Feasibility Study of Post Harvest Project in Mozambique and Tanzania

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The view expressed in this report are solely those of the author and are not necessarily those of the Swiss Development Corporation

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TERMS AND ABBREVIATIONS

AMSDP	Agricultural Marketing Services Development Project
Armazenista	wholesale trader (Mozambique)
ASD	Actellic Super Dust
CM	collateral manager
DALDO	District Agriculture and Livestock Development Officer, Tanzania
DE	diatomaceous earth
DPA	Provincial Agricultural Directorate, Mozambique
DDA	District Agricultural Directorate, Mozambique
DINA	National Directorate of Agriculture, MADER, Mozambique
DNDR	National Directorate of Rural Development, MADER, Mozambique
DRSP	District Roads Support Project
Helvetas	Swiss Association for international cooperation
LGB	Larger Grain Borer = prostephanus truncatus
MADER	Ministry of Agriculture and Rural Development, Mozambique
MAFS	Ministry of Agriculture and Food Security, Tanzania
NRI	Natural Resources Institute, University of Greenwich
IPM	Integrated pest management
PADEP	Participatory Agricultural Development and Empowerment Project
PHU	Post-Harvest Unit
PROAGRI	Multi-donor programme to support the agricultural sector in Mozambique
SADC	Southern African Development Community
SDC	Swiss Development Cooperation
TPRI	Tropical Pesticides Research Institute
SPFS	FAO Special Programme for Food Security
VAT	value-added tax

SUMMARY

The objective of this mission was to determine the case for post-harvest projects in Mozambique and Tanzania, examining context, pertinence and feasibility, and building on SDC's long and successful experience with the metal silo in Latin America. If appropriate, proposals should be made for project implementation. The study involved a visit to Swaziland to review experience in the one African country that had adopted metal silo technology for on-farm storage of crops, fieldwork covering the north of Mozambique (Pemba to Angonia) and four regions of Tanzania, and a range of meetings in the capital cities, Maputo and Dar es Salaam.

The authors start by identifying useful lessons that can be drawn from Latin America and Swaziland. Both these cases showed how the metal silo could be highly marketable with maize-producing and consuming peasant populations. It was primarily suitable for storing maize for home consumption as well as small marketable surpluses, and its marketability was favoured by its fumigability and general convenience in both acquisition and handling. Adoption had led to a wide range of socio-economic benefits, beyond the simple reduction of storage losses.

In the Latin American case, the high level of adoption has been generated by aid-funded projects, involving a consistent 22-year commitment by SDC, and a social-marketing approach which attended to all elements in the marketing mix. In Swaziland, the silo (or grain tank) was adopted spontaneously by farmers, and public support was limited to a more modest technical assistance role. However adoption seems to have been spurred, indirectly, by the public incentive framework for maize production, as well as by remittances from South Africa.

The Latin American experience raised certain issues with regard to aid-funded "transfer institutions", project collaborators which had done much to boost the demand for the silo but which, arguably, had distorted market forces to the detriment of the transfer process.

The authors go on to describe on-farm storage structures and practices in both countries, and to assess recent public, donor and NGO support programmes. In Tanzania, past programmes have successfully alerted farmers to the dangers of the LGB, and a large proportion now shell their grain and use contact insecticides. However, farmers are still experiencing high losses due to problems in the marketing and usage of these insecticides, resulting from the proliferation of fake products and ignorance about their usage. As far as can be ascertained, most provinces of Mozambique are still clear of LGB, but farmers nevertheless experience heavy losses, due to the low level of knowledge, and the non-availability of storage insecticides in most commercial channels.

In Tanzania there have been substantial programmes to introduce improved storage structures at farm, and above all village, level, but they have been poorly conceived and singularly unsuccessful. The country has a large agricultural extension network which has become very "project-dependent", and does not appear to be initiating actions independently or following up on problems in the field. In Mozambique, central Government capacity is weak in the post-harvest field, but practical storage initiatives have been launched at provincial level, with donors and NGOs working in various arrangements with provincial and district authorities. However most of these initiatives have been characterised by: (a) a lack of long-term commitment; (b) weak

monitoring, quality control and follow-up; (c) lack of a coherent approach towards insecticides, and; (c) insufficient sharing of knowledge and experience. However, it must be pointed out that our itinerary did not allow us to visit Sofala and Manica provinces where GTZ have been collaborating with the provincial authorities on post-harvest matters since 1990.

Farm storage losses have very serious socio-economic impacts in both countries. They lead to localised food shortages during the November to February lean season, farmers sell early to avoid losses and this is resulting in unfavourable selling prices, as well as leading to higher lean-season prices for the food-deficit population, and reducing farmers' ability to invest in raising productivity. To reduce the impact of losses, farmers must pursue costly coping strategies, including restricting their production of insect-susceptible hybrid maize (in Tanzania), and focusing resources on food crop production at the expense of income-generating cash-crops. Adverse nutritional and health impacts are also inferred.

The consultants tested alternative on-farm storage concepts with farmers in four regions of Tanzania, including Shinyanga, Singida, Kilimanjaro and Iringa, and five areas of northern Mozambique, stretching from Cabo Delgado to Angonia District (Tete). A range of other informants were also consulted. The findings indicate:

- Stong potential for the metal silo among the mass of farmers in Kilimanjaro region and among more prosperous smallholders in both countries
- Potential for effectively marketing the silo through contract-farming schemes involving cash-crops, in both countries
- Poorer producers need a range of options, including low cost improvements to their existing structures and handling systems, the *improved kihenge* (in certain parts of Tanzania), and the mud-brick silo
- Demand for the burnt-brick silo is limited by its cost, but there may be localised demand where bricks are cheap
- There is less demand for new storage systems in some parts of Mozambique close to Malawi, with good access to storage insecticide (and apparently unaffected by LGB), and
- Significant demand for the drying crib in Mozambique

There are a series of problems which highlight the need for support *in post-harvest areas other than on-farm storage*, particularly in stronger surplus-producing areas,. In both countries, farmers are losing out heavily from lack of services in the areas of storage, financing, market information, input supply, threshing etc., making it difficult to escape a cycle of low productivity. There is a lack of alternative forms of transport between motorised trucks and pickups on the one hand, and bicycles on the other. Moreover storage losses are not restricted to farmers, but at least in the case of Tanzania are seriously affecting traders too.

Outline proposals are presented for post-harvest projects in the two countries. At the outset SDC will draw heavily on its traditional area of strength in on-farm storage, while gradually "broadening out" with strong knowledge management, and local capacity to deal with a range of post-harvest issues. As in Central America, SDC will need to make a long-term commitment, involving stand-alone projects and the building of local implementation capacity, primarily in civil society institutions.

In Tanzania we recommend an initial three-year project based in Arusha, with three components involving improved marketing of storage insecticides, on-farm storage (PostCosecha style), and improved storage and marketing of surplus production, and costing US$ 3 million. In Mozambique we recommend an initial three year project, with cost of US$ 2.3 million, concerned with improving farm storage structures and practices in Nampula province, and collaborating with post-harvest initiatives elsewhere in Mozambique with a view to raising overall standards and exchange of information. The latter will include the development of an accreditation system and discretionary support for initiatives with prospect of early success and modest supervision requirements. As the Mozambican project develops it will gradually establish other post-harvest activities as in Tanzania, but this will require separate funding.

Both projects should be institutionally autonomous, and be managed by a consulting company or other independent organisation, under the supervision of a five person steering committee including, tentatively, SDC, Government, private sector, the NGO community and local financing agencies. SDC should look for ways of ensuring the long-term stability of these institutions, with a view to their providing much needed service to the countries concerned over a long time-horizon.

INTRODUCTION

Objective and terms of reference

The objective of this mission was to determine case for post-harvest projects in Mozambique and Tanzania, examining context, pertinence and feasibility, and building on SDC's long and successful experience with the metal silo in Latin America. If appropriate, proposals should be made for project implementation

The terms of reference are shown in Appendix 1.

Approach adopted by the consultants

We decided to start with a three day visit to Swaziland. This is the one country of Africa where metal silos have been adopted for on-farm maize storage, and the team felt that this experience would probably throw light on the potential in Mozambique and Tanzania. An NRI staff member, David Walker, had worked with the Ministry of Agriculture at the end of the 1970s providing technical assistance in support of the new technology.

In Mozambique and Tanzania, several days were spent in the capital cities meeting key informants, reviewing documentation on the post-harvest situation and previous attempts to introduce post-harvest improvements, preparing for fieldwork and in presenting our findings at the end of the trip.

Most of the time was taken up by field visits covering selected areas. Because of the size of the countries, each bigger than the combined area of the five Central American republics, it was only possible to visit selected provinces or regions. These were selected on the basis of the following criteria:

- SDC priority zones – these include the three northern provinces of Mozambique (Cabo Delgado, Nampula and Niassa), and three central regions of Tanzania (Shinyanga, Singida and Dodoma)
- Zones which are largely self-sufficient in food or produce surpluses. Most storage losses are incurred after storing food for six months or more, and for this reason, it is more difficult to find early adopters of new storage technologies in deficit zones.
- Likely demand for the silo, on the basis of an *a priori* assessment. While SDC wishes to consider a range of storage structures, the metal silo is the only one for which it has an off-the-shelf production and marketing package. Hence, it made sense to identify areas where this could be introduced with a view to achieving early impact. In the African context this pointed towards diversified agriculture and cash crops which could allow farmers to finance the acquisition of the silo, and also favoured zones with the most socially progressive contract farming operations, and where traditional building materials were scarce. This pointed towards the inclusion of Tete Province in Mozambique, and Kilimanjaro and Arusha regions in Tanzania. Our *a priori* assessment was informed by previous missions, particularly the FAO/PROAGRI mission to Mozambique (Coulter et al, 1996), and NRI's previous and current post-harvest work in Tanzania[1].

[1] NRI is currently working with the Ministry of Agriculture and Food Security (MAFS) on the testing of Diatomaceous Earths (DE) as a natural grain protectant in Tanzania.

- The existence of earlier post-harvest projects whose experience could be reviewed, as a guide to the future.

On the basis of this the following provinces and regions were visited:

- in Mozambique: the three northern provinces (focusing on Chiure, Malema and Cuamba), north-western Zambezia (Lioma and Milange) and Tete Province (Angonia district).
- in Tanzania: Shinyanga Region (Maswa and Semuye), Singida District, Kilimanjaro (Hai and Murango Districts) and Iringa District.

Our itinerary can be seen in Appendix 2. In the case of Mozambique, it was unfortunately not possible to include the central provinces, of Sofala and Manica, the provinces where GTZ had been working with the Provincial Agricultural Directorates (DPAs) on post-harvest technology since the mid 1990s. However it was possible to obtain some information on the project from GTZ.

In each area visited, we interviewed key informants from the ministerial and district authorities, agricultural projects, NGOs, agricultural input suppliers, hardware suppliers, artisans and grain traders, as well as one or two pre-selected villages. In each village we visited households to view storage structures, examine the condition of stored crops and discuss post-harvest systems with the owners. We then proceeded to group meetings, which we conducted as far as possible in the form of focus-group interviews, and in which we concept tested alternative storage structures, and the drying crib. Farmers were shown pictures of a range of different structures, going from the simplest and cheapest to the more expensive ones, and were read a narrative description including estimated cost, following which they were asked to state advantages and disadvantages, their interest in acquiring the structures and their reasons. At the end of the session they were asked to compare the different structures and indicate their preferences.

The following structures were compared:

TABLE 1: STRUCTURES COMPARED THROUGH CONCEPT TESTS WITH FARMERS		
Structure	**Approx cost in US $**	**Durability of structure**
1. **Improved traditional store**, raised 1 m off ground with rat guards. Stores unthreshed grain	Depends on cost of local materials. Rat guards use part of a $6 galvanised iron sheet	Depends on materials used. Grass thatch, bamboo slats etc. need replacing after 4-5 years. Termites risk with upright timbers.
2. **Mud-brick silo**, based on "Gorongoza"-design introduced by DPA-Sofala and GTZ in Mozambique. Stores threshed grain. Not airtight, unsuitable for fumigation	One tonne silo costs approx $54, of which: • $18.8 in materials (cement, iron, wire & padlocks) & misc expenses • up to $14.6 for skilled artisan • $20.8 for own labour in making bricks and assisting artisan in construction (GTZ estimate)	Conservative estimate of 6-8 years; probably much longer
3. **Burnt-brick silo**, based on Swazi designs. Many different capacities from 500 kg and up. May be airtight and suitable for fumigation, if well made and maintained.	Materials for one tonne unit costs $70 or more, depending on local cost of bricks and other materials. Cost for a finished structure at least $110, depending on local conditions	20 years +, if protected
4. **Galvanised-iron silo**, based on PostCosecha design. Sizes include: 180 kg, 360 kg, 540 kg, 820 kg, and 1,360 kg in dry maize. Is airtight and suitable for fumigation, if well made and maintained.	$70-85 for 820 kg structure, depending upon whether duty exemptions can be obtained on materials.	20 years +, if protected from sun and rain
5. **Drying crib**, with rat guards roof of local material or galvanised iron sheeting. Walls from local materials or chicken wire.	Depends on materials used	Depends on materials used. Grass thatch, bamboo slats etc. need replacing after 4-5 years. Termite risk with upright timbers.

The "improved traditional store" is designed for storing unthreshed grain, and was not presented to farmers in Tanzania, because: (a) in most areas farmers now thresh their grain; (b) of the reluctance to consider external storage structures on the ground of theft, and; (c) it did not relate to most traditional Tanzanian storage structures, i.e. vihenge, vilindo etc..

The information collected from institutional, individual and group sources was summarised in a single table for each country – these represent the team members' consensus view based on the information obtained. In a few places it was not possible to interview groups of farmers, and in these cases information was obtained from individual informants who were highly familiar with the community as a whole.

Due to the qualitative nature of the exercise, and various biases (bias arising from the selection of respondents, from the limited experience of interviewers, and the presence of donor missions etc.) this approach could only provide a preliminary assessment of demand for different structures. The hypotheses generated through the concept tests will ultimately need to be confirmed or rejected through on-site trials. However, the approach was effective in stimulating rich discussion and quickly uncovering motives behind farmers' stated preferences for this or that structure.

Staff involved and backup support

The study was carried out by Jonathan Coulter (of NRI), an agricultural marketing economist with many years experience in Africa elsewhere, and Kurt Schneider, who had spent much of his career with the PostCosecha Project in Central America, and on similar initiatives in Paraguay, the Dominican Republic and Haiti. They were joined by three local collaborators/consultants including:

- In Mozambique - Mario Mutxeco, Head of Plant Quarantine in the Ministry of Agriculture and Rural Development (MADER), in Maputo, and Adelino France Monet, free-lance translator contracted by SDC. Mutxeco had previously worked with Coulter on a Post-Harvest review for Mozambique under PROAGRI (Coulter et al., 1996).
- In Tanzania - William Riwa, of the Plant Protection Service, Ministry of Agriculture and Food Security (MAFS), and Jeremiah Makindara of Sokoine Agricultural University (SUA), Morogoro, Tanzania. Riwa has long experience in post-harvest and is currently co-managing the NRI/MAFS research project on diatomaceous earth as a storage insecticide. He also prepared a note on storage systems in Tanzania, which provides source material for the Tanzanian part of this study (see Appendix 3).

In Swaziland appointments were arranged by Mr Mpanza of the Ministry of Agriculture. This included visits to the Malkerns Research Station, four farmers in different parts of the country, artisans producing metal silos, hardware importers and a technical school.

In Mozambique and Tanzania we received considerable logistical support from SDC, including the offices in Maputo, Nampula and Dar-es-Salaam. In Mozambique we were also supported by CARE which in liaison, SDC, Helvetas, OXFAM, World Relief, World Vision, TechnoServe, and the District Director of Agriculture in Malema, planned the itinerary and arranged visits. We are extremely grateful for the magnificent support provided by all these parties' support.

Relevant findings from Latin America

Most of what SDC has to offer Africa in post-harvest matters derives from its 22 year involvement in Central America. For this reason it is worth asking just what lessons were learnt, that might be useful in Mozambique and Tanzania.

Up to March 2002, the project had recorded the "transfer" of 266,000 PostCosecha-type metal silos, mainly to small farmers. However much of the production remains unrecorded, and project staff estimate that the real number transferred to date is between 400,000 and 500,000 units. The programme also caused farmers to build or have built small numbers of other structures, i.e. improved traditional stores, improved stores on stilts (with rat guards), and drying cribs. After Central America, Helvetas promoted the metal silo technology in Paraguay (1993-2003) and the Dominican Republic (1999 to 2003), causing 15,000 and 3,000 silos respectively to be distributed respectively.

The players in the transfer process were respectively:

- SDC which financed post-harvest units in the four countries concerned
- national governments and their extension services
- "transfer institutions" i.e. NGOs, integrated rural development projects and other players that promoted the silo in their respective areas, contracted with artisans to produce the silos, and where necessary arranged credit so that farmers could acquire them[2], and
- artisans trained and supported by the programme and who also became salesmen for the silo in their respective areas of operation

A large percentage of the silos were sold for cash at a price which covered the artisans' full cost, a part was sold for credit, a part was subsidised, and the transfer institutions also donated some silos to farmers. The last evaluation mission (Bidaux et al., 2002) estimated that subsidies represented 40% of the effective demand for the silos. This element appeared to be growing in the new millennium with the governments of the three countries planning to enter the field with massive transfer programmes of their own.

The following are some of the main lessons from evaluations and the experience of project staff:

1. The silos brought farmers a wide range of benefits, somewhat greater than originally expected – see Box 1.
2. *Willingness to buy* or *effective demand* for the silo is a powerful indicator of demand for the silo. The measure brings together the various benefits that the farmer is deriving from the silo, and which are difficult to calculate exactly in cost-benefit terms. For this reason it was advantageous to have a major component of unsubsidised sales, as this provided the programme with objective feedback on farmers' own valuation of the benefits derived, and of their willingness to invest in post-harvest improvements.

[2] One of the conditions of participation is that the transfer institutions had to agree to follow all the Programme's norms on the technical side (Schneider, 1999).

BOX 1: FARMERS' BENEFITS FROM USING THE SILO - CENTRAL AMERICA

- The benefits consisted of improvements to family food security, reduction in post-harvest losses, increased income from selling grain at a later date, improving farmers' negotiating position with middlemen (more of a sellers' market as there was no rush to sell), savings from not having to buy back in the lean season, and improvement in the position of women within the home economy (reducing drudgery etc.), improvement in health, hygiene and general household welfare, easing the diversification into profitable cash crops and production of (high-yielding but less pest-resistant) hybrid maize (Coulter et al., 1995).
- The adoption of the silos not only benefited the owner's family but non-owners within the same rural communities. More grain was being stored locally and was being sold locally *libreado* (a pound at a time). This advantage is of the greatest significance in Africa where even in surplus-producing areas, a small minority of farmers normally produce most of the surplus and most farmers produce insufficient for their annual needs. When farmers have more grain to sell in the lean season, it tends to force prices down in favour of the consumer.
- Another important advantage of the silo was the *convenience factor*. Despite the poverty of most farmers, the simplicity of the structure was a major attraction. It could be purchased "ready to use", without the need for the farmer to find the materials him/herself, it did not require much maintenance and was easy to use.

3. The need for a long-term approach to marketing which involves: (a) attention to all aspects in the *marketing mix*[3], and quality control; (b) focusing effort initially on a limited geographical area, and; (c) the involvement of many collaborating transfer institutions. It takes considerable time for farmers to evaluate and adopt new storage technologies, and strong follow-up is needed to ensure that the structures are being correctly made and used – failing which the whole concept can easily fall into disrepute. This provided a rationale for SDC's 20 year + commitment to the PostCosecha Project.
This observation is important because such systematic long-term approaches were mainly lacking in post-harvest initiatives we saw in Africa during this trip.

4. The silo lends itself to quality control better than most other structures, given that this function can be focused largely on a limited number of artisans – 650

[3] Marketing mix = 4 Ps, i.e. product, price, place (or distribution) and promotion

at the last count as opposed to hundreds of thousands of adopting farmers. Standardisation of the silo in terms of both design and a small number of standard sizes made training and quality control much easier.

5. The silo was mainly used to store grain for home consumption, and was less suitable for storing marketable surpluses which needed to be disposed of in wholesale quantities, due to the low speed of unloading through the outlet spout (Bideaux et al., 2002).
6. The involvement of the *transfer institutions* was very beneficial in building up demand for the silo and developing artisans' supply capabilities, but may have diverted the artisans from developing their own markets directly with the farmers. However Bideaux et al. (2002) note that "institutional demand, which is very high for some workshops, seems to be discouraging them from searching for channels for distributing directly to farmers." On page 33 of the same report, the authors also note apparent failures of some transfer institutions to apply the programme's quality control norms. This concern probably explains advocacy by Heierlei (2000) for a move from an "aid-driven" approach to an entrepreneurial and marketing-oriented approach. However he still sees a continuing need for public investment in promotional activities which entrepreneurs cannot be expect to carry out individually.
7. The experience showed that it was possible to train small farmers to treat their grain safely with fumigant (phosphine), when using the metal silo. Recorded accidents and loss of life are minimal.

FINDINGS IN SWAZILAND

Overall agricultural situation in Swaziland

The small landlocked kingdom of Swaziland lies between the Republic of South Africa and the southern extremity Mozambique, and has a land area of 17,364 square km of which 11% is arable. The population is 980,722, with a growth rate of 2.9%. The country has the unimodal rainfall season characteristic of the Region, and is divided into four eco-geographical regions, namely highveld, middleveld, lowveld and the Libomba Plateau.

The economy of Swaziland is largely dependent on agriculture, which employs 70% of the population, and contributes about 12% of Swaziland Gross domestic Product (GDP). Tourism, Mining and remittances from South Africa also play a major role in the economy of the country.

Maize is the main staple, covering 43% of the arable land, but there is a wide range of other food crops including sorghum, potatoes, soya beans, jugobeans (bambara nuts), haricot beans, sweet-potatoes, groundnuts, pumpkins, sesame, cowpeas, melons, cassava, watermelon, yams and sweet-cane. Sugar-cane is the only cash crop grown on large scale.

More than 60% of the population is engaged in peasant farming. According to the Annual Agricultural Survey 2001-02 there were 90,399 homesteads of which 74% produced maize. The harvest in that year was 67,640 tonnes, with an average yield from 997 kg per hectare, having varied between 60,000 and 80,000 tonnes per annum over the last ten years.

Government supports production with gazetted minimum producer prices, which are sometimes well above market-determined prices in neighbouring South Africa (for most of the time between 2000 and 2002, prices were around US$ 300 per tonne, but at the time of the visit they were about $190). However farmers are free to sell to private buyers at higher than gazetted prices. Remunerative pricing, coupled with the supply of high-yielding hybrid seed from South Africa and fertilisers assures that the country is broadly self-sufficient in maize. Most maize producing farmers cultivate between 1 to 3 hectares of maize sometimes intercropping with beans.

