R6503 -001

THE STORAGE AND MARKETING OF GRAIN LEGUMES IN GHANA

Peter Golob, Irene Gudrups and Caroline Moss
Natural Resources Institute, Chatham Maritime, Kent, UK

Introduction

Grain legumes, or pulses, belong to the family Leguminosae and are an important subsistence crop in tropical Africa. Their value lies particularly in their high protein content of approximately 20-25% (McFarlane, 1983) and additionally, through their nitrogen-fixing ability, they help to maintain agricultural yields in areas where fertilisers are hard to obtain or not easily affordable.

Cowpea (*Vigna unguiculata* (L.) Walp.) is by far the most important grain legume in Ghana followed by bambara groundnuts (*Vigna subterranea* (L.) Verdc.). Both are grown throughout the country although production is concentrated in Northern, Upper East and Upper West Regions. National annual production estimates for cowpea for the years 1986-1989 inclusive are 15 -20,000 tonnes (Golob *et al.*, 1996). Production figures for bambara groundnuts have not been collated.

Many of the producers are extremely poor. They grow a small amount of these grain legumes primarily for food but also to sell any surplus to raise cash. The need for money, in particular, forces many farmers to sell pulses soon after harvest to traders who then take on the responsibility of storing through the remainder of the year. Most farmers store small quantities of pulses for home consumption and retain additional grain for seed.

Larger-scale production of grain legumes in Ghana is undertaken by a few wealthier farmers who sell produce directly to millers or other people associated with the processing chain, or to the Ghana Seed Inspection Unit for use as certified seed. These farmers often store pulses before sale and can generally afford reasonable storage facilities and appropriate protective measures.

The information contained in this paper was collected during three recent surveys conducted in northern Ghana to assess the constraints to storing and marketing grain legumes in the region (Golob *et al.,* 1996; Brice *et al.,* 1996; Gudrups *et al.,* 1997).

Pulse varieties cultivated

Cowpea

Farmers throughout northern Ghana grow one or more local varieties though only a few grow improved, high-yielding varieties (HYV). White, black-eyed HYVs are larger and fetch a better price at market than local varieties. However, to attain the high yields insecticide must be applied and this is a major constraint to their cultivation because the chemicals are expensive and often not available in local markets. Lack of improved seed is also a problem; farmers in several villages visited are willing to plant new varieties but they have no access to seed. Furthermore, because of poor resistance to storage insects all improved varieties are sold at harvest and none are stored.

Local varieties, in general, have greater resistance to field pests and diseases than improved varieties. They are also more tolerant to adverse climatic conditions and poor soil fertility. However, variations in resistance characteristics are also found among the local varieties. For example, farmers in Mandari village (Northern Region) cultivate two local cowpea varieties: a white "cripple bean", and a brown/black variety, "demodow". The brown/black variety is grown because it was more resistant to insect pests in the field and stores. The white variety, however, suffers heavy losses in the field and during storage, but is still produced because it cooks faster, tastes better and fetches higher prices at market.

Another reason for growing more than one variety is because of differences in the maturation period after planting. For example, farmers from the village of Naafaa (Northern Region) grow two cowpea varieties; a white short-maturing variety, "benbla", and a black, longer-maturing variety, "bensola". The black variety is planted early in April and harvested in July, whilst the white variety is planted in May and harvested in October. Staggering the harvest of cowpeas helps to overcome

constraints due to labour shortages at planting and harvesting, and provides food before the main harvest of staple crops in October.

Bambara groundnuts

Bambara groundnut is an indigenous legume grown primarily by subsistence farmers in semi-arid regions of Africa (Brough and Azam-Ali, 1992). Its tolerance to drought and poor soils, combined with its resistance to pests and disease, make it ideally suited to production in marginal areas (Harris and Azam-Ali, 1993). Although widely cultivated, bambara is an under-utilised crop and no improved varieties have been developed (Azam-Ali, 1992).

