Grain storage in Africa: Learning from past experiences

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Rising food prices have once again drawn attention to the issue of post-harvest losses and to the role that good-quality storage can play in reducing those losses. Donor support in this area is increasing. However, evidence from past interventions in Africa during the last wave of enthusiasm for work in the post-harvest area gives some cause for concern that investments in storage improvement may not be too effective. This paper briefly reviews past experiences with grain storage upgrading, from farm-level stores up to large-scale infrastructure for marketing boards and food reserves. Lessons from those experiences emphasize that storage development must not be carried out as isolated ad hoc interventions but must be seen within the context of the operations of the entire supply chain, taking full account of the way marketing systems function, the relationships within those systems, and the economic viability of proposed interventions.

Keywords: grain storage, food reserves, food storage, silos, cereal banks, supply chains, farm storage, storage viability

THE FIRST PART OF THE PAPER considers some of the activities that have been promoted by governments and donors in the last few decades to improve grain storage at all stages of the chain, together with problems that have resulted from those actions.

Storage at farm level

Farmers have consistently resisted innovations in storage, usually for sound economic reasons

Attempts by ministries, donors, and others to introduce improved farm-level grain storage have had mixed success; the promotion of improvements to traditional stores has generally been more successful than the development of new, and more expensive, structures. In some countries, farmers have consistently resisted innovations in storage, usually for sound economic reasons. In other cases, however, they have taken designs introduced by outsiders and successfully adapted them to meet their requirements.

There are many different types of grain storage at farm level in Africa. Techniques employed depend to a certain extent on whether

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the farm is in the equatorial or savannah zone and stores are generally well-adapted to the prevailing climate, but even within one country there can be a wide variety of techniques. In many countries storage of shelled maize in jute sacks in farmers' houses seems the predominant mode of holding grain, for both personal consumption and for later sale. Fear of pilferage is one reason for this, as is the fact that grain in bags can be easily marketed. In some cases maize for sale is kept in bags whereas maize for consumption is kept on the cob in traditional stores. Families require easy access to grains for their daily consumption and 'improved' stores have not necessarily provided such access as they are usually required to be airtight.

There is a range of factors affecting on-farm storage requirements. Clearly, whether or not a family is likely to have surplus for sale is important in deciding whether to make storage investments. Contrary to the common assumption, many rural households are actually net food buyers rather than net food sellers (Weber et al., 1988; Christiaensen and Demery, 2007; Nkonde et al., 2011). Availability of drying facilities is important, particularly in areas of high humidity, as grains must be dried to acceptable levels if they are to be stored (Armah and Asante, 2005). Farmers are likely to have greater marketable surpluses when the harvest is good. These will require storage because when there is a large surplus and significant price rises are unlikely, traders will themselves be reluctant to store and will only buy what they are able to sell. However, if good harvests are rare farmers may not want to make large investments to cover themselves for infrequent events. A study in Tanzania suggests that in good years under rainfed agriculture it is the larger farmers who are most likely to lack adequate storage (Ashimogo, 1995).

Some grains lend themselves more easily to storage than others. In Kenya, farmers sell wheat soon after harvest, but store maize. Hybrid maize varieties are presently more difficult to store at farm level and farmers may thus seek to sell hybrid production, while retaining traditional varieties for their own consumption. Farmers with only one harvest per year will probably require storage for family consumption purposes but those able to grow two crops may have less need for long-term storage for such purposes. Speculative storage in the hope of price rises does not appear to be widespread. Construction of storage for purposes of price speculation is only viable when such storage is profitable in most years. However, farmers in remote areas may require more storage than they did in the days of marketing boards. Traders tend to buy close to their base soon after harvest and gradually move to distant areas.

Traders buy close to their base after harvest and gradually move to distant areas

There appears to be a correlation between farmer wealth and use of improved stores. In Tanzania, larger farmers use metal bins for storage more than smaller farmers. A study in northern KwaZulu-Natal in

South Africa found that wealthier households were more likely to use metal tanks than were poorer ones (Thamaga-Chitja et al., 2004). In Ghana, wealth enables farmers to construct improved drying cribs and use the commercial drying services necessary if grains are going to be stored on farm.