Metal bin experiences compared to other storage facilities

There are various traditional storage methods, including the underground pits and woven baskets on platforms, but these have largely been displaced over the last 50 years. According to the 2001/02 Agricultural Survey, 55% of all farmers had metal tanks as a storage structure[4], 2% concrete tanks, 5% maize cribs and only 1% the underground pits - a method which is no longer to the taste of the younger generation. The pattern varies little between zones, though the adoption of the metal bin is somewhat lower in the Libombo district which is also the area we saw underground pits. The four farmers we saw owned 2 to 3 tanks of different sizes. If one estimates each tank-owning household has an average of two tanks, then there are about 100,000 tanks in the country, or 1 for every 10 head of population.

Farmers appear to have starting storing in metal tanks in the 1960s, and the structure seems to have been an adaptation of larger silos used on commercial farms in South Africa. Sizes vary from 5 bags capacity (350 kg) up to 125 bags (8,750 kg), but the most popular sizes are 12 bags (840 kg), 18 bags (1,260 kg) and 24 bags (1,680 kg). Tanks are normally located in the farmyard under a corrugated iron roof supported by wooden pillars.

Farmers buy tanks from artisans in different places in the locality. The farmer has to arrange the transport to home, but the distance is not very large; an artisan we met said that his most distant customer came from 15 km away. Generally silos are purchased on cash terms, but some get as much as six months to pay. There are few credit facilities for farmers to buy tanks, but this does not to pose a major obstacle for adoption.

The high adoption rate is largely explained by the attractive prices for maize in Swaziland which, coupled with additional sources of income, facilitate purchase, as well as by its proven effectiveness in pest control. Farmers are mostly happy with their tanks, but are nonetheless encountering significant problems. Three out of the four farmers we visited had experienced grain caking and rotting due to condensation problems[5], and were mainly attributing this to high temperature variation caused by the tanks being exposed to the sun. Indeed we found that the tanks were not fully

[4] 26% of homestead produced no maize in 2001/02, and 50% less than 10 bags. From this one may conclude that the ownership of metal tanks must be heavily skewed to the 24% (21,700 households) who produced 10 bags or more, and the market is approaching saturation.

[5] For this reason, one farmer condemned three bags in last year's crop. Another complained or rays causing condensation, and losing four bags in 2000/01.

shaded. Farmers are aware that grain must be well dried before storage, and for that purpose they de-husk their cobs and hold them for 2 or 3 months in drying cribs or stores - however they do not normally sun-dry their maize. After this they shell the maize and store it in the tanks, treating it with phosphine for about then days.

Phostoxin tablets are readily available in the trade, in tubes of 30 tablets. We did not hear of any cases of people being accidently harmed by using these tablets, but there have been suicides; last year six deaths were recorded as being due to this cause.

Farmers told us they store firstly for their household needs, and then sell part of their crop if prices are good. Sometimes they store for more then a year, for example when prices fell by a third, in the hope that it would subsequently rise.

Fabrication of the metal tanks

The artisans who make the tanks have either learnt their trade from neighbours or family members, or at the Small Business Promotion School in Mbabane. The sides are made with sheets of corrugated material of 0.58 mm thickness, while tops and bottoms are made of flat sheets of 0.4 mm. Unlike the PostCosecha silo, rivets are used in joining the side pieces instead of the *overlap-and-solder* approach.

The Central Cooperative Union (CCU) and other importers purchase the materials in South Africa and distribute them in different places in the country, and various parties provide the service of corrugation for a fee. The retail price of the tanks varies according to the size, though as with the PostCosecha silo, larger units are cheaper per 100 kg of storage capacity. Allowing for a 5% trade discount, the price of a 12 bag tank (840 kg) is around US$ 140, which gives a price per 100 kg of US$ 16.70, and we estimate that the artisans get a margin of about US$ 18.50 per tank. Notably, the retail price for the tank is over twice the level Central American farmers until recently were paying for flat sided PostCosecha silo of similar capacity, and 65% more than what we estimate farmers will need to pay for the same structure in Tanzania, under a tax regime which is more severe than that in Swaziland - see Table 2 in section entitled supply of galvanised iron sheets for making metal silos.

The well trained and experienced artisans can assemble a tank in about 4 hours with one non qualified mate. The farmer has to pick up the tank in the house from the artisan, and this often costs over $10. A group of artisans to whom we spoke claimed they gave farmers a 10 year (verbal) guarantee to repair the tanks in the event of quality defects. When we visited farmers, we noted that several were damaged and had openings at the seams, which may be attributed to bad construction, improper handling or age, or any combination of these. Artisans do not generally go to the farm to repair tanks, so the farmers must generally take their tanks to the artisan’s premises.

Areas of ministerial concern

Ministry officials take samples and monitor grain quality in several parts of the country, on a yearly basis. They express various concerns, namely about farmers not correctly drying and fumigating the grain, and about the Larger Grain Borer (prostephanus truncatus) which, though not so far detected in Swaziland, is already present in other countries in Region. They mentioned the need for various actions to address the range of problems they face, including:

- an education and training program for farmers
- some LGB monitoring work
- technical assistance in post-harvest loss assessment, and
- a planned licensing scheme for retailers (to address the suicide problem)

The Ministry is also promoting the burnt brick silo which was introduced to Swaziland under an IFAD initiative. They are lined inside and out with cement-based plaster, and according to Ministerial officials are fully fumigable, though it is a moot question how well they maintain their hermetic quality over time in normal farm conditions. The structure has the advantage of protecting the grain from the sun irradiation, and a Ministry official indicated that they can be safely used to store the grain longer than with the metal tanks (two years vis à vis one year with the metal tanks). However they are considerably more expensive - US$ 21.40/100kg for a similar sized structure. The agricultural survey of 2001/02 shows that 1,964 homesteads have concrete tanks - probably synonymous for the burnt-brick silo. We used this structure as a basis for concept tests in Mozambique and Tanzania.

Conclusions from the Swazi grain storage experience

It is clear that the introduction of the metal bin has been a major success, contributing to the food security of Swazi farmers, and of the nation as a whole, while making it much easier for farmers to sell grain at the time of their choice - a opportunity which we shall see later is largely denied to farmers in Mozambique and Tanzania. The grain also becomes a means of saving, which can be drawn upon when required.

All this has been achieved at low cost to local taxpayers and the donor community, notwithstanding ODA's (now DFID) provision of technical assistance at the end of the 70s. The level of adoption is very high - maybe as much as 10 units for every 100 head of population, vis à vis an average of 1.5/100 units in four Central American countries. It appears that adoption has been facilitated by small farmers having a generally higher standard of living than neighbours in Mozambique and Tanzania (and probably Central America too), and there being a very strong incentive framework for maize production. The same factors may have likewise facilitated the large-scale adoption of the drying crib.

The cost of the structure has not proved an obstacle to adoption, nor have market interventions by the parastatal National Milling Corporation. When properly sited and used the metal tanks show major pest-control advantages over traditional systems of storage. Indeed farmers have largely abandoned these traditional systems, and have become so habituated to the tank that they continue demanding it despite significant storage losses which result from a combination of poor siting and maintenance, and probably inadequate drying of the grain.

Tanks are significantly more expensive to build than flat-sided PostCosecha metal silos of similar sizes. However the corrugation of the walls gives them extra strength and for this reason they are made in sizes up to 3.2 times the largest flat silo which the PostCoscha project has felt it prudent to promote (8.75 tonnes versus 2.72 tonnes). However, in view of the lower costs of the more popular smaller units, we believe that the flat sided silo will of more interest to small farmers in Mozambique and Tanzania, and for this reason we included this structure in the concept-testing exercises we subsequently carried out in those countries.

If SDC funds a post-harvest project in Mozambique and Tanzania there will be scope for beneficial exchanges between these projects and Swaziland. For example, Swazi experience with the drying crib and the burnt brick silo may be of particular use to Mozambique and Tanzania. SDC's approach to dissemination and quality-control may be of interest in Swaziland.

REVIEW OF ASPECTS COMMON TO BOTH MOZAMBIQUE AND TANZANIA

Meteorological conditions and their implications for grain storage in Mozambique and Tanzania

Grain can be stored when meteorological conditions fulfil certain basic conditions in terms of relative humidity, rainfall and temperature. In general terms the higher they are, the greater the risk of infestation by insects and mould.

Relative humidity is of particular significance, but surprisingly, despite attempts through national governments and FEWS, we have been unable to obtain data on this parameter. However, we can say from experience that climatic conditions are likely to present no major problems except in zones of particularly high humidity.

In the case of Tanzania, Mushi (1983) refers to the *hot humid lowland areas*, including the coastal belt and the area surrounding the Great Lakes, characterised by high mean daily temperatures (usually above 25° C) throughout the year, and high mean monthly relative humidity (usually above 70%) throughout the year. He refers to this as a danger zone, *where crops never dry naturally and often rot when stored for periods of longer than three months.*

The only coastal or lakeside zone which we visited was Cabo Delgado in northern Mozambique. In this area grain has to be particularly well dried and monitored during the storage period. In all areas, storage structures and particularly those made of metal must be protected from exposure to sun rays and rain and high temperature fluctuation. In some areas rainfall is strong during harvest time, which makes drying difficult. In such cases it is feasible to bring down moisture by placing grain a drying crib, before final drying in the sun and long term storage in shelled or unshelled form.

Supply of galvanised iron sheets for making metal silos

With the introduction of the metal silo, it is of critical importance to be able to obtain galvanised iron sheets of suitable quality. In both countries, the sheeting currently available fails to meet standards established under the PostCosecha project, i.e. sheets of 6 x 3 feet or approximate metric equivalent, thickness before galvanisation of 0.45 mm and 0.48 mm after galvanisation, with the following norms:

- American – ASTM, A 924, commercial quality, LQF (lock-forming quality) and annealed (i.e. heat-treated to avoid eliminate brittleness and make it easy to work), or
- Japanese – JIS G3302-SGCC-SD galvanised sheeting, and for the feedstock (iron sheeting) JIS G3141spcc-sd (annealed)

The absence of such sheeting is noticeable in Mozambique. There are about seven local “profilers” who import coils of two tonnes or more of unannealed 0.27 mm to 0.35 mm sheets from South Africa, India and Kenya, then cut and corrugate them locally as roof sheeting. By carrying out this local value addition, they pay only 4% duty, vis à vis 40% they would have to pay if they imported ready-cut sheets, but they still have to levy VAT at 17%[6]. The demand for flat metal sheet of the type used by PostCosecha is too small to justify profilers ordering it; hence when it appears on the market it is very highly priced and appears to be subject to import duty at 40% (Cor Esterhuizen, Zincos de Moçambique, *pers. comm.)*. Even tinsmiths making buckets, water cans, suitcases, candleholders, and guttering in northern Mozambique, buy the corrugated sheeting and then straighten it before making their goods!

This lack of supply does not pose a major problem. A post-harvest project can create the necessary demand in its area of operation to attract commercial supply of galvanised iron sheets which would be cut by local profilers, and subsequently retailed through local hardware stores. However to avoid facing an endless *chicken-and-egg* supply problem, the Project would need to make the first order itself, pricing the sheeting at a level which simulates expected commercial margins.

In Tanzania, a post-harvest project would face slightly more difficulty due to the protection of local manufacturers with import duties. There are three galvanising companies with considerable excess capacity, but it appears that none of them can supply material to the required specification (*we are still trying to double check this*); hence the need to import. Import duty is 20% + suspended duty 10% and then there is 20% VAT. Such high levels of tax will severely penalise the production of metal silos, and put them at a competitive disadvantage advantage vis a vis contact insecticides – an alternative form of combating pest control – on which zero import duty and VAT are paid.

At the time of the study, international prices for ferrous metals were at a very high level, due to extra demand from China. Between November and April prices have risen by approximately 60% in dollar terms (Miguel Giorgis, INGASA, Guatemala, *pers. comm.*), but may fall back in the future. Partly in view of this situation we found it difficult to obtain quotations. However, we could make the following calculations based on an estimate price provided by a Tanzanian trader for sheeting of 0.45 mm, on a with- and without-tax basis:

[6] We were given various information on duties payable. According to a South African supplier, the import duty payable in Mozambique was 7% for unprocessed coils and 15% on finished product, while a Mozambican importer indicated that "the Government sometimes gives duty exemptions".

TABLE 2: PROJECTED COST OF METAL SHEETING IN TANZANIA - in US$		
	With taxes	**Without taxes**
Price per sheet 6 x 3 ft, CIF Dar es Salaam	4.9	4.9
Port handling and clearing (10%)	0.5	0.5
Import duty (15%)	0.7	
"Excess" duty (10%)	0.5	
Sub-total	6.7	5.4
Importer/wholesaler's margin (10%)	0.7	0.5
Sub-total	7.3	6.0
20% VAT	1.5	
Wholesale price, Dar es Salaam	8.8	6.0
Transport to interior	0.2	0.2
Retailer's margin (12.5%)	1.1	0.8
Retail price	10.1	6.9
Central American retail price, mid to late '90s	6.0	6.0
Difference/sheet with Central America	4.1	0.9
Difference in cost of 820 kg silo (4.3 sheets)	17.8	4.1

The metal sheeting, which represents around 85% of total materials, is more expensive than it was in Central America. This is the main cost item likely to vary in Africa, so we may make a rough projection of the price of 820 kg silo by adding the difference in the cost in the sheeting to the price of that silo in Central America, which was until recently about $60, assuming other costs remain the same. This means that the cost per unit would be about $64 ($60 + $4.l) using tax-free materials, and $78 ($60 + $17.8) with tax included. Making allowance for lack of prior experience in Africa, less competition in material supply chains and the slightly thin material quoted (0.48 versus 0.45 mm), it would be more prudent to assume figures of $70 and $85 respectively per silo. Of course these figures could fall somewhat if world prices of metal fall and as African supply becomes highly competitive.

In view of this situation, there appears to be a good case for SDC to ask that sheets of the required quality be granted duty-free treatment by the Government of Tanzania, on the grounds that they are an agricultural raw material. It might be necessary to get the sheets printed alternatively with the words *Post Harvest* and *Pós-Coheita* so that Government and the project can take steps to prevent large-scale leakage of the duty-free materials onto the duty-paying market. The project could contribute to this by creating a complete system of traceability, whereby every sheet of galvanised metal and every silo have to be accounted for. The system would be useful to the project's quality-control function, while it would provide the revenue authorities with records to follow up on suspected cases where sheets are diverted to other uses. Duty-exemptions would also provide a more market-friendly way of encouraging the adoption of the silo, vis à vis the proliferation of direct subsidies to buyers of the kind noted with some of the *transfer institutions* in Central American case.

SDC should request similar treatment in Mozambique, though in this case it might buy through local profilers who pay 4% import duty. We noted one importer referring to the Government "sometimes giving duty exemptions". A future post harvest project in Mozambique should take care to avoid a situation where silo makers pay the full duty while other users of metal sheets manage to get all sorts of *de facto* exemptions. The matter can be examined in greater depth, and in a longer study, with the Ministry of Commerce.

Artisanal skills for making the silos

In all small towns of northern Mozambique, we observed tinsmiths who already work with metal sheets, making suitcases, water cans, candleholder, tubes, waterchanels,etc.. Most of them learned it on the job, and there is a certain lack of institutional capacities for training skilled labour in this area.

We visited an area of tinsmithing in Dar es Salaam, and found more highly developed skills, and that artisans were using a much wider range of raw materials, including mild steel, aluzinc, galvanised iron including a softer material made from the packaging covering imported coils. They made a similar range of products to what we saw in northern Mozambique, though apparently to a higher standard. We spoke to Mr Gerezani, of the Dar es Salaam Small Industries Cooperative Union (DASICO Ltd.). He indicated that there was a vocational training centre, but claimed that they were not up to the standard of those trained on the job.

Based on experience with the PostCosecha project, we can say that an SDC-backed project in Mozambique or Tanzania will need to organise its own training program or develop one through one or other of the vocational training institutions in the country. This is needed to achieve a high degree of professionalism, as well as the standardisation of the products themselves, a key factor contributing to the success of metal silo projects.

Due to time constraints we were unable to evaluate local training capacities, though we were informed of various organisations, e.g. catholic institutions in Gurue and near Namialo in Mozambique and the following in Tanzania: the Centre for Agricultural Mechanisation and Technology (CAMARTEC), Small Industries Development Organisation (SIDO/UNIDO), Kilimanjaro Agricultural Training Centre (KATC) and the Centre for Technology IGURSI in Mbeya. It will be job of a future project manager to evaluate existing training capacities and decide exactly how to develop this function.

FEASIBILITY OF A POST-HARVEST INITIATIVE, IN MOZAMBIQUE

Public policy towards grain storage

According to Mr Boaventura Nuvunga, of the National Directorate of Agriculture, the Government of Mozambique is concerned about a national food deficit of around 500,000 tonnes, and considers that this is partly due to weaknesses in storage and marketing of agricultural products. We heard similar concerns from the Carlos Tembe and Ramão Cossa of the DNDR, and they spoke of plans to improve marketing through the SADC Food Security and Nutrition Programme.

A more immediate concern has been the arrival of Larger Grain Borer in parts of Tete, Sofala, Manica and Inhambane provinces, and which caused FAO to field a mission to Tete and Manica in 2002. Large quantities of grain flow south from Manica province to Maputo and other parts of southern Mozambique so these parts are likely to be infested quite soon. The three northern provinces and Zambesia are surplus producing provinces, with grain flowing outwards to Malawi and southwards within Mozambique. Cross-border trade with Tanzania is minimal. For this reason they may prove to be the last areas to be affected by LGB.

Public sector capacity in the post-harvest area is weak. An FAO-funded study of the post-harvest sector was carried out under PROAGRI auspices in 1996 (Coulter *et. al.*, 1996), and recommended to carry out loss assessment, to evaluate a range of different storage structures, and to evaluate natural insecticides which farmers were using. There seems to have been no follow-up on this study.

The authors of some later initiatives do not refer to this study, and may not have been aware of its existence. This is the case with the FAO/MADER Special Programme for Food Security (SPFS) initiative which involved the contracting of Bolivian consultants to train local artisans to make the PostCosecha-type metal silo (e.g. Sitoe, 2002; Anon, 2004). The 1996 report might have been of interest to these authors because of the background information on post-harvest matters, and because it provided a preliminary sounding on the feasibility of introducing the metal silo. Another indication of the poor circulation of information is the fact that our team only learnt about the SPFS work two days before departing for Tanzania.

During our visit we heard that central government's effectiveness in the post-harvest area had been affected by a disputed mandate, between the Department of Plant Health (Sanidade Vegetal), which is part of the National Directorate of Agriculture (DINA) and the extension service (DNDR). In principle, post-harvest activities should be of interdepartmental character, bringing together research and extension but in practice its placement appears to have become a bone of contention.

As we indicate above little has been done to implement FAO recommendations. Responsibility for combating LGB rests with the Head of the Plant Quarantine Section (Mario Mutxeco) an assistant (Eng. Antonio Vaz), and quarantine technicians working in the provinces. In practice it appears that the Section has been limited to some retraining courses for technicians in post-harvest matters. The Section proposed an emergency programme to FAO including the acquisition of traps to ascertain the pest's geographical reach, but this has not been funded[7]. The Section wishes to use an IPM approach combining natural predators, improved stores (particularly plastering them and sealing holes with mud), and better grain handling (including selection of healthy grain, drying and use of insecticides). In practice however, it appears that action is only occurring at provincial level, notably in Sofala where the DPA is implementing an emergency control project. The DPA is seeking to control the movement of the LGB by control points on the road, in which it will treat the grain that bears no certificate saying it has been treated at origin. It is the district agricultural technicians who are required to carry out the treatment and issue the certificates.

Previous and on-going post-harvest projects

The longest standing initiative is that of GTZ and the Sofala and Manica Provincial Directorates of Agriculture, but our itinerary did not allow us to see this. In 1996 it was called the VAC-TAC project, a rural technology project which had started in 1990 and which had a component promoting drying cribs and mud granaries, with free provision of certain inputs (chicken wire and nails). By 1996 it had caused farmers to adopt 1,400 post-harvest structures, of which 90% were drying cribs.

Since 1999, DPA-Sofala and GTZ have been trying to introduce a mud-brick silo which contains certain cement and metal components (Structure 2 in Table 1), with a view to enabling farmers to deal with pests, including the LGB which is already present in the province, and store longer to obtain high lean-season prices. We were able to obtain full cost details from GTZ but could not obtain information on the number of units adopted in the province.

The silos are being promoted both for use with Actellic Super Dust (ASD) and for fumigation with phosphine, but the GTZ engineer concerned could not confirm that the structures were airtight, a key prerequisite for using phosphine gas. This is a little worrying because the fumigation of grain in non-airtight structures is likely to fail in killing all the insect population therein, and lead to the development of phosphine-resistance.

Another significant initiative is a three country Action Programme for Prevention of Food Losses, involving Cambodia, Mauritania and Mozambique, and undertaken by FAO's Special Programme for Food Security (SPFS). In Mozambique the Programme worked through MADER and its provincial extension services in Inhambane, Sofala, Manica and Tete. It involved a diagnostic review by a consultant (Sitoe, 2001), and three courses for artisans in the production of silos and tools in Boane, Beira and Chimoio, demonstration days with press coverage in Boane and Beira, and the production of manuals. Bolivian experts were contracted to introduce the PostCosecha-type metal silo.

According to FAO officials to whom we spoke, some 20 artisans were trained to make both the metal silos and three "traditional improved structures" (including the

[7] Rick Hodges, pest management specialist at NRI, writes as follows regarding trapping: *Trapping is good to indicate degree of spread and for biological research but is of limited value when it comes to control. More interesting these days is the NRI risk model which allows climate data to be used to predict when a year is going to be a bad one for farmers. If required, we can supply papers describing this.*

Gorongoza and *Nhametade* silos). Some silos have been sold but overall the project was unsuccessful. They attributed this to various factors including: poor selection of local artisans; poor selection of trainers; artisans lacking entrepreneurship and capital; scarcity of metal sheets of the appropriate thickness in the local market, and; inadequate backstopping support and promotion. In addition to this the following points were made regarding the metal silo: the temperature – rising as high as 52 degrees in parts of Zambesia and Tete, was "too hot" for them[8]; farmers lacked ready access to phostoxin, and; they were costly vis a vis traditional structures. Two or three artisans were still making the metal silo, but in very small quantities.

Without spending time in the zone of intervention, we cannot make a full assessment of this experience, but this account suggests that it was not planned as a long-term endeavour (a key ingredient to PostCosecha's success), and to have suffered some shortcomings on the managerial side. The project's simultaneous implementation in three very different countries may also have been detrimental.