At least one or more local varieties of bambara are grown in northern Ghana. Variations in production, storage and processing characteristics occur depending upon the variety. For example, two varieties of bambara are grown in the village of Naafaa (Northern Region): a white variety, "sinjiblebla", and a red variety, "sinjiblejie". The white variety is more susceptible to insect storage pests but it is said to taste better and cook considerably faster than the more resistant red variety. Producers also obtained a higher price at market for the white variety (3000 cedis/bowl at planting time in 1996) compared with for the red variety (2000 cedis/bowl). As with cowpea, different varieties of bambara are also grown because of their different planting dates and maturation periods. Farmers from the village of Bulenga (Upper West Region) produce two bambara varieties: a short-maturing variety (three months) and a long-maturing variety (four to five months). The long-maturing variety is planted in May/June and harvested in September/October, and the short-maturing variety is planted later in July/August and harvested in October/November.

Storage of grain legumes

Farmers tend to store grain legumes only for consumption by the family and as a source of seed for the next planting season. Despite an annual increase of up to 200% in the market prices, which occurs between harvest and the 'lean season' seven months later (Brice *et al.,* 1996), few farmers are able to retain grain on the farm long enough to benefit. There are a number of factors preventing long-term storage: low yields as a result of the small areas cultivated; low yield because labour, to assist with farming operations, is too expensive or unavailable when required (especially for women farmers); early sale to raise cash for clothing, medical and household expenses, school fees, etc.; excessive insect damage; and insufficient or inadequate storage facilities.

Traders are mainly responsible for storage of pulses. Quantities held by traders vary from five to perhaps 5,000 sacks (up to 500 t), though most store less than 1,000 sacks. Traders generally buy immediately after harvest when prices are low and attempt to store until just before the next harvest when market prices are at a premium. Those that keep small numbers of sacks do not store and turn the commodity over relatively quickly. Wholesalers dealing in larger quantities are not so common, but are expected to increase in numbers with the availability of credit facilities.

Storage losses

Grain legume losses in Africa are not well documented, due partly to the lack of suitable verified methodologies. Information refers to damage rather than weight loss. For example, Amuti and Larbi (1981) found bambara samples, collected after 3-4 months storage from three areas in Ghana, exhibited up to 24% damage with a mean of 3.7%; Golob *et al.*, (1996) found damage to bambara to be 14-100% after 6-8 months storage; Caswell (1968) in Nigeria and Golob *et al.* (1996) in Ghana found damage to stored cowpea to be 14-37% and 15-94% respectively, the latter being assessed after 7-9 months in store. Tables 1 and 2 illustrate damage recorded in pulses during the recent surveys.

A few studies have attempted to correlate this damage, which was due to insect adults emerging from the grain, to weight loss. Caswell (1981) showed that 9-30% damage equated to 1.6-5.4% loss, but much higher losses, 30% by weight, were found by Singh and Jackai (1985) when damage reached 70%. A post-harvest loss prevention project in Uganda suggested that, after 3 and 6 months in farm stores, cowpea loss as a percentage of the harvested grain was 1.7 and 5.9% respectively (Anon., 1992).

There is some evidence to suggest that bambara varieties possessing a darker coloured seed coat, or testa, are more resistant to attack by insects in storage than the paler coloured varieties (Amuti and Larbi, 1981; and Gudrups *et al.*, 1997). Higher yielding, improved, varieties of cowpea do not possess suitable storage characteristics and were more susceptible to insect damage than traditional varieties.

Farmers perceive insect damage to grain legumes to be severe and believe an average of up to 20% is lost during storage. Sometimes, the entire crop was judged to be unfit for consumtion. As there have been very few studies of on-farm losses it is not clear whether this is a true reflection of quantitative loss or not. Weight loss *per se* may not be the only factor in determining farmers' action to limit insect damage. The appearance of the grain, particularly the presence of insect emergence holes, may be more important as this factor influences market prices. However, although there is evidence that quality affects the price of pulses sold through urban outlets in southern Ghana there appears to be no premium for good quality grain sold in local markets in the north. This may change as consumer demand for quality increases.