In many situations insect pests are the major cause of the weight and quality losses that occur during storage. Improved storage sometimes requires the use of fumigation and this usually has to be done by extension officers. Where insecticidal dusts are used, cost, lack of training in application, and lack of availability at the time required can all be problems. Furthermore, in addition to the general health and environmental concerns about synthetic pesticide use, there is some concern that inappropriate chemicals are being used or that the correct chemicals are being used in the wrong doses. Nevertheless, such chemicals can be very effective and seem to have been a major factor in the relatively successful campaign to control the larger grain borer (World Bank, 2011).

New storage methods were based on technological aspects, with little attention to farmers' economics

Past attempts to introduce new methods of on-farm storage have often been based on technological aspects, with little attention being paid to farmer economics and other issues discussed above. Farmers seem prepared to tolerate quite high losses before undertaking complex or expensive changes to their storage systems. Traditional stores have been developed to meet the climatic and social needs of farmers and are normally relatively inexpensive (Golob et al., 2002). Furthermore, evidence regarding the true extent of on-farm storage losses is confusing. There are difficulties with accurately measuring storage losses over a long period when farmers are continually removing grain from stores to meet their own consumption needs (for a discussion of issues related to accurate loss assessment, see Proctor, 1994). The African Postharvest Losses Information System (www.aphlis.net) has attempted to reduce some of this confusion, but this system's accuracy remains reliant on the availability of good-quality data, which is often lacking (World Bank, 2011).

High losses justify storage improvements to researchers but farmers do not share their perception of the problem

A high estimate of losses may appear to justify expensive storage improvements to the researcher or technical specialist but uptake of the technology by farmers is likely to be poor because they do not share the outsiders' perception of the problem. Capital costs of new storage are significant and may fail to offset the value of loss reduction, particularly when the store is not used to full capacity.

In Benin in the 1980s breeze block 'silos' were developed for use in very humid areas. Some 350 were built but few were used. Apart from construction difficulties, it was concluded that the silos were not economically feasible. Reviews of the programme highlighted the lack of any studies of farmers' needs prior to the design stage. Also in Benin, donor-introduced cribs made of wood

and chicken-wire were rejected by farmers for several reasons, including the fact that sides made of chicken wire showed others the size of each farmer's harvest. In Zambia, past efforts to promote fairly expensive ferro-cement bins or brick bins have now largely been replaced by promotion of mud plastering of traditional stores. In Cameroon, ferro-cement bins were found to be too complicated for farmers to construct, and too costly. In Burundi, subsidized cement-plastered bins were initially well received but demand quickly dropped when the subsidies were removed. On the other hand, in the Central African Republic, a simple 1-tonne capacity structure was found by farmers to be easy to construct and proved popular even without project support. In Ghana, the promotion of traditional mud-plastered silos in areas that had not previously used them has reportedly been quite successful, although this required a considerable extension effort (World Bank, 2011).

Metal bins have been widely used for grain storage in Swaziland for half a century, drawing on the availability of local entrepreneurs who supply water tanks. An FAO project in the 1980s improved the effectiveness of these bins by noting that moisture migration was significantly reduced when the tanks were kept under shade. Lessons can be learned from outside Africa. In Central America, for example, the Swiss Development Cooperation supported the development of farm-level grain silos with an average capacity of 800 kg. These were constructed by local artisans and in a 20-year period over 400,000 were sold. The structure was purchased 'ready to use' so the farmers did not have to construct the stores, and maintenance was minimal (Coulter, 2007). Nevertheless, such an approach may not necessarily be viable in much of Africa. The cost of metal silos compared with likely returns needs investigation, as does the capacity of farmers to meet the commercial cost.

In Mozambique, attempts to replicate the metallic bins that were reportedly successful in Central America failed because it proved impossible to identify engineers who could fabricate the bins at prices acceptable to farmers. Obtaining a supply of galvanized iron sheets of the required quality can be problematic, leading some commentators to see a role for development projects to finance initial commercial supplies through retailers, so avoiding a chicken-and-egg situation where there is no demand for the tanks because they are unavailable and none is constructed because there is no demand (Coulter and Schneider, 2004 quoted by World Bank, 2011).

