POST HARVEST LOSS MANAGEMENT IN CORAD LINKS COMMUNITIES

AN ASSESSMENT OF POST HARVEST SYSTEMS & TECHNOLOGIES

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4 ABBREVIATIONS AND ACRONYMS

Africare	Africare (International NGO)
CARE	CARE (International NGO)
CORAD	Consortium for Rehabilitation and Development
CRS	Catholic Relief Services
DACO	Development Assistance Coordination Office
FAO	Food and Agriculture Organization
FFS	Farmer Field School
FGD	Focus Group Discussion
GoSL	Government of Sierra Leone
IGA	Income Generating Activity
IPM	Integrated Pest Management
IVS	Inland Valley Swamp
MAFS	Ministry of Agriculture and Food Security
MSF	Medecins Sans Frontieres
WV	World Vision

5 INTRODUCTION

The Promoting Linkages for Livelihood Security and Economic Development (LINKS) Project is designed to broaden the range and increase the productivity of livelihood activities at the community level and to link these more integrally into regional and national market systems. The CORAD Developmental Relief Project (DRP) that ended in February 2007 and was funded by USAID-FFP, focused on reestablishing agricultural production at the community level. The LINKS Project builds on this foundation by further expanding community productivity in the micro-enterprise sector and, most importantly, by integrating communities into district and national input supply and produce markets. LINKS has sought to achieve its objectives by building the capacity of Farmer Field Schools to continue to increase their agricultural production through experimentation and innovation.

Working with different community groups in the focal communities, CORAD identified post harvest loss management as a major constraint in all the target communities[1]. Post harvest losses present one of the major problems not only in the production system but along the market chain. Post-production losses and deterioration of food or crop quality are areas of major concern as this directly impacts household incomes and the duration of the seasonal food shortage. The importance of such systems for crops that contribute to household income and food security or are of export importance cannot be overstressed particularly as CORAD's strategy is for increased productivity and strengthened household resilience through increased incomes.

A post harvest system is a series of operations and functions between production and consumption of any agricultural commodity. Farm produce from the farm to the consumers must pass through this system. During this transition losses occur due to spatial and time lapse between the producers and the consumers. The total food loss experienced is a cumulative result of all activities along the system and the prevalent physical and biotic factors operating at each phase. Phases like harvesting, transporting, pre-processing, storage, processing and marketing, can either add or subtract value from the end product.

Loss is defined as any change in the availability, edibility, wholesomeness or quality of food that prevents it from being consumed by people[2]. Food losses may be direct or indirect. Direct loss results from spillage or damage by insects, rodents and birds. Indirect loss on the other hand refers to the lowering of quality to the point where food cannot be utilized. Food losses occur between production in the field and purchase by the consumer due to the different phases and time lapse between the

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[1] CORAD DRP Final Assessment Report, 2006

[2] Harries, K.L. and C.J. Lindbled (1976), Post Harvest Grain Loss, Assessment Methods UK; pp.129

two. The total food loss experienced is a cumulative result of the interaction between the various actors along the system and the prevalent physical and biotic factors operating at each phase.

Post harvest loss is estimated at between 30 and 50% of all food crops in Sierra Leone[3]. If post harvest losses are reduced, food supply can be increased by 30-40 % without cultivating additional hectares of land or increasing additional expenditure on seed, fertilizer, water control and plant protection measures. However, for a crop like cowpea, storage losses were estimated at about 50% of total production (Roberts, 1983)[4]. Work done by Roberts (1983) and Rashid-Noah (1985)[5] on cowpea storage systems in Sierra Leone identified plant substances and storage structures that could be used to store cowpea grain. Powdered cloves and airtight metal containers afforded a high level of protection against the cowpea weevil.

Some work was also done on rice post harvest and storage systems by the Rice Research Station at Rokupr before the war. Investigations focused on the effectiveness of one type of storage structure (wooden or metal silo) for storing rice on a large scale. However, when the Government of Sierra Leone experimented with prefab metal silos, they found them unsuitable (Koroma, 2003)[6]. Although no reasons were stated for this, it could be that farmers preferred individual storage systems so as to keep quantities they stock secret, or that they have not been trained to successfully manage and run communal stores. From the previous investigations, drying floors and storage systems were provided for some rice growing communities. Information on how many of these storage systems remain and/or are being maintained or functional is not available.

Identification of weak links where significant losses occur, the causes of these losses and their estimated levels is necessary for an overall understanding of the workings of the post harvest systems in Sierra Leone. The importance of such systems for crops that contribute to household income, and food and nutrition security or export cannot be overstressed particularly as Sierra Leone strives for “food for all by 2007”.

The findings and lessons learned from this assessment will contribute to CORAD’s understanding of the problem and how to increase small holder productivity through a series of activities that promote growth throughout the sector. It will inform

[3] These figures are guestimates as no statistical estimates are available. Some workers in the field believe loss could be much higher.

[4] Roberts, J. M. F. (1983). *Callosobruchus maculatus* (F) infestation of cowpeas and their control using local plant substances; MSc. Thesis, Fourah Bay College, University of Sierra Leone.

[5] Rashid-Noah, A. B. (1985). Cowpea Storage Project (Phase 1: 3-P-79-007). Technical Report submitted to the IDRC. 93pp.

[6] Koroma, E.Y. (2003), Agricultural Mechanization and Post harvest Services in Sierra Leone. Report for the Agricultural Sector Review. 63pp July 2003

CORAD's strategy for increased availability and utilization of crops as well as increased productivity that will strengthen household resilience through increased incomes.

6 METHODOLOGY

Based on the TOR, these target crops were to be assessed, namely:

1. Rice – a grain crop and staple food
2. Cassava – a perishable root crop and a staple
3. Tomato – a perishable vegetable – a major food vegetable with economic potential
4. Groundnut – a non perishable oilseed crop and a major food oilseed with economic potential
5. Cocoa – a tree crop – a major export crop.

The bulk of the field work was carried out in the three LINKS districts in Sierra Leone. These are Kailahun and Kono in the East, areas of tree crop farms, and Koinadugu in the North a lightly populated area, many of its' villages remote, a major vegetable producing district in Sierra Leone (Fig. 1)

Figure 1: LINKS Districts covered by study

Key informant interviews and focus group discussions (FGD) were conducted to gain an in-depth understanding of the context within which the post harvest systems in these three districts operate. Field interviews were with male and female farmer groups. The results of these interviews were also used to triangulate and interpret household survey findings.

Questionnaires were also administered to farm households in selected villages in these districts. During the field study, it was observed that farmers and participants taking part in the survey related to quantity in terms of volumes rather than weights. These volumes were relatively standardized even though weights of different produce differed for the same volumes (Appendix 1). In addition there are inherent constraints in ascertaining exact storage loss in terms of weight. Volumes of

Figure 2: Women using PRA tools in Waiima, Fiama Chiefdom

damaged or infested produce at each phase, were compared with total volume of produce to give proportional percentages of produce loss at each phase. Quantity loss experienced was recorded as volume proportions rather than weight proportions.

Losses in quality are evidenced by a decrease in the market value of the product. These losses are quantifiable only on condition that certain standards of quality have been previously established. In terms of quality, there was no set standard against which the quality could be measured. However what the farmer considered as poor quality was produce that would not be accepted by the consumer or that would have to be thrown away or given away at a very low price. Economic loss for the farmer is when that farmer misses a profit.

Loss was to be considered in terms of quantity, quality and economic loss.

- Quantity – weight or volume/hectare of produce lost
- Quality – proportion of spoiled, infested, infected or contaminated produce
- Economic – if value was added or lost during the commodity's passage through the system.

Data was collected during the month of June 2007, which marks the beginning of the major rainy season. Focus Group Discussions (FGD) were held with communities in the CORAD districts as shown in Table 1.

Table 1: Composition of the FGDs in the different districts

District	Females	Males	Mixed	Total
Kailahun	4	1	2	7
Koinadugu	2	1	4	7
Kono	2	2	-	4
Total	8	4	6	18

The mix was based on the FFS and non-FFS participating groups available during the survey period. The post harvest systems in these three districts were considered in the light of various issues.

7 Issues Considered

The post harvest systems in these three districts were considered in the light of various issues. Key among these issues were:

1. The current status of the post harvest systems in the CORAD LINKS districts
2. Constraints in the use of these systems
3. Identified gaps, promising practices and available technology.

In light of these, various other issues would be considered, such as:

- The available infrastructure,
- Areas where major losses occur,
- Farmers perceptions on the levels, causes of loss, and commercially viable solutions to constraints
- Farmer storage practices,
- Market chains for the different crops,
- Availability of appropriate technologies for female farmers.

It was felt that to understand the post harvest systems for the different crops we first of all had to know where it starts, hence the crop harvest calendar was developed.

7.1 Harvest Calendars

A composite harvest calendar was developed for the five crops in the three districts. This output helps compare those periods when the different areas are able to supply produce with the periods when market prices are likely to be high. In short this type of information helps to minimize losses by informing on duration of available produce in the different areas. The composite picture for each crop is provided in the following chapters.