Table 1. Damage in pulses collected from different markets in northern Ghana, 1995 (harvest Nov./Dec. 1994)

	Month collected	Market	Damage % (insect holed)
Cowpea	May	Tamale	15
Cowpea	May	Tamale	17
Cowpea	May	Tamale	38
Cowpea	July	Bolgatanga	54
Cowpea	July	Bolgatanga	67
Cowpea	July	Gambaga	94
Cowpea	July	Yendi	84
Bambara	May	Tamale	24
Bambara	May	Tamale	23
Bambara	May	Tamale	20
Bambara	May	Tamale	14
Bambara	May	Tamale	18
Bambara	May	Tamale	32
Bambara	July	Gambaga	100
Bambara	July	Yendi	100

Table 2. Damage in pulses collected from traders in southern Ghana, 1995 (harvest Nov./Dec. 1994)

	Month collected	Location	Damage % (insect holed)
Cowpea	May	Accra retailer	13
Cowpea	May	Accra wholesaler	38
Cowpea	May	Accra wholesaler	20
Cowpea	July	Ejura itinerant trader	16
Cowpea	July	Accra supermarket	2

Storage structures

The type of structure used to store cowpeas or bambara is dependent on the yield, intended use and whether the legumes are to be stored unthreshed or as grain. Cowpeas are frequently stored in the pod though many farmers does shell before storage. Bambara groundnuts are almost always stored in-shell because the spherical cortex is difficult to remove - 3-4 people can only decorticate one bag of bambara kernels in a day - but the presence of the cortex does not impede handling in the way a long, narrow cowpea pod does.

Clay pots are the most popular choice of structure in which farmers stored threshed pulses. Other structures include jute sacks, calabashes (gourds), small mud silos, metal oil drums and baskets coated with cow dung and wood ash. Unthreshed produce is normally stored in larger structures such as the "kambong "and "kunchun" which are large baskets woven from grass matting, or sorghum stalks, sometimes plastered with mud. Cowpeas and bambara kept exclusively for seed are stored in hand-made clay pots, small metal cooking pots or calabashes.

Many traders store grain legumes for up to seven months in structures they either own or hire. Produce is held in jute or polypropylene sacks in store rooms located either in or close to the market, although traders holding only very small quantities may store within the home. None of the stores is large, the maximum capacity is about 2,000 bags (200 tonnes), but larger traders maintain several stores. Store rooms are often totally inadequate for storage purposes, frequently being simply large enclosures constructed from wooden planking and corrugated iron sheeting with cement rendered floors. The structures are often flimsily built, poorly maintained and infrequently cleaned. Good storage management is very difficult to practice and pest control operations difficult to adapt to maintain effectiveness.

Post-harvest problems

Pulses are particularly susceptible to insect attack by bruchid beetles and all farmers who grow cowpeas complain of their inability to store this crop for any length of time, whether shelled or in pods, because the grain quickly becomes heavily infested. During the surveys, the main pest identified on cowpea is *Callosobruchus maculatus*. Both this species and *C. subinnotatus* are frequently found on bambara.

Cowpeas seen in villages during the surveys were mostly recently harvested and were either free of visible infestation or only lightly damaged. More heavily damaged cowpeas are observed in markets when the crop has been harvested a month or more previously; Table 1 indicates the level of damage found in samples examined at different markets throughout the north. One particular farmer/trader, Mr Alhaji Malkole Wasa from Gusiagu village, showed the team his store of cowpeas in-pod which had been harvested one month previously, approximately the equivalent of 10 bags of threshed cowpeas. When this farmer opened his store a cloud of adult bruchid beetles flew out, and the ceiling of the store was found to be covered with a black layer of adults.

