Establishing the future potential for the use of mud silos by the smallholder farmers: an assessment of mud silos promotion in the Northern Region of Ghana.

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CHAPTER ONE

INTRODUCTION

1.1 Background

National, international and private development organizations attach the highest priority to maintaining and improving the food security of an ever-increasing world population. One of the more successful efforts in this regard has been the development of varieties that are high yielding, resistant to pests and diseases and abiotic stresses. However, acceptance of these varieties by farmers in the developing world usually depends upon farmers' abilities to store at least some of their production and keep seeds from harvest for planting in the following season. Many new varieties promoted by plant breeding programmes have poorer storage characteristics than traditional landraces. Traditional storage practices were developed in the context of location-specific environmental, climatological and social conditions and according to the specific characteristics of the varieties grown (Rhoades *et al.*, 1991). When new varieties do not store well, the traditional storage technique per se may not be at fault; rather, the increase in volume of production or changes in the varieties' storage needs may have made existing facilities inadequate (Greeley, 1982).

As most developing countries have little new land to put under cultivation, and yield increases resulting from breeding and improved agronomy seem to have leveled off for many crops, post-harvest improvements have been seen by many scientists and policy makers as a promising means of increasing food availability. A major problem in achieving such improvements is the development of novel approaches that are appropriate, accessible and affordable to smallholder farmers. One such new approach by the Ministry of Food and Agriculture (MoFA) and other development oriented organizations in Ghana is the extension of the mud silo to communities in the areas where farmers depend on less efficient storage structures. Mud silos are a traditional storage structure for the Bimobas and Kokombas in the East Mamprusi and Saboba/Chereponi districts respectively of the Northern Region of Ghana. This study aims to assess the achievements made so far in promoting mud silos and to suggest an on-going way forward.

Most of the post-harvest technical problems in Northern Ghana relate to storage issues (Golob *et al*., 1995). Secondary data reveal that as far back as 1990, mud silos from the northeastern parts were introduced on a small-scale into the central and western parts of the Northern Region by Sasakawa Global 2000 to alleviate problems faced by farmers in the storage of their cereals (Stevenson, 1999)

Apart from the Bimobas and the Kokombas in East Mamprusi and Saboba/Chereponi districts respectively, where the mud silo is used as a traditional storage structure, farmers in other parts of the Northern Region of Ghana depend largely on storage baskets woven from grass matting or sorghum stalks for the storage of cereals, pulses and oilseeds. These structures are not very durable and allow easy access to food stores by rodents and insect pests. Revenue losses of 11.7 – 58.4 percent have been recorded on cowpea markets (Bediako, 2000). A further disadvantage of these structures is that their construction requires materials like wooden poles and grass that are steadily diminishing resources in Northern Ghana. Golob *et al*. (1995) recommended the provision of durable, cost-effective storage structures for long-term

storage of cereals and pulses and the development of low-cost methods of protecting grain against insects and rodent damage.

Subsequent to this recommendation, and in response to farmers request for a storage structure more appropriate to their requirements in the central and western parts of the Northern Region, the Ministry of Food and Agriculture in collaboration with Adventist Development and Relief Agency (ADRA) in 1996 undertook the construction of a series of the Bimoba mud silos (formerly called Mamprusi mud silo) in selected villages for demonstrations and trials. The areas covered at the time were Tamale, Savelugu/Nanton, Tolon/Kumbungu, Salaga, Bimbila and Damongo districts (Stevenson, 1999). Simultaneously, experiments and demonstrations of cost effective and safe produce treatment methods with plant materials, chemical substances and solarization were undertaken on farms and in markets with technical assistance from the Natural Resources Institute (NRI) of the University of Greenwich, UK. The object was to educate farmers and traders on the treatment of food stocks under long-term storage.

Prior to the large-scale introduction of the mud silo it was apparent that farmers were keen to adopt them. The views and impressions expressed by farmers about the Bimoba mud silo were that they would be willing to pay for their construction and that women and the youth would be prepared to maintain them (Stevenson, 1999). A complementary appraisal on cereal and legume storage systems in Northern Ghana similarly indicated that farmers were willing to participate in communal storage systems (Stevenson, 2000). Based on the positive findings of these and earlier studies as well as results of experiments by the NRI, the Opportunity Industrialization Centre of Tamale (OICT) in collaboration with ADRA and MoFA embarked on a massive mud silo extension programme for Gushiegu/Karaga in mid 2000, with funding from the United States Agency for International Development (USAID).

Almost three years after its introduction to farmers in the new communities, it is now time to assess the programme, its achievements, strengths and weaknesses, and to determine whether further promotion can be justified and if so, how this might best be done.

1.2 Objectives of the study

The specific terms of reference of the study were to:

a) Examine the mud silos extension procedure in view of recommendations prior to the study
b) Assess the impact of the new structure on the food and cash security of smallholder producers.
c) Determine the problems so far encountered with the new structure.
d) Identify the causes of these problems.
e) Suggest recommendations for redress**.**

1.3 Target Respondents

With each category earmarked to consist of:

- Male farmers
- Female farmers
- Male adolescents and

- Female adolescents

The farmers included in this study were either from districts where mud silo use is traditional, Saboba/Chereponi and East Mamprusi, or where they have been promoted recently Gushiegu/Karaga. Included in the *a priori* expectations for Gushiegu/Karaga was that a satisfactory number of women beneficiaries would be available for interview.

1.4 Time frame

A total of 8 days was allotted to fieldwork for gathering primary data from three districts, followed by data collation and analysis.

1.5 The study area

Areas for the study consisted of villages in Saboba/Chereponi and East Mamprusi districts, which constitute the traditional users of the mud silo; as well as Gushiegu/ Karaga district where the mud silo was introduced three years ago. All three districts belong to the north eastern corner of the Northern Region of Ghana (Fig. 1)

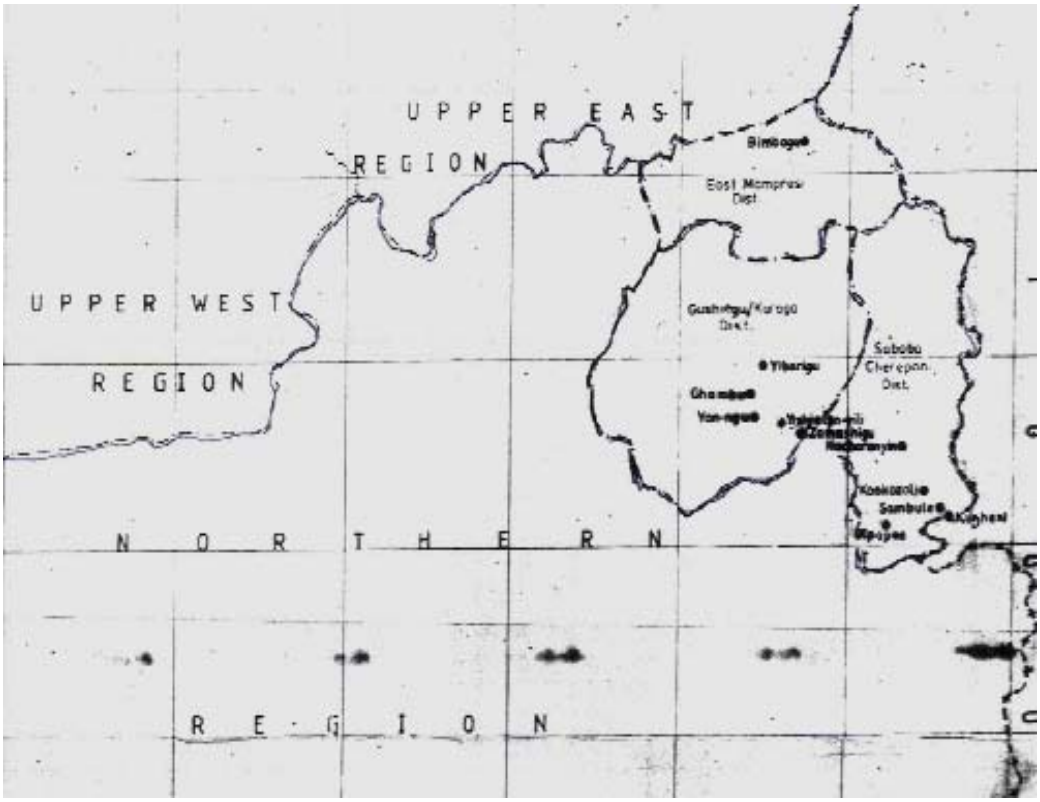

Figure 1 Map of the Northern Region of Ghana showing the locations of villages visited in the mud silos survey.

Correspondingly, the villages covered under each district are as follows:

1. Saboba/Chereponi

Sambule	Konkozoli
Kpapaa	Nacharanyin
Kɲani (origin of the Kokomba mud silo)	

2. East Mamprusi
   Bimbagu

3. Gushiegu/Karaga
   Kpatili Gbambu
   Yiborigu Yan-ngu
   Yishielan-yili

From the map, the number of communities not covered by the mud silo extension programme in the Northern Region is obviously large. About 80 –85% of the people in the area depend on small-scale farming for their livelihood. The method of farming is mainly traditional, although a few farmers have incorporated some aspects of modern technology into their farming operations. The major crops grown are maize, yam, sorghum, millet, groundnuts, 'neri' a variety of melon or agushie and rice with cowpea grown on a limited extent.

