferences have been used as forum for exchange of information and experiences among affected and those at risk. They have served also as forums to evaluate progress and identify future needs. One of these workshops was the East and Central Africa Storage Pest Management Workshop which was held in Naivasha, Kenya in 1996.

The Naivasha workshop recommended evaluation on how farmers have so far coped with the LGB problem, the efforts already invested by donors for the past twenty years withstanding. This evaluation was intended to justify further proposals for research and hence donor support without re-inventing the wheel.

Due to its long history of LGB and its control strategy, Tanzania was chosen to be one of the survey countries, and the survey was conducted in the storage season towards the end of 1997. The workshop of 25th August 1999 in Tanzania of which is the subject of this report, was intended to bring together post harvest stakeholders in order to review the LGB crisis, to share experiences with regard to ongoing post harvest loss reduction activities with reflection on the 1996 post harvest survey results. Specifically, the objectives of the survey was;

- (1) Stakeholders to be informed of farmer coping strategies against storage problems as a basis for planning further support interventions.
- (2) To facilitate information exchange with regard to current/ongoing post harvest improvement activities by different institutions.
- (3) To identify our future needs and propose the way forward to improve the post harvest situation in Tanzania.

2.1 ACKNOWLEDGMENT

The 1997/98 post harvest survey in Tanzania has shed light on the strength with which the farmers are fighting LGB and other post harvest problems for their survival. Throughout their endeavors, their strength has been re enforced by interventions by the Government with support from local and international groups, providing both technical and financial support. This workshop was intended to add strength to the farmers at war, by identifying appropriate strategy and weapons.

The post harvest survey and the workshop could not have taken place if not for the kind support by the Department for International Development of the United Kingdom, and the commitment of all participating scientists and donor representatives, particularly FAO and GTZ.

We are also indebted to Dr. Peter Golob of NRI and the team members who tirelessly endured the difficult El Nino conditions throughout the survey. Last but not least we acknowledge, the unlimited co operation and transparency by the farmers in expressing their hopes and fears.

2.2 POST HARVEST WORKSHOP PROGRAMME

FARMER COPING STRATEGIES FOR POST HARVEST PROBLEMS WITH PARTICULAR EMPHASIS ON THE LARGER GRAIN BORER

25 AUGUST 1999

BRITISH COUNCIL CONFERENCE HALL-DAR ES SALAAM

	CHAIRMAN	<i>Director for Crop Development, (DCD) Dr. N.Sicilima</i>
9.00	Introduction of participants	I/C (PP) Mrs Katagira
9.15	Opening of workshop	Permanent Secretary, MOAC
9.20	Historical perspective of LGB in Tanzania	PPD- G.Maliya
9.40	Background of the Post harvest survey of 1998 plus Video	Dr. Golob
9.45	Description of the survey	PPD- M/s Adela Moshy
10.00	TEA BREAK	
10.10	Post harvest survey results	Dr. Golob
11.00	Current post harvest activities by TPRI	Dr. Uronu
11.15	Post harvest activities in the Southern Highlands	Uyole Research Inst. Mr. Shetto/Mr. Mkoga
11.30	Integrated Control of Storage pests in Tanzania and Biological control project	PPD-Nyakunga & Riwa
12.00	Contribution of Farmer Education and Publicity Unit in promoting post harvest technologies	Mr. Nyangi
12.15	Post harvest activities by stakeholders, projects, releaf food handling etc	NGOs/ WFP,Uganda,
12.30	LUNCH	
13.30	Future plans - introduction, objectives, Groups	Dr. Golob
13.45	Group discussion	
15.00	TEA BREAK	
15.15	Plenary	Dr. Golob,Group representatives
16.15	Summary of workshop	Dr. Uronu

2.3 Chairman's address

Our Guest of Honour,

On behalf of the participants to this workshop, and on my own behalf, I have the honour to welcome you, and to express our profound gratitude to you, on account that despite your busy schedules you have committed yourself and managed to join us. This signifies your keen and unwavering interest and support to post-harvest technology in the country. We deeply thank you. Asante sana.

Dear Guest of Honour, the participants in front of you are representing a cross section of post harvest stakeholders; the Ministry of Agriculture and co operatives, Prime Ministers office, Non governmental organizations, Technical co operation agencies; GTZ, British Council, NRI and multilateral organizations; FAO and the World Food Programme. We have also been joined by our neighbors from Uganda.

Dear, Guest of Honour, we have come together, scientists , policy makers, and development agencies, to face the challenge of food security issues in respect to prevailing post harvest problems and issues.

It has been widely accepted that safeguarding harvested crops is more economical than trying to compensate losses through other means such as importation.

We see this as a challenge because the food situation of the country is not so good, at the same time farmers are confronted with problems of securely storing their crops in an environment of lack of proper storage facilities, inadequate food storage technology and the destructiveness of the notorious larger grain borer popularly known in kiswahili as DUMUZI.

We believe that farmers hopes and fears are vested in us and that it is our responsibility and noble task to provide practical solutions to their problems. The task is daunting but desirable. Let us execute this task with total commitment and diligence.

A one day workshop may seem to be too short to be able to adequately address all the problems I have mentioned, but Dear Guest of Honour, a lot of work has already been done both in Tanzania and elsewhere, and our duty is to share our experiences, review , consolidate and translate recommendations to practical solutions for immediate dissemination to the target beneficiaries.

However, ultimately the knowledge shared here should be translated into a form and language understandable by farmers and other users.

With these few remarks, may I now request you to open the workshop.

Thank you.

2.4 OPENING ADDRESS

BY THE PERMANENT SECRETARY, MINISTRY OF AGRICULTURE AND CO OPERATIVES
DURING A WORKSHOP ON FARMER COPING STRATEGIES FOR POST HARVEST PROBLEMS.

DAR ES SALAAM, 25 AUGUST 1999

The Chairman,
Distinguished Guests,
Workshop Participants,
Ladies and Gentlemen

May I, on my own behalf and on behalf of the Ministry of Agriculture and Co operatives welcome you to the intended Post Harvest workshop. I am informed that our neighbors from Uganda are represented and I welcome them to Tanzania and in particular to this workshop. Special welcome goes also to Natural Resources Institute Scientist Dr. Golob, who apart from co ordinating a post harvest survey in the country, the report of which will be discussed in this workshop, is among the first international consultants to research and publish on the Larger Grain Borer (LGB, Dumuzi) in Tanzania in the early eighties.

All of you, please feel at home while in Dar Es Salaam, "The heaven of peace".

Let me now on behalf of the government of the United Republic of Tanzania, and on my own behalf, thank the government of the United Kingdom which through its Department for International Development, facilitated all the necessary arrangements for conducting this workshop.

Mr.Chairman, since the accidental introduction of the LGB into Tanzania in the late seventies, the food security situation has continued to be under threat. Losses in stored maize which is a staple food of Tanzanians increased from 2-5% to more than 36% within six months of maize storage. Farmers who do not attempt control may suffer up to 100% loss over a storage period of about one year. Cassava is similarly affected. However, the good work of scientists, both local and from various Institutions across the world, with generous financial support by donor agencies, has transformed an alarming situation to one that is tolerable when the recommendations are adhered to.

Those who are devoting their time and resources to arrest the LGB crisis and improve on the post harvest situation in general are many and cannot be mentioned individually here. However, the following governments and institutions deserve special mention: FAO, the United Kingdom and its institutions; Natural Resources Institute, International Institute of Entomology and the British Council,

Germany and its institutions; GTZ and DSE, Australia, Canada, the European Union, the International Institute of Tropical Agriculture and others. Their efforts have restored hope to the farming community and the nation as a whole.

Mr. Chairman, the economy and livelihood of Tanzanians depend on agriculture. In an environment of unpredictable weather conditions, high costs of inputs, catastrophe like the recent El Nino, pest outbreaks like LGB, and intensive labour requirements, farming becomes a very challenging enterprise. This is what the Tanzanian farmer is confronted with, and therefore any effort directed towards improving productivity and reduce post harvest losses is a motivation and a great contribution to the survival of the majority of Tanzanians.

This workshop will address one of the challenges, namely post harvest problems, and I am optimistic that it will critically analyze the present situation as fundamental to a process of finding practical solutions to emerging problems.

Mr. Chairman, most farmers controlling LGB and other storage pests in Tanzania have been using insecticides. Actellic Super Dust has been in use since 1986 and has become the most popular storage insecticide among our farmers. However, of recent, there have been complaints about its quality, and many farmers are believed to have suffered great losses in the past three seasons, allegedly resulting from ineffective insecticide. Without speculating the reasons for this ineffectiveness, I leave the workshop to discuss and deliberate on how to rectify the situation.

Mr. Chairman, Tanzania has not been left behind in advances in pest management, particularly Biological control. In respect to the larger grain borer, we have released some predator beetles in pilot areas in three regions. We are rearing and producing the beetles in enough quantities to release in many more regions. We understand that we are still a long way to realize the results from this control method and that we need to make an impact assessment to that effect. We look forward to continued co operation and support in this programme both by donors and relevant scientific institutions.

It is my hope Mr. Chairman, that the workshop will further refine the post harvest management recommendations, and take into account farmers fears and expectations as may have been expressed in the latest post harvest survey, the results of which will be presented by the survey co ordinator.

Pests do not acknowledge manmade boundaries. The spread of LGB from Tanzania to other countries was neither the consent of Tanzania nor the country of its destination. This will also be the case for the predators we are releasing to control LGB. Either those released earlier in Kenya and Zambia may have crossed borders to Tanzania or Uganda. Likewise those we are releasing in Tanzania may cross the East African borders. This being the case, and that all three East African countries are working on LGB biological control, I would urge

the workshop to consider how this programme and similar ones could be coordinated regionally, in order to make efficient use of the available expertise and other resources in the region. This will also contribute to making the East African Co-operation a reality.

Mr. Chairman, I do not intend to be one of your key speakers. However since this is only a one day workshop, I cannot avoid to suggest again that the workshop deliberations should focus onto simple, affordable post harvest technologies that the farmers can easily adopt to save the crop in a sustainable manner.

Lastly, I wish to assure you that the workshop recommendations and deliberations shall be taken seriously and that with co operation of all stakeholders represented here, the output will reach the target beneficiaries.

With these remarks I have the pleasure and honour to declare the workshop open and I wish you success.

Thank you.

3. WORKSHOP PRESENTATIONS

3.1 THE HISTORICAL PERSPECTIVE OF THE LARGER GRAIN BORER *PROSTEPHANUS TRUNCANTUS* (HORN) IN TANZANIA

G.A. Mallya,

Pest Control Services, Ministry of Agriculture and Co operatives, P.O Box 7473
Tengeru, Arusha

Summary

The occurrence and spread of larger grain borer (LGB), *Prostephanus truncatus* (Horn) in Tanzania, a major pest of stored maize and dried cassava is presented. Currently, all 20 region of Tanzania Mainland are infested. The impact of this pest on national food security and export market in the 1980's is highlighted. Strategies for the control of LGB and their impact in the loss reduction are described. The control strategies adopted include the LGB Containment and Control and also the Intensive Control, both of which resulted in loss reduction although the pests continued to spread in the whole country. A number of constraints that have hampered LGB control activities in the country are presented together with the recommendation on the strategy to be adopted.

3.1.1 Introduction

LGB, *P. truncatus*, is alien to Tanzania and Africa in general. A countrywide survey of insect pests of stored products conducted in 1969/71 (Ringo and Mushi 1971) indicated that Tanzania was free of this pest. In Meso-America where the LGB is endemic, the insect is not of any economic significance.

