Storing Grains as a Survival Strategy of Small Farmers in Ethiopia

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Abstract
One hundred and six farmers in two provinces were interviewed about their strategies of storing grains for survival on their farms. The main findings were: (1) Farmers find it difficult to use the chemicals suggested by the extension service for post-harvest pest control. (2) Instead, farmers use more local plants as traditional pesticides, although their actual effect is not proven. (3) Farmers observed that certain varieties seem to be more resistant than others to major pests. Formal research stations did not study this issue. (4) Farmers use indigenous knowledge to keep the costs of inputs down and find compromise solutions when they are confronted with a clash of factors influencing the situation of the crop (e.g. when fixing the optimal harvest time).

Introduction
In Africa, the bulk of grain is produced by small scale farmers (Poswal and Akpa, 1991). Food security of these farmers, and especially in famine prone countries, depends on their success to grow and store their staple food that they need for their families, with a minimum loss of quantity and quality, using an effective method that they can afford. They must be able to keep the stored produce until the next successful harvest, and this might be more than a year, in the case of a crop failure. Even in developing countries, which have central storage facilities, farmers in peripheral regions find it difficult to procure the needed grains in times of famine, unless they can rely on their own food stores. Besides obvious economic considerations, African farmers are strongly influenced by socio-cultural factors like the norms of their ethnic group (Horton, 1993, Elwell and Maas, 1995).

So far, nearly all research on grain storage in Ethiopia focused on what happens to the stored grain without asking what farmers think about storage problems, e.g. Berga Lemaga et al. (1990), Dawit Abate (1982), Franzel et al. (1989), Kasho (1985), Lynch et al. (1986), Solomon Birhane (1983), Yemane Kidane & Yilma Habteyes (1989). Only Itana Ayana (1985) analyzed factors influencing the adoption of packages of agricultural technology. He found that extension agents were tied up with the distribution of inputs and other administrative tasks. During the Mengistu regime, extension agents were also team leaders for recruiting militia and in “agitational committees for tax collection” - certainly not the best preconditions to gain farmers’ trust! The researcher also found that farmers had limited access to inputs. He did not investigate farmers’ grain storage behavior.

The high costs and the erratic supply of chemical pesticides in developing countries have stimulated a renewed interest in traditional botanical pest control agents (Bekele et al., 1996). Their potential was largely ignored, in the past. Thus, FAO’s latest summary of grain storage techniques in developing countries (Proctor, 1994) does not even mention these indigenous methods, probably because their efficacy has still to be experimentally demonstrated. In Ethiopia, Lynch et al. (1986) mentioned Datura stramonium, Phytolacca dodecandra, Tagetes minuta and Weinia longiflora as plants with pesticidal effects, which are used by farmers to protect stored grains. Yemane Kidane and Yilma Habteyes (1989) added chilli pepper (Capsicum sp.) and Croton macrostachyus to the list of local plants used to protect grains in on-farm storage. However, our knowledge on farmers attitudes towards these plants are still minimal. As to physical protection measures, polyethylene lining of underground pits was recommended by Boxall (1974), Lynch et al. (1986) and Hassan Shazali et al. (1996).

The objectives
The objective of the research was to get a better understanding of farmers’ objectives and
practices in, and their attitudes towards on-farm grain storage, and the problems they have to solve. This understanding is expected to help in the development of extension messages leading to an actual increase in the quality of small farmers’ storage practices.

The two study areas

The districts of Minjar and Shenkora in Shewa Administrative Zone are situated southeast of Addis Abeba at an altitude ranging from 1500 to 2200 meters above sea level, in the central highlands of Ethiopia. The average annual rainfall is about 600 - 750 mm, and the soil is highly productive. Nearly all the land is cultivated. Tef and wheat are the staple food in Shewa, but also sorghum, chickpeas and lentils are important crops in the region.

Alamaya district in Hararghe province is situated in the eastern part of Ethiopia, at an altitude of 1000 - 2000 meters. The average annual rainfall is 800 mm, but of a quite erratic nature from year to year. The staple food crops in Haraghe are maize and sorghum.