Damage to unshelled bambara, which is often heavy though generally not as extensive as in cowpea, causes concern because the farmers are often unaware of the infestation being present. This is particularly a problem with bambara retained for seed as the insect developes inside the bean and is not visible even when it is shelled and sown; the infestation becomes apparent when the seed fails to germinate.

Insect damage is mostly a problem for traders since they hold grain legumes for an extended period, have inadequate storage facilities and have little or no training in pest control procedures. Damage by insects is heavy and seems only to be contained by very liberal use of synthetic insecticides and fumigants.

Other problems encountered during storage are theft, rain damage, rodent and fungal spoilage, and termite damage. Termites are a problem in all of the major legume-producing areas although the severity varies, with the hotter and drier Upper East Region suffering more acutely than the other two regions. They destroy not only the

stored crop but also the storage structure itself. Damage by rodents (probably *Mastomys* and *Acomys* species) occurs irrespective of whether the produce is stored threshed or unthreshed, though the problem is less severe when grain is stored in well-sealed mud silos or small pots. Fungal damage occurs in the early cowpea crop because the grain is harvested during the main rainy season.

Storage protection

On the farm

Throughout the areas of northern Ghana where the survey was conducted, farmers in general did not take any precautions to prevent pest damage during storage, other than to place the commodity in the sun. In some villages, such as Zinido, Galiwei and Gusiegu in Northern Region, farmers were unaware of any traditional method of protecting stored crops against insect infestation. In other villages, including most of those visited in Upper East, less than 5% interviewed were aware of traditional practices, but even these did not necessarily apply the methods themselves, though they knew of others in the village who did. These methods were not used because they were thought to be ineffective; in Saka village, in Upper East Region, villagers believed too much protectant is needed to be effective and so its use is impractical.

However, farmers who use storage protectants use them on pulses rather than on any other crop. During the surveys, a total of 32 methods for protecting stored cereals and grain legumes at the farm-level were identified: eight of these employed inert materials such as sand and ash; 19 use plant materials (using 14 plant types); and five use synthetic chemicals. Choice of method is strongly influenced by tribal custom. Farmers considered that seven factors were important in influencing their choice of method; these included cost, effectiveness, availability, toxicity, acceptability and versatility.

Inert materials and other physical methods employed to protect legumes at the farm level include: admixing the commodity with wood ash; subjecting the produce to smoke usually from the kitchen fire; admixing with sand; thermal disinfestation by exposure to the sun; roasting; and admixture with specific types of ash such as cow

dung ash. Another type of physical treatment applied only to bambara involves drying the produce, re-wetting it and then drying it again before final storage.

The application of ash is able to prevent insect infestation from occurring. This is particularly the case where small quantities of grain are treated and retained for seed, such as is practised in Upper West Region. In general, the greater the proportion of ash to grain the better the protection. In Upper West, cowpeas are submerged in ash, and more ash (by volume) is used than grain being protected. However, where larger quantities are stored for home consumption, for example in parts of Upper East, the quantities applied are rather small, often less than 1% by volume, and the treatments not nearly as effective. In this latter situation, it would be impractical to apply the quantities of ash required to ensure adequate protection.

The use of plant materials as protectants during storage is common in the legume producing areas of Ghana. The surveys found that residents in 17 of the 20 villages visited used some form of plant material to protect pulses from insect losses. Their use tends to be greater in the poorer localities of northern Ghana, being more prevalent in Upper East Region and the north-east of the Northern Region. Of the 14 plants used as protectants, many are used in several villages including, in decreasing prevalence: *Synedrella nodiflora* ("kim-kim" leaves), *Capsicum annum* (chilli pepper), *Chamaecrista nigricans* or *C. kirkii* ("lodel" leaves), *Vitellaria paradoxa* (shea nut residue), *Azadirachta indica* (neem seeds), "poni" leaves (*Ebanaceae*) and *Khaya senegalenswas* (mahogany bark). Of the plant protectants that are employed in more than one village, lodel leaves are said to be the most effective in preventing insect damage. Shea nut residue and chilli pepper, used in combination, are also considered very effective by farmers in one particular village, but use of this mixture is not common.