In the area we visited, we encountered the on-going initiatives of Helvetas in Cabo Delgado Province, CARE in Nampula, OXFAM in South Niassa and World Vision in Zambesia, and we also found that DANIDA had been active in Angonia District of Tete Province up to 1999. Most of these have sought to introduce "improved traditional stores", structures on stilts and with rat guards, along the lines of Structure 1 in Table 1. In Angonia, DANIDA had promoted a structure with water traps to prevent the rats ascending the stilts, but with no confirmed results.

These projects have encouraged farmers to clean their stores well, and to select uninfested/undamaged crop for storage. They have generally encouraged the use of natural insecticides rather than purchased formulations, on the grounds that the latter are not readily available to farmers in local trade outlets, and/or their own or their funding agency's ideological objections to chemical insecticide. They generally lack any objective information about the effectiveness of these local remedies.

In general, post-harvest activities had been incorporated into larger projects concerned with agricultural production, marketing, seeds and other matters, and there does seem to have been the sort of focused and long-term approach which characterised the PostCosecha project. In the words on one NGO manager, "a district officer had to attend to various project components, and post-harvest might not get the attention it deserved".

This is particularly noticeable with regard to follow-up and monitoring of market penetration. With all projects we visited, and the GTZ project we did not, we were unable to obtain clear data on the level of adoption and market penetration. Such data may exist in some cases, but the information was not readily available to the staff we met or spoke to by phone. In one case an NGO official told us that there has been 60% adoption of the improved storage structure in his district, but he could not tell us how this data had been derived, except that there had been a participatory appraisal[9]. OXFAM (in Cuamba) appeared to be approaching dissemination in a systematic

[8] Latin American experience, e.g. in Paraguay, suggests that high temperatures should not be an issue providing the grain is properly dried prior to storage.

[9] There seems to be a methodological issue here, with an essentially qualitative methodology being used to collect quantitative information.

manner, and had researched current storage practices, and reasons for adoption/non-adoption of proposed improvements.

We were left with a general view that some present and past initiatives had been somewhat short-term and their dissemination/marketing approach has not been very rigorous. However one would need more time to make a full appraisal. The GTZ/DPA-Sofala project has clearly been in existence a long time, and is promoting a mud-brick silo which our own concept tests in both Mozambique and Tanzania shows to have merits in the eyes of many prospective users (see below). Our main conclusion is that any SDC project will need to work with these projects, and set in motion a strong process of mutual learning.

Storage structures and post-harvest practices

Most **storage structures** are traditional in design. A description of the range of structures is reproduced in Appendix 2 of the report by Coulter et al., 1996. The most common structure we were able to observe was built on stilts, with the storage area being between 0.5 and 2 metres above the ground. The sides of the structure are made of bamboo, mud bricks, or by the branches of shrubs, with the latter sometimes being plastered with mud. The structure is roofed with grass, and has overhanging eves which are often supported by additional upright timbers outside of the store itself. This is often a multipurpose structure, where the farmer stores different crops, but mainly unhusked and unthreshed maize cobs. The store is separate from the house and often has also a social functional where people meet under the structure, around a fire which is used for cooking and to smoke the grain.

Sorghum is mostly stored on shelves above a fireplace, in a kitchen or a storehouse. Beans tend to be sold a short time after harvesting and the quantity needed for family consumption, approx. 2 bags (100 kg), is stored in bags or a basket elsewhere in the house.

Farmers give importance to seed storage. Maize cobs for seed are selected after harvesting and suspended under the roof to protect them against pests. In the case of sorghum, panicles are selected and stored in grass sheaves. Bean seed is stored in clay pots or small bins and kept in a safe place in the kitchen or bedroom.

In Angonia District, basket-like structures similar to the *vihenge* in Tanzania are used instead of the stores on stilts we saw elsewhere, as they are in neighbouring areas of Malawi. The level of general hygiene we observe was particularly high in the households we visited.

Cassava consumption is particularly important in the coastal areas of northern Mozambique, and decreases the further one goes west. It is eaten fresh from around April to September, and in dried form for the rest of the year. People peel the roots, cut them into pieces, sun dry them for two to four weeks, and then store them somewhere in the house in bags and baskets, or in outside storage structures of the kind described above.

As regards **post-harvest practices**, farmers still generally store their maize unthreshed, unlike the case in Tanzania where a strong anti-LGB campaign has taken effect. All cobs continue to be shelled manually.

Farmers continue to plant local varieties of maize, as well as open-pollinated varieties produced under the national programme of seed multiplication. Despite their high-yielding properties, hybrids are not being distributed under this programme but have entered the country in the form of post-war emergency relief. As a consequence of this relief farmers are often planting genetically heterogeneous material with different maturing times and storage properties.

Grain is normally selected prior to storage. The most popular and traditional method of combating insects is by exposing stored crops to smoke, and this explains why they are stored above fireplaces. Most farmers also use "natural products" to protect their harvest in storage, and we encountered the following in use: leaves of *Tephrosia volgei* (known as "Mata-peixe"); ground tobacco leaves; ground dried chillies ("Piri Piri"); ashes of a range of plant material including pawpaw and sunflower seeds. There is a lack of scientific evidence for the effectiveness of most of these remedies. Indeed the research on diatomaceous earths in Tanzania suggests that, at least in that country, plant ashes are of no value whatsoever (see www.nri.org/de).

We did however meet one farmer in Lioma who claimed to be successfully storing substantial quantities of maize in a traditional store for about eight months, and that he was successfully treating it with *Teprhosia volgei* leaves. However Hodges (*pers. comm.*) suggests that it may not be wise to spend public money promoting this substance. He states: *Tefrozia has been widely studied in the laboratory although it is not generally used by farmers. It has a whole bundle of toxins, including rotenone, which give it a high mammalian toxicity and make it a good fish poison. This raises serious issues of toxic residues so it would be best to steer well clear.*
Use of contact insecticides is low, because it is simply not commercially available in most parts of the three northern provinces, and even then people don't always apply it in the right doses. It is much more widely available in areas close to Malawi or in relatively prosperous farming areas with good road connections to Malawi (the case of Lioma). Coincidentally Coulter et al. (1996) found that use of actellic was significant in areas of Manica province close to Zimbabwe.

We find the absence of storage insecticides in commercial outlets (vis a vis their widespread availability in Tanzania) to be symptomatic of a weakness in post-harvest projects in the areas we visited. On the one hand farmers are unaware of the product, having not been encouraged to use it, and therefore don't seek it out in the stores; on the other hand local suppliers fail to stock it because of the lack of demand. In the immediate aftermath of the civil war, unavailability could be blamed on the *fraca rede commercial*, but at this stage it is more the result of policy factors. "Northern" missions have avoided including it in their extension missions[10]. It also appears that free and subsidised official hand-outs have discouraged the development of commercial supply. Here we quote Sitoe (2001), speaking of the situation in the central provinces, when he says that "Emgergency programmes which assist affected populations generally end up interrupting the development of private markets through subsidised prices. This practice discourages private traders from entering the input market, particularly in remote areas or those with access difficulties."

[10] Notably USAID prohibits the NGOs it finances from using phostoxin. We do not know the reasoning behind this, but on the face of it find it slightly surprising coming from a country which makes such intensive use of agrochemicals.

Most farmers defence against rats is to keep cats, though a few use rat-poison.

Storage losses and their impact

We are only aware of two quantitative evaluations of losses that been carried out in Mozambique:

a) a study by NRI and World Vision on the impact of rats on resettled households in Zambesia. The loss figure encountered was surprisingly high, around 20% by weight. This reflects to a considerable extent the peculiar circumstances of the returnees, notably their building their stores over their kitchens rather than having some of them outside (as we found in the farms we visited), but it is nevertheless a rare piece of objective data on the damage done by this pest (Belmain *et al.* 2002).
b) a study by OXFAM in southern Niassa 2002, showing storage losses of 33.3% for storage in a traditional stores for six months without rat-guards. We have so far not been able to see the research report, so cannot vouch for the methodology used.

Apart from this, we may quote a study by Temudo (2001) of on-farm storage in Niassa concluding that medium to high storage losses could be expected from existing practices, that dried cassava, cowpeas, some beans, sorghum and millet are most affected, and that external interventions were characterised by piecemeal approach, bypassing pre and post-harvest problems

Appendix 4 contains a table summarising our observations in each of the five areas visited. Generally, post-harvest losses were heavy, but the pattern of damage was different in each place seen, and this can be related to meteorological conditions, the combination of crops, the farming system and the influence of markets. Most significantly we noted, or were advised of the following:

- in Chiure (Cabo Delgado): high losses in cassava and maize, due to insects and rats, and significant losses in sorghum. Significant problems of theft.
- in Malema (Nampula): Losses from rain damage, rats, birds and termites during field drying. Heavy storage losses from insects & rats, with damage to maize being most serious, followed by dried cassava, followed by sorghum. Theft, and fire due to arson and accidents.
- in southern Niassa: Heavy insect losses in maize (both communities) and cassava (one of two communities); minor losses in sorghum (although rat losses reported).
- in Lioma (Zambezia): Less losses observed on maize main crop stored due to improved storage methods and application of Actellic (the activities of World Vision may have contributed to this situation). Rat losses are considered significant.
- in Angonia (Tete): Very high maize losses away from border. Farmers sell beans early largely to avoid insect damage. Less storage problems near the border to Malawi due to widespread availability and use of Actellic.

In Chiure, where in common with other coastal districts, families depend mostly on cassava as a principal food, we found very high levels of insect damage in chips (as of April 15th) which had been stored since the previous August; we saw a mixture of pieces full of holes and a mass of powder. We observed a similar situation in Namacala (southern Niassa).

Notwithstanding the greater use of contact insecticides in areas bordering Malawi, the traders (*armazenistas*) in Milange indicate that there is considerable damage in the maize exported to Malawi. In a group session we held with the armazenistas, they gave us the following consensus view:

- 20 to 30% of the grain moving to Malawi was heavily damaged
- heavily damaged means about 40% of the grains showing insect damage, and
- the discount for heavily damaged grain of about 22% of the price of healthy grain

The above mentioned account indicates that farmers in most areas of northern Mozambique, farmers are experiencing serious storage problems in the absence of known occurrence of the LGB. The loss data for Tanzania suggests that the arrival of the LGB will convert a bad storage situation into a disastrous one, if nothing substantial is done to improve pest management in the zone.

Rats are less recognized as a problem but farmers admit it as an “invisible pest” that mostly affects sorghum. Theft is also mentioned as an increasing problem and farmers give safe places more importance[11]. Termites’ attack was also mentioned as a serious problem affecting storage structures as well as stored maize and cassava. There is a general lack of hygiene and few chemical insecticides are applied.

The adverse **impact of storage losses** includes the following:

- Hunger - the critical period for food shortages is generally between November and February
- Early sale to avoid physical losses, reducing opportunity to sell at favourable prices. Typically we found farmers selling half or more of their crops within the first three months of harvest, due in large part to the problem of pests, and notably insects.
- A coping strategy which involves diversifying production to reduce dependence on a single crop with a single harvesting period. This seems to be sub-optimal in terms of the volume and value of agricultural production; farmers are constrained in the ability to specialise according to comparative advantage and produce relatively profitable cash crops.
- Nutritional loss, due to rats and insects devouring germs, and adverse health impact due to poor hygiene and contamination with mould and excrement

We cannot attempt to quantify the overall economic losses resulting from storage problems, but they are clearly very large.

[11] Comments by farmers in Malema district are reminiscent of comments by Sitoe (2001) on the situation in the central region of Mozambique. With traditional systems of storage - - “high storage losses witness to the lack of trust which can be placed in them; moreover they are susceptible to robbery and at times there are confrontations between neighbours leading to acts of arson against stores.” - - “to avoid these problems farmers sell their crop shortly after harvest, with all the problems that this involves. The solution to this problem lies in finding a technology which is secure and trusted; - -.”

Demand for alternative storage and drying structures

We discuss this under three headings: the metal silo; storage structures using local materials, and; the drying crib.

We encountered general willingness to try new storage structures, but with most reluctance in Lioma and close to the border in Angonia District where, as we have previously explained, farmers appeared to have overcome the most serious storage problems.

In the poorest of the communities visited (Ujamaa, Chiure District), farmers were most interested in adopting the *improved traditional crib*, which is the only structure most of them were able to consider from a financial viewpoint. In other districts, the metal silo and the drying crib were the most popular structures, followed by the mud-brick silo. Convenience factors (much noted in Tanzania) seemed to be driving demand for the metal silo, while effort and time factors appeared to be acting against the brick structures, particularly the more expensive burnt brick structure. The demand for the drying crib was largely driven by the existence of river bottoms in which farmers could produce a second crop in the year, giving them the incentive to harvest early.

Farmers mentioned a range of obstacles in acquiring the new technologies, notably high costs and their ability to finance acquisition. They were also concerned about the difficulties in acquiring the necessary materials, notably metal sheets and pesticides, and their lack of skills in making the new structures. Farmers in Lioma (a highly productive area) were reluctant to shell the grain because of the high workload involved. Concerns over workloads in transporting materials were also raised with regard to brick silos.

There is potentially a symbiotic relationship between the commercialisation of agriculture and the improvement of storage technology. On the one hand commercially oriented agriculture will aid in the adoption of improved storage technology; at the same time improvements in storage technology will make farmers more food secure and allow them to dedicate themselves to cash-crops and other income earning activities. In this way improved on-farm storage can become **a motor for development**.

Tobacco and cotton are the leading cash crops developed under contract farming arrangements, and companies specialising in them favour the introduction of storage technologies which enhance the food security of the farmers with whom they are working. This is particularly the case of a company like Mozambique Leaf Tobacco (MLT) in Angonia which has a progressive social responsibility programme involving 35,000 farmers and is assisting them to enhance their food supplies and develop rotations with tobacco, particularly through the supply of hybrid maize seed. Exceptionally among contract-farming sponsors, the company is encouraging the organisation of farmer associations, and their formal registration, and has helped establish an arbitration system for the settlement of disputes. We also met a representative of the João Ferreira dos Santos (JFS) Group which works in Nampula and Niassa provinces, who indicated that his company may be interested in collaborating with initiatives which enhance the food security of their farmers. Such companies can become channels for technical assistance in building new structures, and for the necessary materials which they may sell on cash or credit terms. The involvement of such companies in materials supply is of particular interest in a country with sparse and weak rural retailing establishments and where storage insecticides are very difficult to obtain, even in district capitals.

The improvement of roads and liberalisation of marketing systems has opened up markets for a range of other crops for which it is difficult or impossible to organise successful contract farming schemes on a sustainable basis. This is due to the multiple sales outlets for the commodities concerned and the absence of monopsony concessions. This is the case for example with maize, pigeon peas, beans, cashew, paprika, groundnuts, and vegetables[12]. Within about 100-150 km of the Malawi border and along the Nacala corridor, maize gains importance as a cash crop, with strong demand from Malawi in three years out of four (Brian Hilton, World Vision, *pers. comm.*). Pigeon pea is the second most important cash crop in this area and is sold both to Malawi and to a new factory in Gurue, for processing and export to India and elsewhere. At the same time, certain areas, notably Lioma, Alto Molocue and Lichinga are specialising in the production of butter beans (feijões manteiga) which are shipped to deficit markets within Mozambique (e.g. Maputo, Beira and Nampula), and to Malawi. Farmers in Moralelo (Malema District) had found a profitable niche in garlic and tomatoes. Notwithstanding the absence of contract farming arrangements, farmers' earnings through the sale of these commodities will assist them in adopting new food storage technologies. At the same time, more reliable food storage facilities will make them less concerned over food security and more able to dedicate land to income-generating activities.

The scope for improvements in commercially-oriented storage

The structures considered above will mainly be used by farmers to store food for home consumption. Our visit to Lioma revealed a similar situation to that encountered in Iringa (Tanzania); farmers already plough with tractors and generate substantial surpluses of food crops. They are likely to need some additional options to those which were concept-tested, for example:

- High-volume mechanical shelling for maize. This will allow them to ready their grain for disposal rapid sale, when the opportunity arises, and better equip them to deal with LGB when it arrives.
- Warehouse receipts and inventory credit systems. This will improve their farm finances – allowing them to hold back crops like beans which they now have to sell to pay for labour. It will also allow them to play the market to best advantage, very important given the high degree of seasonal variability in market prices.

These things will in turn provide some additional resources for intensifying production for the market.

Warehouse receipt systems are also potentially attractive to traders involved in the trade with Malawi. We interviewed a group of 17 *armazenistas* in Milange, and found that they were only engaged in transit trade over the border. Indeed this trade only exists as a result of a tax regime which favours the domestic trading community

[12] Paprika has been promoted under contract-farming arrangements, but there has always been a lot of side-selling. A cashew company in Mojincual is currently trying to organise a contract-farming scheme for groundnuts.

over that from Malawi. With a completely open border one would expect Malawian importers to procure directly through agents in supplying areas of Zambesia province. Instead of this they are buying from a stream of bicycle traders who cross daily loaded with three bags apiece. The trade exists because bicycle traders are allowed to cross tax free, whereas lorries with grain must bear duty on their consignments.

The armazenistas who sell to the bicycle traders buy from farmers and other Mozambican traders who deliver to their premises, or through agents they sell to up-country markets. They do not store the grains for later sale, but would like to if they could access the necessary finance. They responded warmly to the warehouse receipts concept. The District Director of Commerce moreover indicated that there were in Milange eight substantial warehouses which could be used for this purpose, all except one unutilised, and with a total capacity of about 5,000 tonnes.

A warehouse receipts/inventory credit initiative in Milange could have several advantages for Mozambique:

(a) it would assist in stabilising prices and contribute to greater market integration in the Region;
(b) it would allow the country to store more grains on the Mozambican side of the border, and mitigate shortages resulting from overselling to Malawi;
(c) storage in Milange would provide an alternative livelihood to that presently enjoyed by the armazenistas and bicycle traders, and;
(d) storage by Milange traders could be a means of pretesting warehouse receipts systems with a group of “early adopters”, before implementing it in farming areas.

This topic does not form part of our immediate proposals, but SDC may wish to take it forward in the future, if a suitable project partners, e.g. an NGO wishing to set up the system on a pilot basis, can be identified.

Proposed solutions

We propose the creation of a Post-Harvest Unit (PHU), based in Nampula, with the mandate of improving performance of post-harvest agriculture in Mozambique. It will do this by:

1. working to improve on-farm storage structures and practices within a specific core zone of activity
2. collaborating with other post-harvest initiatives in Mozambique with a view to achieving high standards and maximum information exchange in the country as a whole, and
3. establishing other (as yet unspecified) services with a view to improving the performance of areas of the post-harvest system, e.g. transport technology or storage and marketing of surplus production

We will deal with each of these mandates in turn. The Post-Harvest Project we are proposing here will be concerned with the first two of these mandates. For **Mandate 1,** the PHU will initially establish its own core zone of activity within Nampula Province, where it will set about:

- Validating, fine-tuning & field-testing alternative storage. This will involve farmer evaluations through concept testing and demonstrations.

- Developing marketing packages for the preferred storage systems, paying attention to the 4 Ps of product, price, place and promotion, as well as quality control, and
- Promoting these preferred storage systems together with collaborating institutions (DDAs, local development projects, Farmer Associations, NGOs etc.), with whom the PHU will sign agreements involving mutual obligations concerning promotion, training and other aspects)

We provide more details in Box 2. The zone of operation may subsequently be expanded to neighbouring provinces, as the Project gains experience, adoption takes off in Nampula and there is scope for providing concentrated attention to other provinces. The implementation of the on-farm storage component will involve the following activities:

BOX 2: PHU MANDATE 1 - COMPONENT ACTIVITIES

- Identification of suitable technologies for different demonstration zones, involving further concept testing
- Demonstration of prototype structures, which will be installed in homes of lead farmers, and improved post-harvest practices. There will be systematic monitoring, including the collection of grain samples and comparison with samples stored on other farms. This will allow them to be validated by the Project and by local farmers.
- Training of farmers, and collaborating staff of government, NGOs, farmer organisations and private sector, with a view to raising awareness and interest in the new technologies, and equipping the latter as effective promoters. This will be supported by public relations using local radio, videos and written media.
- Training local artisans to build the new structures. These artisans are the key entrepreneurs in this business and their continued promotional efforts with local farmers will ensure continued diffusion. To assist the development of their business, they will be trained in business management (accounting, pricing and marketing), and to make products out of waste materials from silo fabrication. The project will employ its own trainers, and where appropriate contract in specialist services, following an assessment of the suitability of alternative establishments.
- Development of training manuals, and/or adaptation and translation of existing manuals.
- Working with private sector to ensure smooth supply of fabrication materials and insecticides. This may include collaborative educational campaigns concerning the usage of storage insecticides within the core zone.
- Sensitisation of farmers to access local savings and credit services so that they can finance the acquisition of storage hardware.

- Establish quality control over fabrication, and usage of structures in the home. Following Central American practice, large instruction stickers will be pasted on metal silos found to be correctly constructed and installed, and analogous arrangements will be worked out for the other structures.
- Systematic monitoring and documentation of performance and adoption over time, and diagnosis of causes of adoption/non-adoption. The prime sources of information in this case will be material suppliers and artisans trained by the project, complemented by other informants, including material suppliers local extensionists, NGOs and private companies who are collaborating in the distribution of silos.
- Periodically, independent contractors with no involvement in promoting the technology will be hired to carry out cases studies and/or sample surveys of adopting and non-adopting farmers, and artisans[1]. They will feed back their findings to the project, which will use the information to better understand the reasons for adoption/non-adoption, and if feasible or appropriate taken corrective action.
- Refocusing effort on "winning" technologies in the light of market feedback

The implementation of this project may highlight issues which require some research. It would be helpful to have some more quantitative information on storage losses, and on the air-tightness of the burnt-brick silo before this is promoted in Mozambique. There may need to be work on adapting storage structures to local conditions, and understanding how ambient humidity affects the viability of different storage structures. Where necessary, the PHU will identify such topics, draw up research brief and if the project's resources are insufficient, identify collaborators ready to fund and carry out the work. In the event that such work is shown to be necessary, it will take steps to ensure that it is demand-led and carried out in a cost-effective manner. PHU activities should be knowledge-based while ensuring that the search for knowledge is carried out in a pragmatic manner. The PHU will also assist universities in training students and allowing them to carry out research in post harvest matters.

Mandate 2 involves outreach to other parties who are implementing post-harvest projects elsewhere in the country, but without the commitment to provide concentrated attention of the kind which it will provide in the core zone. As we indicated earlier in this report, there is a need to help existing projects raise their standards of operation and for the SDC project to maximise the exchange of information and mutual learning process between projects.