Figure 3: Dried cassava "tuoh". Note absence of coloration or spots of fungal colonies (black spot)

From the calendar, cassava is harvested throughout the year depending on the variety. Also it dries easily to preserve for June and July. By this time 'Tuoh' stocks are low or have run out and cassava is again harvested in August. Depending on the care taken during drying and storage, cassava can be stored for long periods maintaining its good quality, good color and not riddled with insects and covered with fungus

It was observed that cassava harvests in the early part of the year - January are mostly directed at the consumption market as the variety harvested at this time cooks easily; an important consumer requirement. Furthermore, cassava harvested between July and September is to bridge the seasonal food shortage during the hunger season. In Kono district cassava is

harvested in May and June because it fetches a high price and if left in swamps it would rot. This cassava is then processed into gari.

Rice in inland valley swamp mostly Nerica is cultivated twice a year and harvested in February and November. On uplands, rice is harvested in August through September. This rice could either be sold off quickly or dried properly and stored. **"In Koinadugu we are using a combination of varieties to maximize food production."** an FGD participant commented. However there are many problems during the dry season harvest.

Figure 4: Discoloration in dried cassava due to poor drying

Social activities during the start of harvest could explain why some of the rice crop is not stored. It is felt that during these activities food availability is not a problem so there is no need to store. The activities could also delay harvesting times which could lead to post harvest problems such as shattering when over dry paddy is harvested.

In the case of local tomatoes, varieties cropped on upland farms are harvested around June for quick cash to supplement household income needs during the planting/growing season. The improved plum variety is harvested in July and the early tomato harvest in October is to coincide with the World Food Day Program activities.

In the case of groundnut harvest, this peaks during the rains and the crop is dried on elevated thatch covered platforms with slow source of heat underneath to assist with drying.

Cocoa an important economic tree crop in Kailahun and Kono districts and cocoa harvest starts in August and ends in December/January with full harvests obtained in October. 'Fire sales' take place during the latter part of the rainy season and sell off their poorly dried cocoa – heavy with moisture to obtain quick cash (cocoa is bought on a weight basis). Heavy rains and high humidity in August creates a drying nightmare for cocoa farmers; the high humidity and the attendant drying problems causes molding. This negatively impacts earnings in September when cocoa farmers need to pay school fees and pay workers at the onset of the rice harvesting season. The cocoa produced in December and January is stored for a brief period when the rains would have ended and the conditions favourable to produce high quality cocoa. There is an underlying competition for drying and storage facilities between cocoa and other crops harvested between September and December. Looking at the crop price ratios at this time farmers would favour cocoa at the expense of the other crops which could explain why cereals are sold off faster immediately after harvest.

Table 2: Crop harvest calendar for Kailahun

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice IVS	Peak	Peak	End								Start	Peak
Rice Upland									Start	Peak	Peak	End
Cassava	Cooks			Cooks		Start	Peak	Peak	Ends			
Cocoa	End							Start	Start	Peak	Peak	End
Groundnut						Start	Peak	Peak	End		Start	End
Tomato									2-wks			
Rainy Season					Start			Peak			End	
Social Calendar	Traditional Society								SR	Traditional Society		

Table 3: Crop harvest calendar for Koinadugu

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice IVS	Peak	End/N							CCA		Start/N	Peak
Rice Upland	End/Y							N			Start	Peak
Cassava	Start	End						Start	Peak	End		
Groundnut						Start	Peak	Peak	Peak	End		
Tomato	End					Start	Peak	End			Start	Peak
Season Rains						Start		Peak		End		
Social Calendar	Traditional Society									Traditional Society		
Social Calendar									SR	WFD		Xmas

Table 4: Crop harvest calendar for Kono district

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice IVS	Peak	End										
Rice Upland									Start	Peak	Peak	End
Cassava					Start	Peak	End					
Cocoa	End							Start		Peak		End
Groundnut					Start	Peak	Peak	End				
Tomato				Start		End						
Season (Rains)					Start			Peak			Ends	
Social Calendar	Soc. activities								School	School	School	Society

8 CROP IMPORTANCE

Communities in the three districts placed different priorities on the crops to be assessed (). In all the districts, rice was mentioned most times as one of the three main crops that were grown. Due to this rice was ranked as a crop of primary importance and is also the national staple. Tomato as a perishable vegetable was mentioned after the others. The composition of the list shows that in Kailahun district cocoa was considered next after rice. During discussions it became clear that cocoa was being used to provide income to supplement food shortages during rice production. Table 5

Table 5: Crops ranked in decreasing order of importance

	Districts		
Crop Rank	Kailahun	Koinadugu	Kono
1	Rice	Rice	Rice
2	Cocoa	Cassava	Cassava
3	Groundnut	Groundnut	Cocoa
4	Cassava	Tomato	Groundnut
5	*Tomato*	--	*Tomato*

In the Koinadugu and Kono districts, cassava was being used to fill this gap. After these crops came groundnut and tomatoes. It could also be that the latter two crops are seen as a woman's crop to take care of her needs and give her some amount of independence, whereas rice was considered as belonging to the man to provide for the family. In Koinadugu drier climatic conditions would favor the drying of peeled raw cassava into 'Tuoh' or 'kondogbala' which could be stored for considerable lengths of time. The 'Tuoh' was from freshly peeled cassava, whereas the 'kondogbala' was from blanched peeled cassava. During storage, the 'tuoh' was said to be infested by mold or weevils earlier than the 'kondogbala'.

The above should be taken into consideration when planning interventions to address loss reduction in the post harvest systems.

9 POST–HARVEST SYSTEMS

The following systems were observed in the CORAD districts. These systems represented in the following sections were deduced from interviews and discussions held with various members of the CORAD LINKS communities. All the systems appear to be functioning but on further investigations there are major problems that seem to be inherent in the crop being produced.

9.1 Rice

Harvesting→Threshing →Transport→ Drying→ Storage→Milling →Transport→Market

For rice the staple crop, production is geared towards subsistence. Quantities that are sold are mainly as seed and to provide additional income particularly during harvest. The system functions effectively until storage where lack of adequate storage facilities and pest management take their toll.

9.2 Cassava (See attached flow chart for Cassava)

The system for cassava is a functioning system that relies heavily on the ability to process the cassava into storable forms and the availability of appropriate processing technology. In areas where processing facilities have been provided for gari making, the system is functioning and loss of harvested produce has been reduced. In Kono district where WVI provided cassava processing equipment to some of its FFS, training of some members in the maintenance of these machines would be an asset to the community and ensure sustainability when the project ends. However in areas where mechanized processing facilities are absent, the large scale processing of alternative products have not been seriously considered.

9.3 Cocoa

Harvesting→Gathering→ Sorting →Pod breaking → Fermenting →Drying →Bagging →Transporting→Grading→Drying→Collecting/Storage →Transporting→Sorting and Grading→Export

The cocoa post-harvest system is fraught with problems. There is general dissatisfaction with the system from all participants from producers to wholesalers and/or exporters. Cocoa being an export crop is under pressure for quality and standardized produce which the traders want from the producers but cannot get due to the purchasing structure. Producers believe the purchasing structure does not encourage the production of quality cocoa. This leads to various stages in the system being skipped or shortened. The system does not function as effectively as it should to encourage producers to continue producing.

9.4 Groundnut

Harvesting→Curing→ Transporting→Drying→Storage→Processing→Market

Processing [dried)→[shelling]→Market

Processing → [shelling→roasting→ grinding] →Market

The groundnut post-harvest system functions on a cyclical but subsistence level with production geared towards meeting pressing financial needs and provision of seed input for the next season. Processing in this system is in drying and only at the market retail is secondary processing done like roasting and grinding.

9.5 Tomato

Harvest→Sorting →Packing→Transporting→Collecting→Transporting→Market

The system for tomato varies in the different districts. In Koinadugu it is geared mainly towards the Freetown market, whilst that in Kailahun is geared mainly towards the local and district town markets.

Figure 5: Threshing with mortar and pestle

Threshing for small quantities is done using a mortar and pestle (**Error! Reference source not found.**5) throughout the storage period. This was for household use. The process was slow, labor intensive and if not done properly damages the grain. Large scale threshing is done by hitting with sticks or trampling with bare feet on drying floors, depending on the individual farmer and the amount of harvest involved. Threshing with sticks could lead to loss of grain when grain scatters during flailing and hence post harvest loss during threshing. However farmers observed that when threshing was done by feet or sticks on a paved drying floor, there was little wastage as they were able to sweep the drying floors clean.

Figure 6: Drying grated cassava on an old underground petrol tank

In Bunumbu, Kailahun district, grated cassava was observed spread out next to chili pepper on a rusting old petrol tank to remove the moisture (**Error! Reference source not found.**6). There was no protection of the produce from dirt and other foreign matter. Gari produced in this manner would be of poor quality and would cancel all the labor placed into its production. In addition if there were available gari pressing machines then unwanted moisture could easily be removed from the grated cassava before roasting into gari and this type of unsanitary drying would be avoided. Tarpaulin could also have been used to dry this grated cassava and spread out to cover the rusted tank before drying.

