Post-harvest technology transfer to reduce on farm grain losses in Kitui district, Kenya

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Abstract

Training and demonstrations on post harvest technology transfer to reduce grain losses at farm level were conducted in five divisions of Kitui district with the overall objective of consolidating what the farmers already knew about storage. It was also to assist them select appropriate storage methods with emphasis on proper application of pest control products. A total of 163 participants were trained in storage pest management covering pest infestation cycle, use of chemical and non-chemical methods of control, storage practices and identification of major pests using specimen and pictures, dangers of mycotoxins on maize followed by on demonstrations.

Farmers demonstrated traditional practices of determining grain moisture content, and shovel mixing, both on the tarpaulin and wheelbarrows. Sticks were other tools used to mix chemical dust with grain on tarpaulins and in the bags. The research team from Kenya Agricultural Research Institute (KARI) demonstrated proper use of the shovel and the “fuffle”, a device that is faster and more efficient in mixing grain with chemical dusts.

Treated grain and a control were stored on site in 90-kg bags. Evaluation, based on the level of damage and live infestation was done after 3 months. Despite anomalies like lack of uniformity of grain in different bags depending on source, KARI methods appeared better than farmers’ methods in most instances. Farmers were able to make informed decisions based on the mixing methods which gave better results. The fuffle was an effective tool for mixing grain with chemical dusts and farmers were keen to have it fabricated by local artisans. Farmers appreciated the training and demonstration and promised to adopt proper grain preservation techniques as demonstrated to improve grain quality.

Keywords: Post harvest, Technology transfer, Grain losses, Farmers

1. Introduction

Maize is the most important food crop in Kenya with annual maize production between of 2.2-2.7 million tons and forms the bulk of stored grain (Anonymous, 2001). Storage insect infestation causes enormous losses reducing the investment made to its production and perpetuating famine and food insecurity. Efforts are therefore needed to address problems associated with maintaining acceptable quality stored grain.

During the 2001 survey in Kitui district, farmer clusters interviewed considered insect pests as number one constraints to maize storage (Mutambuki et al., 2001). A subsequent study established weight loss in Kitui to be 30% due to the presence of larger grain borer (LGB) *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae) which had been there for 20 years (Mutambuki and Ngatia, 2003, 2006). Previously, the Ministry of Agriculture (MoA) responded by launching chemical treatment campaigns including store spraying whenever LGB outbreak was reported. However, Sumicombi (fenitrothion / fenvalerate), the chemical used was not readily available at the stockist shops in the villages since it was a donation. As one of the outputs from the above study, farmer training was seen as a key factor to successful pest management at farm level. Farmer training and demonstration took place between 4-8 June 2007 while evaluation was carried out between 27-31 August 2007.

The aim was to consolidate what farmers already know about storage and assist them practice appropriate pesticide application methods. The general objective of training was to trace the origin of problems in the storage of maize and highlight the best-suited methods of reducing them. Specifically, the training was:

- To highlight problem areas in the post harvest food pipeline (harvest - consumption).
- To point out improvement areas needed in storage methods.
- To demonstrate effective chemical dust application methods.
- To emphasise timeliness in the chosen IPM strategy applicable in storage pest control.
- To evaluate with farmers the chosen pesticide application methods.

2. Materials and methods

2.1. Venue selection

Pre-training planning meetings were held at the District Agricultural Office (DAO), Kitui and in five selected divisions including Mutomo, which has since been elevated into a new district to identify existing structures that could be utilised (Fig. 1). Five bags of 90-kg untreated maize were purchased from each of the identified Farmer Field School (FFs) who also provided a secure place to store prior and after treatment. The maize used was harvested during March 2007 and infestation had build up to moderate levels due to the 3 months in store without any protection.