Methods

The research was conducted in four steps: In a preliminary phase, Rapid Rural Appraisal (RRA) methods were used to get a better understanding of the farmers’ survival strategies, and especially how they build and use their storage facilities. Then, semi-structured interview schedules were developed and Outreach Field Agents were trained to interview farmers in a uniform way. These interview schedules were used during visits to 28 farmers in Shewa and Hararghe. These provinces have a relatively high potential for grain growing in Ethiopia. The locations chosen represent highland, mid-altitude and low altitude agro-climatic conditions.

Based on the results of these interviews with farmers, a structured questionnaire was developed in two similar versions, which differed mainly according to the crops grown in the two regions, in which the investigation was conducted. The questionnaire was pre-tested with 15 farmers, which were chosen at random from five sub-stations.

In the main phase a stratified sample of 80 farmers (ten randomly sampled farmers from each of eight sub-stations) in the Minjar and Shenkora districts of Shewa, who had storage facilities, were interviewed on their farms by the development agents working in the respective sub-stations. These development agents wrote down the answers given by the farmers to the questionnaire. Our plan was to use a similar sample in Alamaya district of Hararghe province, but due to the unstable and precarious security situation there, only 26 farmers could be visited in this region.

In the in-depth phase, the main issues were discussed with nine groups of farmers from all districts included in the research. Each group consisted of five farmers who were chosen with the help of development agents. The discussion made it possible to “make sense” of the data and in many cases to clarify farmers’ thought process. During this stage, farmers also discussed related practices, which were not dealt with in the questionnaires.

As follow-up, leaves, flowers and fruits of the plants which were used by farmers as botanical pesticides were collected and submitted to the National Herbarium of Addis Abeba University for identification.

Results and Discussion

The choice of varieties and resistance to storage pests

In Shewa, the main varieties of wheat grown were Laketch (by 37% of farmers), Kenya (21%), Cocorit (13%) and Israel (11%). According to 24% and 39% of the farmers, Laketch and Israeli, respectively, are more resistant than others to storage pests. According to wheat specialists of the Ministry of Agriculture and Debre Zeit Agricultural Research Center, it is known that storage pests seem to have preferences for certain varieties, which differ in the hardness of the kernel, but so far no relevant research was initiated, no resistant varieties were bred and there is even no strategy in place for such a research program.

The main sorghum varieties grown in the region were Gorenjo (68%) and Dalicha (19%). In contrast to wheat, there were only very few farmers who believed that there were any pest resistant varieties. Only 6% attributed resistance to the leading sorghum variety - Gorenjo.

In Hararghe, farmers seem to grow more varieties of maize and sorghum concurrently, and therefore the total sum of varieties indicated was larger than 100%. The preferred sorghum varieties were Muyra (77%), Fendisha (54%) and Wagare (19%). Fendisha was considered by
11% of the farmers to be resistant to storage pests. Fendisha is usually consumed as roasted grain, but it is not suitable for making Injera, the popular sour bread.

Grain conditions in the field and storage before threshing

The harvest of sorghum begins in November (15%) but most of it (85%) is harvested in December, after the maize harvest in Hararghe or the wheat harvest in Shewa. In lowland areas, farmers tend to harvest the sorghum earlier. Also where monkeys and porcupines are a danger, farmers try to harvest early. Otherwise, farmers tend to wait until later, when the moisture content of the grain is lower. They consider this factor as the most crucial when deciding on the optimal time for harvesting, especially when the grain will be stored. Farmers do not have any devices to measure the moisture content of the grain. They decide when to harvest by experience, mainly based on the seed color, how hard the seeds feel when taken between their teeth and cracked, and according to the coloring of the stem just below the grain head.

All farmers keep sorghum and maize heads on the ground, until threshing. They stack the grain heads together, facing wind and sunshine. This is done mainly to dry the grain, when it still has a too high moisture content. However in Hararghe, 34% of the farmers kept part of the maize also in their house, and 11% did so with the sorghum. This is considered to be safer, preventing theft.