Modern synthetic chemicals, approved for use as grain protectants, such as Actellic (pirimiphos-methyl) dust are either unavailable, especially away from the main towns, or too expensive; few farmers are aware of the names of these chemicals. However, three farmers in Bongo Soe village and another in Saka village bought Actellic from traders in the market and used it to treat shelled bambara and cowpeas, which were then stored in sacks. Other chemicals, not appropriate for food use, including lambda-

cyhalothrin (Karate), DDT (probably a generic name for a variety of chemicals), aluminium phosphide (which releases phosphine gas), calcium carbide and moth balls (naphthalene) are employed as grain protectants. Nevertheless, farmer groups in seven out of 20 villages expressed concern over the potential health hazard which could occur from using chemical insecticides. If chemicals are used, it is often only for commodities destined for seed or for sale. If a treated commodity is consumed at the farm, some farmers wait three months before using the grain, until the commodity is believed to be safe.

The use of fumigation for controlling rodent and insect pests of pulses (and other commodities) on farms is quite widespread. However, the control obtained is likely to be extremely poor and certainly not cost-effective; only a cosmetic effect would result. Tablets of aluminium phosphide, which release phosphine gas, have been on sale in retail outlets in major towns in northern Ghana for more than 10 years. During recent visits to village markets, itinerant traders were found selling individual tablets. Phosphine gas is extremely dangerous to handle and is acutely poisonous, inhalation leading to nausea, vomiting and, eventually, death. It is remarkable that accidental poisoning does not occur very frequently. From a study conducted in 1995 (P.Golob, unpublished) it is clear that use of phosphine in northern Ghana is not only extremely hazardous to human and animal health but is also totally ineffective. Tablets are placed in well ventilated storage structures from which the gas is lost as soon as it is released; fumigation must take place under gas-tight conditions which allow retention of gas for at least five days. Subjecting insects to sub-lethal doses in this way will result in them becoming resistant to the gas in the longer term. Use of phosphine for on-farm control should be actively discouraged by restricting its sale but, because fumigant tablets are readily available, methods should also be developed which allow effective and safe treatments to be applied.

Control of termites in farm silos is attempted by lighting a fire inside the mud structure to disinfest it, by destroying and re-building the store (although the new store is usually positioned on the original site, allowing reinvasion), or by the use of seed from the "vitso" tree. This seed is soaked in water overnight to produce a black, bitter solution which is mixed with the soil as the silo is constructed. Although this

method is considered to be effective availability of the seed is restricted both geographically and seasonally.

Protection against rodent damage, in villages that have received appropriate extension or NGO assistance, includes use of rodent guards made from metal sheeting. However, this practice is rare and most farmers take no action though a few keep cats. Protection against ground water ingress is largely by raising the store above the ground on a small platform, though this is not common for mud silos. Damage by rainwater is prevented by covering the store with a thatched roof, although in drier areas these are not often used and both stores and grain sustains water damage. Theft is best prevented by storing the commodity in the house.

In traders' stores

Traders protect grain legumes by the liberal use of chemicals. Pest control operations are carried out by the trader himself, or by government or commercial organisations. Pest control procedures are often applied without due consideration of efficacy, health risks or cost. No attempts are made to tailor the treatment to fit the storage facility, or to modify the store to optimise control options. If grain pests are controlled, and insect and rodent damage limited, it is because of excessive overdosing of chemicals and by increased turnover of the produce. Due to the manner in which the produce is stacked it is rarely possible to cover the stock with fumigation sheeting and so usually the entire store is fumigated. The nature of construction of the stores, however, is such that almost all buildings are far from gas-tight and fumigations must fail. Since application rates of phosphine are high - approximately one tablet per bag of commodity, which is 3-5 times the recommended dosage - the fumigation may, superficially, be seen as a success. However, although insect adults on the surface of the grain are likely to be killed by these treatments, the internally-feeding immature stages will certainly not be controlled.