One of the large produce buyers in Kenema (M.S. Dayoub) is shown drying cocoa beans on canvas tarp in front of the cocoa store (**Error! Reference source not found.**7). Cocoa from Kailahun eventually makes its way to Kenema

Figure 7: A produce buyer's drying floor

Figure 8: Cocoa beans spread out on tarpaulin sheets

from where the bagged produce is transported to the capital Freetown for export. The further drying of the cocoa observed here was necessary because of the mixed produce obtained directly from farmers, middle men and other local buying agents. The size of the tarp being used is larger than some constructed drying floors observed during the assessment where drying floor sizes ranged from 5m x 6m to 15m x 12m. The drying of cocoa and other produce is seasonal. As a result, the tarps would not be in use all year round but would ease the congestion for space when there is a glut of harvested produce in the village. This is turn would help prevent the fire sale of harvested produce or the improper storage of an inadequately dried harvest (a recipe for disaster).The cocoa beans spread out on the tarps (**Error! Reference source not found.**8) show the mixed quality of the beans that are obtained and are being processed. To improve the quality of this produce and enable the farmers to obtain the appropriate economic returns for their produce, policy issues regulating the grade and quality of the produce must be addressed for both buyers and producers in the community. CORAD should help provide or arrange for training on production of high quality cocoa by addressing subscribing issues before and after harvest. Addressing issues like disease spread reduction, improved fermentation processes and proper storage of beans to prevent contamination, would enable both producers and buying agents to trade in high quality produce acceptable on the international market all year round.

Figure 9: Poorly tended drying floor

This village drying floor in Bendukura, Wara Wara Yagala Chiefdom, Koinadugu district (**Error! Reference source not found.**), was constructed before the war. Paddy has to be swept up to prevent additional wetting during a downpour and further grain loss would occur as not all the grain would be recovered. The central location of this drying floor however was ideal as it was easily observed from all parts of the village; a factor to be taken into consideration during construction of this aspect of a post harvest system in CORAD operational areas. In Koinadugu district, paddy is being dried on woven mats in front of an FFS member's house (**Error! Reference source not found.**10). Note the small quantity of grain that the mat could hold. These mats however could be easily rolled up in the event of a heavy downpour and thus prevent intermittent drying and wetting of the paddy.

Figure 11: Small community store in Taninahun

Figure 10: Paddy drying on woven mats

11 STORAGE STRUCTURES AND CONTAINERS

This small community store in Taninahun, Peje Bongre Chiefdom in the Kailahun District (**Error! Reference source not found.**11) was built after the war by a local NGO. The location of this store had been for logistic purposes rather than for satisfying the requested need of the community. Wandera (2006) in his evaluation of the DRP project that fed into the LINKS project had noted that rehabilitation of community storage facilities had not been an effective intervention because of inconvenient locations decided for logistic effectiveness by agencies. Village mapping exercises

Figure 12: Few pallets and four different containers in store

carried out during the assessment identified ideal locations for community storage, drying and processing facilities. These were to be centrally located particularly for security reasons. In the case of the Taninahun store, this store was situated at the entrance to the town and not at the centre. Shade for the store was provided by the small trees in its immediate vicinity. The branches rested on the roof providing rodents easy access into the store. The CI sheet roof however prevents water getting onto the stored produce via the roof. The metal door also contributes to security. Both CI sheets and metal for doors are imported material and as such expensive and not easily affordable by individual farmers. As a group these items could be purchased by pooling resources in the community or assistance from CORAD. The size of this store was small 70 cubic meters and not able to hold all produce from the whole village.

In this Taninahun community store, four types of storage containers were in use (**Error! Reference source not found.**). From right to left, the PK jute bag, large wicker basket of fixed size for capacities predetermined by the farmer, wicker basket of expandable size and woven polyethylene bag of different sizes.

All storage containers are for paddy rice but the bags could also be used for other types of produce. The expandable baskets are not sealed, can hold up to 30 bushels of paddy, and when not in use rolled up and stored away like sleeping mats. The fixed size baskets can be sealed after filling but take up store space when empty. The roof and ventilation slats of the store were not rat proofed. Conditions in the store allow and would contribute significantly to loss of stored produce. Training in storage container use and pest control maintenance is required in this case. It would be easier for the farmers to accept, adapt and use materials they are already familiar with (e.g. woven baskets or metal drums) and CORAD interventions to prevent loss should take into account these factors. Training in the proper use, care and maintenance of the community store is clearly required. The expandable baskets can be covered with metal sheets to prevent grain getting wet or rodent droppings deposited on the exposed paddy. The baskets could be raised above the ground on rat proofed platforms to prevent moisture absorption by the stored paddy from the bare floor. In addition the 55gallon metal drums can be adapted into a small metal silo so that it can be hermitically sealed and used to store rice. A similar metal silo has been used in South America and Cambodia (FAO, 2003). These interventions could be channeled first through the FFS and the positive effects of the interventions could be tried by individual members for their own personal stores.

Figure 13: Rat droppings on exposed paddy in store

As shown in Figure 12, the expandable baskets are placed on the bare floor with leaves placed at the bottom to act as a base. This allows for wastage to occur and contamination of the paddy when swept off the floor and reintroduced into the containers. Pallet use seen here is inadequate and the dunnage contributes to areas where insect pests and rats would be able to hide and thrive. This store was not well maintained, rat droppings were observed on the floor as well as on the grain in the containers. The open bag in this picture (Figure 13) shows the preponderance of rat droppings (black spots) on the exposed paddy. This could lead to an introduction of disease pathogens particularly in a place like Kailahun where rat borne diseases (Lassa fever) are prevalent. If bags like these are sown up or baskets covered after being *filled the farmers would have better quality* grain.

Error! Reference source not found.4

Figure 14: A traditional rice barn

shows a traditional barn individually owned by a farmer in Peje Bongre Chiefdom, Kailahun district. There was no rat proofing carried out on the building and the thatch roof does not provide adequate protection against the rain or infestation from weevils or other pests.

Figure 16: Post war constructed store made of cement and CI sheets

This store (Fig. 15) also in Kailahun district was built by the Lutheran World Federation Organization immediately after the war but presently being run and maintained by a female group. The store was of medium size, constructed from cement bricks, CI sheets and metal doors. The group had regulations for the running of the store, and paid a minimal onetime fee per bag, for anyone in the community making use of the store. Money from the levied fees enabled them to maintain the store and make adequate repairs as and when necessary. This store was used as a community store with a drying floor built in front of it for easy

Figure 15: Neatly stacked bags on pallets

drying and storage of produce. As **Error! Reference source not found.**6 shows, the inside of the store was well maintained with ventilation slats rat proofed. Most of the containers used were polyethylene and PK (jute) bags, with a few 55 -gallon metal drums. Pallets used to stack bagged produce were placed around the store and raised above the floor. There is adequate space underneath for proper cleaning of spilt grain and for aeration. The store keeper a female member of the group explained they had experienced rat infestation problems but had dealt with it using cultural and environmentally safe methods. They had used bamboo poles which had been cut open at one end allowing the rats to enter but not leave. These poles were set out in the evening, taken out the next morning and any rats disposed of. They also observed that the rats had entered the store via openings at the bottom of the metal doors which they had since sealed. Bags however were piled against the walls predisposing the bagged produce to uneven heating of the grain leaning against the wall, infestation by insect pests crawling along the walls or rats climbing the walls to get at the bagged produce. There is a need to involve secondary actors (e.g. carpenters) in the community. If they are approached and requested to make better pallets with the available wood (rather than leaving them as dunnage), it would provide additional sources of income for the carpenters and help improve the storage conditions in the store. This could foster inclusivity in the community with strengths and available knowledge and expertise being utilized. Again it was observed that training in store maintenance would contribute to reducing store pest infestation and consequently storage post harvest loss in the community.

Figure 18: Interior of private trader's store

Figure 17: Community owned traditional store

The interior of a trader's store in Bunumbu, Kailahun district is shown in **Error! Reference source not found.**. Here pallets were not used and bags were placed directly on the floor. The bags contained dried groundnuts, rice and even cocoa being bulked for sale to other buying agents. The store was constructed from mud bricks, roofed with CI sheets with doors made of wood and used mainly for produce. The store did not have ventilation slots but was clean and well maintained as rat droppings were not observed. Farmers coming to market could store their produce for a few days or even longer and not have to haul it around as the store was situated next to the periodic market. This reduced the distance traveled in the transportation of produce from store to market and thereby loss of produce during transportation was minimal at this stage.

Figure 19: Storage space in barn stacked with bundles panicles

This traditional type rice-barn (**Error! Reference source not found.**8) is owned by the Bandajuma Kpoliehun community in Njaluahun chiefdom, Kailahun district which also had a cement and CI sheets store shown later in **Error! Reference source not found.**. The lower walls of the barn are made of wattle and the upper of palm fronds and sticks. The whole structure is thatched with palm fronds. It is in the portion made of palm fronds that the panicle rice is stored before threshing. The stacked panicles are not completely protected from the elements or from rodent and insect pests (**Error! Reference source not found.**). Grain from this store would most likely be infested by

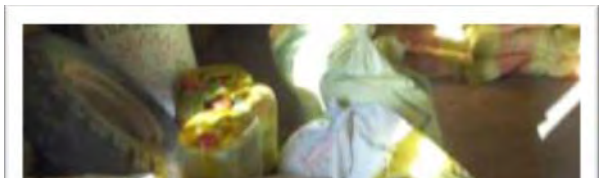


Figure 20: Cement brick community store with drying floor

threshing time and if not properly treated after threshing would be a major source of insect introduction into the cement brick community store seen in **Error! Reference source not found.**. This Africare constructed store in Bandajuma Kpoliehun (**Error! Reference source not found.**) was provided with a drying floor that made provision for drainage. Constructed in the same village as the wattle rice store mentioned above, the community members made simultaneous use of both types of stores with the wattle store used for storing un-threshed paddy and the cement store used for the bagged produce. This should be taken into account by CORAD so that interventions for post harvest loss prevention would address issues that would have resulted during the stacked panicles storage period.