Storage facilities

Farmers in Shewa store wheat in goteras, a kind of large basket woven from wooden branches, covered with a mixture of mud and cow dung. These materials are readily available in the region, and farmers know how to construct them. Wheat is usually stored for one year only, because it can be grown every year, due to the rain conditions in the region. Wheat is not grown in Hararghe.

In Ethiopia, Sorghum can be grown only when the short rains between February and April, are sufficient. Therefore, it is usually stored for more than one year, either in goteras (about half of the stored sorghum, in Shewa) or in underground pits. Occasionally, farmers store sorghum in goteras mixed with tef, which is a very small grain and helps to make the content of the gotera airtight and to keep it cool. It also obstructs the movements of insects in the gotera. Farmers choose a cool place, which is protected from direct sunshine for the location of goteras. They keep the surrounding area free from grass to avoid damage by rodents. Farmers also keep cats against rodents. Those farmers who can produce larger quantities of sorghum in a good year (about half of the farmers) tend to store it for longer periods in underground pits.

Farmers in Hararghe who store maize or sorghum, do so only in underground pits. Farmers who prefer pits, do so mainly out of fear of theft. This fear is augmented when food becomes scarce and when farmers with plentiful stores do not want to let others know how much they have.

Farmers in Hararghe also mentioned that they have a better control over the amounts of grains used by their wife(s), when the grain is kept in a closed pit that the husband opens only once a month. They do not want them to sell maize or sorghum to buy salt or oil (which should be paid from cash income, in order to keep the cereals for as long as possible). Because only the husband can dig up the pit, he has better control over the use of cereals than with other storage alternatives.

Constructing pits

Grain stored in pits is especially prone to attack by fungal diseases. Therefore the lining of the pit becomes an important issue. In Hararghe, where pits are the dominant place for storage, farmers are more aware of the importance to isolate the grain from the surrounding soil. In Shewa, only half of the farmers use any lining in pits, mainly straw or grass. They do not use plastic. In Hararghe, 45% of the farmers use plastic, and 66% use straw or grass. Some farmers actually line the pit with two materials.

Boxall (1974) and Lynch et al. (1986) found in their studies of underground pits in Ethiopia that the grain could be protected from mold by using polyethylene sacks or by lining the pits with polyethylene sheets. Hassan Shazali et al. (1996) reported that grains in pits with polyethylene lining remained cooler and drier, and lost less dry weight and seed germination rate, compared to grain in pits with grass or cement lining, or none at all. However, the price of plastic is still unaffordable for most small farmers, especially in Shewa. Sometimes, farmers use fertilizer bags as plastic lining, but...
these usually do not provide a sufficient barrier between the pit content and the moist surrounding. In both regions, only five percent of the farmers built cement pits, which are much more expensive than the other storage devices. Farmers tend to store sorghum for longer periods in pits, which are used as “bank safes”. The pits are opened and some sorghum is sold when cash is needed.

Use of pesticides
Marginal farmers cannot afford pesticides. Also small commercial farmers pointed out that pesticides are expensive. They complained that even when they wanted to purchase pesticides, these were mostly unavailable, and when they are available, they are too old and ineffective.

Use of indigenous plants as storage pesticides
The use of plants believed to have pesticidal qualities is very common in Hararghe, where fully 96% of the farmers stated that they knew of such plants. In Shewa, only 34% of the farmers indicated that they knew of such plants, but 20% of those who did not know the plants themselves, stated that they knew others who did use local plants to protect their grain. Accordingly, a much higher percentage of the farmers in Hararghe, where pits are more common, actually used local plants as pesticides in their storage (mainly underground pits), compared to farmers in Shewa.