1.6 Climate and vegetation of the study area

There is only one rainy season starting from late March or early April and ending in October. Rainfall in the area is characterized by wide variability within the year and from year to year and appears to be the limiting factor to sustained plant growth. The vegetation is mainly guinea savannah woodland increasing in height and density from east to west. Soils are generally sand-silt and lie on more or less deep layers of laterite. The cropping calendar for the major crops grown in the area is shown below (Fig. 2).

The periods of peak farming activities occur between May and August; while the bulk of harvesting activities are carried out from September to November. Land clearing is largely done by hand with cutlasses and hoes.

1.7 Theory of small farmer production systems

The decision of the small farmer as to what crop to grow involves multiple competing factors. Among these Zuckerman (1977) identified the following:

1. The relationships that determine the farmers other requirements from his farming operations, such as family subsistence and cash for his expenses.
2. Those relationships that define his assessment of constraints like land, climatic limitations, soil type and capital for production.
3. Those relationships that make up his personality e.g. his responsibilities, usefulness threshold of cash and willingness to borrow.

Except for the large-scale farmers whose aversions to risk appear to decrease with more cash incomes, the bulk of the farmers in the study area produce within these limitations. They are influenced by risk avoidance and profit considerations that result in the use of minimal inputs leading to relatively low production. They will sell their marketable surplus only when the new harvests are at hand unless there is an urgent need for money. Even then, they would prefer to sell domesticated animals when they need money rather than selling subsistence staple foods. Hence, the requirement of a reliable crop storage system.

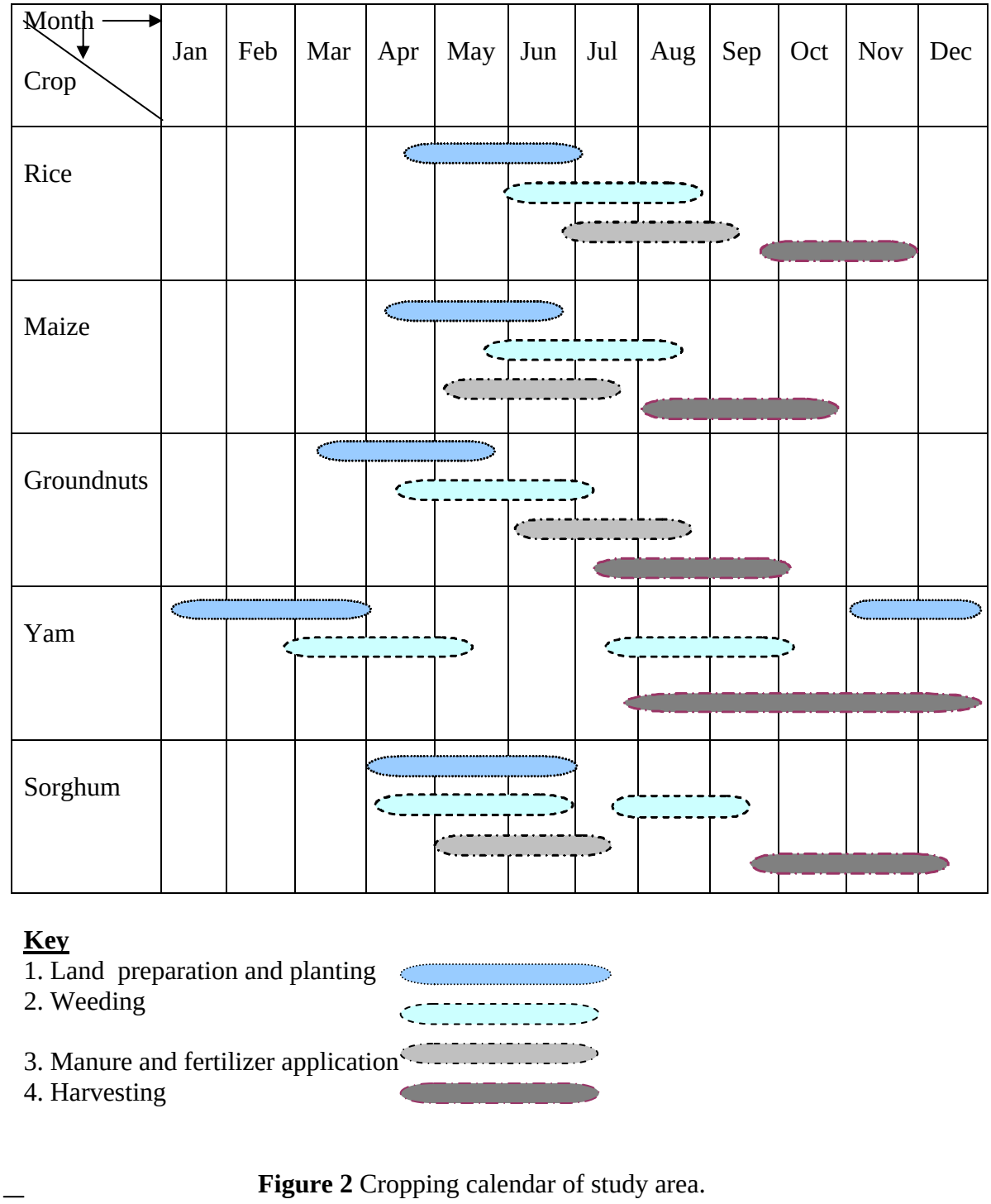

Figure 2 Cropping calendar of study area.

CHAPTER TWO

RESEARCH METHODOLOGY

2.1 Introduction

Generally the methods used for gathering information involved two approaches, namely:

- Formal methods involving structured and semi-structured questionnaires as well as observational approaches such as photographing, collection of sample materials, measuring and counting.
- Informal methods involving Participatory Rural Appraisal (PRA) techniques including focus group discussions. Data from informal sources are community based, mainly generalized data with the advantage of easier and faster collation and analytical procedures but lacking detailed explicit information.

Even though questionnaires were administered in all three districts, particular attention was given to individual interviews in Gushiegu/Karaga for the needed in-depth study of individual benefits derived from the new mud silos as a lead to ascertaining the food and cash security gains made by smallholder beneficiaries.

2.2 Selection of survey districts

The localities from which the study sample was drawn comprised the three districts under study (Fig. 1). The study area was divided into two categories.

- The first category comprised districts where the mud silos originated and is considered a traditional or local storage structure, which had been used for many years.

Criteria for the selection of this category of districts comprised the availability of the local structure in a district. As only two districts in the region use the mud silos as a local storage structure their selection for the survey was an important requirement and therefore purposive. The differences in make and management in the two areas helped to enrich the comparative study of the structures. The districts selected were Saboba-Chereponi, where the Kokomba mud silo originated and, East Mamprusi where the Bimobas also created the Bimoba mud silo many years ago. It was discovered that it is the Bimoba mud silo that is being extended to new users in the region under the name “Mamprusi mud silo”.

- The second category comprised districts where the mud silos were introduced to new users by OICT in the year 2000.

The involvement of OICT at the time of the survey in post-harvest management activities in Gushiegu/Karaga, where they had extended the mud silos two and half years prior to the study was considered by coalition members as evidence of satisfactory production and post-harvest functions of farmers in the district Although communities in other districts of closer proximity to Tamale obtained their mud silos through ADRA, reports from MoFA indicated that unlike the OICT, ADRA more or less abandoned beneficiary communities as soon as construction of structures was complete and did not normally show interest in the performance of the structures they had introduced. It was based on these considerations, that OICT operational areas in

Gushiegu/Karaga were selected for the study of beneficiaries of the newly introduced structures.

2.3 Selection of survey communities in districts

A cluster sampling procedure was used to select communities from Saboba/Chereponi and Gushiegu/Karaga where the mud silos was widely used in many villages. With assistance from district extension officers, a number of villages noted for high food production (since sizeable quantities of storage enabled a longer assessment of mud silo performance) and mud silos utilization were listed as clusters or primary units within the districts. A simple random method of selection was then employed for selecting communities for survey from the cluster of villages listed.

In East Mamprusi district, only the Bimobas who created the mud silo use the structure for storage. Their Mamprusi neighbours on the other hand use kanbons, kunchuns and jute sacks. The homogeneity of the structure, its limited usage in the district and the geographical location and isolation of the Bimobas, necessitated the selection of only one community for survey, this was the village of Bimbagu that is easily accessible on the Gambaga scarp.

2.4 Sample selection and sample size

The farmers were surveyed in June/July 2003 when many had completed the planting of their crops and were in relaxed mood pending the clearing of weeds and harvesting. As such, selected respondents were able to afford the mornings to go through the questionnaire, visit nearby farms for a quick inspection and return in the late afternoons for focus group discussions.

In the communities of Saboba/Chereponi and Gushiegu/Karaga, which had large numbers of mud silos, respondents were selected by a systematic random sampling procedure in which a random starting point was selected by a simple random method after which every third house was entered and every adult mud silo owner, comprising men, women and adolescents were encouraged to participate in the interview. The method was used to enable the study to capture the distribution of actual mud silo ownership among men, women and the youth. The actual mud silo distribution among this group of community members was particularly important for Gushiegu/Karaga where the mud silos promotion was expected to bridge the mud silos ownership disparity gap between men and women, and adults and the youth, in the areas covered by the promotion. At Bimbagu in East Mamprusi however, respondents were invited to the chief's palace by the town committee chairman, to enable the chief to participate in the interviews and discussions.