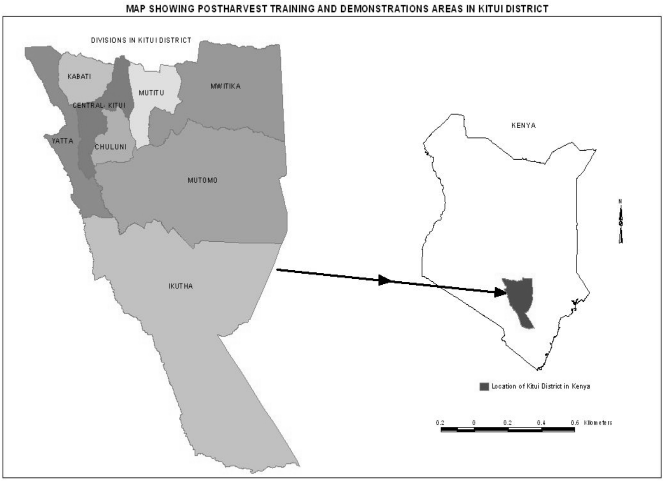

Figure 1 Map-showing postharvest training and demonstration areas in Kitu district in Kenya.

2.2. Farmer field school approach

Farmer field school approach was adopted to make use of the existing structures which guaranteed attendance. A discussion preceded each demonstration and efforts were made to standardise the delivery of topics by incorporating farmer participation using participatory methods adopted from a previous training program. Carefully formulated questions like "Whose maize was this?" ensured active farmer participation and ownership to the demonstration. A question like "What do you think is the problem with the maize?" led farmers to examine the grain and identified the various damage categories such as insect damaged and mouldy grains.

When asked to rate the level of insect pest damage, most farmers reported few insect damaged grains. Farmers were asked where they thought insects originated from. Most said that the origin of insect infestation was the farms probably due to the initial infestation often found on cobs during harvesting time. A question on whether there were insects found on maize but which were not harmful to the crop was puzzling. Farmers could not comprehend the concept of beneficial insects in the storage probably due to the fact that those deemed to be of benefit would ultimately contaminate after they die or due to their waste matter.

2.3. Effect of grain moisture and foreign matter on storage

To determine whether the maize for demonstration was dry, farmers demonstrated their varied ways of assessing produce dryness whose verdict was that the maize was dry. A Dickey-john moisture meter

(Dickey john Corporation, Auburn. IL, USA) confirmed their verdict. Many farmers stored grain with high levels of dust and foreign matter and they learned that apart from harbouring pests, dust can also reduce the effectiveness of the chemical powders applied on maize. Participants then used a sack sieve to remove appreciable amounts of dust, broken grain pieces, foreign matter and to their amazement, many free living insect pests, mainly the maize weevil.

2.4. Baseline damage levels and maize treatment methods evaluated

A kilogram of maize was taken from one bag and divided into 4 using coning and quartering method. Four groups of farmers were each given a portion of the sample maize to sort into undamaged, weevil damaged, mouldy grains, immature grains and broken pieces. Grains in each category were weighed and counted. To determine which methods to include in the demonstration, farmers described how they mixed stored grain with chemical dusts. Shovel mixing was common in all divisions and other methods included hand mixing on tarpaulin, in-bag mixing with a stick and shovel mixing in a wheelbarrow. The research demonstrated better ways of using the shovel and the "fuffle", equipment that can mix 20-kg grain load in about 10 sec. For comparison, a control was included to show farmers the increased level of infestation and damage if one did not treat stored maize.

2.5. Evaluation procedure

All the treated maize were stored on site and assessed after 12 wk, which would be 24 wk since the maize was harvested. A 1-kg sample from each treatment was analysed on site and another 500 g taken to the laboratory for thorough checking. Grains in the sample were analysed for the same parameters as in farmer-analysed samples. For reporting, each farmer-group constituted a replicate, hence the data for each treatment is the average of the four replicates. In laboratory, grains in each category were counted and weighed but only numbers are used for comparison. All the six parameters were evaluated to see which increased or declined over the storage period. Any change from the baseline was then linked to the maize treatment method used.

3. Results

3.1. Attendance

Out of a total of 163 that attended, the lowest, 22, were from Chuluni and 60, the highest from Matinyani divisions. The ratio of women to men varied from 1.5 to 2.3 in four divisions, while in Chuluni it was 0.6.

3.2. Grain damage levels during baseline and at evaluation time

The parameters in which farmers had strong interest were the declining undamaged portion, insect damaged grain, mouldy discolouration, broken pieces of grain, dust and foreign matter and grain moisture. Tables 1-5 shows what farmers did, but only the laboratory figures are used for reporting. The moisture content of maize used varied from 12.4% to 13.3%, which is considered safe for storage. Dust and foreign matter (fm) was below 1%, except for the 2.2% recorded in Mutitu. Initial weevil damage was lowest in Mutomo (1.8%) and highest (9.6%) in Matinyani. Mouldy grains were very low in Central division (1.5%) compared with 3.7% for Matinyani while broken pieces were very close in four divisions (1.1% – 1.2%) compared with 1.7% in Matinyani.