Chili pepper and Finger Euphorbia are among the most commonly used protectants in the areas studied, as well as in other countries (Compton et al. 1993, Elwell and Maas, 1995, Malaya and Banda, 1995). Otherwise, the use of plants changes from region to region. Only few of the plants utilized in Hararghe are also used in Shewa, and vice versa. Sometimes the local name of a species changes not only from one region to another, but also within a certain region (e.g. Madarsa and Muka Ajawa). Tagetes minuta, which is popular in Hararghe as repellent, is also used in other African countries (Malaya and Banda, 1995). Tables 1 and 2 show the plants that were most commonly used by farmers in Hararghe and Shewa.

How the plants are used
Practically all farmers put leaves of the local plants, which are assumed to have a protective effect against insects, between grain layers and on top. This is mainly done in underground pits. About 6% also use the seed from the fruit of these plants, grind them, then mix them with water and apply the mixture to the stored grain. Farmers could not indicate the quantities they used. They relied on their “gut feelings”.

Farmers’ ideas about the mode of action of the protective plants
Farmers were asked why the plants they used as protectants are effective, according to their belief. Some 69% of farmers in Hararghe and 78% in Shewa conjectured that the plants stink (when they rot) and that this drives the insects away, and that pepper is too hot for insects to eat. This seems to be rather an anthropocentric analysis, yet farmers’ observations that the plants have a repellent effect, are corroborated by researchers (e.g. Berger and Mugoya, 1995). Less common beliefs were: that the protectant plants cool the stored grain, and that they are “sticking to insects”.

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Table 1

Local plants used in Hararghe as natural pesticides in grain storage (N=25)

<table>
<thead>
<tr>
<th>Local plant name</th>
<th>Scientific plant name</th>
<th>Actually used by (%)</th>
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<tbody>
<tr>
<td>Kinchib</td>
<td>Euphorbia tirucalli</td>
<td>60</td>
</tr>
<tr>
<td>Hashishi</td>
<td>Tagetes minuta</td>
<td>60</td>
</tr>
<tr>
<td>Burii</td>
<td>Cyphostemma sp.</td>
<td>40</td>
</tr>
<tr>
<td>Cheeka</td>
<td>Calpurnia aurea (Ait)</td>
<td>24</td>
</tr>
<tr>
<td>Muka-Libonata</td>
<td>Schinus molle</td>
<td>24</td>
</tr>
<tr>
<td>Matarsa (hot pepper)</td>
<td>Capsicum frutescens</td>
<td>20</td>
</tr>
<tr>
<td>Madarsa/Muka Ajawa</td>
<td>Pycnostachys abyssinica</td>
<td>20</td>
</tr>
<tr>
<td>Hadame</td>
<td>Euphorbia aff. polyacantha</td>
<td>20</td>
</tr>
<tr>
<td>Katcha</td>
<td>Acacia saligna</td>
<td>13</td>
</tr>
<tr>
<td>Makansa</td>
<td>Croton macrostachyus</td>
<td>13</td>
</tr>
<tr>
<td>Handode</td>
<td>Phytolacca dodecandra</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2

Local plants used in Shewa as natural pesticides in grain storage (N=80)

<table>
<thead>
<tr>
<th>Local plant name</th>
<th>Scientific plant name</th>
<th>Actually used by (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nechi Bahrzaf</td>
<td>Eucalyptus globulus</td>
<td>18</td>
</tr>
<tr>
<td>Kundo Berbere</td>
<td>Schinus molle</td>
<td>5</td>
</tr>
<tr>
<td>Dendane</td>
<td>Cissus quadrangularis</td>
<td>5</td>
</tr>
<tr>
<td>Mitmita (hot pepper)</td>
<td>Capsicum frutescens</td>
<td>4</td>
</tr>
<tr>
<td>Chochobe</td>
<td>Cyphostemma cyphobetalum</td>
<td>4</td>
</tr>
<tr>
<td>Kinchib</td>
<td>Euphorbia tirucalli</td>
<td>3</td>
</tr>
<tr>
<td>Bisana</td>
<td>Croton macrostachyus</td>
<td>3</td>
</tr>
</tbody>
</table>

Persistence of the treatment with protective plants

Farmers believe that the plants are effective up to half a year, until the hot month of May, when weevils are most active. Some replace the plants after that, but most do not, believing that by then temperatures will have decreased and the major danger of weevil damage will be over.