2.5 Data requirement

Data used for the study were both quantitative and qualitative, comprising primary and secondary source information.

The primary data collected from farmers comprised information on the following:

- General information on respondents comprising gender, age, education, ethnicity, marital status/family size and religion.
- Farmers perception of the promotion procedure used in Gushiegu/Karaga
- Mud silo types and capacities available in traditional areas and those constructed in new areas.

- Trends in production levels prior to the mud silos promotion in Gushiegu/Karaga
- Trends in land sizes.
- Trends in storage losses.
- Direct and indirect benefits from the mud silo in Gushiegu/Karaga
- Mud silo management and related problems in traditional and new user areas

Secondary data comprised information from related reports on the mud silo (Refer to references)

2.6 Analytical procedure

The analysis of data was done with statistical programmes including frequency distribution, percentages, measures of location and graphic presentations.

CHAPTER THREE

FINDINGS AND DISCUSSIONS

3.1 Demographic characteristics of farmers

Gender/sex
Out of a total of sixty farmers interviewed in the three districts, only one of them was female. The vast majority of mud silos owners among traditional users, and beneficiaries in the areas where the structure had just been introduced, are men. Reasons for this highly skewed result were not hard to find. According to respondents, women are unable to use or dissuaded from using the mud silo for the following reasons;

- Difficulties associated with maintaining a mud silo
- Difficulty of use. Women are not able to climb and open, fill or remove food from the top of the structure and also close the mud silo. The women explained that mud silos needed some redesigning if their needs and capabilities were to be accommodated.
- Women find it difficult to procure the materials required for their construction.

Many women presently use clay pots, which they can either build or readily buy, to store food products. The problem arises when the quantity of the produce exceeds the capacity of the clay pots. In such cases (which are now common due to NGO/Government focused assistance to them) women have no other alternative but to buy the relatively costly jute sacks for storage.

Further discussions elsewhere, and among coalition members revealed also that cultural food storage arrangements in households may have prevented a conscious effort by the mud silos promotion team to encourage women to procure materials to acquire the mud silos. Furthermore, the traditional practice of building mud silos in the room of a new bride is dying out. This would appear to be at the specific request of brides, who prefer to use other storage structures. It is possible that women actually don't want any type of mud silo but find pots and jute bags more flexible to their needs.

Age of respondents
Thirty-one of the farmers comprising 51.7 percent of the total number interviewed were middle aged, 46.6% including the only woman (Fati Iddrisu) were elderly. Only one respondent was an adolescent aged 17 years. School attendance, the drift of the youth to cities, and the eroding of the traditional norm that youth should depends on the family head and work on his farm were some of the reasons given for the absence of the younger men as respondents. The girls above sixteen years who were still at home were married and worked for their husbands. A few we were told had however left home to find jobs in the cities.

Ethnicity
The predominant ethnic groups in the areas studied were Dagombas and Kokombas who together comprised 75% of the respondents, the remaining 25% were Gonjas or other smaller groups.

Education
Of the respondents 82 % had never had any formal education. Of the remainder, 8.3% had attended primary school, 6.7% middle/junior secondary school and 3.0% secondary/higher education.

Marital status and dependants
All but one of the 60 farmers interviewed was married and had a family. The majority of men had only one wife (Table 1) and most had 10-19 dependants (Table 2).

Table 1 The numbers of wives of survey respondents

Number of wives per farmer	% of respondents
1	50.0
2	36.7
3	8.2
4	1.7

Table 2 Range of dependants of survey respondents

Range	Number of farmers	% of farmers
0	1	1.7
2-9	17	28.3
10-19	26	43.3
20-29	9	15.0
30-50	7	11.7

Religion
Of respondents, 30% are Muslim, predominantly Dagombas from Gushiegu and East Mamprusi districts, while 35%, mainly Kokombas from the Saboba/Chereponi district, are Christian. The remaining 34%, from all three districts are adherents of traditional African religions.

3.2 The procedure for mud silo promotion

The group discussions in villages in Gushiegu/Karaga centred mainly on the preparations made by the beneficiaries prior to the arrival of builders. These preparations included the provision of labour, materials and farmers were given notice to make ready the requirements for construction. Binding herbal liquids and grass were to be made ready for mixing with the clay and the clay itself had to be prepared at least one day before construction.

The main problem encountered in the project was a lack of the recommended binding grass and herbs in some localities. This lead to the use of any available alternative

such as rice bran, ordinary grass and 'dawadawa' seed covers, which were discovered not to provide the required strengthening effect for the structures.

A recommendation that the promotion process takes into account the location of the communities and the availability of construction materials (Stevenson, 1999), was effectively overturned by the pressure of demand from farmers in all the communities. MoFA succumbed to the demand coming from these communities and ignored the recommendation..

Another problem stemmed from the 'piece work' arrangements agreed with the builders. Being paid according to the number of structures they were able to construct, in their bid to maximise their income, the builders were overly hasty. The lower layers of walls were not allowed to dry well enough before starting the next layer, which led to structural weakness.

Estimates of inputs supplied by beneficiaries for the construction of a 12-14 bags capacity mud silo were made during focus group discussions. On average they were as follows:

Labour, materials and food provided by beneficiaries..…...40,000 Cedi
Workmanship paid per structure by OICT……...30,000 Cedi
Total…….**70,000 Cedi**

The indirect expenses incurred by OICT and MoFA on the project were not accounted for in these estimations.

At the time of promotion, farmers were not trained in the construction or maintenance of the mud silos, thus undermining the potential sustainability of the programme. The skills were consequently not available within the community for transference, moreover farmers not involved in the programme as well as the owners of collapsed structures have been unable to get acquire the services of mud-silo builders.

3.3 Structure requirement per household

The highest number of structures we found constructed for an individual in Gushiegu/ Karaga was eight (8), belonging to a large-scale farmer. Three out of the number had however collapsed before our visit.

The average number of mud silos found for the villages visited in Gushiegu/Karaga district was 28 ranging from 12 to 37 silos per village. For all villages visited in Gushiegu/Karaga district, farmers who do not yet have the structure appealed for their turn, while those with few silos demanded additional structures.

There was no indication throughout the study that villages in Gushiegu/Karaga possess any trained builders among the farmers to keep the promotion programme on a self-sustaining schedule in the district. Recommendations prior to the promotion (Stevenson, 1999) quoted below were not implemented.

> " ..that the ease of construction of the mud silos could be greatly enhanced when many more farmers are trained. Farmers said if about 20 farmers per village were

trained, the ease of construction and availability of skilled labour would be greatly improved. MoFA should therefore tackle this issue seriously and facilitate the training of large numbers of farmers in districts where mud silos have been introduced."

3. 4 Types and capacities of mud silos in the three districts

Mud silo types found in Saboba/Chereponi district were principally large and stood on three legs with three internal compartments. However, one respondent in the district was found using a four legged mud silo with four internal compartments. These three or four legged mud silos are normally filled at the same time with three or four different crops for storage in the different sections.

In a village called Kpapaa in the Saboba/Chereponi district two big mud silos were found with 65 bags grain capacities. In addition to the big silos, small single compartment, one-legged silos were also found in villages of Saboba/Chereponi district. The maximum capacities of the mini silos were five bags of grain and were said to be popular for millet and sorghum storage.

We were fascinated to learn during a group discussion at Kŋani that a hundred-bag capacity mud silo had been built in the village about 120 years ago. Unfortunately, it had collapsed some fifteen years back and has not yet been replaced. This disclosure suggests that large-scale farmers could construct big Kokomba type storage structures for safe and long-term grain storage.

Farmers in Gushiegu and East Mamprusi districts were found using mud silos of similar design suggesting that the mud silos extended to the new users were the East Mamprusi types created by the Bimobas. These mud silos are of medium sizes with capacities ranging from 6 to 15 bags, and set on three feet. However, while some of the structures in East Mamprusi are compartmentalized, all the structures constructed for beneficiaries in Gushiegu/Karaga have only one compartment for holding produce. Farmers who needed more storage space and who could provide labour and materials were constructing multiples of the single compartment structure in Gushiegu/Karaga.

The recommendation concerning capacities of structures (Stevenson, 1999), stated that "….whenever MoFA is encouraging the adoption of mud silos, farmers should be allowed to determine the capacity of the structure to meet their storage needs."

It was not clear how or if farmers had any say in the capacity or design of the structures constructed for them, which might explain why those who could afford them were building multiple structures.

3.5 Household management and care of structures

In East Mamprusi, households were found keeping mud silos in rooms. Wives who take charge of weekly food rations given out by husbands have smaller mud silos in their lodgings while men who manage the entire family food stock throughout the year, keep a bigger structure in their halls.

In Gushiegu/Karaga and Saboba/Chereponi however, the structures were found either lined up or grouped in front of houses, in accordance with cultural practices there(?) (Table 3).