Since its introduction in Tanzania in 1970's, LGB has been a threat to the National Food Security due its fast spread and devastating effect to stored maize and cassava. LGB was first reported by farmers from Tabora District in Western Tanzania in 1980 as an unknown pest destroying stored maize and dried cassava. Experts in the Ministry of Agriculture did not pay particular attention to the farmers' reports; they thought the insect must be the common maize weevil, *Sitophilus* spp. It was not until when a group of farmers from Tabora presented to the Ministry Headquarters in Dar Es Salaam samples of LGB damaged maize cobs that the experts realized that the report was of a new insect pest. Samples of this insect were sent to British Museum of Natural History in London for identification when it was confirmed as *Prostephanus truncatus* (Horn).

It was assumed that LGB was introduced into the country following decentralization of Tanzania administration in 1972 (Mushi 1984) when Produce

Inspection Services (PIS) was put under Regional Development Director. Under decentralization PIS was not accorded the importance it deserved leading to inadequate inspection of imported produce.

Locally, LGB became known as "Scania" on account of the shape of its head which resembles the cabin of that particular truck. Later the insect acquired a more popular name of "DUMUZI" which is a noun of the verb "DUMULA" in Kinyamwezi language meaning to grind maize into flour which is one of the characteristics of LGB on stored maize.

3.1.2 Spread of LGB in Tanzania and Neighbouring countries.

A preliminary survey to establish spread of LGB in Tabora region was conducted by Plant Protection Department in 1981 (Dunstan and Magazini 1981). This was followed up by other more detailed surveys incorporating experts from Tropical Products Institute in London. These later surveys put more emphasis on the pest distribution, crop damage and losses. Field trials were also initiated to identify suitable insecticide for LGB control.

The surveys indicated that by 1981, the pest was well established in several villages in Tabora, Shinyanga, and Mwanza regions. By 1984, the pest had reached Arusha and Kilimanjaro and had crossed into Kenya (Taveta district). From Tabora the pest spread westwards into Kigoma region and into Burundi. The 1988 survey confirmed that LGB had spread to all regions of the Tanzania Mainland except coastal regions. Mtwara, Lindi Coast and Dar Es Salaam. In 1993, Dar Es Salaam joined the list of infested regions while Lindi and Mtwara in 1994 were added to the list bringing the total number of infested regions to nineteen. Although there is no record of LGB in Coast Region, it could be assumed that the region is not free from LGB infestation (Map 1 and Table 2). Meanwhile, as LGB continued to spread within Tanzania the pest crossed borders into neighboring countries as shown in Table 1.

TABLE 1. First Records of *P. truncatus* in Eastern and Central Africa.

COUNTRY AND DATE	AREA/REFERENCE
TANZANIA, 1981	Tabora District Dunstan and Magazini 1981
KENYA, 1983	Taveta District Kega and Warui 1983
BURUNDI, 1984	Gisuru market, Massot District
MALAWI, 1993	North Malawi GTZ to FAO (Unpublished?)

RWANDA, 1993	Kigali Bonzi and Ntambabazi 1993
ZAMBIA, 1993	Nakonde District Anon 1995

The spread of LGB in Tanzania has been mainly through movement of grain from areas of surplus to those of deficit. Movement of gunny bags being brought into areas of maize surplus or passing through regions or districts which until then had been free of infestation has also contributed to the spread of LGB.

3.1.3 LGB and Food Security

Losses caused by LGB in maize and cassava are extra ordinarily high and are caused in a short time of storage. Losses as high as 35% can occur in a period of 4 - 6 months and losses of up to 60% or more may occur after 9 months of storage (Golob and Hodges 1982; Hodges et al 1983; Keil 1988). Moreover, maize and cassava so damaged by LGB is rendered unfit for human consumption and is therefore regarded as a total loss, therefore jeopardizing national effort to achieving self - sufficiency in food production. In realizing the impact of LGB on food security, the Government of Tanzania declared the LGB problem an emergency situation in 1983. It meant that should the pest not be effectively controlled, could result into the need of famine relief.

3.1.4 LGB and the Export Market

Unfortunately, losses caused by LGB to external market and price effect on farmers are not well documented. However, such losses are quite substantial and should not be ignored. Tanzania has a great potential for regular exportable maize. For instance, during 1980's Tanzania experienced problems with maize shipment by World Food Programme, the European Economic Community, and the private commercial enterprises. It is also reported that in 1987 - 1988, 18,000 tons of maize could not be exported to Malawi and Mozambique due to concern of these countries about LGB infestation. As a result, the country failed to earn US\$ 1.5 million.

If the country fails to export the surplus produce, the local market have to absorb all maize and cassava produced. This results in domestic supply exceeding domestic demand forcing the local market price for the crops to fall. The fall in price in turn discourages the farmers to produce the crops consequently threatening national food security.

In view of the threat posed by LGB to both national food security and export market, the Government of Tanzania has continuously put emphasis on the control of this pest. In solving the problem of export market , phytosanitary

procedures have been developed and disseminated in the form of FAO Phytoguide (Sempel and Kirenga 1994) to facilitate maize export from and transit through LGB infested countries in East, Central, and Southern Africa. These procedures are now being implemented by an increasing number of countries.

A strategy to contain and control LGB was developed by the Plant Protection Division with assistance from ODNRI and later FAO and its implementation started in early 1980's. the long term objective of this strategy was to develop and implement a pest management system for the control of LGB and other storage pests. The strategy consisted of;

- i) Creating awareness and conducting intensive farmer training in the control of LGB and other storage pests.
- ii) Setting up distribution and sales system of insecticide down to farm level.
- iii) Training of staff of the Plant Protection Division on produce inspection and quarantine measures for the control and containment of LGB.
- iv) Conducting LGB control campaigns in all infested areas.
- v) Restricting movement of infested maize and cassava, especially from infested to non infested areas, and disinfestation of empty gunny bags.
- vi) Formulation and enforcement of dumuzi law (1986)

The activities carried out under the LGB containment and control strategy resulted in reduced losses. However, the speed of spread of LGB to new areas continued, indicating that the strategy was was no effective A different strategy - Intensive control strategy was therefore adopted.

3.1.5 LGB intensive control Strategy

The objective of intensive control Strategy was to reduce LGB infestation level below economic level through intensive control in the outbreak areas. the Dumuzi law was instrumental in facilitating the implementation of this control strategy. activities under this strategy included;

- i) Formation of Mobile Pest Control Teams, to be deployed in LGB control campaigns.
- ii) Establishment of LGB committees at regional, District and Village levels to mobilize the general public in the control campaigns.
- iii) Farmer training on storage pest management
- iv) House to house maize shelling and admixing with recommended insecticide, Actellic Super Dust.

This strategy resulted in the reduction of infestation to below economic level in 22 districts up to 1990. This reduction of LGB infestation was also realized through intensive control conducted in Masasi and Nachingwea in 1994 (Table2).

Constraints to LGB Containment and Intensive Control Strategy.

The implementation of LGB Containment and control activities was hampered by a number of factors;

- unavailability of the recommended insecticide at the right time.
- inadequacy in the functioning of the Co operative Unions which were responsible for the distribution of insecticides.
- difficulties on the part of farmers to accept "shell and treat "and the recommendation to use improved storage structures as these implied that farmers had to change their traditional practice of storing maize on the cob.
- difficulties in complying with Dumuzi law as caused by shortage of insecticides high costs involving treatment of large quantities of maize and lack of manpower and facilities at checkpoints.
- inadequate transport facilities and poor state of roads resulting in pile-ups of surplus maize under poor storage conditions.

3.1.6 LGB situation from 1994.

In 1994 it was assumed that all 20 regions of Tanzania Mainland were LGB infested, although records for the Coast Region are not available. By then, resurgence of LGB infestation was reported from many parts of the country. Farmers as well as maize traders reported incidences of total crop loss even where stored maize was treated with recommended pesticides, implying that the pesticides had either been adulterated or were of sub - standard. During the period of LGB Containment and Intensive Control (up to 1994) the procurement and distribution of actellic Super Dust was done by the Ministry of Agriculture, involving the plant protection field staff at regional and District levels.

As input procurement and distribution went into the private sector and , following trade liberalization, some of the pesticides that was made available to the farmers was not to the standard. In some years pesticides were not available compelling farmers and traders to use any pesticide they thought could control LGB and other storage pests. In such a gamble, a lot of maize has been destroyed by LGB.

In 1996, an East and Central Africa Storage pest Management workshop was held in Naivasha Kenya, it was realized that the various donor countries which has funded LGB control were interested to know whether the problem had been solved or not. In view of this, it was recommended to;

- evaluate farmers reaction to LGB
- identify farmers coping strategies
- ascertain whether LGB was still a problem

A survey to address this recommendation has been carried out in Tanzania, the finding of which will be presented in this workshop.

At the National Plant Protection Advisory Committee Meeting which took place in Morogoro in February 1997, importation of *Teretriosoma nigrescens*, the natural enemy of LGB and its subsequent release in Tanzania was approved. This biological control agent was imported into the country in 1998 and its mass production and release is ongoing.

3.1.7 Conclusion

The LGB is now accepted as a pest to stay (Mallya and Nyakunga, 1996) and a strategy for its control must be formulated in a way that will result in maintaining its infestation to below economic level. The containment and intensive control which were appropriate in 1980's may not be applicable any more. The most effective control strategy for LGB must take the following aspects into consideration;

- integrated post harvest pest management
- manpower development for post harvest pest control
- produce inspection and phytosanitary services
- monitoring crop movement to detect build up of LGB as well as other storage pests
- availability of insecticides as and when required
- enforcement of Dumuzi Law (control of *P. truncatus* Rules, 1986).

3.1.8 References

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3.1.9 Responses to paper presentation

Question: Could you elaborate LGB control from 1994?

In 1994 there was intensive campaign to contain LGB which considerably reduced the pest populations due to the use of ASD and improved storage structures. The Ministry of Agriculture was by then responsible for the procurement and distribution of the insecticide at minimum cost.

Trade liberalization opened doors for private involvement in pesticide procurement and distribution. There was yet to be established a good set up for the private sector to import and distribute pesticides. As a result, pesticides became comparatively more expensive and often adulterated. Many farmers could no longer afford, or used lower doses than recommended giving poor results of treatments. Worst of all is that they may use any other chemical that could kill the pest. LGB populations appeared to increase considerably.

3.2 SURVEY RESULTS ON COPING STRATEGIES FOR *P. truncatus* (see survey report)

Question: In Morogoro many farmers used Actellic 50 EC why? Were they using the right dose?

Response: If farmers have means (sprayers) to use it and Actellic 50 EC is used early enough, it is very effective. Actellic 50 EC can be used on maize and the instructions can be read on the label.

West Africans are reluctant to shell maize, they use Fenithrothion/Deltamethrin which is very effective.

Other methods that are effective is the use of Inert dust - which absorb wax from the insects' cuticle. The insect loose moisture and dies of desiccation.

Question:

25% farmers do not appreciate the results in the use of pesticides, why?

- i) They may have used the pesticide too late.
- ii) For the insecticide to be effective it should be used as soon as the crop is dry enough, crop moisture tends to degrade the insecticide faster.
- iii) They may have used a wrong chemical which did not kill the targeted pest (LGB) or

The chemical used may have not the correct amount of active ingredient

Question:

The complaints about the ineffectiveness of ASD is almost countrywide. It has also been noted that on the market there is widespread ASD from both inside and outside the country. What is a better source of ASD?

Response: There are no better sources of ASD. ASD is a product of England and any country can buy the technical grade and formulate the insecticide. Kenya buys ASD from South Africa. The problem is if it is not formulated correctly it may not last long. ASD formulated in Tanzania is of good quality

3.3 EVALUATION OF ACTELIC SUPER DUST (ASD) EFFICACY IN THE CONTROL OF STORAGE INSECT PESTS, LARGER GRAIN BORER (LGB), *Prostephanus truncatus* (Horn) AND MAIZE WEEVIL, *Sitophilus* spp. IN NORTHERN TANZANIA.