The interior of a store rented for use as a cocoa store is shown in **Error! Reference source not found.**. This cocoa store operated by a buying agent in Segbwema, Njaluahun chiefdom contained other produce like polished imported rice in polyethylene bags, husked rice and coffee beans in PK bags and palm oil in plastic containers. The conditions in the store could predispose the cocoa beans to contamination by other products and hence quality loss.

Figure 21: Inside a cocoa trader's store

Figure 22: White powdery substance on jute bags

The cocoa beans were placed in wicker baskets during the drying period with properly dried cocoa beans bagged in PK jute bags. PK jute bags with paddy rice (**Error! Reference source not found.**) were also kept in the same store

White powdery substance was observed on the bags containing paddy (**Error! Reference source not found.**). This could be due to insect infestation by weevils as the bags were not opened for proper checking or verification. In the top left of Figure 22 is a folded blue tarp which is used as a drying floor when a lot of extra produce is received at any one period. If the farmers can have access to tarps themselves and proper processing and drying of produce enforced, it would contribute to an improvement of the quality of the produce and translated into increased earnings for the cocoa farmers themselves.

On closer inspection, the beans in the wicker basket (Fig. 23) were observed to have some moldy beans, due most likely to improper drying from the farmers in a rush to sell off their crop. Such produce would be of low quality if not properly re-dried, contributing to further quality and quantity loss after harvest.

Figure 23: Mouldy cocoa beans in a basket

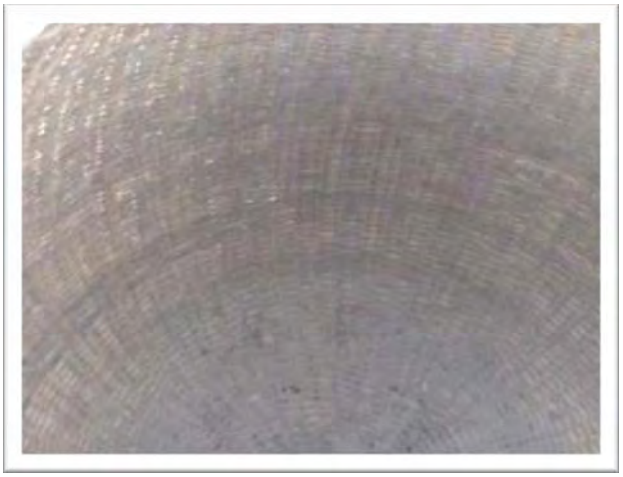
Error! Reference source not found. shows a room used as a farmer's personal store in Bambukura, Sengbe Chiefdom, Koinadugu district. Paddy stored in plastic bags was placed on top of tins or old mortars in order to prevent direct contact with the

Figure 24: Separate room in private dwelling used as store

floor as the floor was unpaved. Training to encourage farmers through the FFS to further develop their ideas with some improvement would encourage them to be innovative, make suggestions and accept new ideas more readily.

Figure 25: Fixed volume baskets for storing rice

In Koinadugu district woven baskets of fixed volumes were used to store paddy (**Error! Reference source not found.**). The baskets were woven by a weaver (black jacket) in the community who was also a member of the FFS. Although having speech and vocal handicaps, this did not prevent him from being included in the FFS where his skills and expertise were being utilized. The basket on the left was treated with cow dung whilst that on the right was with mud. These two methods of treating the baskets were expected to increase the physical barrier presented against grain infestation by weevils.



However, Figure 26 shows that the basket weave allows gaps through which insects would have easy access to the stored paddy. These baskets could be lined with leaves that have insect repellant properties, the baskets put on pallets that were rat proofed and sealed in addition to the treatment of the exterior with mud to seal the holes.

When not in use, the baskets are stored out of the way under the rafters of the dwelling (Figure 27). Training on maintenance and fumigation of these storage containers before re-use should be a part of any rice post harvest storage training for members of the FFS in this district.

Figure 26: Interior of a basket showing open weave

Proper sealing of these wicker containers would be necessary to provide adequate and insect free stored paddy up until the next harvest

A trader's store in Kabala town, Wara Wara Yagala chiefdom,

Figure 27: Fixed volume baskets stored under roof

Koinadugu district (**Error! Reference source not found.**). This store was used by members of the community and actually functioned as a produce warehouse. Produce was stored by middle men/women who had bought produce from members of the community in the surrounding villages. The produce was bought during harvest when there is a glut, processed by drying into an acceptable moisture content either by the farmers before selling or the middle men themselves after buying, transported to this store15 – 40 miles down the valley and up the hill roads, stored for a few months then resold to the same farmers at a higher price for seed or food as the need/case arises. In addition, the same produce could be used to pre-finance the farmers during the hunger season.

Figure 28: Inside a traders store in

Being a multipurpose store, all types of food produce were stored together and stacking was based on ownership rather than on commodity/produce type. Cross contamination of the produce easily occurs when vegetable oil is spilt on the bagged produce or any infested stock is introduced into the store. Cats were used to control rodent infestation and so reduced the possibility of contaminating produce with dangerous chemicals or rodenticides.

If the farmers themselves are able to properly store some of their excess produce when there is a glut and not have fire sales, they would be able to break out of the glut, scarcity, glut cycle. This would enable them to make a profit from their hard labor and harvest and not experience economic loss by quickly selling off their grain for fear of pest attack and infestation during storage.

Figure 29: Store with assortment of

A large bag (orange sack in middle) of dried cassava chips (tuoh) was stored among other dry produce (**Error! Reference source not found.**) indicating that there was a market for this type of processed cassava produce. In areas where cassava production is confined to certain periods of the year, farmers through the FFS, could be encouraged to harvest, properly dry their cassava produce, diversify their product market range whilst adding value to their harvested crop. This would contribute to a reduction in the level of post harvest loss

encountered as all the harvest would be utilized and also be available to convert to cash during the hunger season.

12 PROCESSING OF THE TOMATO CROP

Harvested ripe and unripe mature fruits are shown in Figure 30. During harvesting of the tomato crop, both unripe and ripe fruits are harvested. Preliminary sorting is done to separate whole from damaged fruit. The damaged and overripe fruit are then piled in heaps at the local market whilst the firm and whole fruit are packed in plastic bowls for transportation to the town market. In the bowls both ripe and unripe fruits are massed together. However when being packed into boxes for transportation to Freetown, mature but unripe fruits are placed at the bottom and mature ripe fruits at the top. This mode of packing was to prevent the softer ripe fruits from being crushed by the weight of the firmer green fruit and present attractive ripe fruits when containers are opened giving green mature fruits packed at the bottom the chance to ripen also. During transportation, further damage and loss of fruit produce occurs when delays due to vehicle breakdowns or impassable roads occur. CORAD interventions for the LINKS programs should consider helping with road rehabilitation or transportation facilities that the female members of the community could easily use to help in the speedy and timely transportation of their produce to market.

Figure 30: Ungraded tomatoes

Error! Reference source not found. shows shelled groundnuts with insect frass and blackened seeds at the end of the storage period. If the groundnut had been properly dried and stored, the amount of damaged seeds would be lower and the seeds of better quality. This would enable the farmers to demand and have better prices for their stored produce.

Figure 31: Shelled groundnuts showing insect frass

13 INFRASTRUCTURE

For a system to work effectively the infrastructure in place must be appropriate. It is necessary to consider the available infrastructure in the three LINKS districts to see how best they contribute to effective post harvest systems for the different crops. The main infrastructure components in these districts are stores, drying floors, roads, transport facilities and communication facilities. They are available and accessible in various degrees to members of the community and the community as a whole.

13.1 Stores:

These are both communally owned as well as privately owned. The predominant types of storage structure in the 3 districts are shown in Table 6. Communal store sizes varied in size (length x breath x height) from 5m x 4m x 3.5m to 16m x 8m x 4m. All NGO or Government agency communal stores were constructed with cement blocks roofed with corrugated iron (CI) sheets and fitted with metal doors. Ventilation slats were provided high above ground near the roof. Floors were sealed with concrete mortar. Communal stores are owned by the community and managed by designated community members or groups.

Table 6: Community used storage structures

District	Type of Storage Structure	Communal Store	Own Dwelling	
			Separate Room	Own Bedroom
Kailahun	Cement wall CI Sheet	X		
	Mud walls CI sheets			X
	Mud walls Thatch		X	X
Koinadugu	Cement wall CI Sheet			
	Mud wall CI Sheets		X	
	Mud walls Thatch		X	X
Kono	Cement wall CI sheets	X		
	Mud walls CI sheet			X
	Mud walls Thatch		*X*	*X*

During the FGD's, groups in Koinadugu did not appear to have communal stores but had separate rooms set aside as individual stores in their homes. In Kabala town groups were not enthusiastic about the use of communal stores as the communal store built by FAO before the war had been vandalized and even after reconstruction community members were apprehensive in its use resulting in the store not being used effectively.