Table 3 Household management of structures

District	Location	Control of structure	Care of structure	Veneer
Saboba/ Chereponi	1. Located in front of homes 2. Some structure fenced into roofed walls.	Head of household	1. Polished body surface with red or white clay, covered with grass cap and layers of thatch. 2. Many structures fenced with roofed circular walls.	Smooth and watertight
East Mamprusi	1. Big structure in halls of household head 2. Smaller sizes sited in wives' room	By men and women	Polished body surface with a mixture of cow dung, red clay and herbs. Covered with woven grass cap in rooms.	Smooth and watertight
Gushiegu-Karaga	Located in front of homes	Head of household	Layers of thatch and grass cap.	Rough and prone to water retention

Many of the structures in Saboba/Chereponi were found enclosed in roofed fence walls, while those in Gushiegu/Karaga by contrast were all exposed to the harsh climate of the area resulting in forms of damage to the structures. Furthermore, in East Mamprusi and Saboba/Chereponi, the structures found were smoothly polished with a mixture of cow dung, clay and herbs, providing additional strength and resistance to water entry. The external surfaces of structures in Gushiegu/Karaga were however rough and prone to water retention.

The latter examples are out of line with an earlier recommendation which recommended:

> "The initial hard work and costs of constructing mud silos is normally offset by their longevity, as well as other benefits of mud silos. Farmers in areas where mud silos have been introduced recommended that it would be very helpful to train them in the maintenance of mud silos, as carried out in its areas of origin" (Stevenson, 1999).

This recommendation needs to be implemented as early as possible to enhance the potential of mud silos in the new areas.

3.6 Crop production levels in Gushiegu-Karaga

Land area planted to maize in 2002 and 2003 was reduced while the area of land cultivated for rice, sorghum and millet increased significantly in the same period (Fig. 3). The area of cowpea cultivation remained almost unchanged.

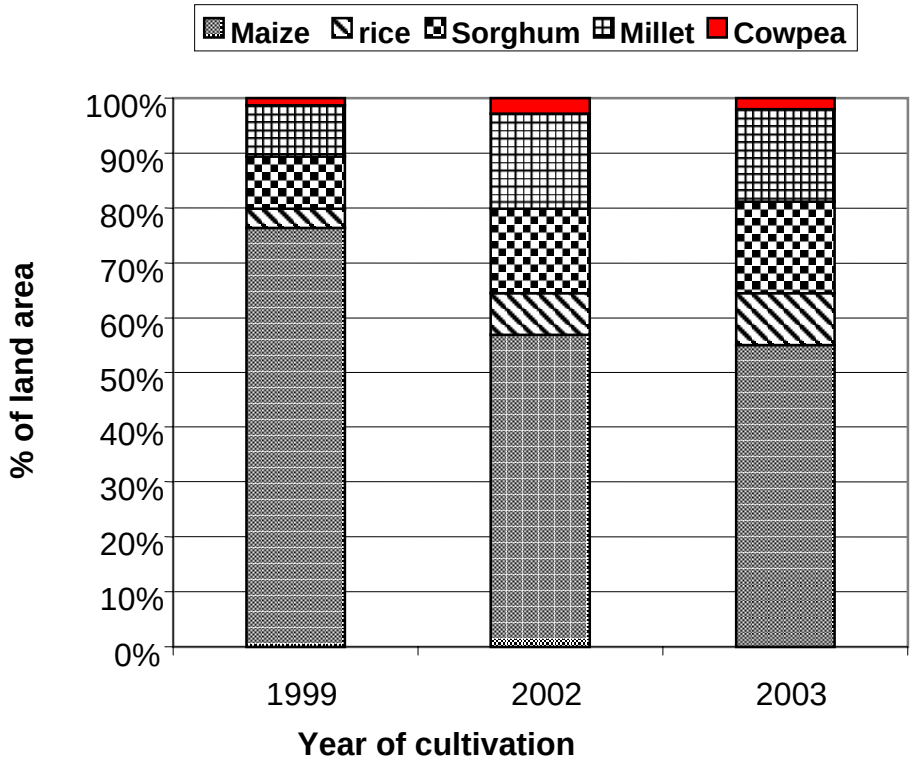

Figure 3 Percentage of land area allocation to different crops

These changes in area cultivated had an obvious impact on the size of the harvest (Fig. 4) so that maize output between 2000 and 2003 declined and the production of rice and millet showed modest increases. The production of sorghum declined in 2001 and 2002 but regained its original level in 2003, while cowpea seemed to remain at a low level throughout the period.

The emerging changes in the cropping pattern of the farmers imply new trends in benefits derived from the various crops, resulting in gradual increases in the production of promising crops. The mud silos in Gushiegu/Karaga appeared to have caused some changes in the crop mix of farmers in the area.

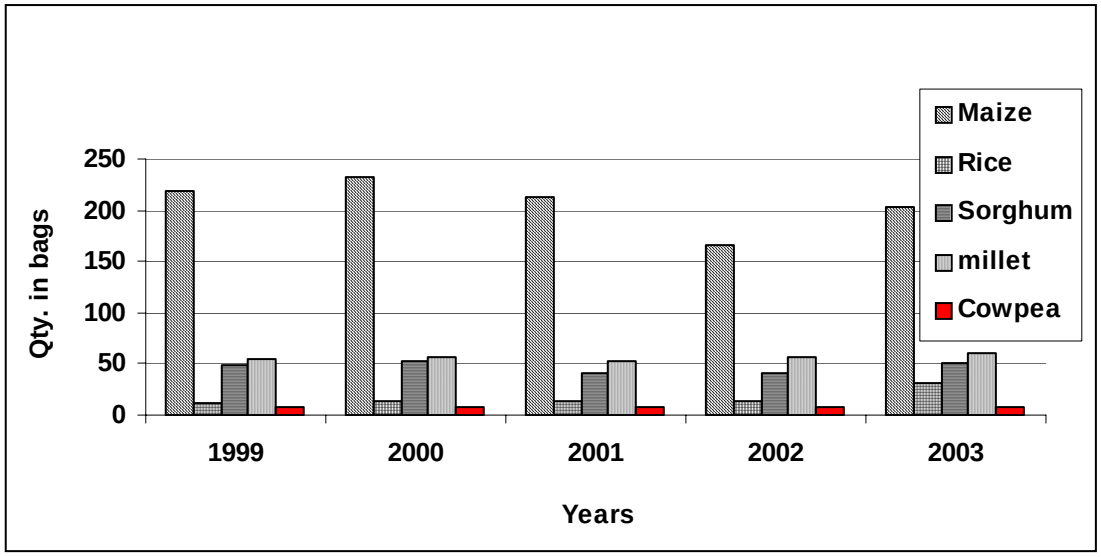

Figure 4 Trend in food production in Gushiegu/Karaga before and after mud silo introduction in 2000

3.7 Benefits derived by owners of mud silos

Reduction in Storage Losses

The protective capacity of the mud silo was strongly commended by beneficiaries in Gushiegu/Karaga during group discussions. This reaction was confirmed by the results of storage losses estimated for the year 2002, shown in Figures 5, 6 and 7. The total quantity of maize, sorghum and millet lost to farmers during storage in mud silos were low compared to losses from other structures used by those who did not have the mud silo.

Figure 5 Estimates by farmers of maize storage losses from mud silos and other structures in 2000 (N = 60)

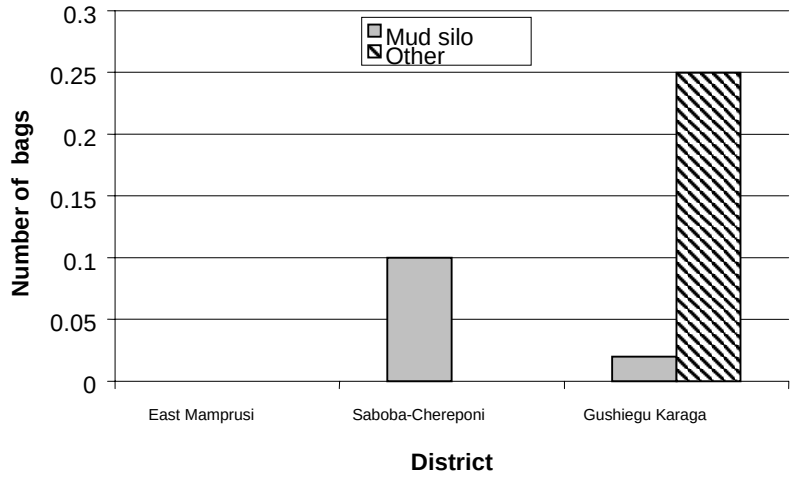

Figure 6 Estimates by farmers of sorghum storage losses from mud silo and other structures in 2000 (N = 60)

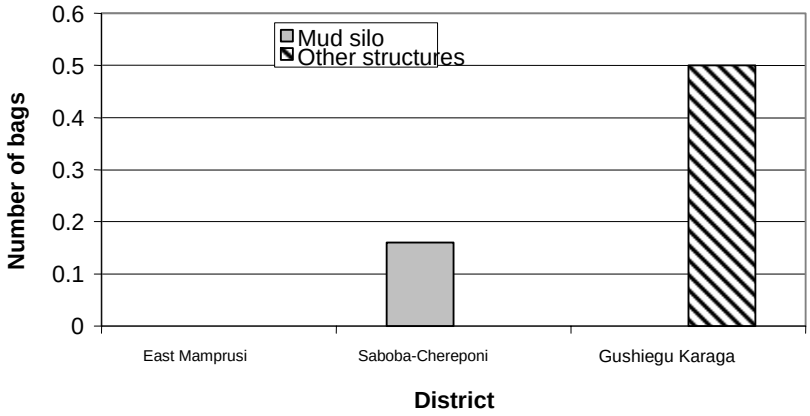

Figure 7 Estimates by farmers of millet storage losses in mud silos and other structures in 2002

Generally, no storage losses were found for all the crops in all structural types in East Mamprusi district unlike Saboba/Chereponi where storage losses were high in the traditional mud silos. Respondents in the district had earlier complained at group discussion sessions about insects entering their food stores during processing and loading of grains into their structures. It was also evident that farmers in Saboba/Chereponi do not do a thorough cleaning and treatment of their structures in preparation for the arrival of new produce. Many farmers were found keeping long-term stocks in the different compartments.