In other countries there have also been significant efforts to promote metal silo storage although these activities still remain very much at the pilot stage. Indications from an FAO project in Malawi suggest that there are problems with gaining farmer acceptance for the idea of metallic bins, despite enthusiastic support from the

previous president. Farmers are concerned about theft and prefer to store maize inside their houses as padlocks on the silos can be easily broken. Farmers also lack extension advice on the use of the bin and are reliant on extension officers to do the necessary fumigation. For these reasons uptake of donated bins has reportedly been poor, raising serious questions as to whether the bins, costing around US$300 for a maximum capacity of 2 t, will ever be accepted.

Adoption of new storage technologies at farm level has sometimes been disappointing

Rates of adoption of new storage technologies at the farm level have thus sometimes been disappointing. One view is that traditional storage systems are usually well adapted to local conditions, losses from grain storage are relatively low, and efforts should be concentrated on making improvements to existing structures. However, in some cases changes to traditional storage are forced on farmers by external circumstances. Shortages of raw materials mean that alternative designs need to be considered, such as in Lesotho where the traditional 'Sesiu', a grass-made basket, has been almost abandoned, in part because of a lack of suitable grass. In other countries lack of hardwood due to deforestation has led to a change in storage practices.

Village or 'community' stores

Village stores have been constructed throughout Africa. Many are now unused or, at least, not used for the purposes for which they were constructed. The existence of empty stores must, at the very least, give rise to caution about such investments in the future. While some stores are empty because of marketing system changes, the fact that more recently built stores are also empty may indicate a lack of detailed consideration as to how such stores would function and their planned role within the supply chain. In countries that underwent structural adjustment and in countries of the Sahel where cereal banks were widely encouraged, efforts to promote community stores were often based on the notion that traders were exploitative and that farmers should collaborate in order to combat this perceived exploitation.

Many village stores remain unused, indicating lack of consideration of their function within supply chains

In Tanzania in the 1980s, when cooperatives were beginning to move out of cereals marketing, donors continued to finance stores for primary cooperative societies. Around a thousand stores, each with a capacity of about 300 tonnes, were constructed, in the belief that societies would use them to hold surplus production prior to marketing. In practice farmers preferred to store their maize at home, mistrusting the cooperatives (Coulter, 2007). In Sierra Leone, an FAO project constructed 50 village stores each with a 50 t capacity for farmer associations. The stores were eventually well used, although not necessarily for the purposes for which they were originally planned. However, even though association members fully participated in

construction activities there was an initial reluctance by farmers to use the stores due to worry that others would see how much they produced, a lack of confidence in association record-keeping, shortages of jute bags, and concern over seizure by the government.

Donors usually insist that stores should be constructed for groups of farmers or for an entire village. However, there has sometimes been a failure to adequately examine the nature of the groups applying for stores. Groups have often been set up in order to access the infrastructure being made available and then collapsed as soon as the buildings were constructed. Some were artificial groups designed to facilitate elite capture of available resources. Stores were sometimes built on the land of an important village leader or politician and some are now even being used as private homes or, as witnessed by the author in Zambia, as a church. In other cases, such as in Cameroon and Kenya, stores were constructed to enable cooperatives to carry out marketing activities, but the cooperatives lacked both funds and managerial skills to do this.

There are clear advantages to informal collaboration by farmers in order to aggregate produce so that traders do not have to move from one farm to another, buying small quantities at each. However, it is questionable whether such activities necessitate a village store that may only be used for a few days of a year. In some locations farmers are reportedly reluctant to use village stores because they do not trust village officials and others who hold the keys and fear that items in storage may disappear. As noted already, there is also concern that others will see how much grain they have.