Table 1 Parameters assessed in Mutitu division.

Parameters	June baseline results		August evaluation results	
	Farmer analysis	Lab analysis	Farmer analysis	Lab analysis
Foreign matter (%)	2.2	2.2	0.8	0.8
Grain moisture content (%)	12.4	12.4	12.4	12.4
Insect damage (I)	3.8	4.5	11.3	11.2
Mouldy grains (M)	6.2	2.9	3.2	3.3
Immature (I)	2.8	---	---	---
Pieces(P)	2.5	1.2	4.4	1.3
Total of IMIP	15.3	8.6	18.9	15.8
Mean	3.8	2.9	6.3	5.3

Table 2 Parameters assessed in Central division.

Parameters	June baseline results		August evaluation results	
	Farmer analysis	Lab analysis	Farmer analysis	Lab analysis
Foreign matter (%)	0.6	0.6	1.0	0.8
Grain moisture content (%)	12.6	12.6	12.4	12.4
Insect damage (I)	2.5	6.2	25.3	20.8
Mouldy grains (M)	0.7	1.5	1.4	1.8
Immature (I)	4.1	---	---	---
Pieces (P)	1.8	1.1	3.9	1.8
Total of IMIP	9.1	8.8	30.6	24.4
Mean	2.3	2.9	10.2	8.1

Table 3 Parameters assessed in Matinyani division.

Parameters	June baseline results		August evaluation results	
	Farmer analysis	Lab analysis	Farmer analysis	Lab analysis
Foreign matter (%)	0.3	0.3	1.9	1.9
Grain moisture content (%)	13.3	13.3	13.4	13.4
Insect damage (I)	0.9	9.6	34.4	30.5
Mouldy grains (M)	2.8	3.7	2.4	3.2
Immature (I)	5.6	---	---	---
Pieces (P)	5.4	1.7	4.8	1.8
Total of IMIP	14.7	15.0	41.6	35.5
Mean	3.7	5.0	13.9	11.8

Table 4 Parameters assessed in Chuluni division

Parameters	June baseline results		August evaluation results	
	Farmer analysis	Lab analysis	Farmer analysis	Lab analysis
Foreign matter (%)	0.4	0.4	1.5	1.5
Grain moisture content (%)	12.4	12.4	12.8	12.8
Insect damage (I)	3.6	2.8	10.1	9.5
Mouldy grains (M)	3.5	2.1	2.7	2.4
Immature (I)	6.4	---	---	---
Pieces (P)	2.2	1.2	2.2	1.7
Total of IMIP	15.7	6.1	15.0	13.6
Mean	3.9	2.0	5.0	4.5

Table 5 Parameters assessed in Mutomo division.

Parameters	June baseline results		August evaluation results	
	Farmer analysis	Lab analysis	Farmer analysis	Lab analysis
Foreign matter (%)	0.4	0.4	0.1	0.1
Grain moisture content (%)	13.0	13.0	12.2	12.2
Insect damage (I)	3.7	1.8	2.7	2.6
Mouldy grains (M)	1.5	2.2	1.8	2.1
Immature (I)	2.5	---	---	---
Pieces (P)	3.2	1.2	2.8	1.1
Total of IMIP	10.9	5.2	7.3	5.8
Mean	2.7	1.7	2.4	1.9

After three months, a rising trend was expected for all the parameters. Grain moisture did not vary much and declined in two out of five divisions. Greatest percent increase in weevil damage was recorded in Matinyani (20.9%) and Central (14.6%) respectively while the same in Mutitu and Chuluni was 6.7%. Mutomo had the lowest at 0.8%. Mouldy grains increased by 0.3-0.4% in Mutitu, Central and Chuluni, but declined in both Matinyani and Mutomo divisions. The increase in broken pieces was 0.7% and 0.5% for Central and Chuluni compared with 0.1% for Mutitu and Matinyani divisions. In decision making, farmers appeared to use a combined damage factor approach to reject or accept grain for consumption. A weighted average for weevil damage, mouldy grain and broken pieces indicated the order of most affected division to be Matinyani with 11.8–5.0% = 6.8% increase from June to August followed by Central (5.2%), Chuluni (2.5%), Mutitu (2.4%) and Mutomo with 0.2%.