Figure 32: Corner designated store in a

Private stores are mostly single rooms dedicated specifically to the storage of produce by the household head (Figure 24), personal bedrooms with a corner designated to the stacking of produce bags (Figure 32) or trader stores operating like community stores but owned by individuals or a specific group. House stores were of wattle or mud bricks, roofed with thatch or CI sheets (Figure 33), and the floors are of hard packed earth. CI sheets and metal sheets for doors are imported and thus relatively expensive.

13.2 Drying Floors

These are communal or privately owned. Communal floors are larger and in various states of disrepair/maintenance. All are cemented and ranged in size from 5 x 6 meters to 15 x 12 meters. Field observations indicated that new drying floors had been constructed and these ranged from 4 years to a few weeks and were in better conditions than old ones which were about 10 years old. Drainage seemed to be a problem in new ones as some puddles of water were observed to have settled on some floors.

Figure 33: Rice dried on tarpaulin. Mud and brick store with CI sheets in background

Field observations also indicated that alternative materials were being used as drying floors. Adaptable, moveable and appropriate drying floor alternatives were observed in Kailahun and Kono Districts. These consisted of MSF or UNICEF Tarpaulins spread on the ground and the crop dried on top of the tarpaulin. The tarps featured prominently as an alternative drying system to the cement drying floor. Their virtues were extolled by users showing that they had been in use for some time. The main feature was its versatility. It can be used for threshing and drying produce in the field, wrapped up quickly if rain bursts occur and protect the quality and quantity of produce on it. Use of tarpaulins was noticeably absent in areas visited in Koinadugu District and the reasons given were that these tarps were expensive. In areas where they were used, reasons put forward were that they had been used as roof covers during the refugee camp period and were practical. Available pieces were small and not adequate for the volume of produce being harvested.

Table 7: Reasons for use and non-use of different types of drying facility

Drying floors and alternatives									
Cement		Woven mats		Tarpaulin		Bare Earth		Covered raised platforms	
Use	Non-use	Use	Non-use	Use	Non-use	Use	Non-use	Use	Non-use
Durable Quantity loss reduced Alternate uses possible Can be fenced	Initial costs high Non moveable Too small to accommodate everyone's produce at the same time Fights ensue if user time slots not allocated Maintenance/repair costs involved are high	Locally produced from local materials Moveable No other alternative available	Contamination of produce quality can occur Lasts only about 3-4 years Produce can only be dried in small batches	Versatile Durable Moveable Protects produce from rain and is efficient Quantity and quality loss prevented and reduced	Availability Initial cost involved in its purchase high Torn by very sharp objects	No capital outlay required Effective Not efficient Can be constructed anywhere it is needed No other alternative available	Not efficient Contributes to quantity and quality loss Produce contaminated with foreign matter	Very useful during rains Made from local materials Effective in drying groundnuts	Non moveable Need additional source of heat Not versatile. Contributes to loss of seed viability if not properly used

Reasons put forward for the use or non use of the various drying facilities are presented in Table 7. No motorized or mechanical dryers are in use in the LINKS communities. The main large scale electrical dryers were for cocoa and located in Kenema town and Freetown. During the CORAD DRP evaluation it was suggested that woven rattan mats be used as the materials were locally available. However when this issue was raised with FGD participants they commented that these mats allow extraneous material into produce being dried through the space between the straws and that the straws are brittle when dry and break during folding and unfolding.

13.3 Roads

Access and feeder roads were in deplorable states. Trunk roads were of better quality but in need of maintenance. The road network within the chiefdoms consisted of both graded and ungraded laterite roads. Roads were in various states of disrepair depending on community activities and use of these routes. Feeder roads were in deplorable conditions and primary roads were of better quality but in need of maintenance. Some primary roads were not bitumen surfaced. During the rainy season most access roads are no longer motorable and those areas are virtually cut off and accessible only on foot. As such any produce coming from these areas at this time has to be carried by head.

13.4 Transport facility

Available transport facilities are motorcycles, four-wheel drive vehicles, land rovers, minivans and large trucks. Large trucks did not go into the small communities due to the prevailing road conditions and particularly so during the rains.

13.5 Communication

Radio station transmissions are received in all LINKS areas and the telecommunication system is working and effective. Producers can easily get access to Market Information and know what price their produce is going for in which area of the country and they can adjust their prices accordingly.

14 STORAGE METHODS AND CONTAINERS

In both communal and private stores, storage containers were typical for the different districts. A variety of these containers were used ranging from plastic bags to woven wicker baskets. Whereas bags were mainly used in private bedroom stores, wicker baskets, large bags and drums were the containers of choice in communal stores or private stores.

A variety of storage containers are available with the preponderance of these being used for rice. From observations, the types of wicker baskets used are common in one district as opposed to the other. Wicker baskets of standard volumes

are common in the Koinadugu district. Wicker baskets of expandable volumes are mainly found in the Kono and Kailahun districts.

Rice: Baskets for rice are of fixed size and expandable sizes. Fixed sizes are sealed after filling until required for use. Such baskets are not prone to contamination with rat faecal matter or cross insect contamination. For rats to get at grain they have to gnaw holes at the sides or bottom. Baskets of expandable size are not sealed and there is easy access to grain from the top as well as from the bottom by the rats. This predisposes the paddy to contamination with rat faecal matter.

Jute bags or plastic bulgur bags facilitate produce transportation either as head load or in vehicles. If bags are properly maintained and mended loss due to spillage is minimal. In addition farmers can easily keep account of quantity of produce they still have in store.

Metal drums are only used if grain is for consumption and has been properly dried. Grain for seed is not stored in drums as seed viability is lost. Farmers indicated that seed in drums become overheated if not properly dried resulting in mold problems and dead seeds. Seeds in drums however, are not easily accessed by rats. In South America and the Far East, small metal silos of varying sizes (FAO, 2003) have been used and found to be appropriate for small or medium farmer households to store their grain. (These metal silos look like the metal drums observed in the assessed communities.) This technology could be tried and/or adapted for use in keeping grain for household consumption in the three districts.

Large wooden boxes made from seasoned hardwood planks are used to keep harvested grain safe. These boxes standing on four legs could be of various capacities and be easily rat proofed.

Unthreshed rice is stored in heaps in the ceiling of elevated barns till required for threshing and milling. These barns are not rat proofed or air tight, are easily accessible to rodents and insects thus contributing to the storage problems.

Cassava: Unprocessed cassava is stored overnight in heaps on the bare floor. Farmers feel this allows the tubers to cool down and not deteriorate rapidly as compared to keeping them in plastic bulgur bags. However cassava stored in bulgur bags are easy to transport and load onto lorries.

Dried cassava chips are stored in plastic bulgur bags and kept in bedrooms as it is a ready food source. If stored in a separate room they are stored among the other produce.

Groundnut: Raw unshelled groundnuts are stored overnight in baskets for head load transportation to markets. Dried unshelled groundnuts are stored in either PK jute bags, baskets or plastic bulgur bags in the storage facilities. Groundnuts are shelled when required for selling.

Cocoa: Fermented cocoa is stored in wicker baskets or on the bare floor during drying and in jute bags for longer storage and transportation. Cocoa is not packed in plastic bulgur bags as the beans in the middle heats up, become susceptible to mold growth and the quality deteriorates.

Tomatoes: No known refrigerated cool rooms or vans are available in the districts for keeping tomatoes overnight. However, wooden boxes with dimensions (24cm x 44cm x 29cm height, width, length) are used to pack and store the tomatoes overnight and up to 2 days before transportation to market. Plastic bowls are used if wooden boxes are not available.

15 PRODUCE LOSS ALONG THE POST-HARVEST CHAIN

Table 8: Estimated portions (%) of produce damaged/lost along the post-harvest chain

Crop	Harvest	Threshing/shelling/pod breaking	Transportation	Drying	Storage
Rice	5	5	12.5	15	28
Groundnut	-	-	-	8	44
Cassava	-	-	34	-	65
Cocoa	-	-	-		19
Tomatoes	10	NA	14	-	

It was difficult to get exact quantities or volumes lost during harvest and threshing of rice. Estimates shown in Table 8 were based on farmers' recollections of the past cropping seasons. Loss estimates were based on proportionate volumes present at the various stages and volumes observed missing or contaminated when grain was inspected (documented using proportionate piling). During the harvest season, traditional society activities take place. This could cause delays in the harvest leading to over drying of grain in the field, shattering at harvest and grain being lost. As a lady put it "When we're about our society business, sometimes the rice over dries in the field and as you put a knife to it the grains fall off and most of the harvest is lost". After threshing and gathering, women are allowed to sweep grain left behind on the packed earth threshing floors, winnow it, remove stones and keep that for themselves as it would be too time consuming to remove the stones or the farmer would be considered cheap or tight fisted. During transportation in vehicles, spillages are swept up and reintroduced into the bags. However when transportation is by head load spilled grain is not collected and contributes to loss experienced. When drying on drying floors, mats, tarpaulins, or roadsides, produce is consumed by domestic animals and not all the grain is or can be collected after drying.