Cereal banks were widely promoted in the Sahel in the 1970s and 1980s. They were nearly always sponsored by an outside agency, such as an NGO, which helped finance construction of a small warehouse, often meeting material costs while villagers provided the labour. The NGO would then provide funds to the village to purchase grain after harvest when prices were low, with the plan that it would be sold in the village when prices increased during the lean season. The returns from these sales were intended to be used for new purchases in the following year. Variations on the basic model involved cereal banks playing a more active trading role and lending grain to farmers.

An estimated 4,000 banks were constructed in the Sahel and the idea spread to countries outside that region and even outside Africa. The majority failed. Many of the assumptions on which they were based were subsequently shown to have been wrong. Farmers were not generally forced to sell their entire crop immediately after harvest and buy back grain later in the season, which was the basic justification for the banks. Research also suggested that grain trade in the region was very competitive. This challenged the assumption that cereal banks would protect farmers from 'exploitation' and that inter-seasonal

price spreads would be adequate to fund the bank operations. The assumption was also made that on-farm storage losses were very high, although there appeared little evidence for this. A fourth assumption concerned the practice of traders lending grain to farmers. This was felt to be exploitative but later field research found that high interest rates were necessary to cover high default rates by farmers. Finally, the belief that there were significant inter-seasonal price fluctuations that provided the opportunity for temporal arbitrage was also challenged by subsequent research (CRS, 1998; Reusse, 2002).

As the assumptions behind cereal banks were questionable, it is unsurprising that most failed

As the assumptions on which they were based were questionable it is unsurprising that most cereal banks failed. But the banks also ran into numerous management problems. Costs incurred could not be covered by the available margins. Collective decision-making proved slow and cumbersome and banks became subject to social and political pressures. Incentives for management to perform were limited by the fact that they were handling collective property rather than their own grain and only those banks with selfless and committed managers and committee members had any chance of success. Corruption and theft were widespread, both within the cereal bank management and among representatives of those who were supposed to be assisting them. Finally, there is little evidence that cereal banks were able to reduce storage losses below the levels of on-farm losses.

Some success does appear to have been experienced with cereal banks more recently. The World Bank (2011) attributes relative success by IFAD projects in Chad and Niger to several factors including year-to-year variability in harvests; limited market integration; membership of the more vulnerable who are most in need of access to grain banks; and the strong role of women in management.

Trader storage

Smaller traders usually work on the basis of rapidly turning around stock

Donor support to small-scale traders has been negligible. Smaller traders usually work on the basis of rapidly turning around stock. They visit villages, purchase a truckload and then take the grain to a larger trader, mill or urban market. When they buy in villages relatively close to urban areas they can turn around their capital fairly quickly during the period immediately after harvest. In a good year, traders working in areas about 100 km from Lusaka, Zambia can make eight purchasing trips a month (B. Zulu, personal communication). Whiteside and Amilcar (2006) report that traders in Mozambique can turn over their capital 'every 1–2 weeks'. Under these circumstances it may be questionable whether such traders have significant need of storage. Small traders may simply not store because they can use their money more profitably by buying and selling.

For small traders in remoter areas where production is limited, the situation is less clear. In Malawi there are many 'farmer/traders' who both produce grains and buy from neighbouring farmers. They often store bags in a room in their own homes or in a garage. They may also rent facilities locally, such as unused shops. In Tanzania there was a flourishing, although technically illegal, private maize market even before market liberalization in the 1980s and traders stored much of their produce in their own or rented houses to avoid attracting too much attention. With liberalization they began to invest in relatively cheap permanent stores and to use open-air storage. This led to an estimated increase in their storage capacity between 1985 and 1991 of 38 per cent and an increase in the average amount of stock held (Amani et al., 1992).

Following market liberalization in Africa in the 1980s and 1990s, some sizeable private grain trading companies emerged. In many cases there has been a fairly rapid turnover of such companies, as would be expected in the initial stages of any new business activity. However, the situation appears to be stabilizing and reputable companies are beginning to take on an important role in the grain marketing business. Some are making sizeable investments in infrastructure. These are often companies that have accumulated capital through other business interests prior to liberalization or that have access to offshore finance. Companies that have set up after liberalization with the specific intention of becoming grain traders tend to face more difficulties in financing storage construction.