Standards are necessary in various areas: in the assessment of needs, in the validation of alternative storage systems, in the training of artisans, in the dissemination of technologies and in the monitoring of uptake. There may also be scope for standards with regard to pricing and subsidisation of new technology. With the background of war, relief and rehabilitation, with the prospect of the LGB spreading to the four corners of the country, and with electoral factors contributing, one may expect there to be major pressures to provide inputs and even entire structures for free. While poverty may sometimes provide a rationale for this, it creates difficulty for those trying to develop a sustainable private distribution channels. The efforts of one group of promoters may be undermined by others who provide subsidies, and as reported in the case of Central America, artisans may neglect the development of their local sales opportunities in favour of large institutional buyers. Moreover, subsidies may be absorbed by relatively well-off people and/or diminish the search for cheaper solutions more in tune with the farmers' means. Such problems can be reduced if the relevant players can voluntarily agree on a code of conduct dealing with the issue of subsidies.

The PHU will work with other institutions to establish a network of project collaborators throughout Mozambique, including all institutions with substantive post-harvest initiatives who wish to collaborate, mainly at their own expense. Members of the network will explore the possibility of common standards and a voluntary system of quality certification. Regular monitoring systems will be established, and periodic reviews undertaken to assess new technologies, identify constraints and possible new initiatives. By working with other institutions in this way, while simultaneously carrying out its own programme in its core zone, the PHU will seek to establish its credentials as a "competence centre" in post-harvest matters in Mozambique.

An important aspect of this outreach will be to encourage initiatives where there are prospects for early success, rather like the case of the Kilombero Sugar Complex in Tanzania. Kilombero lies outside the proposed core zone for Tanzania, but is interested in becoming involved in the project, and to provide certain support to farmers and artisans. This greatly reduces the cost of supporting Kilombero in its effort and provides a case for exceptional support to a distant collaborator outside the core zone. A similar arrangement might be made with Mozambique Leaf Tobacco in Tete to which we refer above. In this way the Project will combine concentrated effort within its core zone with flexible outreach where justified by exceptional circumstances.

Mandate 3 involves the future development of the PHU, which hopefully will provide an institutional framework for addressing various challenges in the post-harvest area. On-farm storage is a very important area of post-harvest activity, but our study has highlighted the need for improvements that enable surplus producing farmers to achieve their potential, e.g. labour-saving technology for threshing grain and professional storage services linked to the availability of inventory credit. Another potential area of activity is the introduction of Intermediate Transport Technologies, e.g. donkey carts. Presently there are almost no means of transport between conventional cars and trucks on the one hand, and bicycles on the other. Roads have been rehabilitated but there has not been a parallel development in the modes of transport available, simply a proliferation of bicycles.

We propose an initial three year project, but as we explained at the presentation in Maputo on 27 April, SDC should be prepared to provide long-term support to the

PHU. As we indicated earlier in this report, long-term support has been the key to success of SDC's post harvest initiatives.

Institutional aspects, project management and cost

For the management of the PHU, SDC should initially hire an independent organisation or consulting company for a three year period. Selection may be on the basis of a review of existing and potential contractors, or by open tender.

Even though SDC will be providing long-term support, it his hoped that the PHU can outlast that support and play an important role in the improvement of rural life in Mozambique. For PHU to enjoy legitimacy in this role, it will need to represent varied interests within Mozambique. For this reason, it should have a five person steering committee representing the following parties:

- Government. Nampula Provincial Department of Agriculture may be asked to put forward a post-harvest or plant protection specialist.
- Funding agencies, with SDC representing their collective interest
- Private sector, e.g. an agrochemical supplier or the operator of an outgrower scheme
- NGOs with post-harvest programmes, e.g. CARE, World Vision, Oxfam, Helvetas
- Financing agencies, e.g. GAPI, AMODER, BIM

The steering committee should be constituted, and meet, in Nampula, initially on a six-monthly basis. Its functions should be to agree the appointment of the project management organisation, agree plans and budgets, and review progress made over time.

While the steering committee needs to be representative of stakeholder interests, it is important that it remains strictly apolitical. We believe that a little time spent at the outset investigating how this can be guaranteed will be time well spent; SDC should seek legal and other advice in this regard. One alternative to be considered would be making the PHU a trusteeship and the members of the steering committee trustees, changeable by a majority vote of the members. This will provide the PHU with a sense of stability, while ensuring that membership of the steering group changes as people move jobs and in line with evolving priorities in the country.

Before going ahead with this project, we recommend that SDC negotiates with the Government of Mozambique over comprehensive tax exemptions on the importation of galvanised iron sheeting, along the lines set out in the section above dealing with the supply of metal sheeting.

Appendix 5 shows an indicative budget, which is based on similar projects in Latin America. The total sum required is $2.26 million, (approx. $2.3 million) of which 62% is for personnel costs, including salaries, travel, insurance and local expenses, 18% is for training and promotional material, 12% for vehicles and equipment and 8% for office and administrative expense. The initial investment in equipment and staff training will be approximately $315,000, after which annual expenditure will be approximately $650,000.

FEASIBILITY STUDY FOR A POST-HARVEST PROJECT IN TANZANIA

Public policy towards grain storage

During our visit we were able to meet Adelaide J. Moshy, Assistant Director of Post-Harvest Management Services of MAFS, and Dr. Florens M. Turuka, the Director of Marketing at the Ministry of Cooperatives and Marketing, both of whom welcomed SDC's mission.

As its name indicates, food security is a high priority for MAFS. Relevant policies are set out in the Agricultural Sector Development Strategy (ASDS) and are integral to the mission of Participatory Agricultural Development and Empowerment Project (PADEP). The ASDS provides a basis for action by both the public and private sectors to support Tanzania's efforts to stimulate agricultural growth and to reduce rural poverty. It is a step forward towards laying the foundation for the ways to develop the agricultural sector, hence the national economy at large as well as poverty reduction especially in the rural areas (URT, 2001).

Increased production as a result of interventions by these programmes is expected to call for additional storage facilities at different levels. The co-ordinator of PADEP (Muro, *pers. comm.*) indicated that this organisation might enter into a risk sharing agreement for new technologies like the proposed metal silos.

At the same time, the challenges for pest management, particularly LGB are a driving force to alternative storage, particularly those suitable for storing shelled maize.

The liberalization of markets and cross border trade is moreover seen as means of providing market access and incentives to production, in view of which additional storage will be needed to simultaneously assure food sufficiency and marketable surplus.

A significant issue is public policy on the use of phosphine, which is normally used for pest control in metal silos. Presently phosphine gas is registered under the Plant Protection Act of 1997 to be used only by trained personnel in warehouses and silos. In practice however, it is sold indiscriminately in retail shops so that everybody has access to it. In view of this situation Government may look kindly upon a project of the PostCosecha kind, which trains farmers to use phostoxin safely. However before SDC supports the promotion of such structures, it should seek assurance that Government will treat properly trained farmers as "trained personnel" according to the Law.

Previous and on-going storage initiatives

Until the late 1970s there was no established Government policy on storage of agricultural products. However this changed in the early 1980s, with the awareness of the arrival of the LGB and with FAO/UNDP addressing post harvest losses.

With the accidental introduction of the LGB in Tanzania, FAO co-ordinated donor support to train farmers, artisans and stockists in matters related to pest management, and capacity building for eradication campaigns through various projects. This led to a large proportion of farmers changing their post-harvest practices, notably shelling prior to storage and using recommended storage insecticides. The impact of these initiatives, in terms of loss reduction, has not been monitored or properly documented. However, FAO's LGB control campaign in Tabora 1985/86 was judged to be a success based on a reduction of losses sustained by 105 farmers in 3 villages, from 8.4% over 3-6 months storage as compared to less than 2% after 7-9 months in the next year (Hodges et al., 1996).

The main thrust of FAO/UNDP projects during the 80s and early 90s was the construction and improvement of household and village storage structures, typically 200-400 tonne capacity. Villagers provided labour on a self-help basis. The stores were located with the primary cooperative societies on the assumption that farmers would, under a liberalised marketing scenario, continue selling grain through their cooperatives. Overall, more than 960 stores are believed to be constructed by FAO and by other donors with parallel projects (SOFRAIP, 2000). This investment was effective in creating employment in construction, but as regards combating pests was no more effective than the ***Maginot Line.*** The cooperative societies had become part of the state-controlled marketing system, and long before the start of liberalisation (in 1994), farmers were deserting them for a vibrant parallel trade in grain. The parallel market subsequently became a legalised private market and farmers eschewed the cooperatives and sold to small traders many of who used no storage facilities (see Coulter and Golob, 1992).

The SDC team saw several of these village stores. They were all empty and unused, and while they looked as if they were structurally sound, there were some signs of dilapidation. There are few plans to put these stores to good use. In one of the villages we visited, Isimani in Iringa District, the local authorities were planning to use them to hold back the local crop in an attempt to bargain with middlemen. The IFAD-backed Agricultural Marketing Systems Development Programme (AMSDP) is planning to use some for a warehouse receipt system with coffee and cotton, but presently has no plans for food grains.

Until the early 1990s the focus of these projects was mainly on building storage structures at village level. In the words of a UNDP Report of December 1989: "Studies of the post-production system were overshadowed by the priority being given to village store construction and the more impressive outcome". The latter part of the FAO/UNDP projects placed greater emphasis on the demonstration and promotion of new structures for on-farm storage. Moreover between 1993 and 1997, Sasakawa Global 2000 in collaboration with the Ministry of Agriculture and Cooperatives implemented a project for improvement of the post harvest system in Tanzania, taking an integrated approach to loss mitigation, by addressing all post-harvest processes. Training was conducted with farmers and stockists and more than 300 improved storage structures demonstrated in the project regions of Iringa, Arusha, Rukwa, Mbeya, Kilimanjaro and Mara alongside improved drying platforms and hand shellers (Riwa, 1996).

The uptake of the structures introduced under these programmes has not been systematically monitored, but it appears that few if any were built beyond the demonstration units. SDC study team saw several of these structures in varying states of repair, and could find no evidence whatsoever that any farmers had replicated them in a spontaneous manner. We attribute the lack of success to a combination of: (a) weakness of project design; (b) farmers being insufficiently involved in the conceptual stages, and: (c) lack of monitoring and follow-up.

A more recent exception to this lack of success is the "improved vihenge" introduced recently under a World Vision/Ministry of Agriculture and Food Security (MAFS) collaboration in Shinyanga. The account of an artisan from the village of Ngaganulwa (see Box 3 below) bears out the positive conclusions of a study by Kolowa (2002). However, to confirm this apparent success it will be necessary to rigorously follow up the experience over time with sample surveys. In particular, it will be instructive to find out whether people maintain the vihenge in a way which prevents LGB perforating the structure.

BOX 3: MEETING WITH AN ARTISAN IN NGAGANULWA

In our visit to Ngaganulwa in Shinyanga District we met a farmer, Mr. Schiyanhamirla, who was also an artisan with a sideline of making improved vihenge as an income-earning business. The structure is made of small branches, has a lid and an outlet spout. It is plastered all over with cow dung so as to prevent the passage of insects. According to the artisan it is the responsibility of the owner to plaster his/her kihenge with cow dung, and it is very important to replaster it every year.

There were 459 households in the village, and since 2001, he had made and sold 17 units, another artisan has made nine, and two other artisans who have now stopped producing made four between them. His most popular size is 10-12 bags and costs TSh 10,000[1] each (US$ 9), and he makes a 34 bag structure for KSh. 20,000 (US$ 18). He had not sold any recently because the crop had been poor during the last two seasons, but believed he could sell more if there was a good crop.

He claimed that customers were satisfied because the structure allowed them to get rid of insects and rats. In the village we saw two other farmers with improved vihenge. Both were satisfied with the performance of their vihenge, but in the case of one of them we noticed that the plastering was all cracked and loose.

Mr Schiyamhamirla was not one of the original artisans trained by World Vision, but had taken up the profession spontaneously and was then adopted by the project.

Storage structures and post-harvest practices in Tanzania

Appendix 6 shows a summary table with the consultants' findings in the four regions visited.

Storage structures may be classified as "traditional" or "modern". The most important traditional structures encountered during our trip were *vihenge* (baskets made from branches of shrubs), the *vilindo* (containers made of the bark of the Miombo tree), and *nkuli* (vertical frames from which cobs are hung in bundles). Particularly with the *vilindo*, construction is made difficult by a diminishing supply of raw materials and pressures for environmental protection. There are various other traditional structures in Tanzania including baskets, *dari* and *chanja* (types of platform built beneath the roof of the house), clay pots and gourds (for storage of small quantities of grain and particularly seeds, flour and or semi-processed foods), and *konti* (a pot-like structure made from moulded cow dung and ash, and able to accommodate four bags of maize).

As regards "modern" structures, storage in jute sacks and polypropylene bags, in the home, is very common. However polypropylene bags are tending to displace jute, because they are cheaper, more readily available, and more tolerant to insect and rodent attack. In Kilimanjaro there was considerable use of 200 litre metal drums (holding about 180 kg of grain), and increasingly for larger farmers, large welded-iron tanks, of 6 to 13 tonne capacity. Metal containers are also abundant around towns and commercial centres. Various traditional drying structures were also observed.

Theft, or pilfering by family members, is an important issue influencing the location of storage structures, and for this reason grain tends to be stored in the home or within a closed compound.

As regards **post-harvest practices**, farmers are now tending to store their grain in shelled form, largely as a result of a successful public campaign about the larger grain borer (LGB), an exotic pest introduced from the Americas, in the late 1970s. This in turn is encouraging storage in basket structures, bags and drums[13]. In practice LGB damage is sporadic, but when it occurs its effect is devastating, attacking both stored grain and wooden storage structures.

All cobs continue to be shelled manually, which is very laborious, particularly in areas of high production, e.g. Iringa District. Central American experience suggests that the use of high performance tractor-powered mechanical shellers might be appropriate in such areas.

In Shinyanga, it was observed that farmers typically harvest maize early and stook it, to release fields for planting chick peas, a practice which exposes the maize to termites, rats and LGB.

Farmers continue to plant local varieties of maize, on account of pest-tolerance and taste. There is widespread use of contact insecticides, marred by a serious problem of fake insectides and lack of quality monitoring. MAFS has promoted the use of *Actellic Super Dust* (or ASD), a cocktail of pirimiphos methyl 1.6% and permethrin 0.3%, which is very effective in controlling LGB and other storage pests. Several similar products have been approved including *Stocal Super* and *Shumba* imported

[13] All farmers we interviewed in Kilimanjaro Region indicated that they are getting no insect-related storage losses when using metal drums, despite their not using contact insecticides or fumigants. This suggests that insects were being killed by asphyxiation, and may in part be due to good store hygiene. We heard a similar story about the large welded metal silos, though one user seemed to be having condensation problems. This is surprising given that there is a lack of practical evidence, from elsewhere, of metal containers proving effective at farm level without the application of storage insecticide, simply through asphyxiation (David Walker, NRI, *pers. comm.*). In view of the findings in Kilimanjaro, it would be worth taking a fresh look at the possibilities, investigating their experiences and seeing if it is possible to develop indicators for situations where phosphine fumigation need not be recommended.

from Zimbabwe and Kenya[14]. The officially recommended dose is 100 g per 90 kg bag of maize, over twice the recommended application rate of 50 g per 100 kg in Kenya, Uganda, Malawi and Zambia (R. Hodges, *pers. comm.*).

Under the Plant Protection Act of 1997, it is the Tropical Pests Research Institute (TPRI) that has the responsibility of performing the necessary regulatory function to prevent the distribution of fake insecticides, but results are very scarce. Discussions during the team's field visit moreover indicated that there was little initiative at the level of MAFS plant protection officials, who were responsible for investigating complaints and bringing them to the attention of TPRI and other relevant authorities. The team contacted three suppliers of storage insecticides and all complained about the enforcement situation, either regarding the legal framework, the enforcement capacity or the enforcement itself.

Lack of confidence and high recurrent cost is deterring farmers from using ASD or similar products. According to the recommended dosage, the cost of treating one tonne of grain is between US$ 8 and US$ 10 per tonne[15] plus the cost of mixing. According to NRI pest management specialists, there is no reason to believe that the lower dosage rate used in neighbouring countries doesn't work well, so treatment costs in Tanzania may be unnecessarily inflated. However it should be noted that even at the lower rate the cost of treatment is still high compared to that of treating with phosphine gas in a hermetic silo – about $0.50 per tonne – and less effective, given that contact insecticides do not kill the eggs of the insect. Added to this, insecticides are very often incorrectly applied, due to limited knowledge among farmers. Farmers are frequently using cheaper alternatives, including Malathion and Actellic EC, which do not provide adequate protection against LGB. Natural insectides, especially plant ashes, also continue to be used, but we could find no evidence that they are proving successful. The range of problems is succinctly summarised in Box 4.

[14] Appendix 3 contains information obtained through interviews with the three supplying companies.
[15] equivalent to TSh 1,600 and TSh 2,000 per 200 g pack respectively

BOX 4: PROBLEMS IN USING STORAGE INSECTICIDES IN TANZANIA

Although synthetic insecticides are available for protecting stored maize against insect infestation not all farmers use them. There are various reasons for this. Firstly, many farmers are afraid that they will contaminate and poison their food. Secondly, they may be too expensive for many ordinary farmers to buy; in 1988 the cost of treating a bag of maize grain was 2% of its value, ten years later it had risen to 6% (Golob *et al.* 1999). In rural areas more than 20 km from a town, storage insecticide has been difficult to obtain and when available has often been of dubious quality. Since market liberalisation, supply and distribution of inputs in Tanzania have been the responsibility of the private sector. To maximise returns on investment, insecticide importers and distributors have restricted their distribution networks to wholesalers and retailers in large towns, putting the onus on farming communities to obtain the insecticide themselves. Thus farmers may have to travel 50 km or more to purchase them. Some small-scale traders may visit local markets to sell ASD but in Tanzania unscrupulous traders have, in the recent past, been adulterating the dust and selling it in unmarked packets (Urono 1999). In a survey of the quality of ASD, five out of thirteen samples were below specification for active ingredient, which in one case was not even detectable. Hence, on occasion farmers have been dissatisfied with the control they have achieved with ASD. It is planned to introduce tamper-proof packaging to overcome this problem. However, some of the control failures are the responsibility of the farmers themselves. The relatively high price of ASD persuades some farmers to under-dose. During field visits, farmers often admitted applying one packet of 200 g of ASD to three or more 100 kg sacks of maize grain instead of to just two as is recommended (Golob *et al.* 1999). Farmers also apply the dust to maize cobs, which is likely to be much less effective than application to shelled grain. Poor application procedures will result in insect survival and might also lead to the development of insect resistance.

Source: quoted from Golob, 2004

Quantitative and qualitative **storage losses**, primarily from insects and rats, though fungi and termites are also significant, remain a major problem for farmers, particularly as regards maize. High losses are also encountered with sorghum in Singida and Shinyanga, and sweet potato chips in Shinyanga.

According to Golob (2004), estimates of **on-farm storage losses** for unprotected maize, in terms of weight, are surprisingly scarce for Tanzania. Generally, those estimates that have been made overstate he problem because they do not take into account the effect of withdrawals from granaries during the season (e.g. Keil 1988; Henkes 1994). The real losses to unprotected maize during the course of a storage season lay somewhere between 10% and 30% by weight, primarily the result of *P. truncatus* infestation, significantly more than the 2-3% which is normally lost as a result of attack by indigenous insect pests (Tyler and Boxall 1984). These estimates were derived from storing open-pollinated, flint varieties. For many years, farmers have refused to store hybrid dent varieties because these are extremely susceptible to insect damage. Such varieties have been shown to lose in excess of 25% by weight in less than six months in store when unprotected against insect attack, and even when treated with insecticide damage can still be considerable, especially if cobs are stored (Golob 1984)."

The recent MAFS/NRI study on the use of Diamotaceous Earth tends to confirm this picture of high losses. In samples of untreated grain stored in five locations in different parts of the country during 2002/03, the percentage of insect damaged grains ranged from a minimum of 40% in 8 months to 80% in 6 months of storage (see website on research on Diatomaceous Earth, www.nri.org/de).

Storage losses have a series of knock-on effects on rural welfare, including:

- shortages of food in the November to February period; this was particularly the case in Singida, out of the areas the team visited;
- extra costs to the family farm, notably through the production of low-yielding traditional varieties of maize, and of rice in Shinyanga (we found it used as a food security crop, not simply a cash crop, despite farmers' taste preference for maize)
- early sale of grain (particularly hybrids) to avoid losses. This reduces the opportunity to sell at favourable prices and the funds with which farmers can invest in further production or diversification into other crops or income-generating activities, and makes Tanzanian maize system less internationally competitive;
- higher lean-season prices for the food-deficit population
- nutritional loss, due to rats and insects devouring germs, and probable adverse health impact, due to poor hygiene and contamination of food with mould and excrement

It would be very difficult to quantify the overall economic losses resulting from storage problems, but they are clearly very large.

Demand for alternative storage and drying structures

We discuss this under three headings: the metal silo; storage structures using local materials, and; the drying crib. This should be read in conjunction with Appendix 6 which shows a tabular analysis of demand in the four regions visited.

The metal silo is found to be particularly suited to the mass of farmers in Kilimanjaro regions, and to some relatively prosperous farmers in Iringa, Shinyanga and Singida. In the latter areas, and particularly Iringa, demand is likely to grow as early adopters use them successfully. From the point of view of the user, the key advantages of the silo are:

- its low recurrent cost and convenience: it saves on insecticide and repairs
- it allows for complete control of pests, and
- it's mobility: it is easy to move or transfer to new locations

The disadvantages are its high capital cost, vis a vis traditional structures, modified vihenge or mud-brick silos, and its unsuitability for storage within most existing homes. Larger units, e.g. 820 kg and 1,360 kg, are too wide to go through doors, though in some cases people will get round this by bringing them in through the roof, or even constructing a new building around the silo.

In the case of Kilimanjaro, the silo fills a niche between the metal drums and welded iron silos. According to the farmers interviewed in Sanya Juu, the drums take up too much space and are difficult to handle, having only a small orifice for loading and unloading, while the welded-iron silos are too large for most farmers.

In the case of *storage structures using local materials*, the three options - moving from lowest to highest cost, and from lowest to highest durability - are:

- the improved kihenge (as promoted by World Vision experience in Shinyanga)
- the mud-brick silo, and
- the burnt-brick silo - which can be made airtight and used for fumigation

The improved kihenge and mud-brick silo appear to be the best options for poorer producers, and their relative merits need to be more thoroughly evaluated. The burnt-brick silo is only likely to be suitable for better-off producers, and/or in locations with cheap supply of burnt bricks (e.g. Magulilwa village in Iringa District)

The *drying crib* does not appear to be greatly in demand. There are certain locations where it would assist in drying the crop, notably in Shinyanga where farmers currently stook their maize, but there appears to be an over-riding fear of theft.

Storage of tradable surpluses

The structures considered above will mainly be used by farmers to store food for home consumption. Farmers with substantial surpluses are likely to need other options, which allow them to store at low cost and to use their stocks as collateral for finance (inventory credit) to tide them over to such time as they are ready to sell.