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ABSTRACT

The outbreak of Larger Grain Borer (LGB), *Prostephanus truncatus* and storage pests including *Sitophilus* spp. have threatened grain production in Tanzania since 1980's to date. The cocktail chemical, Actellic Super Dust formulated performed well up to early 1990's. From then, complaints from farmers, Regional and District Agricultural Officers on the failure of the chemical to control the pests were received. Efforts to revisit the quality of the chemical were undertaken by the manufacturer. The chemical was formulated again in Nairobi, and field and laboratory tests were conducted in Northern Tanzania. Two approaches, protective and curative were used in the tests. Complete randomized design replicated four times was followed. In the laboratory test, insect mortality was recorded seven days after the onset of the tests. In the field, percentage seed damage and weight loss was recorded by the amount of flour formed. The 5 months duration of the experiment revealed a good control of insects and superior field protection of the grains by ASD applied at the recommended rate compared to the control. Farmers to be educated on the correct use of the chemical for safe storage of their grains. Proper labelling and monitoring the quality of the chemical is emphasized.

3.3.1 INTRODUCTION

The Larger Grain Borer (LGB), *Prostephanus truncatus* (Horn) was first noticed in Tanzania around 1979 (Cross 1985). It was assumed that the pest entered the country with grain imports, probably shipped specifically for the refugees in camps in Urambo, Tabora - Western Zone of Tanzania (Mushi 1983). By 1983 the pest was declared a national threat in 20 regions (Mushi 1983). In Central America which is suspected to be the place of origin (Cross 1985) the damage is not as high as observed in Tanzania because of presence of a predator *Teretriosoma nigrescence* which prey on LGB larvae. Unfortunately the predator has not been reported in Tanzania and perhaps elsewhere in most affected African countries. The beetle spread from region to region and from infested to non-infested areas through official and un-official marketing of cereal produce. Weight losses of up to 35% in stored maize within 3 - 6 months have been recorded in Tanzania (Golob and Hodges 1982).

In view of LGB pest status in Tanzania, efforts to look for suitable control measures include tests of synthetic pesticides were undertaken. Chemical trials

conducted in September 1981 at Tumbi, Tabora revealed that pirimiphos methyl at 10PPM gave adequate protection of grain during its storage period (Golob et al. 1983). However, by 1982 Permethrin applied on shelled maize provided best control of the beetle (Cross 1985). FAO's Intensive campaign programme emphasized on the importance of treating shelled maize before filling in improved storage structures. During the 1982/83 emphasis was distribution of Actellic Super Dust, a cocktail consisting of Permethrin and Pirimiphos with 0.3 and 1.6% active ingredients, respectively. ASD was reported to have superior control of both the LGB and *Sitophilus* spp. for six months (Mushi 1983). This cocktail continued to exert good control of the storage pests at farm level until around 1991/92 when farmers, village leaders, Extension Officers, District and Regional Agricultural Officer started complaining on poor performance of the ASD. Cases of complaints were received from different districts in the country including Hai District in Kilimanjaro, Babati, Arusha, and Arumeru Districts in Arusha Region, Uyole, Mbeya, Food security Centers in Dodoma and Mwanza. The Registrar of Pesticides based at TPRI received and analyzed several samples of ASD collected from various areas in Kilimanjaro Region (Table 1) and from Babati District (Table 2).

Table 1: Analysis results of samples of Actellic Super Dust collected from various sellers in Kilimanjaro region

TRRI LAB. NO.	SELLERS IDENTIFICATION NO.	ACTIVE INGREDIENT CONTENT (%)		REMARKS
		Pirimiphos methyl	Permethrin	
2385	A (Ndep)	0.6	0.37	Below required specification
2386	C (Kib T.S.)	1.36	0.34	Within specification
2387	B (TF)	1.44	0.35	-do-
2388	E (Kilimanjaro)	1.61	0.40	-do-
2389	F (Kilimanjaro)	1.71	0.37	-do-
2390	D (Kilimanjaro)	1.49	0.37	-do-
2521	Village	0.20	0.03	Below specification
2103*	S (Village)	1.4	0.104	-do-
2101*	W (Village)	Not detected	Not detected	-do-
2106	T (From FT)	1.9	0.28	Within specification

Ref. No. AG/P.10/184 and NO. A 20/63

FAO Tolerance limit

- I. Pirimiphos methyl (1.6%)
- II. Permethrin (0.36%) - 0.255 - 0.34%

N.B. Some of the sellers had products from Mozambique. Trade liberalization to some extent provides loopholes in the quality control of the product. Some of the products were packed in white bags without any label as per specifications. Samples 2103 and 2101 were from the villages. The samples appeared blackish in colour with different lumps of various sizes. This was a direct adulteration of the chemical. Farmers in the rural areas will buy anything available to rescue their grains; as a result failure to control the storage insect pests.

TABLE 2: Analysis results of samples of Actellic Super Dust collected from retail shops in Babati District

TPRI LAB NO.	SELLERS IDENTI FICATION NO.	CONTENT OF ACTIVE INGRIDIENT (%)		REMARKS
		Pirimiphos methyl	Permethrin	
1417 (1a)	Trade name unknown	1.6	0.42	P. methyl within required range while permethrin was above specification
1418 (1b)	Trade name unknown	1.54	0.21	P. Methyl - whitish with required specification while Permethrin was below standard
1419 (2)	Trade name unknown	2.4	0.255	P. Methyl was above specification while Permethrin was within standard

Ref. KIL/BBT/Pesticides/73 - 11th November, 1999

N.B. In samples 1418 (1b) - Permethrin was below required specifications. After receiving complaints from the farmers and relevant Agricultural Offices, ZENECA AGROCHEMICALS UK through their agents - Twiga Chemicals (T) considered measures to solve the problem. Registrar of Pesticides at TPRI communicated

with the manufacturer based in U.K. that they need to take action to improve the quality of their product.

Efforts to improve the labels, formulation and packaging of ASD was done around December/January 1998/99. Formulation of the new package of ASD was done in Nairobi, Kenya. Field tests were conducted in Rundugai, in Kilimanjaro Region while the laboratory bioassays were done at TPRI Arusha.

3.3.1.1 MATERIALS AND METHODS

Two approaches were used:

I. Protectant approach -

Grains are treated and after settling for 24 hours insects are then introduced.

II. Curative approach -

Insects are first introduced and left to settle for 48 hours before chemical treatment.

Grain:

Clean untreated Kilima maize variety newly harvested was used.

Test Insects

Both Larger Grain Borer and maize weevil, *Sitophilus* spp. collected from problem area (Siverdale farm - Moshi) were used.

Test chemical

Actellic Super Dust was supplied by the Zeneca Office, Nairobi. The product is brown in colour similar to the ASD used in Tanzania except the packaging contained 200 g of the product.

Treatments:

1. Untreated control
2. Half the recommended rate (100 g ASD/90 kg grain)
3. Recommended rate (100g ASD/90 kg grain)
4. Double the recommended rate (200 g/90 kg grain)

Sites and Experimental Design:

Field work was conducted in Rundugai, a low altitude area (less than 1000 m above sea level) and temperatures above 28° C. The experimental design followed a complete randomized design with four replicates. A Hessian cloth was used.

In the Laboratory Bioassays, (samples of) 100 g grain was collected from each replicate of each treatment and sent to the laboratory where 50 insects of LGB and *Sitophilus* spp. was introduced. Insect motility were recorded on the 7th day after introduction.

Sample collection

(Sub) samples were taken 24 hours after treatment using a 500 ml volume of grain. Subsequent post-sampling was done at one month interval for a period of six months.

1. Data collected included:
2. Dead and live insects
3. Number of damaged and undamaged grains
4. Flour formed
5. Grain moisture content

Results are presented in Table 3

TABLE 3: Laboratory bioassay responses as mean percentage mortality of adult LGB and *Sitophilus* spp. to different levels of ASD at the end of 3rd month of the trial.

Protectant and Curative approach)

Treatments	Protective approach		Curative approach	
	LGB	<i>Sitophilus</i> spp.	LGB	<i>Sitophilus</i> spp.
Untreated control	1.50	1.80	2.00	3.5
Half rate	6.50	70	16.5	80.0
Standard rate	59.00	100	51.6	100.0
Double rate	73.00	100	55.0	100.0

Mean percentage mortality recorded from 4 replicates collected from the field and assessed on the 7th day.

N.B. There was a significant mortality recorded in the standard rate at 100 g per 90 kg grain and in the double recommended rate of 200 g per 90 kg grain. Mortality of *Sitophilus* spp. were higher than those recorded for LGB. Although both approaches, Protestants and Curative gave almost similar results, Protective approach was superior to Curative. Chemical distribution could have affected the mortalities observed.

TABLE 4: Laboratory bioassay responses as mean percentage mortality of adult LGB and *Sitophilus* spp. to different levels of ASD at the end of 5th month of the trial. (Protective and Curative approach)

Treatments	Protectant Approach		Curative approach	
	LGB	<i>Sitophilus</i> spp.	LGB	<i>Sitophilus</i> spp.
Untreated control	0.00	0.43	0.00	0.17
Half rate	14.00	42.50	25.00	95.00
Standard rate	42.00	100.00	36.15	100.00
Double rate	67.00	100.00	45.64	100.00

Both standard and double rates of ASD resulted in higher mean percentage mortalities compared to the untreated control. Higher mean mortalities in *Sitophilus* were recorded. This infers that the chemical offered safe period of storage up to six months.

TABLE 5: The magnitude of damage as percentage mean bored grains and mean weight loss as flour formed from 500 ml of grain samples at the end of 3rd month of the trial.

Treatments	Protectant Approach		Curative approach	
	Mean damaged seeds (%)	Mean weight of flour formed	Mean damaged seed (%)	Mean weight of flour formed (g).
Untreated control	22.42	3.73	26.71	16.03
Half rate	1.02	0.80	3.20	6.70
Standard rate	0.09	0.15	0.60	0.95
Double rate	0.02	0.00	0.10	0.28

There was a significant difference between the untreated and the treated grains. The untreated control resulted in damage level of 22.42% in the protectant approach and 26.71% in the curative regime. Lower seed damage was recorded in the Protectant compared to curative approach.

TABLE 6: The magnitude of damage as percentage mean of bored grains and mean weight loss as flour formed from a 500 ml volume of grain samples at the end of 5th month trial.

Treatments	Protectant Approach		Curative approach	
	Mean	Mean weight	Mean	Mean weight

	damaged seeds (%)	of flour formed	damaged seeds (%)	of flour formed (g)
Untreated control	49.32	12.50	56.86	57.9
Half rate	6.69	3.00	40.98	31.5
Standard rate	0.76	0.70	0.64	0.7
Double rate	0.29	0.20	1.40	1.7

There was a good control of storage insect pests in the field 5 months after treatment with the standard recommended rate (100 g /90 kg grain) and in the double rate treatment. Mean percentage damaged seed were 0.76 and 0.29 for standard and double rates, receptively compared to 49.32 recorded in the untreated control in protective approach. Similar trend was also recorded in the curative approach.

Weight loss in terms of flour formed 5 months after treatment showed promising results. Clean samples in the standard recommended and double rates. The weight loss in the untreated control was 12.5 g which was higher than 0.70 g and 0.20 g recorded in the standard and double rates, respectively in the protective approach. Similar trend of weight loss was recorded in the curative approach.

3.3.2 DISCUSSION AND CONCLUSION

Protective approach is more efficient than curative approach. This cloud probably be due to high chemical distribution. It is also possible that some insects escaped chemical contact as they may have entered into the grain before the treatment. The newly formulated and packed ASD used at the recommended rate resulted in better control of both *P. truncatus* and *Sitophilus* spp. five months after treatment.