The results of Gushiegu/Karaga show minimal storage losses mud silos for maize and sorghum. As evidence of the efficiency of the mud silo two farmers in Gushiegu district brought samples of very wholesome maize which had been stored in the mud silo for 12 months. The protective ability of the mud silo was further evidenced by the persistent demands by farmers during group discussions for the construction of additional structures.

3. 8 Other benefits derived from use of mud silos

During focus group discussions farmers in Gushiegu/Karaga district were asked to list what they perceived as benefits they were deriving from the mud silos since their introduction three years ago.

A summary of what we received from six groups after long debates are provided below.

Annual savings for not buying jute sacks

Many beneficiaries of the mud silos in villages of Gushiegu/Karaga said they had saved sums of money they would have spent on jute sacks that they would previously used as containers to store farm produce. In many cases, shelled maize and cowpea used to be stored in jute sacks. A development they considered very significant because of the rising price of jute sacks on the market, which has result in an annual increase in the cost of storage for those who do not have mud silos and for those beneficiaries whose silos have either collapsed or those with inadequate storage capacities.

Analysis of the annual nominal price of jute sacks revealed a progressive increase ranging from 1500 Cedis per bag in 1999 to 6000 Cedis in 2003 (Fig. 8).

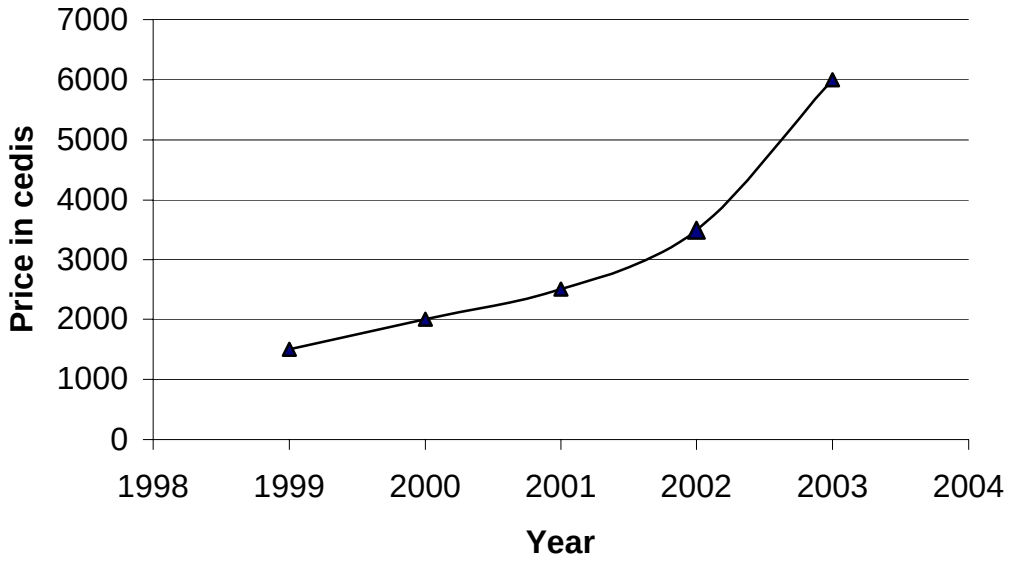

Figure 8: A progressive annual rise in the price of jute sacks

A further analysis of cost savings indicated that even though average maize productivity and storage quantities declined in 2001 and 2002, the amount of money beneficiaries would have expended on jute sacks for storage were higher than the amounts required in the previous years of higher productivity (Fig. 9).

These modest sums of money retained as savings by these particular groups of farmers and the prospect of such future rewards was most satisfying to the respondents.

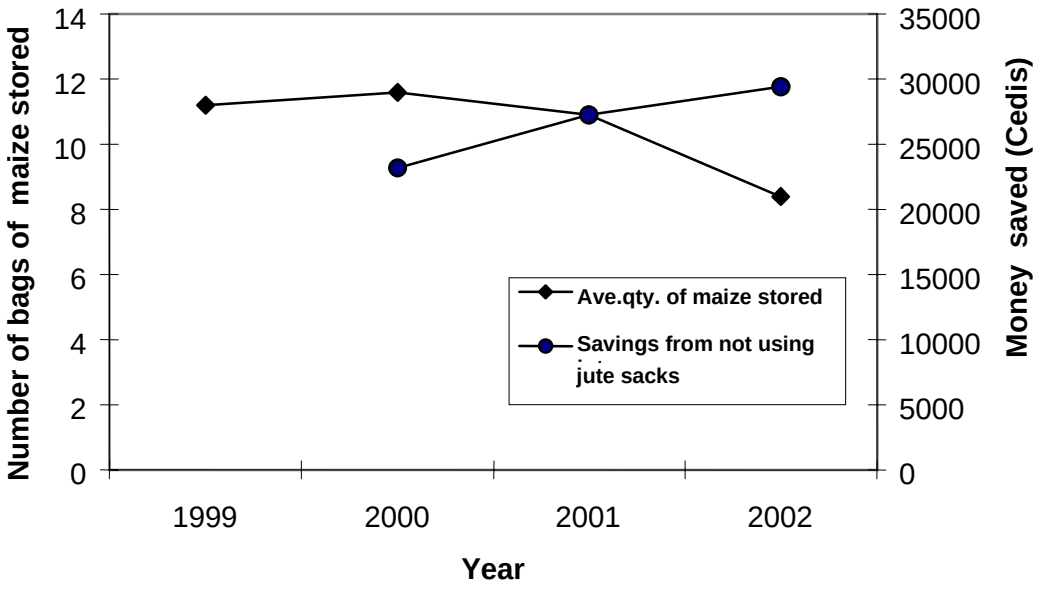

Figure 9 Increasing savings to farmers not storing in jute sacks

Time saving for other household assignments
Farmers believed that without the mud silo those who would not be able to buy jute sacks would expend plenty of time weaving baskets or building kanbons. That time is now used in doing other assignments and for leisure.

Others uses for sorghum stalks and wood lots
Sorghum stalks, which had to be used for weaving storage baskets, are now used for mats, and as fuel wood for cooking.

Reduced exploitation of wood lots
Special types of wood are required for the construction of kanbons for the storage of maize mainly by the Dagombas, Gonjas and the Mamprusis, in the Northern Region. Before the introduction of the mud silo beneficiaries in Gushiegu travelled long distances to procure the right type of wood to construct kanbons. The situation has been worsened in recent years by bushfires, which destroys vast acreages of woodlots annually.

Improved food security for households.
Those farmers able to generate and maintain (i.e. not be forced to sell to meet pressing HH requirements) surpluses can now keep household food reserves for as long as they wished. As evidence two farmers produced samples of good quality maize, which they claimed had been stored for 12 months.

3. 9 Incomes derived from late sales

When we demanded benefits derived from selling produce at better prices, farmers responded that little benefits had been achieved as cash income because of the timing of produce sales. They clarified, that higher quantities of cash crops like cowpea and pepper are sold at harvest together with small quantities of the staple crops to pay

debts, and to offset household expenses and thus retaining the greater proportion of foodstuffs for family consumption. By tradition, surpluses from the family store could only be sold at the start, or after the next harvest. By the next harvest however, many other families would also start selling whatever surpluses they saved after consumption. Quantities of food from these surpluses that go to the market, together with the new harvest of early maturing crops that start arriving in the market create periodic annual gluts with resultant low prices at the time poorer farmers consider it safe enough to sell. The analytical outcome of formal responses to questions related to sales behaviour over the storage period however revealed that a significant percentage of farmers were involved in stock sales over the storage period in the 2002 storage season. For reasons of time limitation, sales activities involving only maize stocks are produced in figures 10, 11, 12and 13.

The average price of maize just after harvest in 2002 was 80,000 Cedis (Fig. 10). Between three and four months after harvest farmers on the average made the first sale of maize at a high price of 110,000 Cedis after which the price started declining at subsequent sales to 100,000, and 98,000 Cedis respectively.