Apart from the above problems, farmers producing maize surpluses in Iringa, broadly representative of the "big four" regions of the Southern Highlands, continue to experience major financial losses due to poor storage and marketing arrangements, much as they did during an earlier visit by the team leader in 1991 (Coulter and Golob, 1992). By selling locally to intermediaries, and not bulking up to sell further down the market chain, farmers appear to be losing at least 20-25% of their potential sales revenue. This loss results from failure to engage in "spatial arbitrage", and should be added to losses they experience from not engaging in "inter-temporal arbitrage", i.e. storing for higher price later in the season. This situation is all the more surprising given that the District has some 67 village go-downs which are fully suitable for bulking up maize. Pest control could be carried out at low cost, involving fumigation under plastic sheeting.

The authors suggest the following explanations for this phenomenon. Firstly, past experience with State-controlled coops has left farmers disinclined to cooperate in solving this problem. Secondly, Government's approach to the market liberalisation which occurred from 1985 onwards was somewhat passive. It appears to have been accepted with resignation (and occasional backtracking), but without full commitment to an alternative "facilitative agenda", where private players would be the primary actors working in a competitive environment. In Southern and Eastern Africa, the Republic of South Africa stands alone in approaching market reform in a wholeheartedly facilitative manner. With the planned official review marketing policy, GoT's posture appears to be changing, so it may be a good time to suggest innovations in the area of off-farm storage.

Rather surprisingly, rural traders visited in Singida and Kilimanjaro were also found to be experiencing very high storage losses. Traders normally store in cramped conditions in houses, and sometimes store grain of high moisture content, leading to heating. They generally do not fumigate[16]. It appears that only the largest players, e.g. the Strategic Grain Reserve, Export Trading Ltd. and Mohamed Enterprises, have the requisite skills for storage and pest control.

Proposed solutions

We envisage a Post-Harvest Project with three components:

1. Improvement in the marketing of storage insecticides
2. On-farm storage, and
3. Improved storage and marketing of surplus production

We discuss these in turn:

Component 1: Improved marketing of storage insecticides

Before trying to introduce new storage structures, it is necessary to ensure that existing pest control remedies using contact insecticides are properly understood and optimally used. The purpose of this component is therefore to overcome the above-mentioned shortcomings in the market for storage insecticides, and the way farmers use them.

This will be accomplished through the combined initiative of cooperating agrochemical companies supplying ASD, Stocal Super and Shumba, Government and SDC. Agrochemical companies will be required to bear much of the cost, while Government and SDC will provide complementary support given the major public interest aspects involved. The exact modalities will need to be worked out once the Project has been established, but it may consist of the following:

- Agrochemical companies must first demonstrate that they are taking effective steps to "clean up" their distribution chains. At a minimum they must provide a list of accredited retail outlets, which they regularly subject to unannounced spot checks, to ensure that only legitimate products are sold. They will need to apply suitable penalties to outlets failing to comply, ranging from suspension to referral to the Tropical Pesticide Research Institute (TPRI) for prosecution.
- If and when these pre-conditions are fulfilled, the Project should co-fund a three month radio campaign. This will consist of a mixture of generic and branded advertising, with the aim of making farmers and traders aware of the problems with their existing use of storage insecticide, and referring them to their local extension workers or accredited distributors for detailed advice.
- The 5,835 MAFS extension workers, and all the accredited distributors, will be provided with fold-out brochures in Swahili telling farmers: (a) the pros and cons

[16] Traders in Singida stated that: "if you store for the lean season you lose 20% of the grain; in the villages they lose even more".

of different insecticides; (b) how they should be applied, and; (c) the names of accredited distributors. The initial print run will be 500,000, and there will be further runs depending on demand.

- Impact will be monitored by a "before-and-after survey" by a reputable market research agency contracted for this purpose, and working in close consultation with the Project and MAFS.
- Based on the evaluation of this experience, there may be further follow-up activities, if this is shown to a cost-effective use of resources.

With this approach, SDC will be seeking to address the problem of pesticide marketing and usage cost-effectively, without tying up Project staff at the expense of other activities. Rather than pushing the message through the extension workers, the radio campaign will prompt farmers to seek out the information they need. The Project will only commit resources when the Agrochemical companies have clearly demonstrated their determination to police their respective distribution chains. The advertising mix should be used with a view to inducing firms to collaborate.

Two aspects however remain to be worked out: (a) the dosage of storage insecticide prescribed by Government in relation to prescriptions in neighbouring countries, and; (b) the role of statutory agencies concerned, notably TPRI, with enforcing the Plant Protection Act, 1997, and its regulations, and the Plant Protection Regulations, 1999.

If it is correct that 50 g per 100 kg is an acceptable dose, investing public resources in public advertising to the effect that farmers should apply 100 g per 90 kg is highly questionable, both from the farmers' and taxpayers' perspective. While it may be difficult to change established regulatory positions, we feel that SDC should raise this issue with the relevant authorities before this component of the project goes ahead. Evidence should be marshalled for and against reform, and regulations amended or maintained accordingly.

TPRI has had difficulty addressing the problem of fake insecticides in the past. Solving this problem is likely to require a wide and deep administrative reform, and even changes to the Law, which are beyond the scope of the project we are proposing. For this reason the main thrust of the project should probably be to get the suppliers to police their own distribution chains, in their own self-interest.

Component 2: On-farm storage

This will build directly on SDC's experience in Latin America, and will start in Kilimanjaro and Shinyanga Regions. In Kilimanjaro, the principal purpose will be to market the metal silo and gain a high level of market penetration, with a view to its subsequent dissemination in Arusha Region and elsewhere in Tanzania. The Project should also seek to introduce the metal silo through a commercial contract farming scheme, probably the Kilombero Sugar Company (KSC), which is interested in becoming involved in the project[17]. It is important to develop this type of delivery

[17] As the Estate is located far from Kilimanjaro and Shinyanga regions, the Project will not be able provide the same intensity of support to farmers and artisans. Hence the company itself will need to take significant responsibility in this regard, while relying on the project for initial promotion, training and periodic monitoring. The company's response - see emails from Kate Prottey to Jonathan

mechanism, and Kilombero appears to be a suitable partner given its progressive approach and effectiveness.

There may be a case for promoting the existing metal storage structure alongside the galvanised iron silo. In some cases, the farmers' best option may be to acquire more metal drums, and there may be scope for the large metal tanks as well in strong surplus areas (e.g. around Hanang, Mbulu and Babati in Arusha Region) where many farmers harvest more than 100 bags. The Project will produce a typology of farmers according to the most suited storage structure, and promote their use accordingly[18]. The Project should also investigate claims that the drums and large silos are effective without the use of storage insecticide, and see if it is possible to develop some indicators for situations where phosphine fumigation need not be recommended.

In Shinyanga, the purpose will be to thoroughly evaluate the comparative marketability of the structures using traditional materials, and the metal silo, and to promote large scale adoption of the "winners". Once a strong adoption curve has been established the same exercise will be initiated in Singida Region. We envisage that work will start in Shinyanga a year after beginning in Kilimanjaro, allowing all efforts to be concentrated on a single region during the first year.

Before engaging in the promotion of the metal silo, SDC should seek exemption of all import duties and VAT for the galvanised iron sheeting used, and for raw materials used in making this sheeting. It should be possible to obtain such exemptions on the grounds that the silo is an agricultural input, and/or that local manufacturers cannot supply sheeting to the Project's specifications.

There are two additional reasons for the Government to give favourable duty treatment to raw materials used in making the metal silo:

a) The silo lends itself to quality control over construction. With the introduction of phosphine fumigation to the village environment, there is a significant risk of poor silo construction resulting in silos that are not airtight, and this leading to the development of resistant strains of insects. In the case of the metal silo, unlike the case with structures made partly by the farmers themselves (e.g. burnt-brick silos), quality control can be exercised by following up on a limited number of specialist artisans, and holding them accountable for the quality of the structures they build.
b) ASD already enjoys duty-free treatment, so it would make sense to give the same treatment to an alternative storage system.

For these reasons, Government may wish to regard the metal silo as part of a definitive and long-term solution to on-farm storage problems in Tanzania.

Coulter, forwarded to Romain Darbellay – indicate that there are good possibilities for agreement over this.

[18] A DFID-funded project in northern Ghana is developing a decision support-tree that combines a series of questions relevant to both technological considerations and the social situation of the farming family that is looking for advice. This approach will ensure that farmers' advisors will identify a fuller range of the constraints to technology adoption, so improving the chances that farmers receive the best possible help. The decision support tree will be operational by about December 2004 and with some adaptive research could be used to assist farmers in similar situations elsewhere in Africa.

The implementation of the on-farm storage component will involve the following activities:

- Demonstration of prototypes, which will be installed in homes of lead farmers
- Training of artisans, farmers, and collaborating staff of government, NGOs and private sector
- A public relations campaign using local radio, videos and written media.
- Sensitisation of farmers to access local savings and credit services so that they can finance the acquisition of storage hardware.
- Working with private sector and farmers to ensure smooth supply of fabrication materials and insecticides
- Establish quality control of fabrication and usage of structures
- Systematic monitoring and documentation of performance and adoption over time, and diagnosis of causes for adoption/non-adoption
- Refocusing effort on "winning" technologies in the light of market feedback

As in the case of Mozambique the approach will be *knowledge-based.* Project management will keep abreast of relevant research-findings in the post-harvest field, and where there are important issues bearing on the project's ultimate success, it will (pragmatically) carry out or commission its own research with a view to clarifying matters.

Component 3: Improved storage and marketing of surpluses

We have included this component in view of: (a) the above-mentioned weaknesses in the storage of tradable surpluses; (b) Government's apparent willingness to revisit its marketing policy framework - a major study is planned, and; (c) SDC's interest in the development of competitive marketing channels and logistics, as manifested through its involvement to the District Roads Support Project (DRSP), and through that project to the Kibaigwa grain cleaning facility.

This component could be implemented in Iringa District, making use of the existing 67 village stores, most of them of 600 tonnes capacity. Most of these are probably structurally sound, but some remedial repairs will definitely be needed. Subject to study one might implement this component in another surplus-producing part of Tanzania, e.g. elsewhere in the Southern Highlands, the area around Kibaigwa or in the southern districts of Arusha.

In order to implement this component, SDC first needs a clear understanding with Government over policy matters and managerial aspects. The Director of Marketing (Ministry of Cooperatives and Marketing) has already indicated that agreement is likely to be forthcoming, but SDC needs to engage Government in a more extensive discussion to see if the necessary preconditions for a successful operation can be fulfilled. Clear policies are particularly needed in view of the reputation of maize in Africa, as a "political crop" subject to ad hoc market interventions[19]. SDC will in particular need to know that:

[19] See Coulter and Poulton, 2001.

a) borders will be permanently open for trade in maize (or at least the maize stored under warehouse receipts), and that trade rules will be applied in a consistent and user-friendly manner[20].
b) the Strategic Grain Reserve (SGR) and food aid will be managed in a market-sensitive manner. It would also be helpful if the SGR can itself accept warehouse receipts as a means of delivering grains to the Reserve.

Agreement will also be needed over the management of the scheme; it should be fully under the control of the Post-Harvest Project[21].

The following steps should be taken to implement this component:

i. SDC discusses the concept with Government, and agrees the policy and management framework
ii. SDC commissions a detailed feasibility study, including engineering, business and legal aspects, leading to discussions with district and village authorities, and a final decision whether or not to go ahead with this project component
iii. SDC sponsors a Trust which takes the leasehold of the stores and rehabilitates them. Such an institution is needed in addition to the Post-Harvest Project, because of the long-term nature of investments in warehouse rehabilitation. We presume the Project will only be funded three years at a time, but the property management function will be needed for a much longer period.
iv. The Project develops regulations and manuals for the management of the system, including such aspects as the rights and obligations of the parties, grading systems, dispute resolution etc.. Arrangements are made for the production of a market newsletter to guide depositors' storage decisions.
v. The Trust launches a tender to appoint a collateral manager (CM) to manage the stores during a 3 year pilot operation. The CM will need to provide standard terms and conditions for depositors, certain financial guarantees against non-performance, and be able to generate the support of banks, who are willing to finance against stocks held in the stores on the basis of the CM's reputation.
vi. Motivation of farmers and local traders to make use of the new system, education in rights and obligations, and training in specific business skills required, e.g.: numeracy and accounts, group formation, development of business plans etc.. Specialist trainers will be recruited for this purpose.
vii. Implementation of the pilot project. Depositors deliver grain to the warehouses for safekeeping according to agreed standards, against payment of all-inclusive storage charges (e.g. TSh. 250 or 300 per bag-month).

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[20] Here the objective is to ensure that people who have deposited stock in warehouses will not be suddenly deprived of an export outlet, or that banks financing them find the collateral value of their stock to be undermined. Such fears may seem far-fetched, but were realised in Ghana in 1997, damaging two inventory credit projects.

[21] Alternatively it could be placed under another SDC-funded project, e.g. DRSP, though this will tend to lead to a lack of a systems perspective with "Post-Harvest" becoming exclusively associated with on-farm storage.

This component should be seen as an option to be pursued if Government wants it to happen and will provide a supportive environment. From SDC's side it will be a vehicle for dialogue over the future development of market-oriented farming.

Institutional aspects, project management and cost

The project will need to work closely with MAFS and the Ministry of Marketing and Cooperatives. MAFS, which is most important for components 1 and 2, has considerable staff (5,835 extension workers, one for every two or three villages), and considerable knowledge of post-harvest issues (e.g. vis-à-vis Mozambique). Ministry involvement is therefore vital for project implementation. However the Ministry also has a number of problems: it is under-funded; authority over front-line staff is divided between the Ministry and district administrations; internal budgetary arrangements are complex; most activity is project-dependent, and; there is limited strategic initiative, this being evident in the lack of action: (a) in checking out farmers' complaints about insecticides and whether they were using them correctly the problem, and; over fake pesticides.

Until these problems are resolved, and this may take many years, SDC should avoid putting great emphasis on institution building within the Ministry, though it can strengthen the skills of individual Ministry staff who work with the Project. SDC's primary aim, by contrast, should be to build capacity in civil society, with farmers, artisans and private companies/service providers, and leave behind a self-sustaining process of improvement in the post-harvest area. To do this, SDC should be prepared to engage in the in the area on a long-term basis, for at least 10 years, much as it did in Central America, but managing knowledge and using accumulated experience so as to achieve more rapid impact. As in Central America, the Project will need to work with a range of collaborators, including NGOs, development projects and private partners, signing MoU's for this purpose.

The Project will be funded by SDC and, potentially, other donors wishing to act in partnership. It will be managed by a consulting company or independent organisation to be chosen by review of past or potential contractors, or by tender, and will have a five-person Steering Committee, including SDC and a single Government representative from the Ministry of Agriculture, and representatives of other collaborating parties, such as private sector collaborators (e.g. Kilombero Sugar Company), collaborating NGOs and financing agencies. The role of the steering committee will be to agree the general approach and direction of the Project, approve the appointment of a consulting company to manage the Project, approve budgets and review progress. In operational terms the Project will act independently of Government or other parties. SDC may wish to consider the option of creating a Trust, as suggested in the case of Mozambique.

We have budgeted a sum of US$ 3 million to cover all three components of this project - see Appendix 7. Of this component 2 accounts for US$ 2.26 million, including all the managerial and office support for the whole project - the same amount as budgeted for Mozambique (Appendix 5). Component 1 accounts for $240,000, and component 3 for $500,000. The latter amount includes $50,000 for feasibility study and a provision of $450,000 for subsequent activities that can only be budgeted for accurately based on the feasibility study. This provision will endow

SDC-Tanzania will the flexibility to proceed according to the response of Government and other local stakeholders and the findings of the feasibility study.

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APPENDIX 1: TERMS OF REFERENCE

Bern, 15.3.2004/SIT

Terms of Reference for the Appraisal of Pertinence, Feasibility and Context Analysis Regarding Replication of the

"POSTCOSECHA"-Metal-Silo Technology (developed in Central America) in Mozambique and Tanzania

1) Introduction

Towards the end of 2003 SDC's Cooperation Offices in Tanzania and Mozambique had made their own "pre-appraisal" and then decided to include a "POSTCOSECHA-Appraisal" in their annual planning for 2004. These Terms of reference are to be the starting point for an appraisal mission which is to be conducted **in the first half of 2004**, in order to provide the results in time for the subsequent multi-annual and annual planning cycles.

The appraisal is organized by SDC's East and Southern Africa Division (=SOSA; Max Streit, Andreas Gerrits) in collaboration with the corresponding Cooperation Offices. By March 2004 a **team for the appraisal mission** is to be constituted. This team will collaborate with the respective Cooperation Offices and their local partners (NGOs, Government, Universities, …) in order to optimally prepare the exploration mission. Although the organization of the appraisal mission is entrusted to the team mentioned above some support from SDC's Cooperation Offices (for data collection/verification, selection of actors to visit, …) will be necessary. Swiss NGOs with Inhouse-POSTCOSECHA implementation experience and presence in Tanzania or Mozambique (IC, Helvetas) will be invited to locally give their input to the exploration mission.

In a nutshell, the appraisal mission in Mozambique and Tanzania will involve:

- Providing certain socio-economic and other background information specified in the TOR
- Identifying locations and types of user with highest probability of acquiring the silo.
- Visiting these locations and estimating a range of likely cost price for the silo there
- Determining acceptability with target users vis a vis current practices and possible alternatives, and assessing potential demand
- Learning the views of the relevant Government authorities, in areas of food policy, agricultural marketing, pest control and storage technology
- Appraising the need for any modifications to the product, the promotional approach, training and after-sales support or other aspects of the technological package
- Appraising the scope for any alternative storage technologies which are found to be particularly attractive
- If appropriate, to develop proposals for a project to introduce new storage technologies into Mozambique and Tanzania

2) Pertinence

What?	How?	Comments
Situation regarding Food Security?	• Are there significant fluctuations in the availability of parts of a basic diet that should cover basic food needs, especially for vulnerable groups? • Indications of malnutrition or famine? • Is there any dependence on imports for basic foodstuffs? • Consumption patterns for basic grain (families, their domestic animals, helps to determine the optimal size of silos), organization of seeding and harvest (participation women) • Existing food security strategies (of the vulnerable people, individual or in groups)	• National food security strategies, if existing, may also be of interest
Are post-harvest losses of grain part of food security problems?	• What products are suffering post-harvest losses? • Causes for the losses (insects, rodents, humidity, theft, …)? • Presently used methods to reduce post-harvest losses? • Availability of any scientific analysis of the scope of the post-harvest losses? • Perception of small and medium producers of the magnitude of postharvest losses (consider chain of production) • Periodicity and number	• Presence and impact of the Larger Grain Borer? • Also have a look at the demand for community food security approaches (which exist in Central America, although the individual household food security approach is predominant)

	of harvests	
Would reduction of post-harvest losses be poverty relevant?	• To what point is storable grain part of the diet of the poor? • Potential for supporting existing micro and small enterprises of tinsmiths for offering POSTCOSECHA-metal silos (production and ensuring correct use by buyers)	• See FAO …
Are there harvest-cycle-dependent fluctuations in availability and price of basic grain to be stored?	• Fluctuations allow the metal silo owner to get additional income from sale of surplus grain stored safely until shortly before the next harvest	

3) Feasibility

What?	How?	Comments
What parts of the basic diet of the poor (or fodder for the animals that are part of the basic diet of the poor) can be dried sufficiently and stored in a metal silo?	• Problems with humidity/drying? • What storable foodstuffs are relevant to diet of the poor? • Cultural aspects of traditional storage	In Central America, the metal silos are mainly used for storing dried grain such as maize, beans, but it is also possible to store sorghum and rice. In principle, **all dried grain can be stored in metal silos, but also cassava chips, well dried oil fruits such as peanuts, cocoa, seeds, and products of food aid (wheat, barley, etc.).**
What is the performance of all the presently used methods for reduction of poverty-relevant post-harvest losses?	• Analysis of all existing methods and their effects	• The proven “Concept testing” methodology (prueba de concepto) could be used • Give special attention to existing inappropriate use of chemical products in vain

		attempts to reduce post-harvest losses
Estimation of real demand for metal silos from the "end users" (typically the small rural producers which will buy them in the end)	• Estimate demand for metal silos taking into account all possible alternatives: Grain for the family, domestic animals, seeds and surplus production for sale in the local market	• The proven "Concept testing" methodology (prueba de concepto) could be used • Caution: The direct question regarding "his post-harvest losses" to a small farmer is sometimes misunderstood. Some farmers think that post-harvest losses are unavoidable (godgiven). So the answer to the direct question can be "no losses", although the small farmer in fact means that he has the same losses as everybody else.
Estimation of real post-harvest losses	• Main causes and their impact, geographical distribution • Measurement by qualitative methods • Rely as much as possible on existing scientific data	• Special attention to be given to presence and impact of the "Larger grain Borer" (Prostefanus truncatus) • The climatic patterns, particularly high temperaturas, are good indicators for postharvest problems
Estimation of cost of local, decentralized production of a metal silo	• Availability/price of Aluminium Phosphide tablets • Availability/price of galvanized sheet metal of sufficient quality • Local production (competition?) of galvanized sheet metal or importation? • Possibility to expand on existing	• Galvanized sheet metal respecting European norm(DIN-17162) or American norm (ASTM-A) • Existing work culture of tinsmiths

	supply chain for sheet metal for roofs? • Is the silo payable from gains made from it within one yearly harvest cycle? • What are the possibilities to develop the entrepreneurial spirit of the metal silo producers?	
Existence of motivated and capable partners (institutional, civil society, private sector, scientific) for promotion/replication and **quality control** of a "POSTCOSECHA-like" programme	• The idea is to also go for impact multiplication through broad participation of numerous civil society/private sector organizations ("transfer channels") for silo promotion and credit facilitation • There is a need, especially during the initial years, for **institutionalized, efficient quality control** regarding **sheet metal quality, silo production, training of silo producers and transmission of the necessary knowledge for silo-application to the "end-user"**	• Quality monitoring is crucial
Existence of a decentralized network of services catering to small farmers	• There is a need, for some time, to have an institutionalized	

	offer of training for the decentralized silo producers ("artesanos POSTCOSECHA" in Central America)	
Which approach to implementation is convenient?	• The same approach as in Central America: In the first few years SDC ensures quality control fairly directly and invests in promotion and scaling up. • In case of presence of strong and interested local partners (who are prepared to engage their own resources): Can SDC delegate part of the crucial tasks to other actors without jeopardizing chances for success (reaching the objective with less investment by SDC)?	Especially if POSTCOSECHA technology turns out not to be feasible, the COOFs are interested to have any alternative storage technology appraised (which has to be done anyway under point 3, including methodology, savings, cost, …) and would in any case like to get fairly concrete proposals for a project (Moz: approach, local partners, backstopping/consultants, …) for the introduction of any promising new or improved postharvest technology.