3.3.3 RECOMMENDATIONS

1. If the newly formulated ASD is used as recommended, it proves to be a useful protectant against storage pests.
2. Creating awareness in terms of seminars or workshops to Extension staff and to end users will ensure proper use of the protectant.
3. Appropriate statistics on the need for ASD to be well recorded to avoid accumulation of the chemical in store that lead to expiring of the chemical. This concern people like Regional, District and village stockist.
4. To minimize adulteration of the chemical, manufacturers should be advised to monitor the quality of their products at least after every three months.
5. A good control over trade liberalization to be looked at.

6. Proper guidelines, labeling, packaging to be emphasized.

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Question:

Can you comment on other functions of TPRI with respect to crop storage?

Response: TPRI conducts studies on efficiencies of storage structures, studies on biological control of LGB, Tn breeding and methods of release

Question:

Are we now importing pesticides from Kenya? The problem is that farmers have been compiling that ASD from Kenya was not effective against LGB. Why did you decide to obtain ASD from Kenya?

Response: ZENECA Tanzania was requested to avail ASD but they advised to contact the Regional representative based in Kenya. Twiga Chemical Company was to be a stockist for ZENECA products and this company had indicated that it was improving its formulation and packaging in conformity with Tanzanian specifications to improve quality and minimize the chances of adulteration. ZENECA conducted a workshop in Moshi to create awareness of the new packages and means of identifying their product

The package has the following identification marks:

Tanzanian Flag

'Window' on one side to show the color of the insecticide

Three different storage insect pests

A blue band on one side and white band on the opposite side which is intended to curb opening and re-closing the bag with the intention of adulterating the product.

Comment: Illegal copying of the packaging materials would not stop unless the Government takes stern action against it.

Comment: The new product is not being sold fast purposely because some stockists still have the old stocks to clear and are selling both the old and new stock. The old stock is thought to be ineffective.

Suggestions:

- This issue should be taken up by National Environment Management Council to have ineffective old stocks of pesticides identified and disposed off accordingly
- Manufacturers to educate farmers through mass media
- Manufacturers to buy back the old stock because farmers in the remote areas do not have access to new information.

3.4 SOUTHERN HIGHLANDS FARM LEVEL POST HARVEST MAIZE SYSTEMS RESEARCH: HIGHLIGHTS AND FUTURE TRENDS.

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3.4.1 INTRODUCTION

The Southern Highland regions produce over 50% of the total maize output in the country which fluctuates between 2 and 3 million tones annually. Over 90% of the maize is produced by small holder farmers. It has been established that between 70 and 80% of the grain is handled at the farm level where also grain losses are known to occur. Bengtsson (1991) reported that grain loss at farm level in Tanzania ranges between 2 - 30%. Moreover the actual Grain damage may be higher than the quoted figures. Farmers have always been blamed for the poor grain handling and storage practices. Attempts by Research and Extension interventions have given little accomplishment to loss reduction. Definitely, further grain loss reduction programmes require input of adoption studies from past interventions, if the hard sought resources are to be effectively utilized.

Subsistence grain storage research program was initiated at Uyole in 1976 which dealt mainly with modifications and improvement of local storage facilities (Uyole Agricultural Centre, 1976. However the early efforts met financial and manpower constraints (Lutende, 1980). From early 1990's to date, the institute has actively conducted on-station and on-farm post-harvest research. This paper gives highlights of post harvest maize systems research conducted at the Uyole Agricultural Research Institute and outlines pending research agenda for the Southern Highlands of Tanzania.

3.4.2 MAIZE POST-HARVEST SYSTEMS

The post-harvest systems entails all of the essential technology of storage, transportation and processing of agricultural produce into food products (Wos 1985). Harvesting, drying and cleaning among others are complementary post harvest operations. Factors and practices in each of the post harvest operations influence quality of grain and quantity of losses. The post-harvest systems research activities conducted at Uyole may be grouped into the following major areas:

1. Studies on small holder post-harvest systems in the Southern highlands
2. Evaluation of traditional storage structures
3. Evaluation of Improved storage structures

4. Collection and Evaluation of insecticidal plant materials for the control of storage pests in maize

3.4.2.1 Studies on Small-holder Post-harvest Systems in the Southern Highlands

A two stage survey was conducted in 1990/91 season. It began with a rapid appraisal survey. The appraisal involved collecting information from key informants from regional, district and village agricultural offices as well as individual farmers and village leaders. A total of 85 farmers from Iringa, Njombe, Mbozi, Sumbawanga, Rungwe and Mbinga districts were interviewed using a semistructured questionnaire. The appraisal was followed by a detail survey meant to further describe the storage systems in the study area. This involved 214 farmers from 29 villages in 9 districts of the southern highlands. Some salient features of the stages through which the grain passes from harvest to storage were noted.

3.4.2.1.1 Harvesting and drying.

In many parts of the Southern Highlands, maize is harvested in the dry season between May and September depending on climate. Normally maize is left standing in the field to dry after physiological maturity. Some farmers prefer to dry their maize at the homestead. Due to the relatively low humidity and little rain after harvest season, grain can be dried to reasonably safe storage moisture content by sun drying. The practice is drying by spreading cob maize at various depths, either on the ground or on raised platforms. The majority (55%) of small holder households interviewed dry their maize at the homestead either on ground (35%) or on raised platforms (20%) as shown in Table 1. Small portions of the produce for immediate consumption are dried after shelling.

TABLE 1: Percentage of Farmers by district using different maize drying methods .

Method	Mbozi	Iringa	Sumbawanga	Njombe	Total
On ground/floor	40	32	41	26	35
Raised Platforms	13	12	9	36	20
Field drying	47	47	50	36	45

Source: Mkoga and Shetto, 1995.

In some parts of Mbeya region such as Mporoto, Umaliila and Bundali divisions, and some parts of Rungwe and Makete districts experience severe drying problems due to high humidity and rainfall. In such cases sun drying is not reliable, while smoke drying is impossible where large volumes of crops are harvested. Unfortunately, there is no record of any interventions extended to alleviate this problem. This remains a challenge.

The drying methods used on the farms bear some risks due to facility design, lack of control of incoming field infested harvest by insects and rodents, and lack of protection from rain (Ashimogo, 1995). This leads to early infestation and severe losses.

3.4.2.1.2 Farm level transport

Transportation of maize from fields to homestead is primarily done by pack animals and oxen drawn sledges. Few farmers use oxcarts and motor transport is extremely prohibitive to many. For example Ashimogo (1995) reported that only 11.7% of farmers in Sumbawanga district used motor transport. The average farm to homestead distances (Table 2) allow head pottage which is mainly done by women and children. Moreover proper interventions are needed to alleviate the on-farm transport drudgery for these unprivileged gender sections.

Table2: Farm to homestead Distances (km) by district.

	Average	Range
Sumbawanga	0.1	1.5-3.0
Njombe	0.3	0.4-10
Mbozi	1.5	0.5-2.5
Iringa	2.4	0.5-5.0

Source: Mkoga and Shetto, 1995.

3.4.2.1.2.1 Sorting and grading

It was found that mould and insect damaged cobs are normally sorted out. The sorted out portion is not wasted, but fed to animals or used in preparing local brew. Free range pigs and chicken kept by farmers feed on the so thought to be lost grain. In this way what is considered as loss is effectively utilized by livestock component in the prevalent farming systems. The slightly damaged grain is immediately shelled for sell. The sound grain is stored as household food reserve and for future sale. With the current food shortages many farmers have ignored sorting procedure. The hungry market has no strict quality demands.

3.4.2.1.2.2 Shelling

Majority of farmers (69.1%) interviewed store shelled maize (Table 3). This might be due to the impact of the Lager Grain Borer control campaigns carried out in early 1980's. Only 30% of farmers store cob maize. They consider it as a safeguard against misuse by family members (Ashimogo et al, 1993). The temptation to sell is minimized with cob maize. Also thieves can easily steal larger amounts of produce if shelled maize is stored. Although, It is a logical

assumption, but pests can likewise "Steal" the grains as it creates a more conducive environment for them. Storage of cobs with sheath intact exposes the cobs to heavy infestation whether or not the insecticides are applied (Golob and Hanks, 1990).

Table 3: Form of maize storage practiced by farmers in the Southern Highlands
n = 214.

Form of storage	Shelled	Husked Cob maize	Dehusked cob maize
Frequency	148	34	32
Percentage	69.1	15.9	15.0

Source: Mkoga and Shetto, 1995.

The common shelling practice is beating the cobs either on the ground, on raised platform or in a jute bag (Table 4). The shelling methods cause high grain breakage. The broken grain may not be considered as loss since it is absorbed in the market. However, broken grain is ideal for insect activity. Shelling machines are seldom used by small holders farmers.

Table 4: Maize shelling facilities commonly used in the Southern Highlands

Beating of maize cobs			
n=24	On ground/foor	Raised platform	Storage
Frequency	118	60	36
Percent	55.1	28.1	16.8

Source: Mkoga and Shetto, 1995.

Spillage and scattering during shelling is the order of the day and is considered by experts as a loss agent. On the contrary, farmers take the trouble to pick every grain or leave the grains to be consumed by the domestic animals. It might be right to consider the shelling methods as laborious and time consuming. But how do experts consider the fact that farmers have no limiting farm activity shortly after harvest other than shelling grain until the next farming season. It is however necessary to easen shelling activity so as to release family labour for other off-farm economic activities.

3.4.2.1.2.3 Control of Insect Pests:

Mkoga and Shetto (1995) observed that about 80% of sampled farmers in the Southern highlands used chemicals to control storage insects in maize. The figure is highly different from other studies in a similarly setting of farmers (Table 5). It was noted however that only 19% used Actellic Super dust, most of them use incorrect doses (Mkoga, 1992). It was noted with concern that chemicals are grossly misused. For example, Bengtsson (1991), Mkoga (1995) and

Ashimogo (1995), found that 11%, 27% and 12%, respectively, of pesticide users surveyed used DDT. This is a threat to peoples' health. The grain so treated finds distant markets.

On the other hand reliable sources of Actellic Supper dust are difficult to find in townships, let alone in the villages. A new wave of substandard or fake products in the liberalized market has made farmers skeptical to invest on the industrial pesticides. Many have reverted to use of natural plant materials harnessed and prepared at farm level.

Table.5 Use of pesticides in Stored maize, Tanzania 1986/87-1992/3

Region or District	Sample size	% Farmers using Pesticides	reference
Sumbawanga	120	42	Ashimogo (1995)
Southern Highlands	214	80	Mkoga and Shetto (1995)
Iringa, Mbozi, Njombe, S'wanga	54	94	Mkoga (1992)
Rukwa	214	53	Nyagali et al (1996)
Rukwa	498	17-72	Agrar-8 hydrotechnik GmbIt (1987)
10 Districts	71	45	Bengtston (1991)

Source: Ashimogo, 1995.

3.4.2.1.2.4 Storage Structures

Storage methods vary widely depending on economic, environmental and cultural practices. Basically three types of storage structures are used, namely the cylindrical baskets, rectangular mud block stores and cribs. The cylindrical baskets are the most common in the Southern Highlands (Table 6). They are either made of wickerwork or woven twigs, bamboo, reeds and thatched with grass depending on availability of material locally. The structures may be plastered or unplastered. Where cob maize is stored structures are not plastered. The structures are plastered with a mixture of mud and cow dung. Cow dung is said to deter storage insects.

Table 6.Type of storage structures used in the Southern Highlands (n=186)

Type of store	Cylindrical Basket	Rectangular bins	Cribs and others
Frequency	145	30	11
Percent	78.0	16.1	5.9

The structures may be located indoors or outdoors. Near townships, the majority of stores are placed indoors to avoid pilferage (Ashimogo, 1995). The capacity of stores range from 2 to 13 m³ with a life-span of between 3 and 20 years (Table 7). Stores for cob maize are larger than those used for shelled grain. Families have more than one storage structure for small portions of produce. This eliminates need to have large granaries. Therefore economics of scale is seldom considered.