Until recently there was also little evidence of donor support for large-scale traders to construct stores, although that may now be changing. In some countries grain traders are presently renting former marketing board or cooperative stores from government agencies. Such arrangements are not always satisfactory, which is why traders are often looking to construct their own facilities. In other countries empty warehouses are not even available for rental or sale even though the government has no obvious need for them.

One of the largest investments in private grain storage in Africa is to be found in Kenya. A large-scale wheat growing company in the Rift Valley area obtained finance from the World Bank's International Finance Corporation (IFC). The 30,000 t facility not only stores the company's grain but also offers storage to traders and mills, and for grain in transit. Offshore finance was necessary because of the inability or unwillingness of local banks to handle loans of the required size. Investment in storage infrastructure by an individual company would only appear to make sense when it expects to be using that storage at close to capacity for most of the year. However, the problem faced by traders is that suitable, alternative storage is often not available for rent.

Government stocks

Many countries continue to believe that intervention in the grain market is necessary

While structural adjustment and market liberalization tended to reduce the role of state agencies, many countries continue to believe that some form of intervention in the grain market is necessary. Most countries in Eastern and Southern Africa, for example, retain a marketing board or food agency that intervenes to varying degrees. Storage infrastructure planning by these agencies is complicated by a lack of clarity regarding grain marketing and pricing policies. Available warehouses and silos may be adequate for marketing board and food security reserve purposes in one year but may be inadequate in the next, following a change of government policy. Where, as in the case of the Food Reserve Agency in Zambia, the reserve is also charged with renting out government warehouses not required for reserve purposes, ever-changing government policy means that the agency does not always know how much surplus capacity it will have available for rental (Nkonde et al., 2011).

Much grain storage was constructed in the era of marketing boards, with heavy donor inputs. Storage planning at that time was often based on the assumption that the boards would buy most of the crop soon after harvest. The pan-seasonal prices used meant that it was irrational for farmers to hold on to grain that they would not need to consume (other than for seed). Storage planning had therefore to be based on the assumption that the marketing board would have to be in a position to store almost all of the entire commercial surplus within a few weeks of harvest. Even this assumption sometimes resulted in inadequate storage facilities. Heavy buying price subsidies, input subsidies, and cheap credit sometimes combined with excellent growing conditions to produce bumper harvests for which no suitable storage could be found, an experience that has resurfaced recently in Zambia, among others (Nkonde et al., 2011). High losses of highly subsidized maize were often and still are the consequence.

Without appropriate maintenance the condition of stores will deteriorate. This is most obvious in the case of silos, once described by an FAO report as 'rusting monuments to inappropriate technology transfer' (FAO, 1994). In some cases silos have been constructed but hardly ever used. Olajide and Oyelade (2002) noted that of 165,000 t of silo capacity built for Nigeria's Strategic Grain Reserve in the early 1990s, only 2 per cent was occupied in 1999. Rehabilitation of silos is costly and governments often lack the resources to do this. At the same time, there appears to be a growing need for silo storage in the private sector, although at smaller capacity levels. In Ghana one ambitious trader plans a network of small rural silos that could feed into a central silo complex that, in turn, could supply silos positioned in the major areas of demand. In time, there appears to be no reason

One ambitious trader plans a network of small rural silos to feed a central silo complex

why traders could not purchase in bulk from small farmers, although some restructuring of the transport fleet may be required to facilitate bulk transport. Relatively small silos are available and these could, perhaps, be used by the more developed rural traders. Some tentative proposals have been explored for public–private partnerships to rehabilitate existing silos, although the cost of rehabilitation may exceed the cost of constructing new silos that more efficiently meet the needs of the private sector. Partnerships for new silo development are under consideration in Mozambique, among other countries.

There are few examples of food security reserves having a major role in overcoming the consequences of crop failure

Despite the considerable work that has gone into developing the concept of food security reserves, there are few, if any, examples of where such reserves in Africa have played a major role in overcoming the consequences of crop failure. There are, on the other hand, several examples of where reserves have been used primarily for political purposes, particularly close to election time. Storage requirements for security reserve purposes are the subject of considerable debate. However, the size of a national reserve can probably be much smaller than often supposed, without jeopardizing food security. Ideally a reserve should complement 'a broader non-stock strategy that addresses both the resiliency of rural livelihoods and the functionality of overall safety nets' (World Bank, 2012).