For cassava, harvested broken roots are consumed as food by the household, retailed at the village, or dried to make cassava chips 'Tuoh' or 'Kondogbala' to prevent spoilage. Whole cassava roots are used to make gari, sold wholesale to traders, sold retail at the village or at the town markets. During transportation of whole cassava, bags are handled roughly, breakage of the roots occur which affects the price of the cassava at market.

Groundnut harvested during the rains is mainly sold off wholesale immediately or soon after harvest. In some areas, this groundnut is dried for seed. Drying during this time is done on raised covered platforms with a low heat source underneath to

accelerate the process. In the Dry season, groundnut is dried in the sun for seed, sale and family consumption.

Cocoa harvesting practices introduce contributors to poor grade/quality cocoa into the post harvest system. Diseased pods are given to other household members for their help during harvesting. Beans from these pods, find their way into the produce presented to buying agents at a latter stage (collecting) resulting in low grade cocoa. During intermittent drying and storing, pilfering takes place. This could account for the portion lost to pests during storage.

Along the post harvest chain for tomatoes, the volume of loss observed after harvest can be attributed to harvesters picking both damaged and undamaged ripe and ripening fruit. On sorting the damaged tomatoes are then sold retail at a lower price or kept for seed. Losses could get to 100% if there are delays in the transport system as the fruits are not kept under refrigerated conditions during transportation.

16 USE OF HARVESTED PRODUCE

The harvested crops differed in their comparative use directly as food, seed, cash or for processing [Figure 34]. This affected the care taken in the handling of the crop, time spent in storage and the consequent losses realized at the end of storage as shown above in Table 8.

From Figure 9 we see that whereas the cocoa and tomato crops were mainly for sale, the groundnut crop was equally for sale, seed and food. In the case of the cassava crop it was mainly for processing into other useable forms whilst the rice was for food and sale with a small proportion kept as seed. These uses should be taken into consideration when planning interventions for improving the post-harvest systems for the various crops.

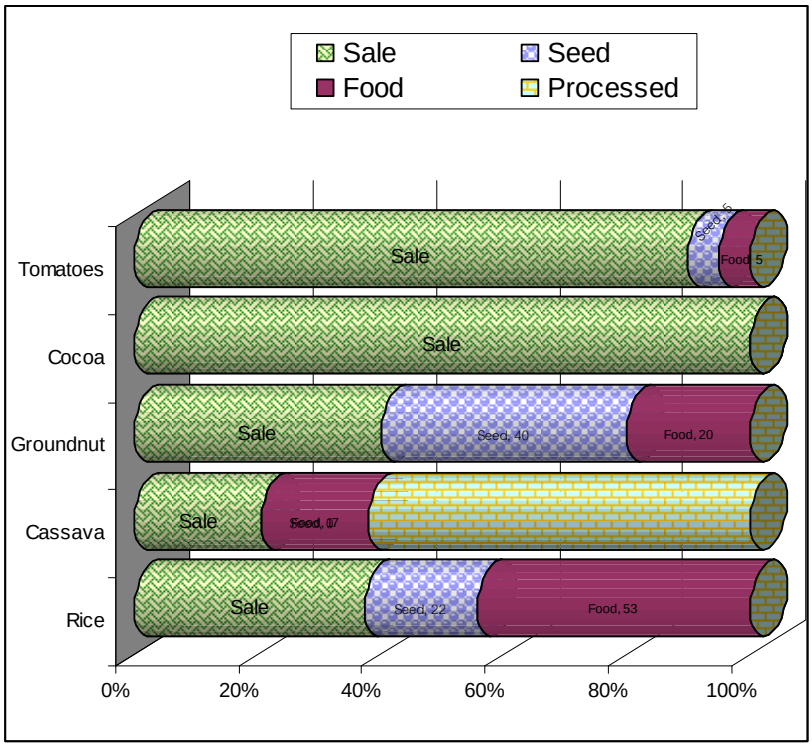


Figure 34: Comparative use of harvested produce.

17 IDENTIFIED CONSTRAINTS

Certain factors and conditions affected the amount and type of losses experienced within the post harvest systems for the various crops. These are considered to be constraints to the proper functioning of such systems. Responses to constraints faced by LINKS communities were clustered under 6 main headings. These were as follows:

- Pests
- Infrastructure
- Processing equipment
- Economic
- Training
- Policy

Table 9 details these constraints and their perceived causes or contributors. For the CORAD consortium to adequately address these issues, training, some financial investments and training and support in good governance at the community level are required. These should be channeled through the FFS as the impact would be felt as a group and quickly disseminate to other members in the community.

Quick wins for these would be the following:

- Provision of tarpaulins to the FFS communities to reduce the pressure on presently available drying floors;

- Advice through FFS on appropriate varieties for the different communities which would contribute to sustainability (e.g. IVS varieties for women farmers that would be harvested before their traditional society activities)
- Provision of threshers and training in their use for processing rice,
- Provision of cassava grating equipment and training to handle increased cassava production
- Training on the use of improved fermenting boxes for cocoa
- Training on standards and proper grading of cocoa
- Awareness raising and training on the proper use of cultural methods and naturally occurring pesticides during storage of harvested produce [e.g. Neem tree leaves as insect repellants and bamboo canes as cultural methods for reducing rodent attack].

Table 9: Constraints in the post harvest systems in the LINKS communities

Constraints	Crops	Issues	Comments
Pests	All	Major constraint • Rats • Insects • Mold • Humans	Inherent in the type of storage facilities and containers used. Rat infestation observed throughout and Insect infestation towards end of storage period Mold incidence dependent on appropriate drying before storage and type of storage facility; Social attitudes in the community
Infrastructure	All	Major constraint • Roads • Storage facilities • Drying floors • Transportation facilities • Market facilities	Roads are a major constraint in areas distant from trunk roads. Most feeder roads not properly maintained and in poor condition. Communal stores not available in all districts (Koinadugu). Where available (Kailahun, Kono) and if available (Koinadugu), location in village, size of store, security issues, gender consideration, management responsibility, predisposition to pest incidence, all affect use of storage facilities and were mentioned in each community. Private home stores were purely on subsistence level. Location, size and local regulations on use, affected use of drying floors. Feasible and appropriate alternatives were already in use and suggested and requested as possible constraint solutions; Transportation facilities affected by road conditions and season. Large vehicles not easily available for large produce volumes on feeder roads. Overloading of produce on smaller vehicles a problem. Lack of periodic market (Lumoh) or trader markets in/near community affects level of post harvest losses in the post harvest system.
Processing Equipment	Cassava Rice Cocoa Tomato Groundnut	Graters Threshers, Mills; Fermentation boxes Canning equipment; Driers	Available graters are mainly hand powered and require a lot of effort, processing can only be done in bits; Threshers not available, Mills not available in all communities; Fermentation boxes not available, fermentation by baskets affecting quality Canning equipment not available for tomato; Driers for groundnuts are elevated heated platforms that affect uniformity of drying and might affect seed viability.

Economic	Cocoa Rice	Pre-financing; Established relationships	Pre-financing during hunger season for labor and seeds affects price of produce at harvest, disincentive to store; Established relationships between buying agents and producers for cocoa and tomatoes.
Training	All crops	Post harvest pest management; Store management Pre harvest disease control for cocoa and plantation rehabilitation; Facilitators for adult literacy	Training from NGO's has been on pest management in the field and crop production Adult literacy facilitators not enough to help alternative processing and uses of crop to prevent losses
Policy issues		Road rehabilitation; Pricing for different cocoa grades and adherence to cocoa grading standards	Establish a base price for cocoa, Cocoa grade standards not adhered to by buying agents

18 INEFFICIENCIES WITHIN THE POST HARVEST SYSTEM AND SOLUTIONS

Various inefficiencies plague the various post harvest systems, but an inadequate transportation system and poor road infrastructure are common to all. Inefficiencies particular to each crop's post harvest system are addressed below.

18.1 Rice

Threshing methods, drying and storage facilities are inadequate for grain storage past the immediate subsistence level. Store maintenance of communal stores, storage containers used and pest management practices within stores are inadequate to prevent or even reduce losses.

To overcome these, the following are suggested;

- Simple foot pedal threshers can be introduced to help prevent losses during threshing.
- Alternate and appropriate drying facilities such as tarpaulins could be provided particularly to ease competition for available drying floors at peak harvest periods.
- Proper regulations for effective maintenance of communal store should be encouraged.
- Gender differences should be considered when providing storage facilities with a simple thing like a partition wall between the areas the women store their produce and the areas the men store theirs and corresponding doors to these areas. This would give the women a sense of buy in to the ownership of the communal store and empowerment in storing the amount of produce they want.

18.2 Cocoa

Proper maintenance of cocoa plantations not carried out, traditional method of basket fermentation still practiced, quality standards not adhered to and produce regulations not enforced.

Produce is bought indiscriminately from all sources by middlemen without regard for quality as low prices are given for such under the counter purchases. Although standards and grades exist, much regard is not placed on grading. There are thus no incentives for producing quality produce which in turn affects profits realized. The produce Inspectors are seemingly not enforcing produce standard regulations in order not to 'spoil business'.