4) Context Analysis

What?	How?	Comments
Interest (and credible offers of committing their own resources) from possible **local** partners (Government, civil society, private sector, producers of storable foodstuffs)	• Panorama of possible actors, roles and coordination mechanisms	Does the general climate allow for non-politicized collaboration with civil society, without ethnical discrimination.
Level of governance	• Conflicts? • Is it possible to directly support the poor? • Other special circumstances?	
Possible alliances with other donors and **international** NGOs		• DFID is present in Eastern Africa with a research oriented crop protection program • CYMMIT has shown interest for the POSTCOSECHA exploration
Politico-cultural feasibility of South-South knowledge transfer from Central America to Southern Africa	• Existence of negative attitudes towards South-South transfers (like “good things can only come from the industrialized North”)?	
Other factors considered relevant?	• It seems worthwhile for the appraisal mission to get a good understanding of the situation in Swaziland, apparently an example of successful use of metal silos in Southern Africa	• Conclusions from Swaziland will strengthen the information base for the appraisals in Tanzania and Mozambique • Information from 2 previous support visits of Hans Sieber (ex-POSTCOSECHA) in Kenya should be taken into account (read reports, one

		participant from Tanzania)

APPENDIX 2: TRAVEL ITINERARY: SWAZILAND – MOZAMBIQUE – TANZANIA: 4.4 TO 18.5.2004

Date	Location	Activity
Sun 4.4.	Guatemala – London - Johannesburg	- Arriving from Guatemala to London Heathrow (KS) - Flight from London to Johannesburg BA 55 (KS and JC)
Mon 5.4	Johannesburg – Manzini, Swaziland + Mountain Inn, Mbabane	- Arriving Johannesburg, Flight to Manzini, Swaziland. - Visiting Malkerns research station - Mr. P.D. Mkhatshwa, Chef Research officer, Research station, Malkerns - Visiting artisans constructing silos - Reception airport: William Rivas from Tanzania

Tues 6.4	Swaziland: Maphungwani Mpkhwakhe Lo Bamba	- Visiting farmers with Luc from Postharvest unit, research station Malkerns:
		  - Mrs. Notzbandzaba in Maphungwani
		  - Mrs. Lulane
		  - Mrs. Malenga, Rural Center in Mpkhwakhe
		  - Mrs. Vilakati in Lo Bamba

Wed 7.4	Swaziland: Mbabane Malkerns Mbabane	- Meeting in Ministry of Agriculture - Mr. Mpanza Thamsanga, - Visiting Central Cooperative Union of Swaziland (CCU) - Visiting Small Business - Visiting Retail store in Malkerns (SEDCO), Mr. Petro Giameni - Phoning RSA metal suppliers - Writing up findings and coordinating contacts in Maputo

Thurs 8.4	Swaziland – Mozambique; Namacha; Maputo, Hotel Terminus	- Meeting in Ministry of Agriculture
		  - Mr. N.M. Nkambule, Principal Secretary
		  - Mr. Mpanza Thamsanga,
		- Visiting farm in Namacha, Border in Mozambique
		- Travel to Maputo by car
		- Diner with SDC and different representatives: USAID, Helvetas, SDC,

Fri 9.4	Maputo	- Meeting with Domitilia from SDC
		- Meeting DNDR + PAMA
		  - Mr. Gabriel Tembe, Director National
		- Meeting DNA del MADER
		  - Mr. Boaventura Nuvunga, Director national Adjunto
		  - Mrs. Setina B. Titossa, Crop Production department, Head
		- Meeting Andres Vonk, V&M Traders
		- Visit PROAGRI
		  - Mr. Duncan H. Boughton, Michigan State University, Agricultural Economist
		- Reading documents and writing up

Sat 10.4	Maputo	- Meeting with painter in Helvetas office and
		  - Mr. Albert Bürgi
		- Supervision drawing show cards
		- Reading documents and writing up
		- Dinner World Bank consultant
		  - Mr. Eduardo de Sousa

Sun 11.4	Maputo	- Preparation concept testing - Reading documents and writing up
Mon 12.4	Maputo	- Meeting AMODER (NGO) - Mr. José Trindad - Meeting SDC

		- Derrick Owen Ikin, Rural Dev. Domain - Nicolas Randin, Deputy Country Director - Meeting TECNOSERVE (NGO) - Mr. Carlos Costa, assistant director - Mr. Jake Walter, Director
Tues 13.4	Maputo	- Meeting with Mario Mutxeco, Postharvest Specialist, MADER - Meeting GAPI (Microfinance) - Mr. Antonio Souto, Director - Meeting GTZ Rural Development Program - Mr. Rodney Reviere, Program Coordinator - Meeting with Import Metal Sheets - Mr. Sesinando Cuna
Wed 14.4	Maputo – Pemba	- Flight Maputo – Nampula – Pemba - Reception Helvetas - Mr. Carlsten Schulz - Meeting Director Provincial de Agricultura, Cabo Delgado - Visiting artisans - Visiting ZIMOC Ltd. Import Metal Sheets - Cor Esterhuizen - Visiting ironmonger and grain wholesaler - Meeting with personnel of rural development project from Helvetas
Thurs 15.4	Pemba – Chiure – Nampula Ujama	- Drive to Chiure - Presentation rural development project from Helvetas in Chiure - Drive to Ujamaa - Visiting farmers in Ujamaa and Concept testing - Feedback to Helvetas staff - Drive to Nampula, Hotel - Reception meeting in Malema - Mrs. Ilse Fürnkranz, SDC - Mr. Tim Russel, CARE
Fri 16.4	Nampula - Ribaue - Malema	- Visit 2 artisans (tin smiths) - Meeting with CLUSA and OLIPA - Johnny Colon, Country Coordinator CLUSA - Mr. Raul Tapalua, Director OLIPA - Meeting SDC-Norte - Mr. Marc Hoekstra, Head SDC - Norte - Mrs. Ilse Fürnkranz - Mr. Adelino France Monet, Interpreter - Mr. Jose da Silva, CARE - Mr. Oswaldo Catin, Coton Institute - Mr. Mario Mathehu, MADER, Pest Monitoring - Visit hardware store: Study of input supply channels, Electro Ferrageira - Saju Abdul Wahah - Meeting CARE - Mr. Tim Russel, Director - Drive to Malema
Sat 17.4	Malema Moralelo	- Meeting with Tobacco Company (Grupo Joao Ferreira dos Santos – JFS) - Mr. Pedro M. Calheiros - Visiting farmers in Moralelo and Concept testing - Writing up findings
Sun 18.4	Mitata Malema - Cuamba	- Visiting farmers in Mitata and Concept testing - Drive to Cuamba (Hotel Vision 2000) - Meeting with CLUSA - Mr. Benjamin Nascimento, Local Coordinator - Writing up findings
Mon 19.4	Cuamba	- Meeting PAMA - Mr. Anibal dos Anjos Antonio

	Napacala	- Visiting farmers and concept testing in Napacala with Oxfam
		- Meeting with APROPEC
		    - Mr. Noema Simon Mapira
		- Meeting UCASN
		    - Mr. Carlos Chungo, Gerente
		    - Mr. Julio Pessego, President
		    - Mr. Adriano Alisto, Extensionist
		- Write up findings

Tues 20.4	Cuamba	- Meeting DDA, Provincial Director Cuamba
		    - Eng. Palate
		- Visit hardware store: Study of input supply channels, Electroferrageira
		- Visiting farmers and concept testing in Mevava with WRS
		    - Mrs. Juliana Yebe, Marketing and Publicity Officer
		- Meeting with Oxfam
		    - Mr. Jaime Ducenta, Coordinator
		- Meeting CLUSA
		    - Mr. Benjamin Nasjemento, Local Coordinator
		- Writing up findings

Wed 21.4	Cuamba – Lioma – Gurue	- Drive to Lioma - World Vision - Mr. Patricio Augustin, coordinator - Visiting farmers and concept testing with farmers' representative - Drive to Gurue - Visit pigeonpea processing factory

Thurs 22.4	Gurue
	– Molomba
	– Milange
		- Drive to Milange
		- Meeting office Solidaridade Zambezia /World Vision
		    - Mr. Jaime Ducenta, Grain Marketing
		    - Mr. Sergio Nemba, Coordinator
		- Meeting with small Traders
		- Entrance to Malawi, Paperwork for Visa

Fri 23.4	Milange – Blantyre – Vila Ulongue	- Writing up findings - Drive to Blantyre and Ulongue, Angonia - Visit M.D. of Mozambique Leaf Tobacco (MLT)

Sat 24.4	Vila Ulongue	- Meeting: MLT:
		    - Estevao José Kanandula, Head Social Responsibility
		- Meeting with DDA
		    - Mr. Xarife L. Induv, reg. Director
		    - Mr. Albertino Teness, Extensionist

Sun 25.4	Vila Ulongue – Tete – Maputo	- Drive to Tete, Airport - Flight to Maputo - Desk research - Informal meeting - Adrian Hadorn, Res.Rep. SDC - Dinner with A. Hadorn
Mon 26.4	Moputo	- Preparation of Debriefing in SDC

Tues 27.4	Moputo	- Presentation and Feedback findings Field visit:
		    - SDC Office: Participant: USAID, GTZ, EU, GAPI, AMODER, CLUSA, Tecnoserve, CARE, MADER, Helvetas, World Vision, Trade Ministry, etc.
		- Meeting World Vision
		    - Mr. Gerry Bayer, Agricultural Program Director
		    - Hercilia Estrela, Programme Officer
		    - Marcelino Botao, Agronomist
		- Dir. Nac. de Comercio Interior: Franz van de Ven
		- Visit to FAO, Mr Mocama, Special Programme for Food Security
		- Writing up findings and discussion

Wed 28.4	Maputo	- Breakfest with A. Hadorn
		- Writing up 1. draft report
		- Lunch: Alexander Schalke, marketing and trade Information Expert, FAO
		- Meeting SDC, Feedback
		  - Derick Ikin
		  - Nicolas Randin
		- Writing up report

Thurs 29.4	Maputo – Pemba – Dar es Salam	- Meeting with Peter Vandor, FAO Representative - In Dar es Salam - Reception William Riwa, Plant health service MAFS - Preparation Concept test

Fri 30.4	Dar es Salaam	- Visit artisan in Gerezani public place
		- Meeting Aluminium Africa Ltd.
		  - Mr. Hiren P. Miyani, Marketing Manager
		- Meeting MAFS, Postharvest Management Service
		  - Mrs. Adelaide J. Moshy, Assistant Director
		- Briefing SDC, Dar es Salam
		  - Mr. Peter Arnold, Country Director
		  - Mr. Romain Darbellay, Deputy Country Director
		  - Mr. Felix Bachmann, Representative IC
		  - Mrs. Dorothy Bikurakule, Programme Officer
		  - Mr. F.M. Kirenga, SDC
		- Writing up

Sat 1.5	Dar es Salam	- Meeting Iron Corrugated Sheets Ltd - Mr. Ranjan Singh, Marketing Manager - Handicraft market - Writing up - Diner with Urs Egger, Swisscontact - Meeting with Jeremia Ramos Makindara, Sokoine University of Agriculture
Sun 2.5	Dar es Salam	- Writing up - Meeting with Tania from NRI, Research on storage pesticides - Preparation concept test - Writing up
Mon 3.5	Dar es Salam – Mwanza – Shinyanga	- Flight to Mwanza - Drive to Shinyanga - Meeting with Regional Agricultural Advisor, and Acting Regional Administrative Secretary - Meeting with Extensionists from Ministry of Agriculture and NGOs - Writing up and preparation field visit
Tues 4.5	Shinyanga; Bukangilija, Maswa Division	- Drive to Bukangirija village - Visiting farmers and Concept testing - Writing up findings
Wed 5.5 to Fri 7.5	Kurt Schneider: Shinyanga - Mwanza – Dar es Salam	- Flies back to to Dar es Salam - Research on Price and availability of Metal Sheets - Visit Steelmaster Ltd - Mr. Hitesh Patel, Managing Director - Writing up - Fly home

Wed 5.5	J. Coulter, W. Riwa and others: Samuye village	- Arrange Kurt Schneider's flight
		- Visit to Ngaganulwa village with World Vision Tanzania and discussion with local craftsman and farmers:
		  - Mr Foslinand Myaya, WVT project coordinator
		  - Pius Kalega, District Plant Protection Officer
		  - Mrs Nyarada, Extension Officer
		  - Mr Msafiri Seif, Craftsman

Thurs 6.5	Travel to	- Arrived late due to burst tyres

	Singida	- Met Midugu Amir Mussa, Regional Agricultural Adviser

Fri 7.5	In Singida District	- Meet District Authorities and agric staff:
		  - RAS
		  - Halima Kasungu, Regional Commissioner
		  - Mr Benjamin Manento, DALDO
		  - Mrs Moshi, Manager of PADEP
		- Visit to Kituntu village, in Puma Division, visit farmer and group discussion
		- Visit to village of Sekou Touré:
		  - Discussion and concept testing with Mr Juma Mohamed, farmer and key informant

Sat 8.5	Start **Singida**, travel to Arusha	- Meeting with traders in Singida - Crafts and Artisans Promotion Unit, Singida
Sun 9.5	Visit to households and farms in Kilimanjaro Division	- Makindara home: see welded iron storage structure - Riwa home: see storage system with metal drums - Lucas Lekule, private grain trader, Kwaracha, Marangu District: discussions and visit home to see storage systems

Mon 10.5	Visits in Hai District	- Visit MAFS Northern Zone office and Hai agriculture offices:
		  - Salomé Wilson Munisi, Coordinator for Plant Health Services
		  - Ngoma, Post-Harvest Management and Phytosanitary Services, and others
		  - Mr. Marawiti, District Plant Protection Officer
		- Group discussion and concept test with farmers of Mshikamano, Sanya Juu Division
		- Visit two farms with welded iron stores
		- Meet Emmanuel Ringo, artisan
		- Return to Arusha for meeting with Agric Marketing Systems Development Programme (AMSDP)
		  - Nathaniel A. Katinila, Coordinator
		  - Stephenson Ngoda, Assistant Coordinator
		  - Julius Kallambo, National Inventory Scheme, working for Audit, Control & Expertise (ACE)
		  - James Riwa, Asst Inventory Promotor, ACE

Tues 11.5	In Arusha and travel to DSM	- Visit Mr. E.R.K. Mshiu, Chairman and MD, Tanganyika Farmers' Association Ltd. - In DSM: Telephone interviewing from hotel with Rolf Link, GTZ, Mr - - -, TPRI, Mr Gupta, Twiga Chemicals - Dinner with Dr Brian Cooksey, Tadreg

Wed 12.5	Travel to Morogoro and Iringa	- More telephone interviewing during travel
		- Meeting with ITECO Consult (T) Ltd:
		  - Erwin Schelbert, MD
		  - Benjamin - -
		- SUA: Emmanuel Mbiha, Agric Economist

Thurs 13.5	Iringa District	- Meet agric authorities
		  - Mr Swai, Regional Agricultural Advisor
		  - Mr Philemon Mpwepwe, Acting DALDO
		  - Mr Amon Zakaria Lyimo, Plant Protection Officer
		- Visit to Makulilwa village: visit 3 farms, group meeting with concept tests

Fri 14.5	Iringa District, and travel to DSM	- Visit to Isimani: interview with large group of farmers and visit to farmer's stores - Travel back to DSM
Sat-Sun 15/16.5	In DSM	- Draft presentation for SDC - Work on report - Deal with sub-contractors' expense claims - Meet with Erwin Schelbert, ITECO

	In DSM	- Meet Dr Turuka, Director of Marketing, Ministry of Marketing & Cooperatives
		- PSI Tanzania
		  - Nils Gade, Exec. Director
		  - Romanus Mtung'e, Deputy ITN Director
		- Presentation and wrap-up meeting at SDC, with Romain Darbellay and Peter Arnold
		- Meet David Howarth, MD, Kilombero Sugar Co.
		- Wrap discussions with William Riwa and Jeremiah Makindara

	DSM to London	- Coulter flies home

APPENDIX 3: NOTE ON POST-HARVEST SITUATION IN TANZANIA, by William Riwa

AGRICULTURE is the mainstay of the economy of Tanzania. It contributes 47.5% of the Gross Domestic Product (URT, 2002), and is a source of livelihood for about 80% of Tanzanians. The sector is dominated by small scale farmers who own land holdings of less than 2 ha, but cultivate an average of one ha. per household (URT, 1999). Larger scale farmers accounts for only about 20% with farm holdings of above 20 ha. Major food crops include maize, paddy, sorghum, millet, wheat in order of importance (Ashimogo, 1995), and pulses and cassava. The agricultural sector has maintained a steady growth rate of over 3 percent per annum over the last decade. Although this is greater than the growth rate of the population, this rate is considered to be unsatisfactory because it has failed to improve the livelihood of the rural people whose major occupation is agriculture. This includes localized food insecurity and hunger that continues to be influenced by lack of access to and inadequate resources endowments at the households level(URT, October 2001). Despite also of abundant land suitable for agriculture (43million ha. Of which only7mil is utilized) the sector is challenged by a multitude of problems that contribute to the inadequate growth and food shortages. These includes(URT,June 2001);

- (i) inadequate public resource allocation and disbursement.
- (ii) Poor rural infrastructure
- (iii) Limited capital and access to financial
- (iv) Inadequate supporting services
- (v) Weak and inappropriate legal framework, land tenure and taxation policy.

Food crop production has been growing at an average of 3.5 annually, a rate slightly higher than the rate of population growth estimated at 2.8%.(URT,2001,URT,n.d). Production of grains have more than kept up with population. For instance, maize which is the most important of all cereal grains(Achimogo,1995), cultivated throughout the country and considered the backbone of providing food security for the population, has a growth rate of 2.95%0 per annum almost similar to the population growth rate of 2.8, and it is argued that except for a few regions, much of the maize marketed may not be surplus, but immediate post harvest sales to earn some cash income(Ashimogo 1995). Regions considered to produce surplus maize include Iringa, Ruvuma, Rukwa and Mbeya. Other major producing regions include Arusha,Shinyanga,Tabora and Mwanza.

SEASON	MAIZE	PADDY	WHEAT	SORGHUM	BEANS	CASSAVA
81/82	1402	309	59	388	315	1403
82/83	1740	255	59	403	322	1345
83/84	1712	328	72	469	340	1385
84/85	2013	276	67	714	378	1086
85/86	2671	418	98	685	432	1499
86/87	2244	511	72	613	251	1125

87/88	2423	782	75	622	379	1399
88/89	2528	767	81	627	385	1272
89/90	2227	736	106	537	384	1731
90/91	2331	406	84	750	425	1566
91/92	2226	392	64	850	312	1778
92/93	2267	641	84	1143	398	1708
93/94	2188	655	60	908	279	1802
94/95	2875	517	75	665	166	1992
95/96	2822	495	84	629	196	1498
96/97	2387	413	79	645	147	1426
97/98	2921	1402	111	959	592	1528
98/99	2452	506	82	561	528	1795
99/00	2128	576	32	576	584	1440
2000/01	2579	871	75	795	636	1722
2001/02	2698	524	72	830	733	1722
2002/03	2526	562	75	675*	713	1449

SOURCE. MAFS STATISTICS.

ON FARM STORAGE OF MAIZE

It has been estimated that 70-80% of the harvested cereals including maize is stored on the farm in household stores (Makundi and Mphuru,1991,UNDP,1994, Ashimogo,1995, Ministry of Agriculture, n.d) being stored for up to 10 months(SOFRAIP,2000). The production and storage of these cereals are mainly undertaken to meet household consumption and cash needs(Ashimogo,1995). The study team observed that most farmers also store grain for seed for the next season.

There are different levels of storage.

- Storage in household stores

This type of storage is the most prevalent as most of the farm produce by subsistence farmers, particularly cereals is stored on the farm. There are various types of storage facilities and structures, designed to reflect cultural differences and commodity needs. These stores are intended to store supplies of food for the family and for the market in case of surplus production. In most cases, storage duration is determined by the amounts harvested, and in case of surplus the market prices will have influence. where the family has other sources of income to meet the social needs like school fees, medication, housing improvement etc. there will be a tendency to store longer anticipating good prices. According to Ashimogo,1995 and SOFRAIP, 2000, the on farm storage capacity in Tanzania is difficult to ascertain but estimates it to be sufficient to fulfill the storage requirements for the immediate future. As production increases (as was observed in Iringa, Kilimanjaro and Shinyanga), farmers are likely to construct additional storage structures or larger stores. Alternatively farmers will store grain in sacks which is a more efficient form of storage in terms of storagespace and convinience.

Transit storage

This is usually done by medium scale traders, most of whom are middle men between farmers and larger business operators. These are bulking centres and produce is not stored for a long time before it is resold or transported to larger markets in towns and cities. The stores are usually hired during the harvesting season and may later be put into other uses like storing fertilizer and other inputs off season. Some of these stores were observed in Singida and Iringa during the survey. During the last 15 years, 960 village stores of about 300tons capacity have been constructed around the country by government and donor projects to meet the need of surplus production(SOFRAIP,2000) under the Ujamaa mode of production and storage. Since these modes of production and storage are no longer in place, some of these facilities are not being put into use todate.

Central stores

These are stores for holding produce for redistribution, processing or export. They are usually owned by traders, particularly millers and exporters. The government own the Strategic Grain Reserves intended to provide for food security in times of widespread food shortage in the country. Larger storage capacities of between 2,000-2,700 were constructed in the southern highlands and Tanga for the National Milling Co rporation, but to date some are unsed or converted for other purposes e.g one in Tanga is now a bag factory complex.

Factors affecting storage

Generally, stored produce is affected by climatic factors in varying degrees, depending on the type of storage structure or facility. These climatic conditions are temperatures, relative humidity and rainfall. The combination of these factors may induce biological proceses to stored crop. Temperature affects the drying of crops, and influences the rate of reproduction, development and survival of micro organisms and insects responsible for crop spoilage. Ralative humidity affects the drying of crops while rainfall influences relative humidity. With regard to these factors, Tanzania can be devided into4 crop storage climatic zones (Mushi, 1984) as follows;

THE HOT HUMID LOWLAND AREAS:

These are characterized by high mean daily temperatures (usually above 25^{o}C) throughout the year; high mean monthly relative humidity (usually above 70%) throughout the year. This zone includes the coastal belt and the area surrounding the great lakes (Lake Victoria basin). This is a danger zone. Crops never dry naturally and often they rot when stored for periods of longer than three months.

THE PLATEAU ZONE

Is characterised by warm weather, with mean monthly temperatures of 20-28^{o} C; mean monthly relative humidity below 70% except during the long rains. Rainfall varies between 500-1000 mm, which comes mainly in one season.This is an area extending from the Western Arusha down to Mbeya covering most of Dodoma Region and part of Singida. This is an ideal zone for long term storage.