Many traders attempt to control infestations themselves in order to save money. Much of the insecticide used is simply sprayed onto the bag surfaces, a practice known to be of limited use (McFarlane, 1989). It is also likely that the treatments are applied incorrectly and that inappropriate chemicals are used. The government does

not direct any extension effort towards traders. Thus commodity traders do not receive any advice or technical information on storage issues other than from private pesticide wholesalers, retailers and applicators, who have a vested interest in promoting their services and products.

Marketing of grain legumes

Farm level

At the farm level, the marketing of cowpea and bambara is almost exclusively the responsibility of the female members of the household and women also dominate trading activities in local markets. The commercial benefits of interseasonal storage are widely understood by villagers although the majority claim they are forced to sell early on in the storage season due to an immediate requirement for cash. During the course of interviewing farmers, a commodity marketing sequence has emerged. Groundnuts, as well as paddy in the Upper East, appear to be the foremost cash crop and are sold first. Thereafter, cowpeas and yams are traded and then bambara.

Farmers may sell to traders living locally or to itinerant traders. They often have a regular buyer who calls on them shortly after harvest. The relationship may be sufficiently established to allow credit arrangements to operate. The evidence suggests that these operate in either direction: farmers supply on credit which is be repaid when the produce is sold, and traders advance loans, particularly at planting time, in return for payment after harvest (in cash or kind). Farmers take their produce to market if they require money urgently but if the need is less urgent they often wait for traders to visit the village to save the time and expense of transportation, although they get a reduced price by doing so. Women producers often sell their own produce at local retail markets, by the bowl.

Village-level trading involves a web of informal financial arrangements. These are difficult to characterise as the nature of any given arrangement is determined largely by the relationship between the trader and the producer. The frequency with which producers entrust their produce to traders for payment after sale illustrates the lack of liquidity in the system: traders do not always have the working capital to pay cash.

This limits their operational capacity to the extent to which they are known to, and trusted by, their suppliers.

However, credit frequently flows in the other direction, from trader to producer, especially at planting time when farmers may exhaust their stores and require cash for purchasing seed and land preparation. The terms of the repayment may be fixed in advance (for example, the farmer will agree to sell at harvest to the trader at a predetermined price) or they may be negotiated after harvest. Repayment is in cash or kind, and interest might or might not be charged. Whatever the arrangement, the producer is generally short of cash after harvest and has to sell produce to meet debts.

Some new initiatives are being undertaken to provide farmers with credit at harvest thus enabling them to store commodities until market prices have risen. In Northern Region, a group of farmers in Zinido village are in receipt of inventory loans for maize held in a specially built village store (funded by the International Fund for Agricultural Development) and managed (at no cost to the farmers) by the local extension officer. Each farmer is limited to keeping 10 bags of maize and the total in the store is about 150 bags (15 members). The store is simply a mud-plastered room, constructed for the group at no charge, and the extension worker bears the responsibility for overseeing the grain and maintaining its quality. Although the extension officer is trained to use insecticides, he would be unable to implement corrective measures, such as fumigation, if any serious problem occurs during storage, because of the poor quality of the store itself. The store is too small to permit the use of fumigation under gas-proof sheets, and the mud wall is too permeable to gas to allow effective whole-store fumigation. However, group members express satisfaction with the arrangement, but within the village the scheme is only benefiting fifteen out of several hundred farmers.

The IFAD smallholder development programmes have been operating for several years. The two banks involved in the programme, the Bank for Housing and Construction and the Agricultural Development Bank in Tamale, who have 24 and 5 such groups respectively, report a high repayment rate (over 95%), far higher than for any other lending programme under IFAD. However the high degree of subsidy involved (storage and supervision costs are met by IFAD and interest rates charged

are below market rates) limited its sustainability and potential as a widely replicable pilot project. A number of NGOs have also recently introduced similar lending programmes.