Few countries, or indeed donors, seem to appreciate that building stores is the cheapest part of a reserve policy. More expensive is buying the grain and the financial costs of holding it, which can be prohibitive, especially when exacerbated by poor storage practices that can lead to large physical stock losses, which become more costly as prices rise. An effective reserve would also need to be spread throughout a country, particularly in those countries where roads can be cut off by seasonal rains. Management of such stores can often be problematic and the need for stock rotation provides an additional problem. Reserves have to be rotated and this cannot be done without interfering in the workings of the market. Stocks should ideally be sold at the end of a season when prices are high and replenished after the new harvest when they are low. However, this lowers prices at the end of the season and increases them after the harvest, which reduces temporal arbitrage possibilities and, hence, the incentive for the private sector to store.

Recommendations

There are many factors that can influence storage decisions. These include population growth and migration, climate and climate change, crop diversification, access to finance, the perceived costs and benefits and risks attached to storing, the location of production and processing, the relative importance of domestic and export

markets, and changes to marketing systems including the growth of commodity exchanges. Transport infrastructure is a major factor. The poor condition of railways in many areas means that it is no longer considered necessary to site stores along the rail line. New roads and bridges (e.g. in Mozambique) can have a significant effect on trading patterns and storage requirements.

Knowledge of rural grain stockholding strategies is limited and research for this paper identified few studies on the topic. Programmes to improve household grain storage are often implemented with limited research. Storage programmes have thus tended to have a technology-push approach. Large programmes to promote new technologies should only be undertaken when it is clear that farmers will find them to be cost-effective. If a decision is taken to promote new types of store, attention needs to be paid to ensuring that local fabrication is available on a commercial basis (i.e. that a sufficient number of farmers would be willing to pay the full cost to make it worthwhile for individuals or businesses to set up as fabricators). As noted, improved storage frequently requires the use of specific crop-storage chemicals. Promotion of storage thus also depends on the availability of a good network of farm input dealers who are able to supply such chemicals.

Where there has been a failure to adopt new storage technologies at farm level and where village stores remain largely unused, governments should aim to identify the socio-economic, cultural, and other reasons for this. Instead of inviting donors and NGOs to support new storage construction, governments should seek their assistance to carry out the necessary field research before deciding on new programmes. Similarly, donors and financial institutions have a responsibility to avoid making loans until they have done the necessary research to ensure that the money will be well spent. In this they should avoid the temptation to concentrate on individual stages of the chain and, instead, adopt a whole-chain approach. Improvements at one stage (e.g. at farm level) will have little impact if they are inconsistent with what is going on further down the chain. As an extreme example, promoting village-level stores is likely to have little benefit if the government reintroduces a marketing board with a mandate to buy everything soon after harvest. However, even simple improvements in roads can reduce the need for on-farm storage.

Instead of donors supporting new storage construction, governments should seek their assistance for field research

Farmers using larger storage facilities as a group, association or cooperative will often need specialized storage management skills. Governments need to consider whether the necessary training is available in their country, bearing in mind the importance of such skills to minimize losses and avoid the possibility of health problems from aflatoxin due to poor drying prior to storage. Storage management training will almost certainly also be required by both

the private sector and government agencies. The quality of storage by private sector grain traders is arguably poorer than that provided by the state sector in the marketing board era (World Bank, 2011).

Policies need to facilitate investment in storage by medium- and large-scale traders, either through purchasing existing stores or by constructing their own. In selling redundant state-owned stores governments need to assess a realistic value based on the possible rental income. Credit constraints need to be addressed in consultation with the banks. Residual attempts by governments in some countries to impose pan-seasonal buying prices should be ended. Among other benefits this would provide a possible incentive for farmers and traders to undertake inter-seasonal storage.