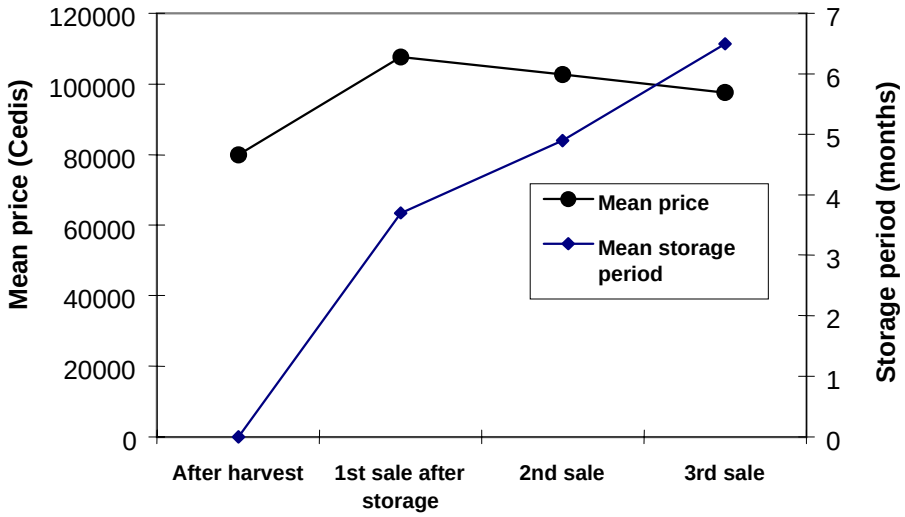

Figure 10 Maize price fluctuations over the storage period in 2002

The number of farmers selling maize increased after harvest up to the period where the majority of the farmers made their first sales and thereafter declined for the second and third sales (Fig. 11). In spite of the relatively high prices prevailing, the inability of many farmers to sell maize during the second and third sales period imply that either the farmers did not have surpluses or that they did not feel safe enough to sell part of the family food reserve. This behaviour portrays the critical state of food insecurity for families in the study area. Hence, the need for an effective storage system for the farmers.

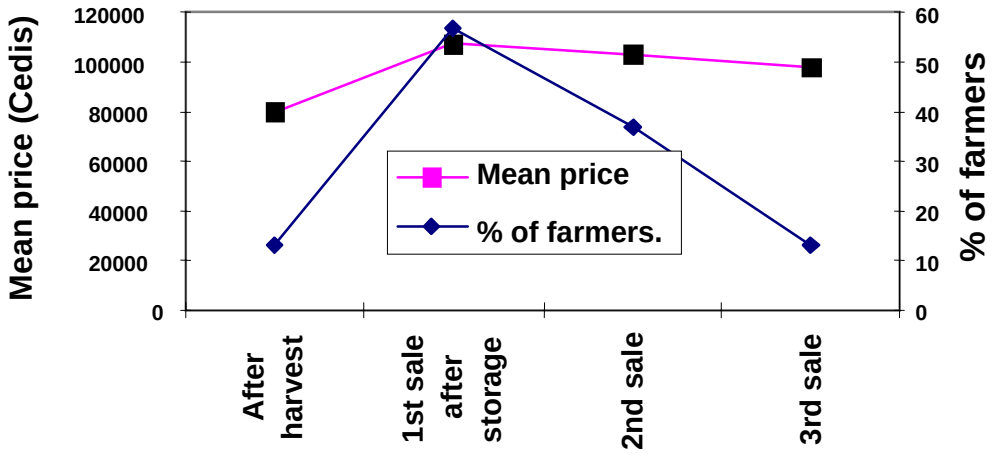

Figure 11 Sales response by farmers to price movements in 2002

More farmers sold maize between 3.5 to 4 months of storage than the number who made sales later (Fig. 12). As the period in store increased fewer farmers had maize surpluses to sell, implying food insecurity at a time when prices are high.

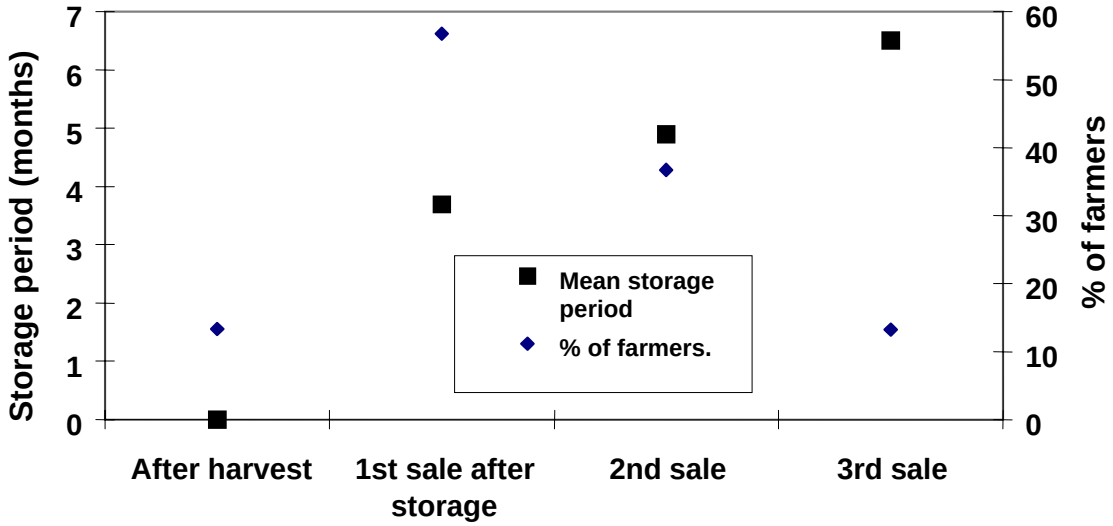

Figure 12 The proportion of farmers selling grain at harvest and the length of storage before subsequent sales (N = 60)

The quantities of maize sold by farmers immediately after harvest were higher than quantities sold in subsequent sales periods even though a lower percentage of the farmers sold maize during harvest (Fig. 13). The implication however is that, crops like groundnuts, rice cowpea, 'neri' and sorghum were sold in the process of storage in addition to domestic animals for family expenses, while higher proportions of important staples like maize, millet and dried cassava stayed at home for household nourishment.

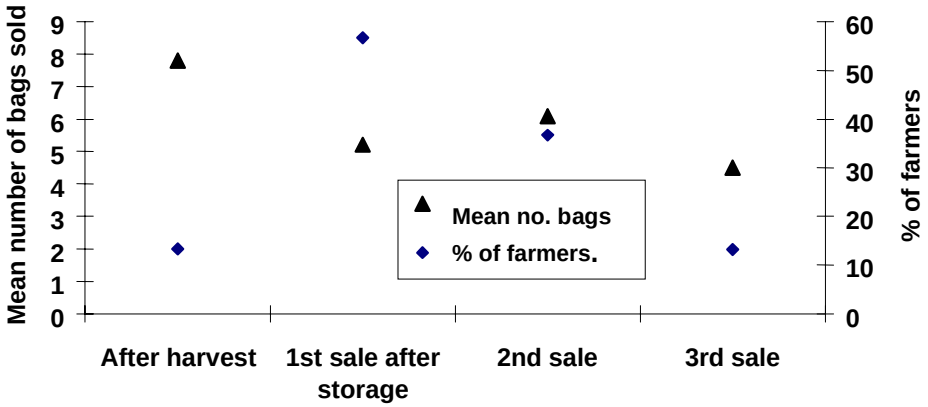

Figure 13 Quantities of maize sold by farmers over the 2002 storage season (N = 60)

3. 10 Problems of new mud silos in Gushiegu/Karaga

The problems found to be associated with the newly introduced mud silos were mainly technical and relate to construction defects comprising the following:

- Wide opening which makes grass coverage more difficult to manage.
- Thin legs, which are not strong enough to support the structures when loaded with goods. They easily get wet from rain water
- Wrongly shaped and unbalanced stone supports for legs
- The lack of adequate grass and other binding materials
- Construction in haste and not allowing for layers to dry before next layers are pasted.
- Wrong clay type used for construction in many communities. This weakens the walls of the structure
- No fence wall to protect structure from rain
- Small sized capacities.

Some of these problems were said to result from the following issues:

- Improper construction. The silos were constructed too hurriedly so that the clay used was not given sufficient time to mix and set into the appropriate consistency required for mud silo construction. In many cases the wrong type of clay were also used.
- Insufficient binding materials during construction
- In many villages the plant that is mixed with water to provide the 'sliming' liquid to cement the clay was not available for use. In places where these local binding agents were applied the number of silo demanded per village and the limited time available for their construction made it impossible for a good job to be done. There was a recommendation (Stevenson 1999) concerning the availability of construction materials as follows:

> "Projects aimed at promoting mud silo technology should take into account the location of the communities, the availability of construction materials, and efforts should be made at creating awareness among farmers for the need to judiciously exploit the natural environment. The first point of focus for achieving this could be the trainee builders. When they are made sufficiently aware, they could pass on the message to other farmers and their apprentices while they go round constructing mud silos in communities."

Observations during the study revealed that stones used as support for the feet of mud silos under traditional construction were appropriately shaped for the legs to stand comfortably. At Gushiegu we observed that stones of irregular shape and uneven surfaces had been used to support the legs of structures. As such, many structures did not look well balanced in their standing positions as compared to the local silos in Saboba (Fig. 14)

Figure 14 Thin legs of Gushiegu/Karaga mud silos, set on rounded instead of flat stones

Figure 15 Elephant size legs of Saboba/Chereponi mud silos set on flat, firm and well balanced stones

In addition, the small sizes of the legs are not able to support the weight of the silos when loaded with food. Beneficiaries are experiencing difficulties in providing watertight grass coverage to the wide openings allowing rain water to enter the silos in small quantities and eventually weakening the structure at the base and since the legs are also small it is easy for the structure to collapse.