To overcome this, the following is suggested:

- Training on cocoa plantation husbandry and maintenance through the FFS.
- Fermentation methods and equipment need to be improved e.g. fermentation boxes.
- Policy for produce regulations to be enforced and advocacy with the government through MAFS for incentives to be given for better quality produce.

18.3 Cassava

If proper processing is not carried out it could lead to rapid deterioration of the processed product and losses would ensue. In addition adequate processing facilities and equipment are not readily available to address the increased cassava production causing loss of the harvested produce. The following is suggested:

- Motorized graters should be provided to handle the increased produce
- Appropriate varieties should be chosen for the prevailing ecologies taking into account policies or laws in the area that could affect production. Laws such as free grazing by cattle allowed during January to May in certain areas in the Koinadugu District would render long duration cassava unsuitable for cultivation in such areas.

18.4 Groundnut

Drying facilities are inadequate to handle excess production during the rains. Storage facilities are predisposed to pest and mold attack. The following is suggested:

- Traditional drying facilities be tested and improved on to accelerate efficient and effective pod drying.
- Tarpaulins should be provided to enable drying of more produce.
- Training on proper store maintenance would reduce the losses encountered due to rodents and improve the efficiency of the groundnut post harvest system.

18.5 Tomatoes

Tomatoes are a highly perishable crop and bruise easily. Distances, transportation facilities and time taken for transportation from farm gate to market have contributed to inefficiencies within the tomato post harvest system. Sometimes losses of up to 100% have been encountered when a lorry breaks down and there are no other alternate vehicles coming that way till the morrow! The following is suggested:

- Provision of a refrigerated truck or cooling air conditioned van would ensure reduction in losses
- Group provision of transport facilities like the WABE (women agro business enterprise)(Koinadugu) to transport produce readily.
- Lobbying local district government to get major feeder roads maintained.
- Training on alternative value-adding processes to prevent losses.

Table 10: Storage duration and pest incidence in stored produce

Commodity	Storage duration	1st Rodent incidence noted after storage	Insect and mold damage noted after storage	Frequency of produce inspection
Rice	3 – 6 months	2 weeks	2 – 3 months	2 weeks

Groundnut	2 – 6 months	2 weeks	3 months	2 weeks
Cassava Unprocessed	1 – 3 days	1day	NA	Daily
Cassava Dried	6 months	1month	4 months	Monthly
Cocoa	1 2months	1week	1 month	Weekly
Tomatoes	1 – 3 days	NA	NA	daily

The frequency of inspecting stored produce depends on the length of storage. The perishable tomato and unprocessed cassava are not stored for long as they start deteriorating. Storage of these two items occurs when the crop has been harvested and awaits transportation to a wholesale market.

Table 81: Pests attacking produce during storage

Crop	Type of pest	Type of damage	Type of control
Rice	Rats	Quantity & Quality	Rodenticide
	Weevils	Quantity & Quality	Chili pepper added
	Grain moth larvae	Quality	Sun drying
Groundnut	Rats	Quantity	Rat Poison
	Moth larvae, weevils	Quantity & quality	Sun drying
	Fungus	Quality	Sun drying
Cassava (dried)	Rats	Quantity	Quantity
	Weevils	Quantity & quality	Sun drying
	Fungus	Quality	Sun drying
Cocoa	Rats	Quantity &Quality	Traps
	Fungus	Quality	Sun drying
	Humans	Quantity	None

Rodents are considered serious pests of stored produce. However human beings are cited as serious with pilfering of cocoa particularly during drying and storage. Cocoa farmers realize that pre-harvest attack by Black pod disease affected the quality of beans produced. Beans were slaty and flat which are characteristics that negatively affect the grade of the produce. Farmers feel helpless and frustrated about controlling this field disease. They feel the only way to control it is by the application of chemicals which are not presently available. They have witnessed a rapid decrease in the quality and quantity of cocoa beans harvested. However training through FFS on using AESA (agro ecosystem analysis) and awareness raising would address the issue so that high quality cocoa beans would be produced once more and the environment would be safe as well. Indeed this could be a blessing in disguise as plantations have not been sprayed with chemicals and the cocoa could be checked and certified for organically grown cocoa which commands a higher price.

19 RESPONSIBILITIES, DISTRIBUTION OF BENEFITS AND PROFIT

In the cocoa post harvest system is the distribution of benefits clearly seen. However due to the mode of such a distribution, there are attendant problems with the quality of cocoa available for market.

During harvest, the whole family is involved; the men pick the fruits, the women gather and heap. In sorting, diseased or damaged pods are piled to one side. This belongs to the women. These they can break and ferment in baskets, dry, sell and use the proceeds for their own incidentals. This cocoa is what the women sell in weight or volume portions to the collecting and buying agents living in the village or who come periodically during harvest season with their scales. In addition, the women and youths could 'collect' some more beans from the main harvest whilst it is drying. They add this to what they have and sell. The buying agents collect and bulk these till he has full bags and sends them to the bigger buying agent for transportation to the wholesaler.

The household head sells his dried cocoa to the agent who then mixes everything resulting in poor quality cocoa with moldy beans. The price is therefore low and farmers do not get the expected profit they had envisaged. To combat this, there has to be a change in the attitude and approach to what is being done to the diseased pods. To achieve this training is required.

20 TRAINING MODULES FOR FARMER FIELD SCHOOLS FOR IPM IN POST HARVEST SYSTEMS

IPM is an approach to enhance crop production based on an understanding of ecologic principles. All interventions are need based and applied in ways that minimize undesirable side effects. (Inter –Centre Working Group on IPM, March 2000). The IPM package identifies pests found in the stores and is designed to make the environment less favourable to both insect and vertebrate pests.

Table 92: Proposed modules for IPM in post harvest systems

Module	Crop Stage	Activities
I	Pre harvest	Selection of villages and farmers Farmers meetings to explain the FFS Gender consideration as women normally do the drying and maintenance of the stores
II	Harvest	Group formation and Leader selection Pre evaluation test Store sampling, Store preparation
III	Drying	Determination of safe moisture level (culturally e.g. color, sound, feel) Use of moisture meter to verify culturally corresponding safe moisture level Type of dryer and drying used; Preparation of stores Sampling technique

IV	Storage (beginning)	Introduction to AESA for storage structures Bio-ecology of major pests understood Identification of pests, their management. Development of insect zoo.
V	Storage (mid term)	Installation of pheromone or sticky traps; Store hygiene and maintenance Installation of physical traps e.g. bamboo poles for rats AESA applied in store and monitoring of store and produce conditions
VI	Storage (end)	AESA applied in store and monitoring
VII	Storage (awaiting)	Repairs to store roofs Fumigation of stores using smoke
VIII	Reflections	Farmers presentation Loss prevention comparison between IPM and non IPM stores Post evaluation test and Discussion on Post harvest techniques

For the LINKS communities, different stages in the post harvest systems would be targeted for different crops. For example, for rice, cassava and groundnut training should focus on the storage component. Field and storage components are the key areas of focus for tomato and cocoa given the nature of their physiology. Training in these components should be conducted whilst rice is still in the field and harvesting has not commenced. Alternatively it could be done after harvest is completed to highlight the loss between the field and the store/market.

MAIN FINDINGS

21 CURRENT STATUS OF THE POST HARVEST SYSTEMS

The post harvest systems are functional though not efficient. The farmers perceive that improper drying and ineffective storage are main contributors to produce loss. In addition they realize that the transportation system is a main contributor to produce loss. This is because when traders have to come to the farmers to collect produce they do not give the asking price or that announced over the Radio but site the terrible road system as the reason for the low buying prices being offered. The farmer thus experiences economic loss. This does not augur well for increased production because rather than seeing what they have produced rot or sold for nothing they would prefer to produce only what they need!

Indeed the LINKS program should not only pay special attention to increasing access to viable markets, but should consider improvement of the road network. This could be by sensitizing the communities of their capabilities of lobbying for improved roads and being ready to help their local government to do so.

21.1 Use of Storage facilities

They need help in reducing the losses encountered. However the farmers are willing to use available communal storage systems if these systems are located centrally in

the village for security reasons, are effectively rat proofed and are properly managed. As in the words of a female farmer "if you store your produce in a communal store the rats would eat a bit from everyone's and not concentrate on yours alone which would be the case when you store alone in your room".

21.2 Constraints

The constraints to the use of the communal stores are in the multi purpose nature of the stores. If cement is put near food produce, it would contaminate it. Even caustic soda used for soap making or diesel used to run the milling machines could spill on your produce and spoil it. Women and men using the same store poses problems as the women would not want to be in the store at the same time as men who are not their husbands. They would prefer having a store with separate doors and compartments for men and women.