Traders appear to be resident in all villages, providing producers with immediate linkages to outside markets. They ae generally considered to be the wealthier members of a village as they own cattle or are in receipt of a government salary. Traders may also travel to other villages to buy produce at the farm gate or in local markets.

Markets

Markets operat at local, district and regional level. With the extensive network of markets 94% of villages are within 10 km of a market and 54% of villagers sell at a market (Golob *et al.*, 1996). The price of cowpeas is higher in the major southern markets where there is a large, non-producing population.

Local markets are held in the open with no storage facilities and only rudimentary stalls for the traders. A major characteristic of these markets is the large number of petty traders who may travel considerable distances to buy only a few bags of commodity which they then load onto waiting lorries and carry back to the district or regional centres where they live. Middlemen also operate in these markets, buying from producers and selling on to traders coming from further afield.

At district markets the wholesaling function is more obvious and larger traders operate from these markets. There are some limited storage facilities. An example of this type of market is found at Bawku, Upper East Region, where there is much evidence of trade with Burkina Faso and Togo (the town is only a few miles from the border). Despite the strong CFA relative to the cedi, traders still cross the border to buy cowpeas because they are of a better quality. Some of the traders interviewed have quite large operations, employing many agents and buying 50 -100 bags of different commodities each market day (twice a week) during the harvesting period. These larger traders invest in long-term storage for which some receive assistance on pest control from the Ministry of Food and Agriculture. Smaller traders interviewed (trading between five and 20 bags a week) said that limited access to finance constrains their ability to store. Indications that Bawku is a deficit area are provided by the fact that several traders are involved in bringing grains (maize, millet, sorghum, cowpeas) from outside the area for local sale.

Regional markets are larger and often have a permanent market site on which a market day is held perhaps once a week when the general public trade; market traders operate each day mainly wholesaling. In Tamale market, larger-scale traders may purchase up to several hundred bags of durable commodities a week. Traders buy

directly from the local and district markets in the region through agents, who receive a commission, or from regular suppliers in these markets. Credit operates in both directions. Traders sell on to buyers from the southern markets (principally Kumasi, Techiman and Accra). Traders are aware of the benefits to be gained from long-term storage and many of those interviewed store groundnuts, cowpeas and maize for up to 6 months, some with assistance from the Ministry. However, the quantities stored relative to the quantities purchased do not appear to be high, reflecting a commonly voiced view among traders that their ability to store is constrained by their limited access to finance. In addition, traders are concerned about storage losses which they perceive to be high, even after treatment. Warehousing facilities in Tamale market are not conducive to good storage management and traders generally are poorly informed about the effective use of chemicals and fumigants.

From the north, pulses are transported to the central commodity market at Techiman and then to the large consumer markets in the south, particularly in Accra. In all these markets, commodities are simply stored in transit overnight for onward shipment or sale the following day.

Conclusions

Cowpeas and bambara groundnuts are highly susceptible to damage by storage insect pests. Methods to reduce infestation must be regarded as a priority to enable these commodities to be stored safely, so as to ensure adequate protein intake by the farm family. Two approaches should be taken.

Firstly, short to medium-term solutions are required which the farmer can implement relatively simple and cheaply. People storing grain in the homestead must be given the opportunity to enhance quality and reduce losses with as little change to normal practice as is necessary. Therefore, they should be in a position to select which changes they want to employ, and the amount of money, if any, they wish to expend to make improvements. A raft of options should be developed from which the farmer can choose one or more to use at different periods during the storage season Such solutions may include developing cheap hermetic storage structures or the application of thermal disinfestation techniques. These options will include store management

practices, store types and protectants, and the choice will depend on the type of commodity, its end use, its value and the predicted storage period.

Secondly, in the longer-term, pulse-breeding programmes need be adapted to incorporate insect resistance. Although resistant varieties have been developed by legume breeders, the varieties do not seem to be widely cultivated, probably because their grain does not meet cooking or organoleptic needs. The only long-term sustainable way to reduce insect infestation is to develop varieties which are both resistant and acceptable to the consumer.