Table 7: Capacity and lifespan of storage of structures

Type of Store	Life span	Capacity (m ³)
Cylindrical baskets	4-8	3-8
Thatch grass	3-7	5-8
mud block	7-10	9-13
Burnt Brick	15-20	9-13

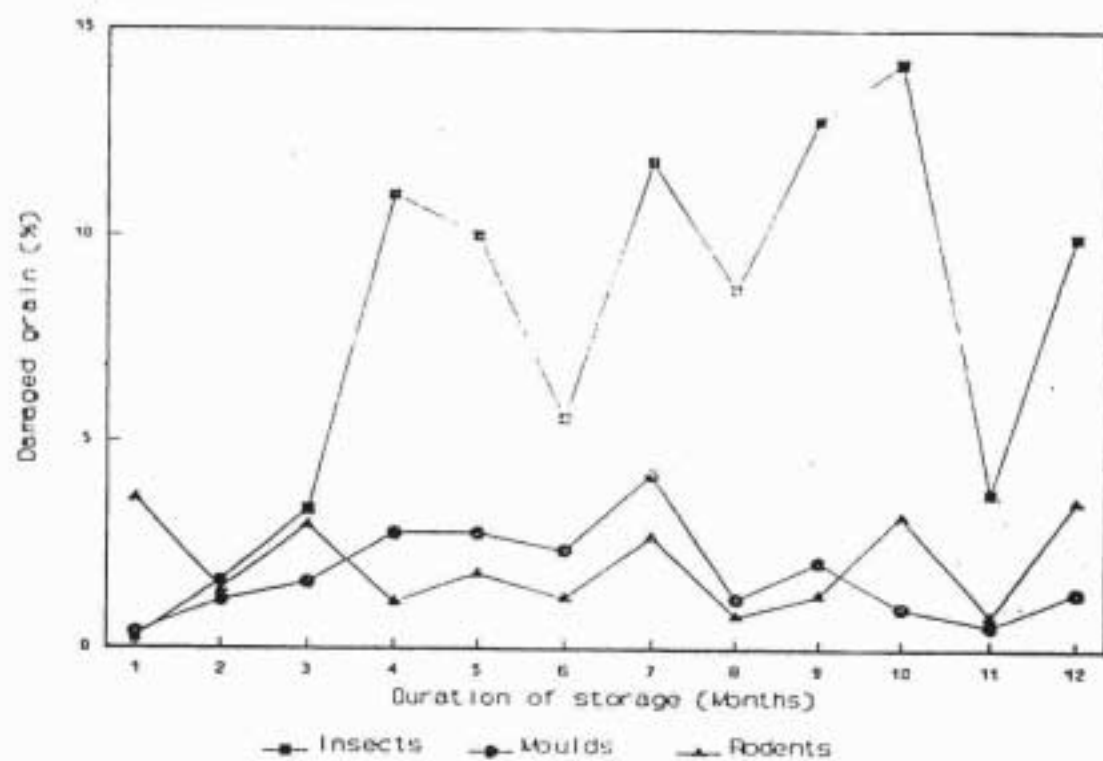
Source: Mkoga and Shetto, 1995.

3.4.2.1.3 Evaluation of Traditional Storage Structures

The three types of traditional stores mentioned in section 2.1.6 were evaluated both on-station and on-farm. On-farm evaluation involved 106 farmers from Mbinga, Njombe, Songea, Iringa, Nkansi and Mbozi districts. In general the traditional structures are cheap as they are made from locally available materials and they are simple to build. However it was observed that they are not insect and rodent proof. Moisture movement is not effectively restricted. Insects can easily enter and exit from the structures through the roof, open eaves, cracks and crevices on the wall and the floor. Cracked and rough walls provide a favorable environment for insect infestation while the open nature of some stores reduces the effectiveness of the applied insecticides. Also, most building materials are prone to termite attack and fire hazards. They also need frequent repairs which increases the storage cost. On the other hand the traditional cribs meant for short term retention and drying are wrongly used for long term storage.

Insects, fungi and rodents were identified as the main biological agents associated with losses of stored grain. Insects were ranked to be the most important (Fig .1) maize damaging agents of which the grain weevils (*Sitophilus* spp.) were the most common, followed by grain moths (*Sitotroga cerealella*) while the Larger Grain Borer (*Prostephanus truncatus*) was rarely found.

Figure 1. Major biological agents of grain loss



3.4.3 Development and Evaluation of Improved Storage Structures

Seven types of improved storage structure were developed based on traditional structures and adaptation of such structures from elsewhere in the region such as Zambia, Kenya and Ghana. These were tested against the traditional storage structures. A number of experiments were set at Uyole between 1976 and 1985 involving these structures (Pedersen, 1978; Lutende, 1979 and Shetto, 1985). The structures were the burnt brick silo, mud plastered basket, cow dung and mud plastered basket and bamboo unplastered store. Others were the cement plastered silo, cement stave silo, the Ferrumbu and three types of traditional granaries. Capacities ranged between 1-2.5 tons. The cement plastered silo, the Ferrumbu and cement stave silo were more promising. However construction cost of such stores were beyond reach of many farmers.

Between 1994/95 and 1996/97 other four improved structures were constructed and evaluated at Uyole (Mkoga and Shetto, 1995). The structures were the burnt bricks, mud block, bamboo and thatch grass baskets. Burnt brick store was plastered with cement and the rest were plastered with mud. These structures were chosen based on a survey proceeding the study (Mkoga, 1992) and designs promoted by a FAO – UNDP Project (Bengtsson, 1991). The structures were replicated four times in a Randomized Completely Block Design. Each of the structures were filled with about 2 tons of maize treated with Actellic Super Dust.

Rethorpe sensors and thermistors were placed in pre-determined positions in the structures to measure moisture content and temperature, respectively. The thermistors were connected to Delta T data loggers configured to read and record hourly temperatures. The Marconi instrument was used to read temperature data on weekly basis. The structures were found to be equally good in preserving the grains. Intergranular temperature and moisture regimes were not alarming (Fig. 2 and 3). It was concluded that provided the structures are well covered and plastered there is no significant difference in performance between the structures made from different construction materials.

3.4.4 Potential of Insecticidal Plant Materials

Recent field visits have revealed a growing use of the plant materials in storage (Mkoga et al, 1999). Over 15 plants with insecticidal properties have been identified (Table 8). Powder made from tubers, roots and leaves of the plants are used by farmers to control storage pests. The materials are also used in field crops protection mainly for stalk borer control in maize (Uyole Agricultural Centre, 1990) as well as medicines for treating livestock (Akkaro et al 1998).

Efficacy of some of the plant materials against common storage insects was roughly determined in the laboratory trial conducted at Uyole in season 1995/96 and in on-farm trials conducted in 1996/97 and 1997/98 seasons (Mkoga et al., 1999). The on-farm trials were conducted in 6 districts, namely, Iringa, Mufindi, Njombe, Songea, Sumbawanga and Chunya. Performance of the materials in the on farm trials were highly in consistent. The geographical variation, nature of on-farm trials and nature of plant materials may explain the inconsistency. Consistent results were obtained in the on-station experiment. However, both the on-station and on-farm experiments exhibited some potential of the plant materials on storage protection at least up to 4 months of storage. Pyrethrum gist performed best and showed same level of efficacy ($P < 0.05$) as Actellic super dust (Table 9 and 10. Materials may perform better if well prepared, finely ground and well preserved before use. Re application after 4 months may extend the storage duration.

However, most of the materials have not been subjected to scientific scrutiny. Much of the information so far collected is anecdotal based on current traditional practice. The quality of information is quite variable. The active ingredients, toxicology, effective application rates, formulations, modes of application and so forth have not been studied. Above all, it important to establish whether the natural insecticides are more effective, sustainable and cheaper than the synthetics. Uyole Agricultural Research Institute is working on these issues in collaboration with the Government Chemist, the University of Dar es Salaam, HIMA Makete (Kabungo, 1999) and COORPIBO funded projects in Mbeya region (Biria and Kwilligwa, 1999).

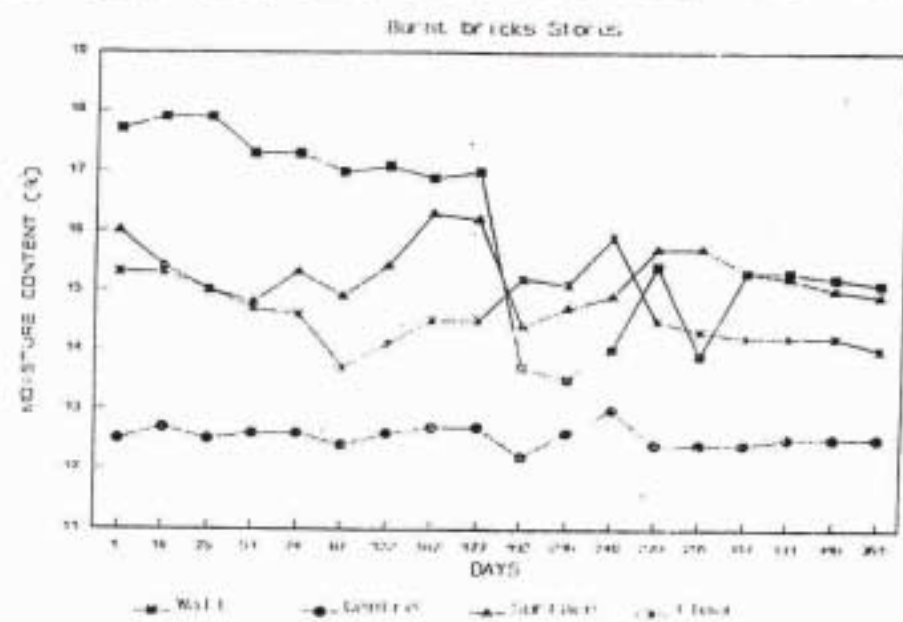
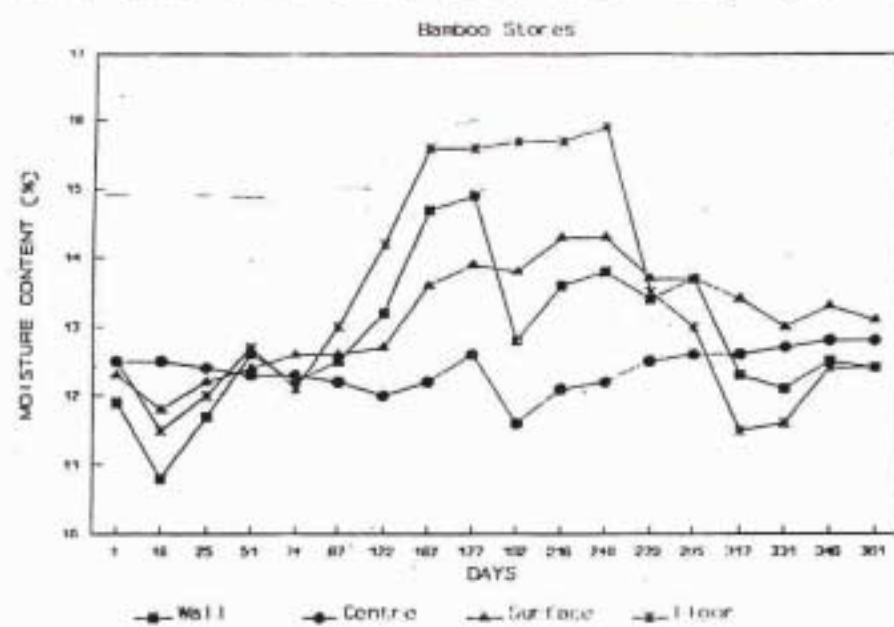