DRY ZONE OF CENTRAL TANZANIA:

Characterized by moderately high temperatures (usually above 20^{o}C) throughout the year; mean monthly relative humidity of below 70% and low rainfall (usually below 500mm) which comes in one season. This zone is also ideal for long term storage of grain.

COOL WET HIGHLANDS:

This area comprises the Northern Highlands (East and West Usambaras, Kilimanjaro, Meru, Hanang) and Southern Highlands. These areas are characterized by cool temperatures (usually below 33^{o}C) thoughout the year, high mean monthly relative humidity (above 70%) and high rainfall (usually above 1000 mm) bimodal or one rain season.

On Farm Storage Structures,

Description of the different types of traditional storage structures and their methods of construction:

Kihenge

This structure was observed in all study regions, but according to Makundi and Mhuru,(1991), it is the commonest storage structure found also in Morogoro, Mbeya, Ruvuma, Mtwara, Arusha, and Mwanza regions. It is in most cases cylindrical but in some areas like in Mbulu and Babati districts (Arusha region) the structure is shaped like a pot. The kihenge is made of either interwoven twigs, reeds, bamboo splits, sorghum or elephant grass stalks depending on the availability of materials. The storage capacity is variable depending on how much an individual farmer stores for his family. Some farmers plaster the structure and others do not. The plaster, which is a mixture of cow dung and mud and sometimes ash, is done either to the inside or outside of the kihenge. A roof may be provided. A kihenge is raised on a platform of around 30 cm height above the ground by supporting poles but in some places the platform is made of stones or bricks. Its location is outside or inside the farmer's house depending on beliefs or security against theft. The kihenge is used to store shelled or unshelled grains.

Kilindo

This is a drum-like structure observed in Iringa. It is made from the bark of the miombo tree while still fresh. It is usually made during rainy season. After removing the bark from the tree the innermost layer of the bark is peeled off from the outermost layer of the bark. The innermost layer is folded to make a big wide tube, and stitches are made at the junction of the fold. Another piece is cut into a rectangular or circular shape to provide a seal at one end of the tube to make the structure look like a drum. After this operation the structure is left to dry and then placed on a platform. This structure is used to store a range of food grains such as maize, sorghum, millet, beans, etc.

Gunny bags

This is an ordinary bag and is in most cases used by well to do farmers. It is made of sisal/jute and is always bought from a market or a shop. It is used to store shelled grain. Gunny bags are however, often not available in sufficient quantity and priority is given to their use for marketable surplus grain or cash crops especially coffee. Farmers mentioned bags to not being durable and are easily damaged by rodents and must therefore often be replaced after one to three seasons.

Polypropylene bags.

These are increasingly being used for storage inside the house and marketing of grain as they are cheaper, readily available, more tolerant to insect penetration and rodent attack.Some farmers complained of them not good for storing maize that is not adequately dried as it will tend to generate moisture inside, making the grain damp and mouldy.

Metal Containers

These were found in households in Kilimanjaro region. Other surveys have indicated metal containers to be abundant around or near the towns/shopping centres. They range from tins and oil drums of 200-litre (about180 Kg grain) capacity to large purpose silos of up to 13 ton capacity.

Mud Block Bins

These are square or rectangular structures constructed using mud blocks. They were observed in Iringa but are said to be common in Tabora and Rukwa regions often constructed by farmers who do not posses the knowledge, skills or tradition to make a kihenge.

Other storage facilities documented to be common both in the study area and other regions include;

Baskets

These are made of palm or coconut leaves or other soft grass leaves interwoven together.

Dari

This structure is a part of the house. The dari is a platform built below the roof of the house. This structure is found in many parts of Tanzania and in most cases it is used to store cob maize. The structure serves the double function of drying as well as storage. The platform where the maize is placed is just over the kitchen to provide heat as well as smoke to the grains.

Chanja

This structure is found in Mbeya, Morogoro, Arusha, Tanga, Ruvuma, etc. In this case the crop is stored on an elevated platform between the ceiling and the roof. The bed may be constructed using sisal poles, sorghum or elephant grass stalks or bamboo splits. The vertical part of the structure is in most cases rectangular, and the above materials are woven around the vertical poles to form the chanja. This structure serves two functions, drying and storage. The lower portion of the structure is used for a fire place thus providing heat to dry the grains as well as smoke to protect the grains from attack by insects.

Pots, Gourds

These containers are widely used in Tanzania for storage of small quantities of grain particularly seeds, flour or any semi-processed food for immediate consumption. The pot is made of clay moulded into a range of variable sizes.

Konti

This is a structure commonly used in Babati and Mbulu districts (Arusha region). It is a pot-like structure made of a mixture of moulded cow dung and ash. The structure can accommodate four bags of maize.

THE POST HARVEST SYSTEM

This constitute the different stages through which crop products pass from the time of their being harvested after maturity up to the time of consumption, and the different activities and operation carried out to maintain crop quality and quantity and/or to add value by processing.

Post harvest practices

Harvesting

Harvesting is considered the last step in crop production, but the first one in the post production system. It is a major operation which has great influence on subsequent processing and preservation of any crop in storage.

However, some farmers harvest late or leave the harvested crop in the field (stooking) for various reasons. Some of these reasons may include labour constraints, lack of harvesting facilities (e.g knives, gunny bags) and transport (Riwa, 1996). Where this is the case, the crop is subjected to weather effects, pest attacks particularly insect pests, rodents, wild animals, vermin, termites theft etc. Practices like stooking common in Shinyanga are intended to release the field for timely preparations for chickpeas. In the event of high losses especially from LGB farmers need to be sensitized to rationalise their labour to be able to protect their maize as further drying may be done at the homestead using suitable facilities like the crib.

Drying

When a crop is harvested after its physiological maturity, it still has a high moisture content (about 35 - 40%) and the grain (cereals) is rather soft. Farmers attempting to store or process grain in this state of high moisture content and soft grain will experience the following problems:

(i) development of micro organisms, insect development and increases the respiration rate of the grain. Experiences in the Southern highlands particularly Mbeya and Iringa has shown that *Dinoderus spp* becomes abundant in this high moisture storage conditions compared to other stored insect pests(Riwa,1996).

(ii) Where other processes like shelling and milling is required it is difficult to do this . Milling machines may clog, and handshelling (maize) can be painstaking and laborious.

(iii) The excessive water contained in the grain can induce sprouting thereby diminishing the desirable qualities of the grain.

Traditional drying methods have been in use through centuries and may involve spreading the crop over a chanja, putting it in a dari over the fireplace, or spreading the crop on bare ground for sun drying. The ease with which farmers dry their produce was demonstrated by lack of interest in more modern drying methods like the drying crib which was concept tested during the survey. With time farmers may need to be sensitized to appreciate additional benefits of the crib, especially with regard to avoiding problems of contamination of the crop, slow drying, feeding and contamination by stray animals, common with their traditional methods**.** For silo storage, particularly metal silo, drying to about 12.5% is a precondition for safe storage.

Shelling

Cereals are stored at the household either shelled (or threshed) or unshelled depending on the type of storage facility in use and cultural believes. Unshelled produce, particularly maize on the cob occupies unnecessary larger storage space than shelled maize. Where LGB is present, maize stored on the cob has been observed to be more susceptible to LGB attack (Golob et al.1999, R.V van Gent Ed. n.d). Protectants applied on cob maize are less effective compared to when applied on shelled maize. *In consideration of the serious losses caused by LGB on cob maize, it is mandatory for farmers to shell their maize not long after harvesting. Shelling will permit better drying and admixing with insecticide***.** This mandate is contained in the LGB rule of 1986. The Extension service through its Plant Protection Inspectors enforced this rule during the early campaigns to eradicate the pest. For high production regions like the big four (Iringa, Mbeya, Rukwa and Ruvuma),and other upcoming regions, enforcing the rule may need to go hand in hand with introduction of more efficient means of shelling, especially mechanical shellers, otherwise shelling by hand can be laborious and tedious.

Ghanaian type hand shellers were introduced by Sasakawa Global 2000 Post Harvest Improvement Programme (PHIP) (Riwa,W.H, 1996) alongside other mechanical shellers on the market but they have not been monitored for their adoption (Lyimo,2004, *pers.comm.*). Some shellers are being manufactured in Tanzania by CAMARTEC, and SIDO, and are available from stockists, including the Tanganyika Farmers Association. (TFA).

Cleaning:

Cleaning improves the quality of produce. It gives better storability and a higher crop grade. It involves removing chaff and heavier particles such as sand and stones either by using sieves , winnowing and hand picking. Some farmers do not clean their maize , believing that it will store better if insecticide is not being used. Results from field trials under an ongoing project has proved this to be otherwise. A treatment of uncleaned maize stored under farmer conditions for 10 months was found to be heavily damaged and with live insects during evaluation (D.E. 2004).

Treatment against insect pests.

Insects are the most serious pests of stored grain. Unlike birds and rodents, they are not easily excluded from stores by physical barriers. Farmers were observed to plaster their granaries as a way of minimising entry of insects. This practice is especially helpful where LGB is present because the pest is a wood borer, and protection of wood construction works in storage helps to deter the pest from destructing and harbouring into the wood. In Tanzania, the larger grain borer (Dumuzi) causes far more damage in stored maize and dried cassava than any other known storage pest and is therefore a special case This pest is believed to be introduced into Tanzania in the late seventees from the Americas. The pest is a wood boring beetle and its presence in traditionalstorage systems where storage structures are constructed with wood is a challenge, since the beetle attacks both the structure and stored grain. In off season it harbours into the structures and in woodlands in the environment. The beetle attacks mostly maize and cassava, with preference on cob maize. The rate of increase of LGB in stored maize under optimum condition is enormous and if no improved storage practices such as application of appropriate pesticides are not taken early in the storage period, weight losses have averaged 10% and up to 30% in 3 months of storage (Hodges,R.J. et al.,1996) Long term storage can suffer 100% loss since the produce will be so damaged as to be unfit for human consumption. Effective control of insects in store is by applying insecticides. The recommended insecticides are a mixture of organophosphate (Pirimiphos methyl) and pyrethroid. The pyrethroid derivative controls LGB while the organophosphate controls other insects. However, most farmers visited were dissatisfied with the effectiveness of the ASD and most had resorted to alternatives without much success. Phosphine gas is recommended to be used by trained personnel for larger stocks of produce than what the average farmer stores. It has less chance for adulteration but its use in storage systems is restricted

Post harvest losses.

Crop losses occuring in the post harvest system varies with each activity, from field drying and harvesting, transportation from farm to store, drying, threshing and shelling, storage, milling and marketing.

Most of the available crop loss estimates for Tanzania are of a very generalized nature, mainly to serve to create general awareness and to draw attention to waste and inefficiency in the post harvest system(URT/91/026,1994). Average figures have been quoted as high as 10% for grains but under favourable conditions the losses may easily be a manifold of this figure (van Gent,R.V n.d.). Important loss causative agents are insects, rodents,fungi and termites. They cause losses in terms of quantity, quality, nutrition, and seed viability. Quantitative loss occurs due to moisture,insect attacks, rodents, termites, birds, and spillage during the various stages of post harvest operations. Qualitative loss will be in terms of appearance in size, colour texture, smell and flavour, while nutritional loss occurs due to high temperatures and humidity, fungi development, insect attack, rodents and birds.The real losses of unprotected maize during the course of storage season lay somewhere between 10% and 30% by weight primarily the result of the Larger Grain borer infestation, is significantly more than the 2-3% normally lost as a result of attack by indigenous insect pests(SOFRAIP,2000).

The influence of the Larger Grain Borer on storage practices

Consequent of the presence of LGB and its behaviour, it has necessitated change in storage practices in efforts to mitigate losses.

- Farmers are storing shelled maize rather than cob maize as the later is more prone to LGB attack with subsequent higher losses. In areas of high productions as was observed in Iringa and Shinyanga hand shelling is very laborious.
- To shift from storing cob maize to shelled maize requires a change in the type of storage . The basket types of storage, bags and drums are hence gaining importance.
- Actellic Super Dust which for long was the only available for protection of stored grain against the Larger Grain Borer is now believed by many farmers to be ineffective and are resorting to finding alternatives, which includes use of airtight containers (oildrums) that will require no insecticide applications, use of Actellic 50EC, Malathion and traditional protectants. None of these chemical alternatives have been reported to provide adequate protection.

Interventions for loss mitigation

Until the late 1970s there was no established Government policy on storage of Agricultural products (UNDP, 1989). In the early 1980s projects, particularly by FAO/UNDP started to address post harvest losses through interventions in the Post Harvest System, especially construction and improvement of Rural Storage Structures, both household and village storage.. This was done hand in hand with training of farmers artisans and stockists. Some projects were implemented through the Ministry of Agriculture and Livestock Development and the Prime Ministers office.e.g FAO project, Prevention of Food Losses PFL/URT/001(1978), Village storage and training projects GCP/URT/052/NET and GCP/URT/059/AGF which constructe dseveral model village stores of capacity 200-400 tons. Project URT/86/016 which was expansion and intensification of previous work on construction of village stores and improved construction techniques for traditional storage structures on self help basis was implemented through the Prime Ministers Office from 1986. This was in line with the Agricultural Policy (1983) which emphasized the need for increased storage capacity especially in areas where transportation services are poorest at village, district and regional leves (Ashimogo, 995). This project was followed by project URT/91/026 between 1992 and 1994 as a collaborative project between UNDP and the Office of the Prime Minister and First Vice President. More than 960 stores are believed to be constructed. With the accidental introduction of the LGB in Tanzania, FAO co ordinated donor support to undertake capacity building for eradication campaigns through various projects UTF/URT/094/URT and GCP/URT/095/CAN.

Between 1993 and 1997 Sasakawa Global 2000 in collaboration with the Ministry of Agriculture and Co operatives implemented a project for improvement of post harvest system in Tanzania, taking an integrated approach to loss mitigation, by addressing all post harvest processes.Training was conducted to farmers and stockists and more than 300 improved storage structures demonstrated in the project regions of Iringa, Arusha, Rukwa, Mbeya, Kilimanjaro and Mara alongside improved drying platforms and hand shellers (Riwa, 1996). The impact of these projects, in terms of adoption and loss reduction, has not been monitored or properly documented. However, FAO's LGB control campaign in Tabora 1985/86 was judged to be a success based on a reduction of losses sustained by 105 farmers in 3 villages, from 8.4% over 3-6 months storage as compared to less than 2% after 7-9 months in the previous year (Hodges et al., 1996) The SDC study team witnessed several storage facilities at household, village, districts and regional level, some dilapitated and not used or are used for purposes other than storage of grain. There are plans by IFAD project to use some for a warehouse recept system with cash crops (coffee and cotton) but we know of no plans to use them for storing food crops in the short or medium term.

Registered pesticides for storage protection

The Tanzania Tropical Pesticides Research Institute has a statutory mandate to maintain a list of Agromchemicals approved for use in Tanzania (PPA,1997). This registration is made under section 18 of the Act. The registration of post harvest /storage insecticides is also guided by list approved by the FAO/WHO Joint Meeting on Pesticide Residues (JMPR),which establishes the Minimum Residue Limits from Average Daily intake of products treated with insecticide, with due consideration on the efficacy of the insecticide and the type of commodity to be treated (SOFRAIP,2000). The contact insecticides that are approved for use are compounds of relative low mammalian toxicity, which are considered to be non hazardous when applied at prescribed dilution rates for the purposes indicated (Proctor, 1994). Fumigants are however highly toxic to humans and non target organisms, and the precautions required to ensure the safe use of fumigants are much more stringent than for most other insecticides. In Tanzania, fumigants are registered under restricted use.

List of registered storage protection insecticides in Tanzania

Trade name	**Reg. No. And category**	**Common name/a.i**	**Registrant**	**Usage**
Actellic Super Dust	IN/0002, full registration	Pirimiphos methyl+Permethrin	Syngenta Ltd (U.K).	Stored products against insect pests.
Stocal Super Dust	IN/0235, full registration	Permethrin +Pirimiphos methyl	Calliope SAS	Control of LGB and maize weevils.
Actellic, 50EC	IN/0224, provisional registration	pirimiphosmethyl	Syngenta Ltd (U.K).	Clean spray in storage structures
Nafaka Super Dust	IN/0237 provisional registration	Fenitrithion+Permethrin	Ecomark Ltd.	Control of LGB and maize weevils
Nuvan 50EC	IN/0074 provisional registration	Dichlorvos	Syngenta Crop Protection AG	Crop storage and public health against storage pests and household insects
Sapa Fenitrothion 50EC	IN/0101 provisional registration	Fenitrothion	Sapa Chem	Coffee, cashew, tobacco, storage against chewing and sucking pests and pests of

				stored products
Shumba Super	IN/0238 provisional registration	Fenitrothion+Deltamethrin	Ecomark	Control of LGB and maize weevils
Sumithion 50EC	IN/0117 provisional registration	Fenitrothion	Sumitomo	Various crops against chewing and sucking insect pests.household against mosquitoes and flies and storage insects
Super Grain Dust	IN/0210 provisional registration	Bifenthrin	Juanco SPS ltd.	Stored grain insect pest control
Degesh Plate	RE/0051 restricted registration	Magnessium phosphide	Rentokil(T) Ltd	Grain storage.
DetiaEX-B	RE/0053 restricted registration	Aluminium phosphide	Detia Freyberg GmbH	Grain storage.
Phostoxin pellets	RE/0050 restricted registration	Aluminium phosphide	Detia Freyberg GmbH	Grain storage.
Phostoxin tablets	RE/0052 restricted registration	Aluminium phosphide	Rentokil	Grain storage.
TOLcarbondioxide	RE/0048 restricted registration	Carbon dioxide	Tanzania Oxygen Ltd	Grain storage. As fumigant only

Source: TPRI, 2003.

Quality monitoring by pesticide dealers

Three major/popular crop storage protectants are on the market.

Actellic Super Dust;

This is a cocktail of Pirimiphos methyl 1.6% and permethrin 0.3%. This is a product that monopolised the market since the 1980s, being very effective for the control of LGB and other storage pests. It has changed hands from the Imperial chemical Industries to Zeneca and todate supplied by Syngenta (Kenya) and distributed by Twiga Chemical Industries(TCI) (Tanzania) Ltd. as the sole distributor. The product is imported duty free but is subjected to a TPRI cess of 0.5 F.O.B and 150US$ analytical fee per sample per 4 ton. The wholesale price per pack of 200gm.is tshs. 1,225 and 1,350 for retail. TCI has 52 authorised dealers across the country (Matanda,2003 personal communication). As a strategy to ensure that stockists and traders source their supplies from these authorized dealers, TCI publishes the list of its distributors every start of post harvest season in 2 english papers and 4 swahili papers. In collaboration with Syngenta, it is also working with MAFS in developing training modules and training frontline extension staff on proper use of their products. Occassionally, a 30 seconds radio programme has been on air through radio Free Africa. Road shows have been conducted in Rukwa, Arusha, Mbeya, Ruvuma. As their plan to have more control of their product, TCI has acquired the Moshi pesticide plant, where Actellic Super Dust will be formulated and packaged, instead of it being done in Kenya by Syngenta. They plan to pack ASD in various sized packets bigger than the current 200gm. packets intended for treating 180 kg of maize or sorghum. In addition to the security features already on the ASD packets, a hologram will be introduced as an additional security mark against tempering with the product. The company is however concerned with the lack of a clause in the Plant Protection Act that provides for entering into legal agreement between suppliers and distributors with respect to assuring quality maintainance of products in the market chain, and the inability of the government regulatory bodies to adequately enforce the Plant Protection Act.

Stocal Super

This is also a product of similar formulation as ASD. It is imported from France and distributed by Balton (T) Ltd. The company has deployed agronomists in its 2 zones, The Northern Zone and southern zone. For each zone there is a Zonal manager responsible for promoting the company products through training, field days, demonstrations, distribution of extension materials and publicity in general (Bernadette , Balton (T)Ltd, 2004, *pers. comm.*). When it is post harvest season the company intensifies supply and monitoring of Stocal Super through direct contact with their stockists in the presence of farmers (stockists are invited and introduced to farmers in a field day or training).

The company is concerned with the inefficiency of the government extension service, which according to Bernadette needs to be facilitated and capacitated to train farmers on effective use of pesticides and other fields. Furthermore the government should deploy inspectors or monitoring agents who are directly under its control, rather than a semi autonomous body like TPRI which does not seem to enforce the law and directives of the government

Shumba

This is a cocktail of pirimiphos methyl and deltamethrin. It is fairly new on the market, being imported from Zimbabwe and distributed by Anicrop services(T). Some of its safety features is distictive colour of cap to distinguish between countries. Red is for Tanzania, other countries have green, yellow, blue. The company so far has no evidence of its products been adulterated, but is concerned about TPRIs'inactivity with respect to what is happening to other products like ASD (Dr. Kessy, MD Anicrop,2004.per.communication). The company is working hand in hand with the Food Security Departmentof MAFS to train farmers on the quality features and proper use of its products. Laflets and fliers have been distributed to create awareness.

Other products

Malathion

Malathion 2% is gaining importance as farmers desperately search for alternatives to ASD. Until 1999, the Minimum Residue Limit on cereal grain as established by FAO/WHO was 8mg/kg but was withdrawn and limits were only established for maize and beans at 0.5 mg/kg. Malathion is not effective inthe control of LGB and is currently not registered in Tanzania, despite it being used by many farmers interviewed in Iringa.

Phosphine

Phosphine gas is registered under restricted category to be used by trained personnel in warehouses and silos. It is however sold indiscriminately in retail shops and every person can access it. None of the farmers contacted during the survey indicated that they have been using it for treating of grain. Some have used it to control rats in their burrows. Although this method provides effective control of rodents, (Riwa, 1989), it poses a health risk when used by untrained personnel especially in living houses.

Field tests of ASD and Stocal Super.

NRI in collaboration with MAFS is testing the performance of ASD and Stocal Super alongside Diatomacious earth in a project "Small scale farmers utilisation of diatomacious earth during storage" in 3 agro ecological zones. Recent evaluations has indicated the products to be effective in protecting stored maize and sorghum for up to10 months.

Pesticide regulation

The Plant Protection Act of 1997 which became operational in 2000 among others, makes provisions to prevent the introduction and spread of harmful organisms, to ensure sustainable plant and environmental protection, and to entrust all plant protection regulatory functions to the Government (URT, 1997). Section 32 of this Act gives the Minister of Agriculture powers to appoint a competent research institute and delegate to it powers and duties, among which are;

I. Carry out research or analysis
II. Perform quarantine, investigation, research and co ordination.
III. Participate in the monitoring of plant protection substances,
IV. Participate in the monitoring of plant protection equipment types
V. Test plant protection equipment
VI. Test and develop plant protection methods
VII. Conduct specialist training in the field of plant protection
VIII. Charge fees or otherwise generate revenue from the services and ensure that revenue generated guarantee sustainable and quality service.