Figure 15 Mud silo at Gushiegu/Karaga with wide opening making protection from rain more difficult. The two mud silos here have collapsed on their small legs.

Figure 16 A Kokomba mud silo tapered into a small opening at the top making coverage easier.

Some structures found on the ground simply burst into pieces spilling their contents in the process (Fig. 16).

Figure 16

The absence of a fence wall or protecting house to ward off rainwater, were absent in the promotional areas. In traditonal areas such as Bimbagu the structures are found sitting in rooms. The smaller storage structures were built inside the rooms of women. However the practice of building a roofed fence (Fig. 17) around a mud silos was very protective against rains in Saboba/Chereponi district where many silos were aged 25 to 65 years. These protective practices need to be introduced to new users of the mud silo.

Figure 17 A mud silo standing inside a roofed fence house for protection against rains in Saboba-Chreponi district. Farmers in the newly introduced areas could be directed to do the same.

3. 11 The issue of collapsing structures in Gushiegu/Karaga

Due to persistent complaints by respondents that some mud silos had broken or collapsed, our team decided to take a preliminary census in the last five villages we visited in Gushiegu/Karaga. The undertaking was to help us determine the extent to which the new structures were collapsing. The results revealed that many farmers have lost one or more of their structures resulting in the loss of a high percentage of the new structures in some localities, as shown for the corresponding villages below (Fig.18).

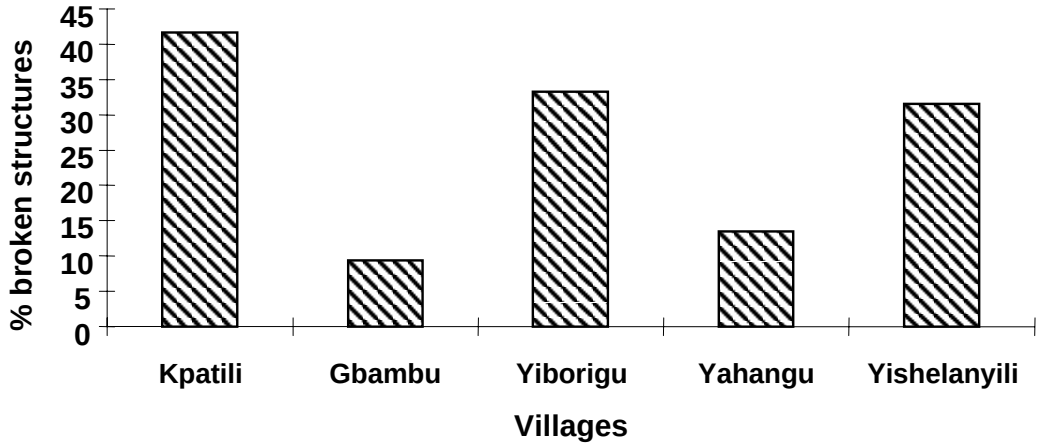

Figure 13 The percentage of structures broken in some villages of Gushiegu/Karaga

The incidence of mud silos collapsing on their feet or bursting while containing food (Fig. 16) was said to be a widespread and ongoing problem. Considering the number of broken silos within the short period of two and half years in these villages, it is suggested that technical expertise is sought and a further study of the problem is made on a wider scale in all the districts benefiting from the mud silos extension programme to assess and to throw a broader light on the gravity of the situation for prompt remedial action.

CHAPTER FOUR

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Using Gushiegu/Karaga as a representative of new users, the study examined the process and achievements of mud silo promotion in new areas in the Northern Region of Ghana and comparing their performance to those in the traditional areas where the structure originated.

4.1 Summary

Relevant Demographic Characteristics

1. The study revealed that the majority of mud silo owners among traditional users, and beneficiaries in the new user areas are men. Reasons for the highly skewed result include the inability of women to procure materials for the construction of the mud silo and the difficulty of maintaining and using the mud silo in its present form. There were indications also that MoFA and the OICT did not make efforts to sensitize women to aspire for and demand the mud silos for their personal use.

The inability to read and write

2. Results of the portrayed a low educational background of the respondents implying that simple promotional pathways need to be employed to help beneficiaries understand the procedures involved in the use of storage options and to enable them see the need to adopt treatment options conducive to their individual needs.

3. The study revealed that about 46.6 % of the respondents practice polygamy with between 2 to 4 wives and 9 to 50 dependants, implying possible usage of family labour for large scale production and the need for household food and cash security in the study area.

Mud silo promotion and recommended processes

A preparatory study to the extension programme (Stevenson 1999), entitled "Report on Participatory Rural Appraisal on Mud Silos in Northern Region of Ghana", came up with the following recommendations proposed to guide the promotion programme:

1. That whenever MoFA is encouraging the adoption of mud silo, farmers should be allowed to determine the capacity of the structure to meet their needs for storage.

2. That the ease of construction of the mud silo could be greatly enhanced when many more farmers are trained. Farmers said if about 20 farmers per village were trained; the ease of construction and availability of skilled labour would be greatly improved. MoFA should therefore tackle this issue seriously and facilitate the training of large numbers of farmers in districts where mud silos have been introduced.

3. Projects aimed at promoting mud silo technology should take into account the location of the communities, the availability of construction materials, and efforts should be made at creating awareness among farmers for the need to judiciously exploit the natural environment. The first point of focus for achieving this could be the trainee builders. When they are made sufficiently aware, they could pass on the message to other farmers and their apprentices while they go round constructing mud silos in communities.

4. The initial hard work and costs of constructing mud silos is normally offset by their longevity, as well as other benefits of mud silos. Farmers in areas where mud silos have been introduced recommended that it would be very helpful to train them in the maintenance of mud silos, as carried out in its areas of origin

5. Yam is a principal crop in 10 out of 13 districts in Northern region. Farmers therefore recommended that builders of mud silos of sizes that can comfortably accommodate and store yams. Farmers should also be trained to create rainproof covers for their mud silos that enhance ventilation.

6. Not all villages in the districts surveyed have been included in MoFA's Mud silos Package, respondents however, said their relatives in such villages are keenly interested and have been asking them how to get such packages. In extending and expanding this package, MoFA or NGOs involved should consider training and educating farmers on the proper and appropriate drying methods to ensure that the benefits of mud silos are maximized. Simply expanding the package alone may not be enough to achieve the desired results.

Capacities of structures

Contrary to the recommendation that mud silo capacities depend on individual needs of beneficiaries, the capacities of mud silos found in Gushiegu/Karaga were almost identical and inadequate for the needs of many households resulting in a new surge of demand for the structure by beneficiaries who could not construct multiples of the structure.

Training of farmers as builders

The recommendation that at least 20 farmers be trained in each beneficial community to serve the needs of farmers who may require the structure after the extension programme was not implemented. Consequently, farmers in Gushiegu/Karaga district who for diverse reasons were not able to construct the structure, those with limited supplies and who as a result need additional structures to increase the household food storage capacity, as well as those who have lost structures through breaking as a result of improper construction, were found still waiting for MoFA to arrange for builders to serve them.

Construction materials

One major problem found to have been encountered during the extension was a shortage of the recommended binding grass and herbs in many communities of Gushiegu/Karaga leading to the use of available alternatives like rice bran, ordinary grass and 'dawadawa' seed covers, which could not provide the required binding effect needed to strengthen the structures in the affected localities.

The recommendation that the promotion process takes into account the location of the communities and the availability of construction materials were defeated by the overwhelming demand by farmers for the structure in all villages. It was not an easy task for MoFA to disqualify such communities who did not have the exact materials required. Furthermore, the aspiration of builders to maximize monetary gains from the project resulted in hurried, shoddy work in many cases.

Mud silo management and cost of structures to beneficiaries

In East Mamprusi, households were found keeping mud silos in rooms. Wives who take charge of weekly food rations from husbands have smaller mud silos in their lodgings, while men who manage the entire family food store for the whole year, keep a bigger structure in their halls. In contrast, mud silos in Gushiegu/Karaga and Saboba/Chereponi were found either lined up or grouped in front of houses.

Unlike Gushiegu/Karaga however, mud silos in Saboba/Chereponi district were found under better care and management hence, the bursting and breaking of the new structures in Gushiegu/Karaga. The need to train beneficiaries in the maintenance of the structures is long overdue. On the average, the direct cost to beneficiaries for constructing a 12-14 bag capacity mud silo in Gushiegu/Karaga district during the extension programme in 2000 was estimated at seventy (¢70,000.00) thousand Cedis. However, other direct and indirect expenses incurred by OICT and MoFA such as transportation and fuel as well as administrative costs, which were much higher are not included.