It is clear that there is a very low level of understanding of good storage practice among traders. Although high-quality produce fetches premium prices, particularly for pulses, many traders are resigned to dealing in grain which is badly damaged by insects. Grain bought in good condition can be maintained at the same quality in store if appropriate pest management practices are put into place. Although some traders employ government and private pest control operators to treat their commodities this is usually neither efficiently done nor cost-effective. Therefore, effective strategies for improving stock and store management should be developed for small to medium scale trading enterprises.

The government does not direct any extension effort towards traders. Thus commodity traders receive neither advice nor technical information on storage issues other than from private pesticide wholesalers, retailers and applicators, who have a vested interest in promoting their services and products. Similarly, farmer groups becoming involved in communal storage to obtain credit also lack the ability to judge the effectiveness of the inventory manager, particularly when storage is on a small scale in the village. This manager, likely to be a government extension worker, may not possess sufficient expertise to be able to address all the issues which are likely to occur, unless more extensive training is provided. A system needs to be established, therefore, whereby traders and those involved in communal storage can obtain impartial advice, training and assistance on these issues.

Lack of financial liquidity forces many producers to sell pulses soon after harvest. The provision of credit through formal sector lending would abate this problem.

However, in the past, banks have been very reluctant to loan without substantial collateral in the form of property. Recent introduction of inventory loans has begun to overcome these problems. Although the system is limited to a very few beneficiaries, it could be extended to enable a greater proportion of the population to benefit. Other methods to improve producers' access to credit need to beinvestigated.

References

Amuti, K. and Larbi, M. (1981) Postharvest losses in the bambara and geocarpa groundnut seeds stored under traditional conditions in Ghana. *Tropical Grain Legume Bulletin* **23,** 20-22.

Anon. (1992) Uganda Master Plan and Investment Programme for the Grain Marketing Sector. Interim Report on Policies for the Grain Marketing Sector. Volume III. Carl Brothers International, i + 188pp.

Azam-Ali, S. N. (1992) Evaluating the potential of bambara groundnut (*Vigna subterranea* (L) Verdc) as a food crop in semi-arid Africa. *Proceedings of the Third SADC Regional Conference on Land and Water Management, Harare, October 1992*, pp. 203-217.

Brough, S.H. and Azam-Ali, S.N. (1992) The effect of soil moisture on the proximate composition of bambara groundnut (*Vigna subterranea* (L) Verdc*). Journal of Science in Food and Agriculture*, **60,** 197-203.

Caswell, H. (1968) The storage of cowpeas in the northern states of Nigeria. *Proc. Agric. Soc. Nigeria,* **5,** 4-6

Caswell, H. (1981) Damage to cowpea in the northern part of Nigeria. *Samaru J. Agric. Res.,* **1,** 11-19.

Golob, P. (1993) Phosphine: A fumigant for small-scale application in northern Ghana. NRI Report (unpublished), 5pp.

Golob, P. Stringfellow, R. and Asante, E. O. (1996) A Review of the Storage and Marketing Systems of Major Food Grains in Northern Ghana. NRI Report (unpublished), 64pp.

Gudrups, I., Asante, E. and Bruce, P. (1997) The storage and marketing of pulses in Ghana. NRI Report, R2232 (S) v+31pp.

Harris, D. and Azam-Ali, S.N. (1993) Implications of the daylight sensitivity in bambara groundnut (*Vigna subterranea*) for production in Botswana. *Journal of Agricultural Science*, **120,** 75-78.

McFarlane, J.A. (1983) Food Storage Manual. WFP/FAO/HMSO, UK. Publication Number Q1547, 263pp.

Singh, S.R. and Jackai, L.E. (1985) Insect pests of cowpeas in Africa: their life cycle, economic importance and potential for control. Pp 217-231 in Singh, S.R. and Rachie, K.O. (eds.) Cowpea: research, production and utilisation. John Wiley, Chichester. 460pp.