At present, the research institute appointed to perform the above duties is the TPRI. As far as pesticide monitoring is concerned, important tools for performing the tasks is a team of inspectors, research scientists and supporting infrastructure. The Inspectors are appointed and given powers under section 33 and 34 of the Act respectiely, with qualifications as spelt out in section 10 of the Plant Protection Regulations, 1999. Although 165 Inspectors have been gazzetted, less than 20% have been trained on pesticide inspection and monitoring. Given the number of pesticide dealers and the size of the country, there is scope for the proliferation of fake and adulterated as was observed for ASD may not be ruled out. In the wake of trade liberalisation and international requirements in pesticide use, TPRI lack capacity to fulfil its mandate.

Opportunities for introducing metal silos under SDC initiatives.

Food security is of high priority in Tanzania and the national policy and vision of the Ministry of Agriculture and Food Security (MAFS) addresses itself to its achievement.

Production of the major staple crops particularly maize and sorghum (which have been identified as priority candidates for metal silos) is given priority by the government for their potential in providing food to the majority of Tanzanians, marketing (maize) and drought tolerance (sorghum). The evidence to this effect is implied in the mission, vision and Strategic Plan of MAFS, resulting to the institutionalisation of the Agricultural Sector Development Strategy (ASDS) and the Participatory Agricultural Developmentand Empowerment Project(PADEP). The ASDS provides a basis for action by both the public and private sectors to support Tanzania's efforts to stimulate agricultural growth and to reduce rural poverty. It is a step forward towards laying the foundation for the ways to develop the agricultural sector, hence the national economy at large as well as poverty reduction especially in the rural areas (URT,2001). With regard to post harvest, the government has included, among a set of innovative approaches in the ASDS, adding value to crops through domestic processing and reducing post harvest losses(URT, TAS n.d.)

Increased production as a result of interventions by these programmes is likely to call for additional storage facilities at different levels. According to Muro, the Co ordinator for PADEP (personal communication) the project may enter into a risk sharing agreement for new technologies introduced like the proposed metal silos.

Furthermore, The challenges for pest management, particularly LGB are a driving force to alternative storage, particularly those suitable for storing shelled maize and loose sorghum grain.

Liberalization of markets and cross border trade as an avenue for market access and favourable prices are incentives to increasing production and hence need for additional storage for assured food sufficiency and surplus for marketing.

Promotion of storage technologies thru the Extension service and Artisans.

The role of the Extension agent

(i) To communicate with the farmer and help incorporate the knowledge and skills for post harvest improvement.

(ii) To choose areas, farmers and artisans for demonstrations and training on the improved/new post- harvest technology taking into consideration the type of community he is working with

(iii) To apply single or a combination of extension approaches for effective communication with the target groups in a participatory manner. The extension agent will link Development Agents with the farmers.
(iv) He or she is required to discuss problems with the farmers and help them in the problem solving process.
(v) An extension agent is a trainer. He/she will plan and conduct demonstrations, field days and excursions for the farmers as part of training
(vi) He/ she is an evaluator as he /she must supervise work and make continous follow ups assessing performance at the same time advising on improvements in implementation of tasks as may be necessary.
(vii) The extension agent is expected to document adoption and write a reports so that his superiors are well informed of the progress and any problems that may require their attention.

Artisans

(i) Artisans should be able to advice farmers on the type and size of structure to be built.
(ii) Should be able to train and advice farmers on suitable materials of construction and quantities required.
(iii) Artisans are trainers. They should be able to train other artisans.
(iv) An artisan should be able to advice farmers on all aspects of storage structure construction and modifications including site selection.
(v) Artisans should be able to advice on low cost repair techniques
(vi) Since the artisan is a farmer, he should be an early adopter of the post harvest improvement recommendations.

DISTRICT AGRICULTURAL EXTENSION LEVEL STAFF IN PROPOSED PILOT AREAS

Region/District Council	**Number of Villages**	**Number of Farmers**	**Number of staff**
ARUSHA			
Arusha (M)	16	73,680	46
Arumeru	143	322,363	121
Ngorongoro	63	62,612	20
Karatu	45	63,340	51
Monduli	73	77,569	55
Total	**340**		**293**
SINGIDA			
Singida (DC)	146	198,230	76
Singida (TC)	55	32,551	26
Iramba	126	165,000	78
Manyoni	75	34,423	47
Total	**256**		**227**

SHINYANGA			
Shinyanga (DC) +	210	133,470	86
Shinyanga (M)	32	84,603	24
Kahama	205	37,479	88
Meatu	143	83,600	46
Bukombe	127	170,000	26
Bariadi	124	52,070	62
Maswa	50	25,000	54
Total	**891**		**386**
KILIMANJARO			
Moshi (R)	151	62,471	130
Moshi (MC)	21	18,000	19
Rombo	62	104,623	78
Mwanga	63	19,200	78
Hai	76	45,000	94
Same	83	121,600	64
Total	**456**		**463**
IRINGA			
Iringa (DC) + Kilolo	186	82,616	128
Iringa (MC)	98	25,983	73
Makete	98	32,000	35
Mufindi	132	61,466	63
Njombe	122	45,983	72
Ludewa	73	27,849	43
Total	**709**		**414**

APPENDIX 4: MOZAMBIQUE - ANALYSIS OF FARMERS' DEMAND FOR NEW STORAGE STRUCTURES

* note villages are mentioned in text by their capital letters

	Chiure (Ujaama)	**Malema** (Moralelo*)	**Cuamba** (Napacala & Mevava)	**Lioma** (18 farmers from 9 associations)	**Angonia District** (DDA and assistant, as proxy for farmer opinion)	**Main common characteristics**
Key characteristics of area	Poor subsistence farmers Main food crop is cassava Lack of major cash crop	Poor farmers but relatively wealthy vis a vis other areas Strong cash crop production	A large group of food-secure farmers with significant earnings from cash crops (tobacco, maize and beans)	Surplus-producing farmers with strong commercial orientation	Surplus producing farmers, with strong production of maize, beans, potatoes and tobacco. More than half farmers work with MTL which is stimulating use of hybrid maize, and diversification. Tobacco producers much better off than non-producers	All surplus producing except Chiure
Observations during walk-about	Heavy losses in cassava; old maize not seen; significant losses in sorghum Stores not cleaned before new crop brought in Only using natural protectants	Large traditional storage structures Sorghum damaged by insects & rats Other stored products not observed, except for a little mouldy maize	Large traditional storage structures Heavy insect losses in maize (both communities) and cassava (Napacala); minor losses in sorghum (although rat losses reported) Stores not cleaned before new crop brought in	Large traditional storage structures Two farmers seen had good storage practices and low insect losses. Both farmers used actellic, but one of them only used *Tefrozia volgei* to protect maize	Authors were unable to make proper field visits. However the DDA noted very high losses away from border, with both maize ("reduced to powder" by January), and beans. Farmers sell beans early, largely to avoid storage pests. By contrast, storage problems are much lower near the border, due to widespread availability and use of actellic	Quite large storage facilities. Often lack of store hygeine High storage damage noted in majority of cases where products from last harvest were seen. Smoke is most common measure for protecting grain Cassava tends to be poor farmers' food and is particularly susceptible to storage losses. Lower storage losses in areas close to Malawi

	Chiure	**Malema**	**Cuamba**	**Lioma**	**Angonia District**	**Main common characteristics**
Main concerns expressed with existing post-harvest system	Very heavy losses with cassava and maize, due to rats & insects some mention of grain moisture as a cause Obtaining good seeds for sowing Theft	Losses from rain damage, rats, birds and termites during field drying Heavy losses from inects & rats: Maize > dried cassava > sorghum Theft, and fire due to arson and accidents Termites Lack of sacks to store beans Dependency on middlemen for marketing Lack of a mill	Losses due to rain damage during field drying Forced to sell maize early because of insect damage. Heavy damage to dried cassava which is hungry season staple (Namacala).	Volatility of prices for maize and feijão manteiga, and lack of assured market outlet Maize prices do not allow for profit, unlike the case for beans Need finance to produce more, particularly for labour Rat losses considered significant	Farmers want to decrease heavy workload involved in frequently changing grass roofs and walls of traditional stores In interior villages: (a) lack of access to insecticides, and; (b) lack of access to markets in rainy season, due to poor state of roads	Storage losses, mainly due to insects, rats, particularly for maize, cassava and beans. Forced to sell early due to losses. Also concern over field losses during drying Theft Marketing, particularly price variability
Expressed willingness to invest in post-harvest improvements?	Yes – “richer villagers could acquire crib while others would observe with a view to later adoption”	Yes, effusively	Yes	Yes, but only drying crib	Yes	Generally favourable, but would need to see technologies demonstrated

	Chiure	Malema	Cuamba	Lioma	Angonia District	Main common characteristics
Technologies in demand; which crops?	Improved traditional store (they liked silos but could not afford them)	All technologies approved, above all metal silo and drying crib Men mostly preferred maize and butter beans; women for groundnuts	Immediate demand for: • Drying crib • Improved traditional store • Metal silo (Mevava only) Note: In Namacala, people want to observe metal & brick silo before making a commitment	Drying crib, for maize Metal silo could be an option for beans	Initially, mud brick silo (cheaper than other silos and uses suitable local soils) After some experience, and assuming strong training input, metal silo will become most popular structure. Major advantage is simplicity. Preferred sizes are 1.36 tonnes for maize and 360 and 550 kg for beans	Everybody wants to adopt low cost improvements to traditional system, but not many will not change the structure to facilitate use of rat-guards Metal silo and drying crib are the most popular new structures, followed by mud brick silo (due to few cases, caution should be used in interpreting such differences finding) Main need is for maize, beans & cassava

	Chiure	Malema	Cuamba	Lioma	Angonia District	Main common characteristics
Main concerns with proposed technologies	The availability of pesticide The expense of purchased inputs Shortage of storable production due to irregularity of rain and lack of river-bottom land	Theft and malicious damage – fear may induce putting metal silos inside homes Cost of materials for structures	Reluctance to shell maize, due to workload (mentioned in Namacala) Expense of purchased inputs/cash-flow constraints Availability of purchased inputs Mevava farmers rejected brick silos on grounds of (a) effort and (b) need to procure external inputs; by contrast they see metal silo as a simple package	Storage technologies proposed do not meet their main concerns, which are about marketing and finance Silos involve high cost in purchase inputs, unlike traditional storage systems Proposed silos are too small for their maize storage requirements	Poor management of silos by farmers, e.g. protecting from sun and rain In areas near Malawi border, lack of wood for poles Theft problem	Local availability of materials and pesticides Cost and financing of new structures Skills for making new structures Effort/time required to make brick silos Perceived benefit-cost ratio inadequate in some areas with better storage practices
Other comments		Individual ownership preferred, vis a vis collective Double harvesting in river bottoms predisposes some farmers towards drying crib Traditional storage was in tree-bark container	Oxfam structures: generally favourable, stressing advantages of rat-guards, but concern expressed over the structures' ability to withstand to wind and rain Traditional storage was in tree-bark container	They want the technologies to be demonstrated Multiple use of traditional stores noted, with onions stored along with maize	Considerable efforts by DDA to improve storage systems under Danida project (1994 to 1996)	

*** Nametade: information obtained in this village was rather incomplete so we have not included it**

APPENDIX 5: POSTHARVEST PROJECT MOZAMBIQUE: INDICATIVE BUDGET FOR 3 YEARS IN US$

cod.	concept	amount	%
1	**Permanent Staff** 1 expatriate, 6 Profesionals, 2 technicians, 2 administrative, 2 non qualified people	1,087,500	49
2	**Consultants** International: Backstopper 90 days, Postharvest trainer 60 days, Artisan training 60 days, evaluation 30, Local: Postharvest trainer 90 days, Translation 150 days.	282,000	13
3	**Local Training** 30 training courses for 600 extensionist, 85 cursos to traine 180 local artisans, 6 students make tesis.	154,500	7
4	**International training** Induction of project staff: 1 month in Postharvest project in Central and Southamerica: Project Manager, 2 trainers, 2 comunicator, 2 artesans	60,000	3
5	**Investment** 6 cars, 2 motocicle, 9computer, beemer, camara, office fourniture and equipement	219,850	10
6	**Postharvest equipment** Materials for training courses and demonstration: flat ans corrugated metal sheets, Moister meter, Scale, grain tools, Refrigerator, Plastic containers, etc.Working table and tools for artesans.	35,195	2
7	**Training / promotion material** Books, Manuals for extensionist and Artisans, flipcharts, Posters, radio spots, LeaFlets, Promotion materials and 100 Demonstration tecnologies for each.	186,500	8
8	**Operational cost: office** Office rent and mantainance, phone, electricity, paper, writing materials, computer software, equipment mantenance.	107,250	5
9	**Operational cost cars** Fuel, Mantenance, Insurance, tyres.	95,550	4
10	**Total amount en US$**	**2,228,345**	100

APPENDIX 6: TANZANIA - ANALYSIS OF FARMERS' DEMAND FOR NEW STORAGE STRUCTURES

* note villages are mentioned in text by their capital letters

Features	Region/District				Summary characteristics
	Shinyanga	Singida	Kilimanjaro	Iringa	
Main source of information in villages	Group of local technicians from MAFS, Municipal Council, WVT and NAFRAC Bukangirija village, Maswa District: group interview Ngaganulwa, Samuye Ward, Shinyanga District: three individual farmers including an artisan	Kituntu village in Puma Division, southern part of Singida District: group interview Sekou Touré, northern part of Singida District: Mr Juma Mohamed, farmer and key informant	Sanya Juu_village Hai District: group interview with Mshikamano farmers group Marangu District: visits to farmers' homes, incl one small trader	Makulilwa village: group interview Isimani: informal group interview	
Key characteristics of the zone	Mixed farming and livestock, diamond mining Main cash crops: cotton, rice, chickpeas and groundnuts Main food crops: maize, bulrush millet, sweet potatoes and legumes Low 2003 yields due to drought	Mixed farming and livestock keeping. Main food crops: Maize, sorghum, bulrush millet. Southern part of is habitually deficit area and not a prime candidate for new p-h technology. Northern part	Around homes on higher ground, people combine bananas, coffee, vegetables and zero grazing of livestock. Maize and beans mainly produced for home consumption on lower slopes, with wide interannual variation in production due to rainfall. Also large-scale commercial production of wheat and barley. Tourism/mountain climbing is also a source of revenue.	Farming with some livestock. Maize is main food and cash crop, and the District approaches monoculture. Other important crops are "Irish" potatoes, sunflower, paprika, tobacco, sweet potatoes, green peas, groundnuts, sorghum and finger millet.	

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		produces surplus maize and sorghum Main cash crops: maize, sunflower, onions, sweet potatoes, coriander, finger millet and chickpeas. 2003 there were low yields due to drought.			

Features	Region/District				Summary characteristics
	Shinyanga	Singida	Kilimanjaro	Iringa	
Consultants' observations	In B., two out of three farmers visited were experiencing storage problems, one was reacting by producing little maize. Complete failure to replicate the large square mud-brick silo introduced by UNDP. In S. improved kihenge had been introduced since 2001, under WVT project, apparently with success. However there was some indication of neglect of maintenance, i.e. annual application of cow-dung. . In all areas, prospect of having carry-over stocks in case of poor next-year crop will spur adoption of improved storage technology.	Farmers are using vilindo and polypropylene bags for storing maize and sorghum. They also hang maize cobs unthreshed in bundles on vertical stands in the open. Bags are gaining in importance. However, they still experience considerable losses due to insects, partly due to using insecticide which are ineffective for LGB (e.g. Actellic EC). Traders experience serious storage problems, partly due to storing wet grain.	Home consumed maize is largely stored safely in metal drums, but there are considerable insect problems with surplus production which is generally held in polypropylene bags. Hai District Plant Prot. Officer estimates 40% of people put in metal drums, 30% put in bags with pesticides, and 30% put in bags untreated. Some larger farmers have adopted the metal silos of up to 110 bags capacity. Some traders experiencing serious storage problems.	Contrasting situation in villages visited: M. with circa 4 acres per farmer; I. with 20 acres per farmer with farmers using ox-ploughs, though some do zero tillage No grain seen due to poor harvest in 2003 and early sale. LGB-related storage losses were less in M., for which reason people still stored without shelling. Farmers often applying Malathion. Sasakawa Global 2000 introduced improved kihenge to contact farmers but not copied by others.	Little 2003-crop grain seen due to poor previous harvest. However, farmers and traders' accounts indicate serious difficulties, due to ineffective and inappropriate insecticides. Varied storage systems, with pp bags gaining importance in 3 out of 4 zones, and metal containers gaining importance in Kilimanjaro Signs of success of WVT-sponsored improved kihenge in Shinyanga; needs further monitoring. Failure noted with other two structures.

Features	Region/District				Summary characteristics
	Shinyanga	Singida	Kilimanjaro	Iringa	
Main concerns expressed with existing post harvest system	LGB attack believed to be worsened by ineffectiveness of ASD. Also concern over high cost. Problem of rats, especially for produce in traditional vihenge without lids – the only problem affecting rice paddy. Termites attack traditional vihenge especially those without platform. Storage in pp bags involves problems with LGB & termites and occupies much space. Sweet potato subjected to infestation if sliced, dried and stored; farmers avoid this by boiling first Food shortages experienced between Sept and March	LGB attack that is hastened by low quality insecticide. Some sell produce for fear of infestation. Vilindo is particularly susceptible to rats and termites, and uses a lot of space in homes. (note: traders in Singida state “if you store for more than 3 months, you experience heavy losses, over 20% if you keep till the lean season. They lose even more in the villages”)	Farmers use ASD, other products and natural remedies but are finding them ineffective against insects. Many sell harvest early to avoid storage problem, so that they have to buy back. Metal drums are effective, but (vis a vis the proposed metal silo) are small, occupy a lot of space and are difficult to handle. Grain in bags are attacked by both rats and insects, and pesticides are not effective	Serious problems with maize due to insects, termites and rats. Farmers apply ASD, Actellic EC and Malathion; however, they tend to go for the cheaper formulations as as compared to ASD which is considered ineffective against LGB. Storage problems result in early sale at low prices, particularly serious in I. Traditional vihenge are subject to attack by insects, which attack structures even if plastered. Theft and lack of twigs also inducing farmers to abandon revihenge in favour of brick structures and bags	Failure of insecticides to perform as expected. Cost also appears to deter farmers from using ASD. Rats and termites are also pose problems. Considerable problems with storage of grain in pp bags. Farmers need to sell early to avoid losses, and incur consequent financial losses.

Features	Region/District				Summary characteristics
	Shinyanga	Singida	Kilimanjaro	Iringa	
Expressed willingness to invest in post harvest improvements?	In S., Demonstrated willingness to adopt improved kihenge (TSh 10,000 for 10 bag structure in 2002), but needs confirmation over time. In B., farmers are aware of adverse impact of high storage losses, and willing to invest in improved structures, though cost is a significant constraint.	Farmers in S.T. (northern area) are looking for improved storage technologies, due to unreliability of traditional storage structures and ineffectiveness of ASD	Farmers want a simple technology that can reliably store up to 20 bags of maize.	Farmers are looking for alternative storage technology, due to attack by LGB, rats and termites.	High level of willingness to invest in improvements, wherever farmers produce enough grain to cover their lean season requirements.
Technologies in demand: which crops?	Adoption record shows improved vihenge to be current "front runner". Advantages are: low cost, increased storage period, rat-proof, better management of family stocks. Potential market also exists for mud-brick silo and metal silo, for maize. Advantages of the latter include durability, mobility, light weight, possibility of having different sizes for different crops, and status value. It	Farmers likely to adopt the mud brick and metal silos, to store maize and sorghum. Farmers can prepare the mud bricks themselves, but need training. Mobility is the strong point in favour of the metal silo.	There is demand for the metal silos with capacity for 15 to 20 bags of maize. M. farmers mention security, efficient use of storage space, mobility, ease of unloading + saving on cost of bags are all perceived advantages. The silo will allow them to store for longer periods and get better prices, and they can also store large amounts as a group and sell the flour.	M: Farmers preferred the burnt brick silos followed by mud brick silos. The main crop is maize. I: structures were not concept tested but given the scale (av 20 acres in maize) and relative prosperity of farmers, they are likely to go for the metal silo and burnt brick silo.	Established market for improved vihenge in some communities of Shinyanga. Potential demand for mud-brick silos in Shinyanga and Singida. Strong potential demand for metal silo in Kilimanjaro, and among more prosperous farmers in other areas visited. Potential demand for burnt-brick silos in Iringa, favoured by low cost and extensive use of burnt.

	will be adopted first by more prosperous farmers, and payment facilities will be important for uptake at other levels.				

Features	**Region/District**				**Summary characteristics**
	Shinyanga	**Singida**	**Kilimanjaro**	**Iringa**	
Main concerns with proposed technologies	Cost, particularly burnt brick and metal silo Labour involved with burnt brick silo Concern about proper application of phostoxin Drying crib would be very useful for drying maize, but concern over theft will slow adoption	Main concerns were the cost of metal silos, and their need for training in making the mud-brick silos.	S.J. farmers mention the cost of the metal silos, though they are confident that those who cannot pay cash can arrange financing. Other possible hazards are rust and the cost of transporting the silos to their homes.	M.: The cost of the burnt bricks to some farmers, for which reason some will go for mud brick silos. Concern about use of children to clean brick silos. Metal silo is costly. With drying crib, concern is security.	Cost is main deterrent to burnt brick and metal silos. Concern over security with drying crib.
Other comments	Farmers harvest and stook maize when mature to free fields for cultivation of chickpea, to allow for drying of maize and to give themselves time to work on other activities such as paddy weeding and/or cotton harvesting			Oilseed processor (Ivory) supplied sunflower seed on buy-back arrangement, but abandoned scheme due to repayment default.	

APPENDIX 7: TANZANIA - INDICATIVE BUDGET FOR 3 YEARS IN US$

		Units		Cost/unit	Total	Total
	Component 1, improved marketing of storage insecticides					
1	**Advertising campaign**					240,000
	Production of spots	units	9	3,000	27,000	
	Factsheet	units	1,000,000	0.05	50,000	
	Broadcasting of spots	spots	900	115	103,500	
	Training of extension workers	extensionists	4,000	10	40,000	
	Consultancy and miscellaneous costs	lumpsum	1	19,500	19,500	
2	**Total for component 2: On-farm storage, managerial inputs and overheads**					2,260,000
	As per budget for Mozambique - see Appendix 5					
3	**Improved storage and marketing of surpluses**					500,000
	Feasibility study	lumpsum	1	50,000	50,000	
	Provision for further work emanating from feasibility study	lumpsum	1	450,000	450,000	
	Total					**3,000,000**