Direct gains from mud silos

1. The new structure in Gushiegu/Karaga occurred at the same time as changes in land allocation to crops by farmers in the area. The implication is that the emerging changes in the cropping mix of farmers using the new structure is in response to new trends in benefits derived from different crops, and thereby, resulting in gradual increases in the production of promising crops in terms of gains derived.
2. Improved food security for households.
   The use of mud silo technology provides beneficiaries with the potential of storing food reserves for long periods of time. As evidence two farmers produced samples of good quality maize, which they claimed had been stored for 12 months. Crops like groundnuts, rice, cowpea, neri and sorghum were sold in the process of storage in addition to domestic animals for family expenses, while higher proportions of important staples like maize, millet and dried cassava now endure longer storage for household nourishment.

Indirect gains from mud silos

Further benefits derived from the structure include the saving of sums of money which would otherwise go into the purchase of jute sacks, the shifting of basket weaving time for other ventures and for rest, the use of sorghum stalks and wood.
for mats, and as fuel wood for cooking, and reduced exploitation of woodlots.

Problems of new mud silos in Gushiegu/Karaga

The problems found to be associated with the newly introduced mud silos were mainly technical and relate to constructional defects caused partly by the hasty work done by builders. They comprise wide openings, thin legs, wrongly shaped and unbalanced stone supports for legs, thin and weak walls resulting from inadequate supply of grass and other binding materials in clay and the use of wrong clay types.

Other problems identified were the lack of education to beneficiaries on the care and management of structures and the inadequacies of structure capacities.

4.2. Conclusions and recommendations

1. The study revealed that the OICT and MoFA who undertook the mud silos promotion programme at Gushiegu/Karaga constructed a large number of structures for many communities across the district. However reports gathered suggest that the promotion exercise was done in a rush. Farmers were not adequately prepared in terms of the procurement of recommended construction materials while builders were not adequately supervised. These omissions led to the following problems:

i. Farmers were not consulted in terms of their storage profiles or requirements, leading to the design and capacities not being matched to the requirements of beneficiaries The implication is the use of a top down process, seeing farmers as passive 'beneficiaries' rather than active and knowledgeable players in their own right.

ii. The process failed to explore or address the needs of women, but built on the assumption that by targeting male HH heads, benefits would be equitably distributed to all other HH members

iii. The contractual arrangements with the builders – piece work – invited unduly hasty construction of the structures with the absence of quality control by the managers before payments.

In subsequent promotion projects, builders should be well supervised to ensure that the construction process is done with recommended materials and at the mandatory pace.

Considering the serious consequences of the use of unrecommended components for construction, it is suggested that subsequent to further promotions, technical expertise be sought. Consideration might also be given to requesting farmers to prepare for the programme as follows:

- To search for, or even plant, harvest and store recommended binding grass close to the time of construction.
- To search for, or even propagate the slimming plant or keep required quantities of powdered dawadawa pods in wait for the time of construction. Powdered dawadawa pods are normally mixed with the clay during construction by the Bimobas.
- To select and cut stones into the required shape to be directed by builders prior to the day of construction.
- To find and store the right type of clay in wait for the construction.

2. Recommendations made by a preparatory study to enhance the success of the promotion programme were in many instances overlooked

For instance, the recommendation to train as least 20 builders in each village was not implemented during the promotion period. It is suggested therefore that MoFA initiates a programme for the training of mud silo builders in beneficiary communities of the districts that have already benefited from the extension programme for the following reasons.

- Provide another opportunity for those who did not benefit during the first stage to have another chance to construct the structure.
- Enable first phase beneficiaries who need additional silos acquire more.
- Provide an opportunity for those who have lost their structures to reconstruct new ones.
- And most importantly, to provide a self-sustaining course of mud silos multiplication in the communities and in the region.

Furthermore, MoFA must ensure that in subsequent programmes, the training of some beneficiaries as builders is treated as a vital component of the extension as recommended earlier.

3. The division of a mud silos into storage compartments have two main advantages.

- The inner partitioning walls provide added support and help to reinforce and enhance the life span of the structure.
- The separate spaces created, augments the utility of the structure by its capacity to hold different crops simultaneously.

Unfortunately, none of the new silos were found to be divided into compartments and farmers pleaded that in the future they should be given the option to choose between structures with or without compartments, depending on the crop mix cultivated. All farmers in the study area cultivate multiple crops as food, cash and nutrition security measure.

4. A number of the introduced mud silos have collapsed.
It is therefore recommended that technical studies be instituted to undertake the following mission:

- Identify the causes of the problem.
- Examine all new structures to identify those in danger of collapsing.
- Embark on a programme to education farmers and help them institute measures to strengthen, fortify, protect and thereby prevent the remaining structures from collapsing.

5. In view of several complaints made by mud silo users in the Saboba/Chereponi district that insects find their way into mud silos when it is being loaded, it is recommended that farmers in that area be given special attention in storage procedures during the ongoing storage options promotion.

6. Farmers in the new user areas have been deriving both direct and indirect benefits since the introduction of the structure. For instance out of a total quantity of 6.42 bags of maize lost to respondents during storage in Gushiegu/Karaga in 2002, only 6.5

percent of the damage came from the mud silos structures. In addition, wood used for building kanbons by beneficiaries as well as sorghum stalks can now be directed to other purposes. Furthermore particular farmers can now have more leisure time after harvest and also make savings when they no longer need jute sacks. As a result more farmers from within and outside the district were request mud silos and thereby reinforcing the need for training some farmers as silo-building specialists in the communities.

7. In spite of the omissions in the course of the project and the associated problems as highlighted in Table 4.1, it was clear that the mud silos promotion was a big success, and that small-scale producers adopted the structure on a massive scale. Those who did not construct the structure are demanding the opportunity, while some of the beneficiaries are demanding more.

It is recommended therefore, that the promotion programme be given a second chance since the map of the study area (Fig. 1) affirms the large section still left uncovered by the programme.

Table 4.1. A Summary of the conclusions and recommendations of the mud-silo survey: A matrix for exploring the process/technology with associated problems

Technology ➔ Process features ⬇	**Role of promotional programme/agencies, MoFA, OICT and ADRA** (differentiate performance)	**Hardware** (e.g. physical aspects)	**Knowledge** (e.g. 'know-how', skills, experience)	**Organisation** (& institutional aspects)	**Product** (storage crops)
Promotion / pre-construction period	1. C - MoFA & OICT promotion exercise done in rush; farmers not adequately. 2. C – Preparatory study recommendations overlooked with negative consequences	1.C- Bimoba type mud silo used for demonstration and experiments on storage efficiency for many years used for promotion. 2.C- Education of farmers on the need to provide recommended component materials not adequate. R- More elaborate preparation required in terms of farmer education and storage of construction materials before commencement of similar exercises in future.	1. C- Farmers informed of mud silo programme by MoFA, OICT and ADRA representatives in beneficiary areas. 2. C- The know-how, skills and experiences of selected builders seemed inadequate. 3. C- The training of a number of beneficiaries per community not implemented. R- Experienced builders preferably from the traditional origins better suited for such massive promotion exercises. R- The training of an adequate number of young farmers from beneficiary communities is urgently necessary.	1. R- Community level organisation is necessary as a pre-requisite promotional information transmission and village selection criteria for self-build training programmes.	C. Apart from yams farmers were encouraged crop types could be stored in mud silos
Construction period	1. C – poor supervision of imported artisans 2. R - Builders need tight(er) supervision. 3. R - Period to promote	1. (C) 'Piece-work' led to too much haste; no time for curing & hence shoddy construction. 2. C - Some evidence that 'alternative' materials were inadequate and weakened	1. R - Period for silo construction is after rains when materials are available and sufficient time should elapse for curing before initial loading.	R-(As above) Organisation should hire experienced artisans to build and to train locals for durability and	1. (C) Traditional users of mud silos, who tend to produce surpluses for different crops, accommodate

	building programme is after rains: materials available and loading will not take place before suitable time elapsed.	structures; and that foundation stones were poorly selected. 3. R – use proven materials; train farmers in finding/identifying (or planting) recommended clay, binding grasses etc; undertake efficacy study of alternative materials?		maintenance of structure as well as the self-sustainability of the technology.	these in 'compartmentalised' silos. 2. (R) Design should take account of (present & potential) production profiles (see 1).
Utilisation period - use & maintenance issues	R. The requisite training in care, maintenance and utilization should be obligatory to promotion agencies in subsequent promotions to avoid a waste of resources through damages to structures and produce.	1. (C & R) Where farmers contributed materials (e.g. cash, materials, labour for fetching water etc) for construction, maintenance more likely to be assured (OICT). 2. C – storage compartments give silos additional strength and utility. R - Design must take account of people's needs (e.g. size of opening be narrowed and design types be available for categories of people /weak/ strong/ adults /children) and compartments must be introduce for increased usefulness and strength of structures.	1. (C) Lack of education given to 'beneficiaries' for the care and maintenance of structures. 2. In Saboba/Chereponi district where large size type silos are used, people report storage pests enter during loading. (R) People need to be informed on how to locate and maintain structures for security R – Farmers might be trained in storage practices to counter the introduction of pests during loading.	C- Promotional institutions could not provide sufficient education to beneficiaries on the care and utilization of structures.	F – In Gushiegu/Karaga 2002, of a total of 6.42 bags of maize reportedly lost by respondents during storage only 6.5% of the damage was associated with mud silos. C- The mud silo could reduce storage losses by 93.5 percent if properly utilized. R- Non-beneficiary farmers have urgent need for the structure.

C – conclusions; R – recommendations; F - finding

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