It is possible that the coming decades will witness significant changes in grain marketing arrangements in Africa. Policy development will need to be forward looking and not just respond to existing problems. Climate change, for example, could have major implications. Marketing systems are also changing, either because of natural developments such as urbanization, or through external intervention such as support for the development of the Warehousing and Inventory Credit (WIC) concept (Coulter and Shepherd, 1995). Donor projects and private companies have attempted to improve regional grain trading in East and West Africa through the exchange of market information using cell phones and the internet. Such initiatives could have an impact on trading patterns and, perhaps, on storage requirements. The South African Futures Exchange (SAFEX) has revolutionized grain trading in that country. Attempts to develop commodity exchanges in other countries have had mixed success, but the possibilities offered by electronic trading are encouraging donors to support experiments in this area. To be successful, exchanges require that a reliable network of secure warehouses be in place.

The South African Futures Exchange has revolutionized grain trading in that country

Shortage of land in some urban, and even rural, areas can constrain storage development. In some countries the lack of adequate land registration means that there is only a limited land market and that it is difficult to obtain land for development. Communal ownership of land in rural areas can make it difficult for individuals and companies to invest. Where such problems exist governments need to formulate appropriate policies to address them.

There may also be some cases when there is a clearly identified need for some particular type of storage, which the private sector is unable or unwilling to provide (so-called 'market failure'). However, in this circumstance governments first need to consider the reasons why the storage is not being provided commercially. Possibly no private company believes that this can be done profitably; possibly the economic and political environment militates against such investment. An enabling environment that is conducive to private

An enabling environment that is conducive to private investment is essential

investment is essential. Stable macro-economic conditions, clear government policies that are consistently applied, a consistent tax regime, rules and regulations that facilitate economic development and are applied fairly, and an absence of corruption are all necessary to promote investment. As the World Bank (2011) points out, legislation and regulations that make it easier to establish business and make investments can have a much greater impact than donor or government-sponsored provision of storage and other equipment. Also essential is efficient infrastructure, including roads, railways, and electricity.

Lacking such an environment, grain traders will not construct storage if they suspect that the government plans to reintroduce subsidized state purchasing through marketing boards or cooperatives; all companies will hesitate to invest if obtaining permission to construct storage requires numerous bureaucratic procedures and the need to deal with rent-seeking officials; grain marketing or milling companies will not wish to construct stores or processing facilities if they expect policy interference in their operations, such as seizure of stocks as a result of allegations of 'hoarding' or attempts by the government to set the prices paid to farmers or to set maximum prices for consumers; and construction of stores in remote areas is unlikely if communications are poor.

Improved storage cannot be promoted in isolation from the main users of storage

Finally, improved storage cannot be promoted in isolation from the main users of storage. Governments need to develop consultative mechanisms with farmers, traders, millers, exporters, and others, such as cooperatives, to ensure that policy reflects the real needs of the grain and agricultural industries. At the simplest level such consultation could be arranged by organizing stakeholder workshops to discuss the various issues raised in this paper. Longer term consultative mechanisms could include promotion of associations that represent the entire grain chain and could provide ongoing policy and implementation advice (Shepherd et al., 2009), such as the Eastern Africa Grain Council.

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References

Amani, H.K.R., van den Brink, R. and Maro, W.E. (1992) *Tolerating the Private Sector: Grain Trade in Tanzania after Adjustment* [online], Cornell Food and Nutrition Policy Program, Washington, DC <www.cfnpp.cornell.edu/images/wp32.pdf> [accessed 29 July 2012].

Armah, P.W. and Asante, F. (2005) *Ensuring Food Security in Ghana: The Role of Maize Storage Systems* [online], SAGA Policy Relevance Summary, Cornell, <www.saga.cornell.edu/images/caurepts/armah-polrel.pdf> [accessed 30 July 2012].

Ashimogo, G. (1995) *Peasant Grain Storage and Marketing in Tanzania: A Case Study of Maize in Sumbawanga District*, Köster, Berlin.

Christiaensen, L. and Demery, L. (2007) *Down to Earth: Agriculture and Poverty Reduction in Africa* [online], World Bank, Washington, DC <http://siteresources.worldbank.org/INTPOVERTY/Resources/335642-1130251872237/DownToEarth_final.pdf> [accessed 30 July 2012].