Fig 3 Temperature patterns

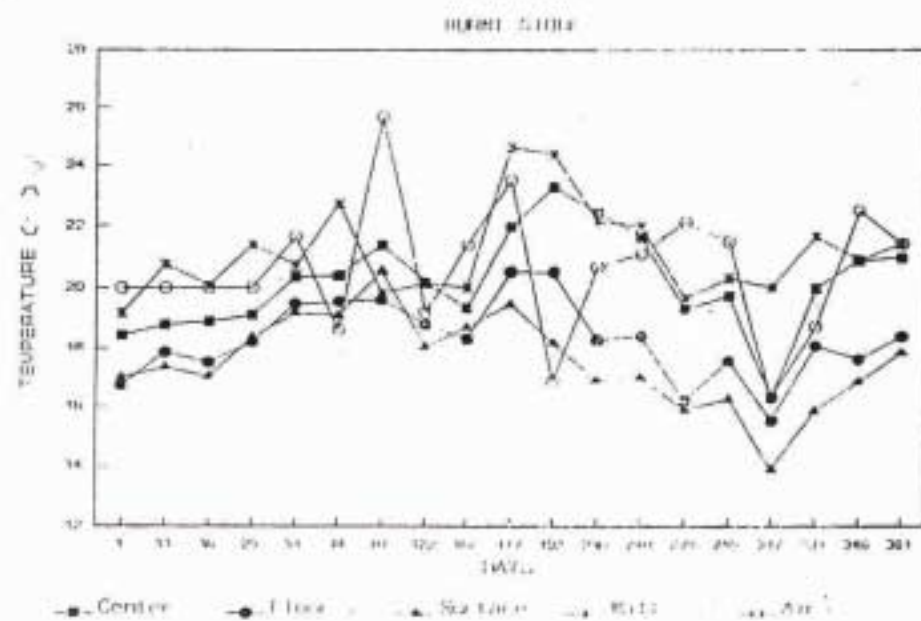
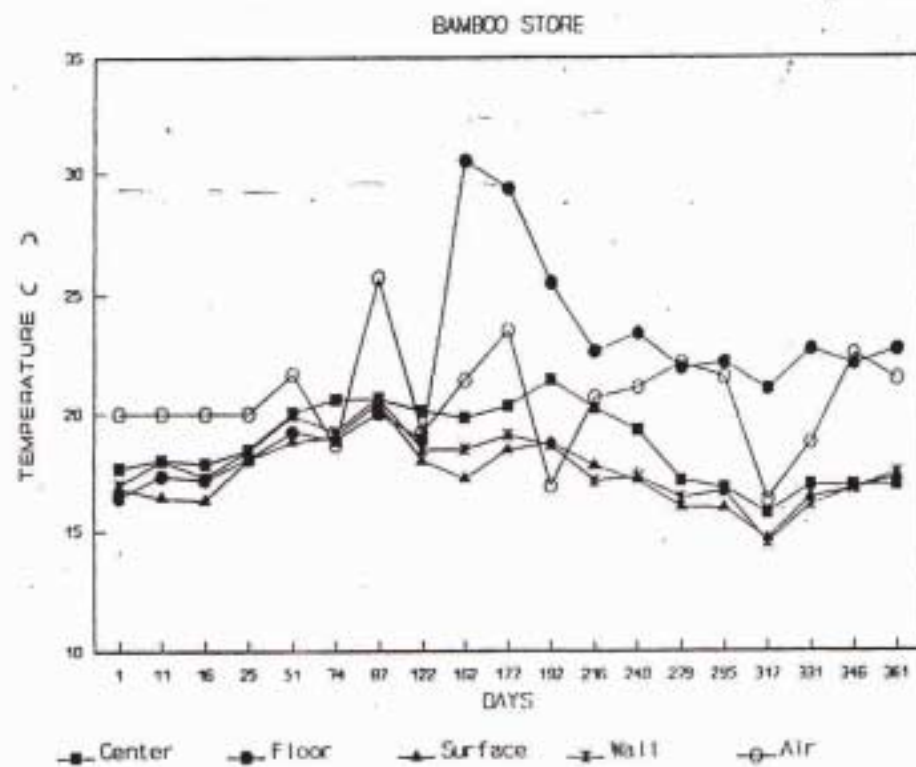


Table 8: Plants with insecticidal properties as used by farmers in the Southern Highlands of Tanzania

SN	Scientific Name	Vernacular name(s)	Plant Characteristics and Plant Habitat	Active Part(s) and Use
1.	<i>Neurastria nitida</i> Fam. Leguminosae	Likowo (Hehe) Lisepe (Hehe) Lidupa (Bena) Lidema (Ngoni) Chitupi (Nyanwaga) Lidua (Bungu) Nyongwe (Lambya) N'gandangoro (Fipa) Iujamisi (Sukuma) Ibumbwe (Safwa) Ivombwe (Wanji)	Leguminous shrubby herb erect and climbing woody stem, trifoliate leaves lobed or full. About 1-2m height, rootstock tuberous massive oval or oblong. Flowers whitish, yellow or purple, produces pods of highly viable seed like common beans. There is a sharp difference in morphology of plants of this specie. Habitat : Miyombo woodland, open woodland and open grassland, widely distributed	Tubers & leaves - grain storage and stalk borer control. - Control new castle in chicken - Insecticide in horticultural crops.
2.	<i>Dolichos Klimandchari</i> Fam. Leguminosae	Liboli (Bena, Kinga) Likolya (Bena)	Leguminous shrubby herb, erect woody stem up to 1m height trifoliate leaves, purple flowers, narrow pods, oblong tuber. Habitat : Miyombo woodland	Tuber - grain storage
3.	<i>Azadirachta indica</i> and <i>A. melia</i> Fam. Meliaceae	Mwarobaini (Swahili) Neem (English)	Small tree 5-6m height. Fast growing, leaves narrow, alternate and serrated. Flowers whitish. Habitat : Cultivated/Planted adaptable to a wide range of Habitat	Leaves - Medicinal, grain storage and field insecticide
4.	<i>Tagetes minuta</i> Fam. Compositae	Linung'anung'a (Bena) Lisapi (Bena) Masigabahaya (Nyanbo) Mexican marigold (English)	Shrubby plant 0.5 - 2m height, erect woody stem, root stock tap with adventitious roots. Leaves serrated edge & plain surface. Flowers yellow or white. Habitat : Grows in cultivated areas as weed. Also in open grass land.	Leaves - grain storage
5.	<i>Cleome scaberrima</i> Fam. Renunculaceae	Ligombwanzuki (Bena) Naliso (Ngoni)	Herb 1-3m height erect woody stem. Flowers white sepals. Habitat : Open grass land, Brachystegia woodland with Uapaca Kirkii and Jatropha globiflora	Leaves - Grain storage - stalk borer control
6.	<i>Zanba africana</i> Fam. Sapindaceae	Livangavanga (Bena)	Small tree 4 - 5 m high with paripetate shortly pubescent leaves. Yellow flowers and long pods. Habitat : Miyombo woodland	Roots - Grain storage and medicinal
7.	<i>Chrysanthemum cinerariaefolium</i> Fam. Compositae	Pareto (Swahili) pyrethrum (English)	Shrub, 20-40cm high white flowers. Habitat : Cultivated	Flowers - Grain storage and field insecticide
8.	<i>Vernonia advenia</i> Fam. Compositae	Mgosa (Bena) Libuchubutcha (Bena) Likenzi (Hehe) Isogoyo (Lambya) Msangusangu (Ngoni) Bulisiya (Safwa) Livulugu (Safwa)	Erect shrub, 3-4m height, leaves serrated and alternate. Habitat : Open woodland and cultivated areas.	Leaves - Grain storage
9.	<i>Vernonia Amygdalinea</i> Fam. Leguminosae	Isogoyo (Lambya) Ilulasya (Ndali) Msoghoya	Small tree 5-6 m high, stem grayish, leaves alternate and serrated. Habitat : Open woodland	Leaves - Grain Storage
10.	<i>Tephrosia vogelii</i> Fam. Leguminosae	Utupa (Swahili) Lidupa (Hehe, Bena) Mrunungu (Ngoni) Nkondo (Safwa, Wanji) Nkonda (Nyakyusa, Ndali)	Leguminous shrub 1-3m height, woody stem, leaves and pods are hairy. Flowers white, yellow and purple or mixture. Habitat : Cultivated	Leaves - Grain storage stalk borer control and ectoparasite spray in livestock.
11.	<i>Piliostigma thonningii</i> Fam. Leguminosae	Maegese (Ngoni) Ipapa (Njiha)	Leguminous tree 5-7m height, grey bark stem. Leaves lobed in butterfly shape. Flowers White, short flat pod. Habitat : Miyombo woodland	Pod - Grain Storage
12.	<i>Artemisia afra</i> Fam. Compositae	Manyagha (Wanji, Kinga)	Shrub up to 3-4m high, gray leaves and aromatic. Habitat : Bushland and cultivated land	Leaves - Grain storage
13.	<i>Gnidia Kruusiana</i> Fam. Thymelaeaceae	Kachenje (Fipa)	Habitat : Erect herb 20 - 40 cm high, multistems emanating from tuber, pubescent leaves, alternating light green colour. Tuber oblong fibrous, skin colour dark brown, flesh cream yellow. Habitat: Open grassland	Tuber - Grain Storage & stalk borer control
14.	<i>Swartzia Madagascariensis</i> Fam. Leguminosae	King'eng'e (Ngoni) limulimuli (Hehe) Mjafari (Swahili)	Leguminosae tree up to 6-7m high. Produces long pods. Habitat : Brachystegia woodland in association with <i>Zanba africana</i> , <i>Combretum molle</i> , <i>apoca kirkii</i> , and <i>sclerocarya birrea</i> .	Pods - Grain Storage

Source: Mkoga *et al.* (1999)

Table 9. Damaged grain (%) by treatment and storage duration (months) for 1995/96 season.

Treatment	Storage duration (Months)				
	3	6	8	9	11
Actellic Super dust	0	0.0c	0.0c	0.0c	0.0c
Ng'andangoro (<i>N.mitis</i>)	0	2.6bc	15.3bc	55.9b	3.2c
Pyrethrum gist	0	1.4bc	0.06c	5.9b	4.6bc
Nyongwe (<i>N.mitis</i>)	0	0.2c	18.8bc	52.7b	11.0bc
Lidupala (<i>N.mitis</i>)	0	4.5bc	41.8abc	81.8ab	17.8bc
Likowo (<i>N.mitis</i>)	0	5.8bc	31.7abc	70.0abc	21.8bc
Likumbanguluve	0	23.9abc	42.2abc	88.7a	40.7b
Manyagha (<i>A. afra</i>)	0	20.3abc	64.4ab	81.4ab	78.1a
Isogoyo	0	24.5ab	59.2ab	96.7a	79.2a
Pyrethrum marc	0	20.2abc	57.7ab	87.7a	84.8a
Neem	0	16.4abc	46.8abc	92.5a	89.8a
No insecticide	0	33.6a	84.2a	99.1a	56.8a
X	0	12.8	38.5	67.60	50.1
CV (%)	-	96.66	71.99	24.26	38.96
L.S.D. (0.05)	-	20.92	46.89	27.78	33.06

Source: IFAD-SHERFSP, 1996.

Table 10. Live infestation of *S. Zeamais* Motsch (no), by treatment and storage duration (months) in the 1995/96 season.