3.3. Effective methods of mixing grain with chemical dusts

The results of farmer evaluation on maize treatment methods in each division are shown in Figures 2-6. In Mutitu, the level of initial weevil damage for 5 treatments including the control varied from 1.9% in the fuffle to 9.3% in farmer-shovel mixing method with 4.5% as the average. Two months later, the same varied from 3% to 29% with 11.3% average. Among treatments, shovel mixing by farmers had the highest increase (6.0%) in weevil damage while the research use of the same had the least change of 0.1%. All methods were better than control where weevil damage increased by 25.5% (Fig. 2).

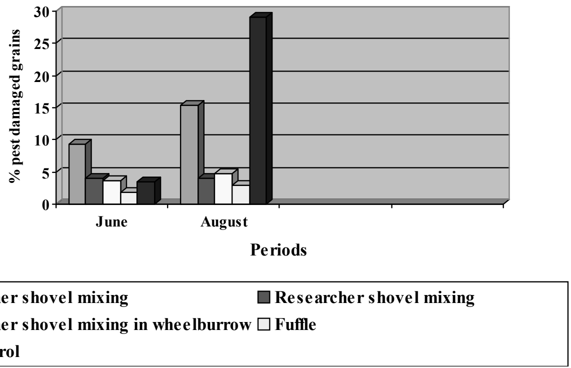

Figure 2 Level of pest damage in different maize treatment methods evaluated in Mutitu division.

The level of initial weevil damage for the five treatments including the control in Central division varied from 3.1% in the fuffle method to 6.5% in farmer-shovel mixing in the wheelbarrow with 4.5% as the average. Two months later, the same varied from 3.8% to 57.1% with 16.8% average. Among treatments, shovel mixing in the wheelbarrow by farmers had the highest increase (7.5%) in weevil damage while the research use of the shovel had 0.8% and 0.7% for the fuffle. All the treatment methods were better than control where weevil damage increased by 54.3% (Fig. 3).

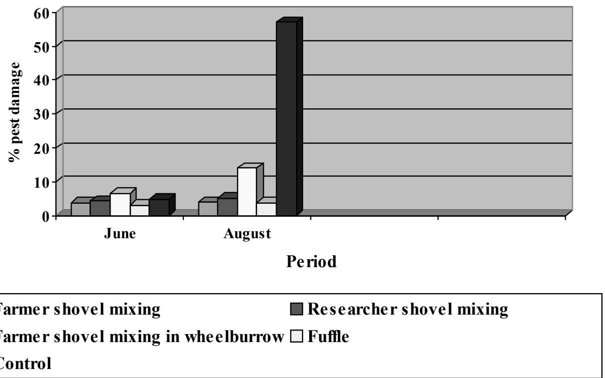

Figure 3 Level of pest damage in different maize treatment methods evaluated in Central division.

In Matinyani, the level of initial weevil damage for the 5 treatments including the control varied from 3.9% in the fuffle method to 9.7% in farmer-shovel mixing in the wheelbarrow with 7.1% as the average. Two months later, the same varied from 4.8% to 89.2% with 26.3% average. Among treatments, shovel mixing in the wheelbarrow by farmers had the highest increase (9.7%) in weevil damage while the research use of the shovel had 2.9% and 0.9% for the fuffle. All the treatment methods were better than control where weevil damage increased by 79.4% (Fig. 4).

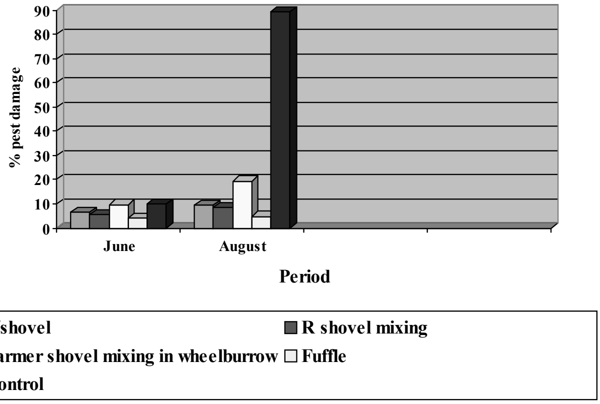

Figure 4 Level of pest damage in different maize treatment methods evaluated in Matinyani division.