Coulter, J. (2007) 'Farmer groups enterprises and the marketing of staple food commodities in Africa', *CAPRi Working Paper* No. 72 [online], IFPRI, Washington, DC <www.capri.cgiar.org/pdf/capriwp72.pdf> [accessed 30 July 2012].

Coulter, J. and Shepherd, A.W. (1995) 'Inventory credit: An approach to developing agricultural markets', *Agricultural Services Bulletin* 120 [online], FAO, Rome <www.fao.org/docrep/v7470e/v7470e00.htm> [accessed 30 July 2012].

CRS (1998) *Community-level Grain Storage Projects (Cereal Banks): Why do they Rarely Work and What are the Alternatives?* [online] notes from the workshop, Dakar, Senegal, January <http://lasdanaides.files.wordpress.com/2009/02/1998-crs.pdf> [accessed 29 July 2012].

FAO (1994) 'Maintenance and operation of bulk grain stores', *FAO Agricultural Services Bulletin* 113, FAO, Rome.

Golob, P., Farrell, G. and Orchard, J. (2002) *Crop Post Harvest: Science and Technologies, Volume 1: Principles and Practices*, Blackwell Publishing, Oxford.

Nkonde, C., Mason, N., Sitko, N. and Jayne, T.S. (2011) 'Who gained and who lost from Zambia's 2010 maize marketing policies?', *Food Security Research Project, Working Paper* 49 [online], FSRP, Lusaka <www.aec.msu.edu/fs2/zambia/wp49.pdf> [accessed 30 July 2012].

Olajide, J.O. and Oyelade, O.J. (2002) 'Performance evaluation of the Strategic Grain Reserve Storage Programme (SGRSP) in Nigeria', *Technovation* 22: 463–68 <http://dx.doi.org/10.1016/S0166-4972(01)00015-3>.

Proctor, D.L. (ed.) (1994) 'Grain storage techniques: Evolution and trends in developing countries', *FAO Agricultural Services Bulletin* 109 [online], FAO, Rome, <www.fao.org/docrep/t1838e/t1838e00.htm> [accessed 30 July 2012].

Reusse, E. (2002) *The Ills of Aid*, University of Chicago Press, Chicago.

Shepherd, A.W., Cadilhon, J-J. and Gálvez, E. (2009) 'Commodity associations: A tool for supply chain development?', *AGS Occasional Paper* 24 [online], FAO, Rome <ftp://ftp.fao.org/docrep/fao/012/i0945e/i0945e00.pdf> [accessed 30 July 2012].

Thamaga-Chitja, J.M., Hendriks, S.L., Ortmann, G.F. and Green, M. (2004) 'Impact of maize storage on rural household food security in Northern Kwazulu-Natal', *Tyudskrif vir Gesinsekologie en Verbruikerswetenskappe* 32 [online] <www.up.ac.za/saafecs/vol32/chitja.pdf> [accessed 30 July 2012].

Weber, M.T., Staatz, J.M., Holtzman, J.S., Crawford, E.W. and Bernsten, R.E. (1988) 'Informing food security decisions in Africa: Empirical analysis and policy dialogue', *American Journal of Agricultural Economics* 70: 1044–52 <http://dx.doi.org/ 10.2307/1241733>.

Whiteside, M. and Amilcar, L. (2006) *Agricultural Marketing in Nampula Province: Constraints and Opportunities*, CARE International, Mozambique.

World Bank (2011) 'Missing food: The case of post-harvest grain losses in sub-Saharan Africa', Report No. 60371-AFR, Washington, DC <http://siteresources.worldbank.org/INTARD/Resources/MissingFoods10_web.pdf> [last accessed 28 October 2012]

World Bank (2012) *Using Public Foodgrain Stocks to Enhance Food Security*, Report Number 71280-GLB [online], World Bank, Washington, DC <http://documents.worldbank.org/curated/en/2012/09/16687047/using-public-food-grain-stocks-enhance-food-security> [accessed 30 July 2012].