22 AREAS OF FELT NEED

The areas of felt need shown in Figure 13 are for capacity building and are as follows:

Table 13: Felt needs reported by communities

Areas of felt need	% Mentioning
Training on Post harvest loss reduction	44
Training on Farm record keeping	44
Training on Store management	20
Training on processing	36
Training on safe pest management methods	36
Training on maintaining/repairing processing machines	12

Recommendations

The following interventions are suggested:

1. Appropriate crop varieties should be chosen for the prevailing ecologies taking into account local policies or laws in the area that could affect production.
2. Training on processing and simple packaging of tomato into paste (the VITAGOAT System) in Koinadugu and Kailahun districts, and rice into locally preferred flakes to be encouraged in all operational districts. Collaboration with the national research institute, university or external donor (e.g. Nampak of South Africa or Ghana Institute of Packaging) should be investigated as would be beneficial).
3. Foot pedaled threshers should be provided to help in threshing rice at the small farm level.
4. Primary processing equipment like threshers for rice, graters and peeler for cassava should be motorized.
5. Provision of tarpaulins to communities as an alternative drying floor for cleaner and better quality produce.
6. Gender differences should be considered when providing storage facilities with a simple thing like a partition wall between the areas the women store their produce and the areas the men store theirs and corresponding doors to these areas. This would give the women a sense of buy in to the ownership of the communal store and empowerment in storing the amount of produce they want.
7. Training on construction of improved rice storage facilities should be done for all the districts.
8. Input stores should be encouraged through the FFS to have certified viable seeds from certified local growers.
9. Pricing policy on Cocoa quality and grades should be enforced along with training of FFS members on quality and grading of produce.
10. Policy for produce regulations to be enforced and advocacy with the government through MAFS and MOTI for incentives to be given for better quality produce.

11. Addition of rat guards on presently available storage containers and their maintenance in storage facilities would help reduce losses due to rat infestation.

12. Trials in the use of metal drums converted to small metal silos or the use of the 'household metal silos' should be considered for safe and effective storing of rice over a longer period. This would ensure quality food availability from harvest to harvest.

13. Training is necessary in store hygiene, maintenance and management in communal stores.

14. CORAD Grain Store sizes with basic amenities should be standardized for all partners in the operating areas during construction.

15. Provision of tarpaulins through FFS for field and village drying purposes would help improve quality of produce. It would ease congestion and competition for use of permanent drying floor facilities in the village. This could be considered as an MED venture where an FFS group owns tarps that they hire out during harvesting. Training on proper use of the tarps should be considered.

16. Drying floors constructed by CORAD partners should also be of standard sizes depending on the size of the community or sector. If a drying floor of 100m^2 supports paddy from a 2 ha area of Inland Valley Swamp (IVS), then a community expected to farm 10ha IVS should have a 500m^2 drying surface area. This can be constructed as 2 drying floors of 250m^2 drying surface area and placed where the community requires it. If drying floor areas constructed would not support volume of harvested produce (paddy) from that community, then tarps should be provided as supplementary drying floors.

17. Provision of a tricycle or three-wheeler that could be used to transport farm produce from the villages to a main collecting point over terrain that would not support larger vehicles or on which these larger vehicles would not ply.

18. Rural infrastructure especially roads should be improved to give better access to markets. CORAD partners in the various districts should help to lobby local governments for access and feeder roads to be rehabilitated through a joint effort by the community and local government authorities.

19. Training of local supporting actors (blacksmiths, mechanics) on the primary maintenance of equipment like threshers, graters, milling machines or even tricycles should be conducted for sustainability. This could be done through the FFS.

20. Adult literacy classes should be mainstreamed into all training so that basic instructions on primary maintenance of equipment, farm record keeping and store management can be followed and adhered to.

21.

23 SUMMARY

This report prepared for the CORAD LINKS CONSORTIUM assesses the Post Harvest Systems and operating technologies in the 3 LINKS Districts in Sierra Leone.

It is felt that the management of loss along the Post harvest system and the various technologies that could be used would contribute to increased productivity and strengthened household resilience through increased incomes.

Objectives and Method

The main objective of the appraisal was to assess the current status of the post harvest systems and available infrastructure in the CORAD LINKS Districts.

The central assumption as if the weak links in these systems are identified and the estimated levels of losses determined, then measures can be taken or at least initiated to reduce the levels of losses at such points. This in turn would reduce the overall level of losses in the post harvest chain for that crop and increase the amount of food available in the CORAD LINKS communities

The list of target crops to be assessed and work to be accomplished was set out in the Terms of Reference at Annex 1.

From 4th – 29th June 2007, the assessment was carried out by the consultant and 5 teams (a team each from the CORAD partner in the district. The teams consisted of 2-9 members depending on the field agricultural staff that were available.

Findings

The Post harvest system for each crop was functional but not efficient. However strides were being made through the FFS participants to reduce losses.

The main thrust was different for each crop.

- For rice and groundnut, it was in drying and storage.
- For cassava it was in processing.
- For cocoa all actors agreed that if policies regarding the grade and quality of the crop were adhered to, then greater effort would be made by the producers to ensure an efficient system from producer to buying agent. This would be the case as the economic returns to them would be higher.
- For tomato it was in collective and effective transportation from rural producers to urban markets.

Infrastructure was found to play a major role in the present post harvest systems either contributing to an improving system or acting as a major hindrance to the effectiveness of the system.

Communal and private storage systems existed in most communities visited. Various factors contributed to the use or non use of communal storage facilities. Collective factors such as location in the village, person in charge of maintenance and management of the facility and size of the facility played a role. Communal storage facilities were good for produce obtained through communal labor or FFS activities. However, use of the store for storing of private produce depended on the individuals managing the store. Females preferring to have their communal stores separate from the men. In areas where communal storage facilities did not exist community members indicated their need for one.

Drying facilities in the form of drying floors have contributed greatly to reducing the amount of wastage or loss that occurs at this stage. However, the size and availability of drying floors in relation to the size of the communities have posed other challenges causing members of the community to continue using the bare earth for drying floor purposes. Because of the war, tarps have been used resourcefully as alternate drying floors where once they did not exist or were used.

Communications and Market Information Systems through Radio Moa (a CORAD LINKS initiative) have improved the dissemination of information with regards to prices of commodities in different districts. This has helped producers determine their asking price for produce. The purchasing price offered by traders or bulk buyers however, depended on the season and the transportation facilities available.

The Road system and Transportation facilities determine the flow of produce and contributes to the loss experienced in these post harvest systems. The deplorable road conditions limit the number and types of motorized vehicles that are available to transport produce. This in turn affects the amount of produce that can be moved or transported out of the community or left to rot. In effect it negatively affects the levels of losses observed in each of the crop post harvest systems. This was noticeable in perishable crops like tomato where a 100% loss can occur or in harvested cassava where a 50% loss of the raw roots can occur if the vehicle in which they are being transported to market broke down.

The farmers perceived that value was added to the cassava when processed into gari or foo-foo or dried. They did not believe any value was added when paddy was milled as the cost of paddy and milled rice were the same at farm-gate considering the recovery rate of milled rice from paddy.

Mechanized processing equipment like threshers or driers are not readily available. Rice hullers were available and in use easing the drudgery of using a mortar and pestle to clean grain.

Recommendations

- Addition of rat guards on presently available storage containers and their maintenance in storage facilities would help reduce losses due to rat infestation.
- Trials in the use of metal drums converted to small metal silos or the use of the 'household metal silos' should be considered for safe and effective storing of rice over a longer period. This would ensure quality food availability from harvest to harvest.
- Training is necessary in store hygiene, maintenance and management in communal stores.
- Provision of tarpaulins through FFS for field and village drying purposes would help improve quality of produce. It would ease congestion and competition for use of permanent drying floor facilities in the village. This could be considered as an MED venture where an FFS group owns tarps that they hire out during harvesting. Training on proper use of the tarps should be considered.
- Foot pedaled threshers should be provided to help in threshing rice.
- Provision of a tricycle or three-wheeler that could be used to transport farm produce from the villages to a main collecting point over terrain that larger vehicles would not want to travel.
- CORAD Grain Store sizes and basic amenities should be standardized for all partners in the operating areas.
- Drying floors constructed by CORAD partners should also be of standard sizes depending on the size of the community or sector. If a drying floor of 100sqm supports paddy from 2ha area of Inland Valley Lowland (IVL), then a community expected to farm 10ha IVL should have a 500sqm drying surface area constructed as 2 drying floors of 250sqm drying surface area placed where the community requires it. If drying floor areas constructed would not support volume of harvested produce (paddy) from that community, then tarps should be provided as supplemental drying floors.
- CORAD partners in the various districts should help to lobby local governments for access and feeder roads to be rehabilitated through a joint effort by the community and local government authorities.

- Adult literacy classes should be mainstreamed with all the training so that basic instructions on primary maintenance of equipment, farm record keeping and store management can be followed and adhered to.

24 APPENDICES

Table 10: Conversion factors for selected crop types

#	Item	Unit*	Weight in Kilograms (kg)
1	Rice	Bushel	25.0
2	Cocoa	Bushel	30.3
3	Cocoa	Bulgur Bag	45.5
4	Cocoa	Palm kernel (PK) or Jute Bag	81.8
5	Tomato	Tie/Pile	0.08
6	Cassava	Tie/Pile	2.6
7	Cassava	Bulgur Bag	67.7

- Above list compiled from World Vision (SL) Food Security Program list.

Table 11: Conversion factors for volume measures in CORAD Communities

2 Simon cups	1 buttercup
7 buttercups	1 Three pence pan (TP)
20 TP	1 Bushel
2 Kerosene tins	1 Bushel
1 Bushel seed rice	1 acre planted
36 TP	1 Bulgur bag
60 TP	1PK bag
3 Bushels	1 PK bag
1acre	0.405 hectares
1 mile	1.60km