Treatment	Storage duration (Months)				
	3	6	8	9	11
Actellic Super dust	0	0.0c	0.0c	0.0d	0.0d
Ng'andangoro (<i>N.mitis</i>)	0	14.0 abcde	8.0bc	3.0 cd	28.0 bcd
Pyrethrum gist	0	2.0 de	2.0c	6.0cd	7.0cd
Nyongwe (<i>N.mitis</i>)	0	5.0 cde	25.0 bc	22.0bcd	31.0 abcd
Lidupala (<i>N.mitis</i>)	0	17.0 abcde	43.0ab	47.0ab	32.0abcd
Likowo (<i>N.mitis</i>)	0	6.0 bcde	18.0 bc	40.0abc	37.00abc
Likumbanguluve	0	14.0abcde	34.0abc	6.0 cd	45.0ab
Manyagha (<i>A. afra</i>)	0	28.0ab	18.0bc	68.0a	34.0abc
Isogoyo	0	35.0a	23.0bc	17.0bcd	39.0 abc
Pyrethrum marc	0	11.0bcde	31.0abc	61.0a	33.0abc
Neem	0	27.0 abc	20.0bc	36.0abcd	30.0 abcd
No insecticide	0	23.0 abcd	66.0a	8.0cd	26.0a
X	0	15.0	24.0	25.00	32.0
CV (%)	-	76.18	82.82	79.4	53.56
L.S.D. (0.05)	-	19.42	33.58	33.2	28.7

Source: IFAD-SHERFSP, 1996.

3.4.5 FUTURE TRENDS.

Priority remains to improve on the traditional grain storage facilities since it is at storage where the greatest losses occur (Bengtsson, 19991; Ashimogo, 1995). However, the improved storage structures have met slow adoption by farmers. The efforts by research and extension service has made little impact. For example it has been generally observed that few farmers have adopted improved cement basket silos promoted by Kilimo Sasakawa Global 2000 Project in Iringa (Shetto, et al, 1994) and Mbeya. Outdoor structures constructed in some farmers homesteads at Kiponzero village in Iringa, among others remain as white elephants. Theft problem has forced farmers to move grain storage indoors. Structures were constructed out doors as demonstration to entice other farmers to the improved innovation. For this matter input of adoption studies is urgently needed in order to identify the right intervention points. We need to explore farmers tastes and preferences, and utilize them to draw up an affective research agenda in a participatory manner.

Insect pest control is also a high priority. Use of natural plant materials seems to overrun the recommended actellic super dust. However, the plant materials are used at risk of health hazards and high grain losses. Future research will focus on exploring the local inventories so as to facilitate use of the plant materials in the most effective and safe way.

The focus will emphasize on improvement of grain drying and shelling facilities as it received little weight in the past. The rising demand for maize calls for interventions for drying of early harvested maize a specific priority to problem areas.

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Question:

Can you give names of some of the traditional insecticides used by the farmers

Neem

Pyrethrum (Check the names of the samples)

Comment: Some work on storage structures and traditional pesticides has been done previously at Uyole A.C. during 1970's. Literature exists in files although not published but can be useful to avoid duplication or repetition of what has already been studied.

Farmers use the traditional insecticide out of desperation because of insufficient supply or ineffective recommended pesticide. Some use other chemicals even DDT.

DDT has been banned in Tanzania, where do the farmers get DDT?

Response: During the survey of traditional pesticides we encountered some of the chemical pesticide used by farmers to store their maize. A sample of the insecticide was taken to the laboratory for analysis and identified to be DDT. DDT is suspected to be imported illegally from Rwanda and Burundi. Farmers buy it because the price is low. Delegate from Uganda also complained of DDT being imported illegally into their country.

3.5 INTEGRATED CONTROL OF STORAGE PESTS IN TANZANIA

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Abstract

This paper regards LGB as a major problem in Tanzania. Before bringing the present control approach in the picture i.e. integrated control, previous control strategies which relied on insecticide use have been described. It is emphasised here that farmers adopt integrated control approach to combat LGB and other storage pests. On the other hand Bio-control efforts using *Teretriosoma nigrescens* (Tn) to control LGB should continue and quickly extended to other areas outside Dodoma - Morogoro and Iringa. Meanwhile assessment of the impact of Tn to LGB reductions and eventually loss reduction will be done in the near future.

3.5.1 Introduction

In Tanzania farmers still experience huge losses of stored maize and cassava due to storage pests, in particular Larger Grain Borer (LGB locally known as dumuzi. This beetle is indigenous to Central America and might had found way to Tanzania in the late 70's through imported maize. LGB cause weight losses of maize of up to 35% within 3-6 months of storage. However spot observation in farmers stores where quantity of maize diminishes as grain is removed for consumption, records average losses of 9-15% after 6 months of storage. These levels of losses are very high compared to losses experienced prior to LGB invasion which were estimated at 1% for the first 6 months post harvest and less than 5% for the whole storage period. Since the damage by this exotic beetle is more severe than that caused by the traditional pests such as *Sitophilus spp*, *Rhizopertha dominica*, *Tribolium spp*, *Bruchids* and *moth spp.*, it is clear that National food security is threatened.

3.5.2 Control Strategy

After the country had been invaded by LGB a control and containment programme co-ordinated by FAO was launched. The strategy undertaken by PPD of MOAC involved:

1. Training of plant protection personnel on improved storage methods, produce inspection, quality control, fumigation and plant quarantine measures.
2. Training of warehouse personnel on improved storage practices to reduce losses caused by LGB.
3. Training of farmers on how to control LGB and other storage pests through existing National extension system.

4. Control of storage pests by:

- Observance of storage hygiene i.e. cleaning of stores before use, destruction of infested residues, disinfection of storage structures with dilute insecticides etc.
- To dry, shell maize and admix 100 kg maize with 100 gm of Actellic Super Dust (A cocktail) of 1.6% Pirimiphos-methyl and 0.3% Permethrin).
- To store maize in suitable containers or store houses.
- To harvest cassava piece meal to avoid prolonged storage.
- Intensive control campaigns were carried out by pest control teams which attempted eradication of the LGB in limited outbreak areas. These campaigns were justified by the shortage of insecticides and other resources which were not enough to be dispensed to individual farmers.

Despite of the elaborate control strategy, LGB continued to spread across the country and by 1994 all Regions of Tanzania mainland had been infested with LGB. It was estimated that the Government of Tanzania was using US\$ 3 million annually between 1980 - 1992 for control and containment of LGB. After the phasing out of this project, this amount of money could not be availed by the government and therefore most of the control activities could not be sustained. Availability of insecticides for instance could no longer be guaranteed let alone the problem of ensuring quality and safe use of insecticides especially after market liberalisation.

3.5.3 The Integrated Control of LGB and other storage pests

The current post harvest activities puts emphasis on the integrated approach as the only rational and sustainable for the control of storage pests. The integrated control activities were set in motion after the plant protection division of the Ministry of Agriculture and Co-operatives signing an agreement of Co-operation with GTZ for the Integrated Control of storage pests project in January 1995.

The objective of the project was to develop and disseminate messages on integrated control of post harvest pests, a component which was lacking in previous projects. The project initiated household oriented advisory concepts using consolidated experience and recommendations on post harvest from previous projects. The integrated control concepts and recommendations have been made available to the extension agents and farmers through training and availing the relevant extension materials such as:

- Hifadhi bora ya nafaka katika ngazi ya kaya
- Hifadhi ya mahindi yaliyo kwenye magunzi dhidi ya wadudu waharibifu bila ya kutumia dawa
- Muhtasari wa mikakati ya udhibiti husishi wa wadudu waharibifu wa mahindi na mihogo Uthibiti husishi wa mchwa

- Udhibiti husishi wa mchwa

3.5.4 Bio-control Activities

Biological control of LGB was initiated since 1997 as a component of Integrated storage Pest Management. The details of the programme will be presented later in the same text.

The integrated control of stored pests is elaborated in a leaflet prepared under GTZ-Tanzania project for Integrated control of storage pests" and can be obtained from:

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3.6 BIOLOGICAL CONTROL OF THE LARGER GRAIN BORER IN TANZANIA

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3.6.1 Introduction

The Larger grain borer is a pest of stored maize and cassava, the staple food of Tanzanians.

Tanzania has been infested by this pest since the late 1970's. The first region to report infestation was Tabora in 1980, but the pest spread to other regions and neighboring countries to an extent that by 1994 all regions of the country were infested.

In the advent of LGB losses in stored maize increased from about 2-5% to more than 36% in a storage period of 6 months. Given the extent of spread and the magnitude of losses mentioned it, follows that the presence of the pest in Tanzania may become a chronic threat to the food security if effective and sustainable control measures are not undertaken.

It is important to note that the extent of spread and establishment of the pest in Tanzania and neighboring countries is an indication that it can no longer be eradicated and therefore LGB is here to stay. The most feasible option is to protect susceptible stored products, especially maize and cassava.

3.6.2 LGB before the 90s

Initially, it was thought that LGB was confined to breeding and attacking stored products therefore early attempts to control the pest concentrated on improved storage management including chemical treatment of produce. Transportation of infested commodities was also restricted to minimize spread of the pest. The Plant Protection Ordinance (CAP133) , Control of *Prostephanus truncatus* rules 1986 was intended to serve this purpose. The extension messages to the farmers were to shell and treat maize with the recommended insecticide. However, todate there is no concrete recommendation for protection of cassava against LGB.

Problems

- Shelling maize in some parts of Tanzania was not a norm and still is the case in many parts of the country and required complete change in practices, values and attitudes which has not been easy.

- The application of insecticides has not also been without problems. Availability at the right place and time is still a challenge. The product is often scarce in areas periphery of towns where the majority of small farmers who have been more severely affected by LGB are found.
- Product quality has neither been assured and many farmers have incurred heavy losses allegedly as a result of ineffectiveness of the recommended insecticide, Actellic Super Dust.
- Prices of the insecticides have continuously been increasing to an extent that most farmers feel it uneconomic to use, let alone the fact that they cannot afford.
- Further to the above problems, it was established that the pest can successfully establish itself in environments outside stores and stored products. That is to say, the beetle can successfully breed in field crops and in the wild environment. The implication in this is that effective control must also consider populations of the pest outside stores which are likely to migrate into the stores. It is worth here to highlight the impracticability of applying insecticides in the fields or bush, and that being the case, LGB is free to migrate from the bush to stores and vice versa.

3.6.3 LGB control after 90's

3.6.3.1 Biological control of LGB

Noting the above situations, and the problems related to earlier recommendations on LGB it was widely felt that biological control could offer the potential for cheap, effective and long term control of the pest and a predatory beetle *Teretriosoma nigrescens* (Tn) also referred to as *Teretrius nigrescens* has been found to be the best known predator for LGB. African countries which have so far released Tn are: Togo 1991, Benin 1992, Kenya 1992, Ghana 1994, Zambia 1996.

3.6.3.1.1 Biological control programme in Tanzania

- Biological control of LGB in Tanzania was approved by the National Plant Protection Advisory Committee at its meeting of 16-17 January 1996 at Morogoro.
- The Ministry of Agriculture then requested technical and financial assistance from the International Institute of Tropical Agriculture (IITA) and GTZ.

- A co-operation Agreement for the LGB biocontrol project between IITA-Plant health Management Division - Cotonou and Plant Protection Division was signed in 1997. The objective of the project was to develop local capacity in biological control of LGB.
- July 1997, two Agricultural Officers were trained at IITA Benin for 4 weeks on Rearing, release and Monitoring of the LGB predator.
- A pilot area was identified for the release of Tn. This is the triangle joining the regions of Morogoro, Iringa and Dodoma.
- 25 pheromone traps were randomly distributed to monitor LGB abundance . Between 1997 and 1998 the traps were observed bimonthly and the number of LGB per trap recorded.
- A mass rearing unit for Tn was established.
- In February 1998, PPD received 10,000 Tn beetles from IITA against an import permit issued according to the Plant Protection regulation. The beetles were hand carried by a scientist of IITA.
- On the 17th February 1998 first releases of 2,000 Tn out of 10,000 received from IITA was done in one site in each of the regions of Morogoro, Iringa and Dodoma i.e A total of 6,000 Tn was released in the triangle.
- Mass rearing of Tn was started with the remaining 4,000 beetles from IITA following the rearing protocol developed by IITA/GTZ.
- Our production potential stands at 8,000 beetles per month against a target of 10,000 per month.
- 40,000 predator beetles were released in the triangle described above and 15,000 in Arusha and Kilimanjaro regions up to July 1999.
- It is planned to start intensive monitoring for establishment and later on impact of the beetles towards the end of 1999.