The level of initial weevil damage for the five treatments including the control in Chuluni, varied from nil (0%) in the fuffle method to 10.8% in farmer-shovel method 3.0% as the average. Two months later, the same varied from 1.5 to 32.6% with 15.6% average. Among treatments, in-bag stick mixing by farmers had the highest increase (20.0%) in weevil damage while the research use of the shovel had 2.5 and 1.5% for the fuffle. All the treatment methods were better than control where weevil damage increased by 31.6% (Fig. 5).

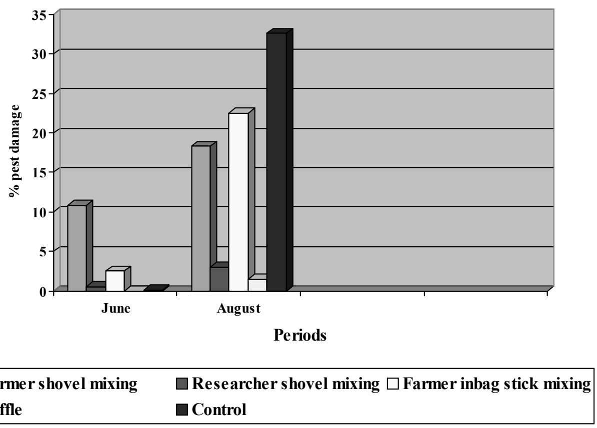

Figure 5 Level of pest damage in different maize treatment methods evaluated in Chuluni division.

The lowest level of initial weevil damage for the five treatments including the control was in Mutomo and varied from (0.3%) in the fuffle method to 4.3% in hand mixing on tarpaulin by farmers with 1.4% as the average. Two months later, the same varied from 1.2 to 5.6% with 3.0% average. Among treatments, hand mixing on tarpaulin by farmers had the highest increase (0.7%) in weevil damage while the research use of the shovel and the fuffle had 0.5% each. All the treatment methods were better than control where weevil damage increased by 5.2% (Fig. 6).

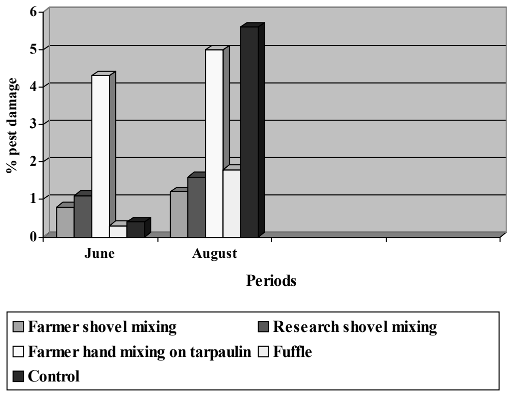

Figure 6 Level of pest damage in different maize treatment methods evaluated in Mutomo division.

4. Discussion

The training was organised to fill the gaps identified during on-farm surveys. The methods used and the approach was ideal for the task. The Farmer Field school setting improved farmer participation as well as learning. Such demonstrations are commonly referred to as "results demonstration" and appear to be most effective as farmers both practised and evaluated the results. They used these results to make informed decisions based on level of damage and increase in insect population found on maize from the evaluated treatments. Also, they were able to compare their methods with the ones demonstrated by the research team.

The demonstrations cannot be regarded as close to experimental trials. Ideally, the grain should have been thoroughly mixed to spread evenly the level of damage and the pest population. This would have cost implications. Despite lack of homogeneity, the results were as expected. Rather than use one factor criterion, the farmers' approach of combined effect was adopted. Farmers reject or accept grain based on extent of weevil damage, mouldiness and size of broken pieces. It was therefore easy to classify divisions according to level of combined damage levels. The delay in taking appropriate measures to protect stored maize was reflected in the level of initial weevil damage. Laboratory experiments have shown that early treatment can maintain grain damage below 5% over a 6-month storage period. However, with initial damage level between 1.4% and 7.1%, it was hard to expect impressive results. Despite the disadvantage of starting with heavy infestation, the fuffle proved to be an effective way to mix grain with chemicals dusts.

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