Use of other traditional methods to conserve the grain during storage

To control rodents, farmers keep the ground around goteras and underground pits free from grass and keep cats. They prefer these agro-technical measures to chemicals, being aware that chemicals could kill the cats. Farmers also expressed the opinion that keeping the land free of grass helps to prevent the hibernation of weevils. Against termites, sometimes water or smoke is let into the holes, in which they live.

When grain is stored for seeds, farmers sometimes sprinkle urine or salt over the grain, as a conservation mean. Urine is applied two days before putting the grain into storage, so that it can dry again in the meantime. When only salt is used, the grain can be stored directly after dressing.

Signs of grain spoilage during storage

Table 3 summarizes the answers given by farmers in the two regions, when they were asked how they recognized damaged grain.
Table 3

<table>
<thead>
<tr>
<th>Sign</th>
<th>in Shewa</th>
<th>in Hararghe</th>
</tr>
</thead>
<tbody>
<tr>
<td>The grain breaks and turns to powder</td>
<td>52</td>
<td>73</td>
</tr>
<tr>
<td>The pest insects are observed</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>The grain changes its color</td>
<td>4</td>
<td>31</td>
</tr>
<tr>
<td>The store becomes hot</td>
<td>26</td>
<td>nil</td>
</tr>
<tr>
<td>The grain loses some of its weight</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>The grain changes its smell</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

23% of the Shewa farmers, and 66% in Hararghe indicated more than one sign. Clearly the most common sign of the damage, which farmers recognized, was the breaking up of the seeds as a result of weevil attack. Still a considerable portion of the farmers recognized the damaging insect itself. Among the less often reported signs are changes in color and smell. The only sign of seed deterioration, which experts use, but farmers did not mention, is viability or decrease of germination rate. The probable reason is that farmers store in goteras and underground pits mainly grains that will be consumed or sold at a later stage. They keep seeds under specially protected conditions, mainly in the house. The practice of giving special care to seed grain seems to be common to warm countries (Compton et al. 1993).

What farmers do with the spoiled grain

Farmers winnow the grain to separate healthy from damaged grain. The light grain is used to feed animals, or as fertilizer. Sometimes soaking in water is used to separate the good grain from damaged grain. About half of the farmers (52% in Shewa and 46% in Hararghe) feed the grain, which was damaged during storage, to animals. Quite a large number of farm families (37 and 42% in Shewa and Hararghe respectively) cannot afford this and consume the spoiled grains themselves. Only 11% and 19% respectively, dump the spoiled grain, or use it as fertilizer.

Conclusions

The following are the most important realizations that come out of this study: The findings of Itana Ayana (1985), that farmers have limited access to inputs, are still valid, more that a decade and a revolution later. Even when they can obtain pesticides, these are often no longer effective and too expensive for many farmers. Actually, farmers use indigenous knowledge, gained through experience, to keep the costs of inputs down and to find compromise solutions to their problems. Thus, for example, farmers decide when to harvest, based on their traditional test. They use their teeth to assess if the kernels are at their optimal dryness. When deciding about the optimal time for harvesting, they also take into account the danger of pest damage in the field and the danger of theft, which is high just before that point in time.

More local plants than mentioned so far in the literature are used by small farmers to protect stored grain from pests and diseases. Especially in Hararghe, some of these plants are put to use by a majority of farmers. Farmers relate the seasonal temperature to the danger of further attacks by weevils, and base their decision to renew or not renew the protectant on their prognosis of how the weather will affect weevils after May. There is an urgent need to scientifically test, if the plants used by the farmers to protect their stored grain really have insecticidal properties. This will enable extension agents to give farmers usable recommendations.

Farmers observed certain varieties which seem to them to be more resistant against weevils and other causes of damage; but so far the agricultural research centres have neither tested if farmers’ observations were correct, nor begun to breed resistant varieties.

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References