3.6.3.1.1.1 Behavior of Tn

- It feeds on the eggs, larvae and pupa of LGB
Tn beetle can eat up to 2 larvae of LGB per day
Tn larva is more ferocious and can eat up to 5 larvae of LGB per day
- Tn is sensitive to the aggregation pheromone of LGB and can therefore easily locate LGB

- Tn is adapted to the same environment and climatic zones as LGB
- Tn cannot breed on plant material and therefore it will choose LGB rather than maize for food
- Tn can survive without prey for a long time.

3.6.3.1.2 The merits of biological control

- It is environmentally friendly unlike pesticides which are also a health hazard
- It is self sustaining
- It is cheaper when compared to pesticides

3.6.3.1.3 Demerits of biological control

- Takes long time to reduce pest population
- Irreversible
- Possibilities of being attacked by hyper parasites

3.7 THE CONTRIBUTION OF FARMERS EDUCATION AND PRINTING UNIT (FEPU) IN PROMOTING POST HARVEST TECHNOLOGIES.

Nyangi, H.
FEPU, P.O BOX 2308, DAR ES SALAAM

Farmers Education and Publicity Unit (FEPU) in the Ministry of Agriculture and Co operatives trains farmers mainly through mass media. The media involved include:

- Print media, leaflets, posters, booklets, magazines (Ukulima wa kisasa)
- The following radio Programmes, of which each is aired once every week.
 - "Mkulima wa Kisasa" (crops)
 - "Mkulima wa kisasa "(livestock)
 - "Chakula bora" (Food and Nutrition)
 - "Shambani juma hili" (weekly farm bulletin)
 - " Kilimo kanda ya Kati Dodoma" (Agriculture- central zone)
- Video episodes/shows
 - Media vans
 - Compact Mobile Units

With respect to Post harvest technology, the unit has produced and distributed to farmers the following material;

1. Posters
 - "Hifadhi bora ya nafaka" (Improved storage of cereals)
 - "Maonyesho ya sabasaba ya Kilimo 1999" (Agricultural Show of 1999)
 - "Vipekecha wa maharage" (Bean weevils)
2. Leaflets
 - " Kanuni za Kilimo Bora" (Principals of improved agriculture)
3. Video episode
 - "Hifadhi ya nafaka" (Storage of cereals)

FEPU receives a number of publications from various organisations, from local and international sources, from which some technologies are extracted, made user friendly and disseminated to farmers and the general public.

3.8 EXPERIENCES FROM UGANDA

M.Silim Nandy

NARO, Kawanda Agricultural Research Institute, P.O BOX 7065, KAMPALA

- LGB was first reported in Uganda in 1997. It is believed to have found its way to Uganda through maize imported from Kenya following shortage of maize that hit Uganda.
- Pheromones traps were set at Mutukula border with Tanzania and one LGB beetle was caught.
- Uganda has already imported *Teretriosoma nigrescens* from Muguga, Kenya
- rearing is being done in the area where LGB was found, 8 km from the Kenyan border.
- Some Tn has also been released at Mutukula.
- However, the pest is not found in storage but most of them are caught in the bush.

Envisaged activities for post harvest protection in Uganda

- Continued rearing and releases of Tn
- Sensitize farmers to shell maize where it is an important food crop.
- Non chemical approach - Botanical and Physical
- Research on Botanicals
- Research on resistant varieties
- Research on pre - harvest protection possibilities.
- Encourage preservation of dry cassava and sweet potato chips against storage pests by:
 - Slight salting to discourage insect infestation
 - Blanching of sweet potato - Immersing the chips in boiling water for a few minutes

Question: Is there any reason why you did not get LGB before 1997 taking into account that your neighbors Kenya and Tanzania were infested since long ago?

Response: In Uganda maize is not an important food crop and do we rarely import maize. In 1997 there was a critical food shortage in Uganda that we had to import maize which also brought in LGB.

4. GROUP DISCUSSIONS AND PLENARY REPORTS

The participants divided themselves into three groups to discuss aspects of the survey report and issues arising from the presentations. The issues for discussion were categorized into;

1. Chemical control
2. Non chemical alternatives
3. Information Dissemination and co ordination

4.1 SUMMARY OF GROUP DISCUSSIONS

4.2 Chemical control

4.2.1.1 Cost and availability

The group discussed chemical control in reflection of complains of unavailability, cost and quality.

Issues

- Government policy on inputs.
- Liberalized market environment
- Market forces of supply and demand.
- infrastructure, especially roads and the market framework conditions are a hindrance to realistic operation of market forces.

Recommendations

1. The input support fund of the Ministry of agriculture could be better targeted, to encourage small stockists and farmers groups especially in remote areas.
2. Extension Service should restore farmers' confidence to continue using the ASD through awareness seminars and trainings.

4.2.1.2 Quality of the pesticide

Issues

- TPRI conducts pre-release quality testing to all pesticides registered for use in Tanzania, including ASD.
- Post release monitoring of pesticides is inadequate

- Generally the country lacks adequate trained manpower and facilities to effectively monitor the quality of pesticides that are already in shops in every corner of the country.
- There are other formulations in other countries but are not available in Tanzania e.g Grain dust and Sumicombi
- Actellic superdust has monopolized the market for over 10 years. why?
- Farmers have no access to reliable information on most of the pesticides they use.

Needs

- PPD to push for speedy preparations for enforcement of the new Plant Protection Act (1997) and its regulations
- Training of more Pesticide Inspectors to enforce regulations
- To intensify awareness creation on pesticide selection, use and safety
- Manufacturers of pesticides to be encouraged to register other products by providing incentives like reduced registration fees and taxes.
- Research into alternative chemicals
- Monitor insect resistance, preferably on regional basis, EAC and SADC

4.2.1.3 Research needs

- Insect resistance to ASD
- Testing of alternative insecticides
- Monitor residue levels of insecticides on the stored products
- Socio - economics aspects of pesticide use

4.3 Non Chemical alternatives for LGB control

Issues

- Impact of Bio control
- *Teretriosoma nigrescens* released in Tanzania
- A long list of plants have been identified by TPRI and Uyole Research Institute as potential for botanical insecticides
- Cultural practices exist, including blanching and salting in sweet potato and cassava chips.
- Inert dusts are cheaper alternatives
- Early warning system to facilitate preparedness and early control

Recommendations

- Designate /establish a post harvest research unit
- Research into bio-safety of the available biocontrol agents, i.e Tn.
- Research on botanicals to ascertain their;

- active ingredients
- toxicology
- dosage rates
- bio-safety
- spectrum of activity (environmental impact) etc;
- Breeding and selecting crops resistant/tolerant to storage pests
- Research on blanching and salting to determine salt amounts, optimum duration and temperature.

4.4 Information Exchange and co ordination

Information exchange and co ordination was discussed in respect of :

- sources of information
- information processing
- dissemination

Recommendation

- Regional co operation in Information generation, processing and dissemination, involving expert consultations among members, literature references in libraries, use of mass media, internet and exchange visits.

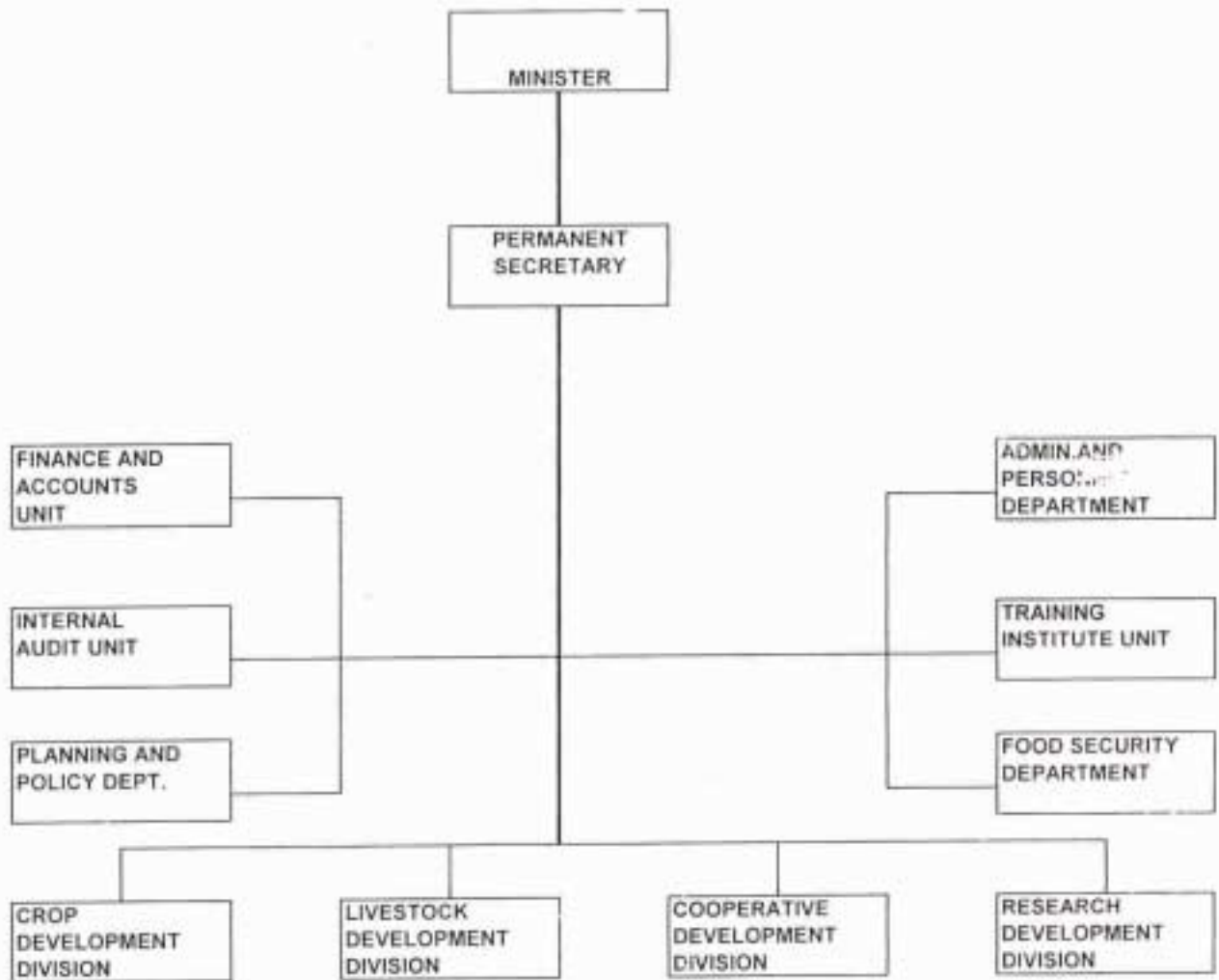
Key aspect of information was relevancy and availability to the target audience on required time.

- Strengthen post harvest services by providing resources and capacity building.
- Existing post harvest committee on roots and tuber (coordinated by the Tanzania food and nutrition Centre) to be sensitized to deal with cereal crops as well.
- forge linkage between Post harvest service, research and extension through the technical committee on post harvest.
- identify areas of co operation between member countries of regional bodies, (EAC, SADC) in order to make better use of available resources, especially on aspects of research and plant quarantine, as was the case before the breaking of the EAC in the 1970,s.

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Machinery and Inputs

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Vet. Board Secretariat
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Inputs

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