Ministry of Agriculture

SMALLHOLDER AGRICULTURAL PRODUCTIVITY ENHANCEMENT AND COMMERCIALIZATION (SAPEC) PROJECT

Post-Harvest practice of rice

(Training module)

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1- Introduction

Rice consumption in Liberia is the highest in Africa (133Kg/ capita/year). It is the major staple food in this country. Liberia produces only 40% of its rice needs. Liberia market is full for imported rice (India, China). Average 90-100 million US is spend per year to import rice. Average 90% of imported rice is parboiled. Quality of local rice need to be improved for competiveness on the market. Technician, farmer and processor, need to be strengthen to reduce the importation of rice. Technological advancements are promoted with experience and training. So capacity building and development of knowledge base has become imperative for the improvement of the quality of rice in Liberia.

2- Objective

In general, the objective of the training is to improve and strengthen the capacity of the t to render it more effective. Specifically, it aims to:

- Strengthen the capacity of the technician on the best rice post-harvest practice
- Provide the best knowledge on post-harvest practice Improved the quality of local produced rice on the market;
- Increased the competiveness of local parboiled rice;
- Contribute to reduce the importation of rice in Liberia

3- Rice value chain

3-1. Concept

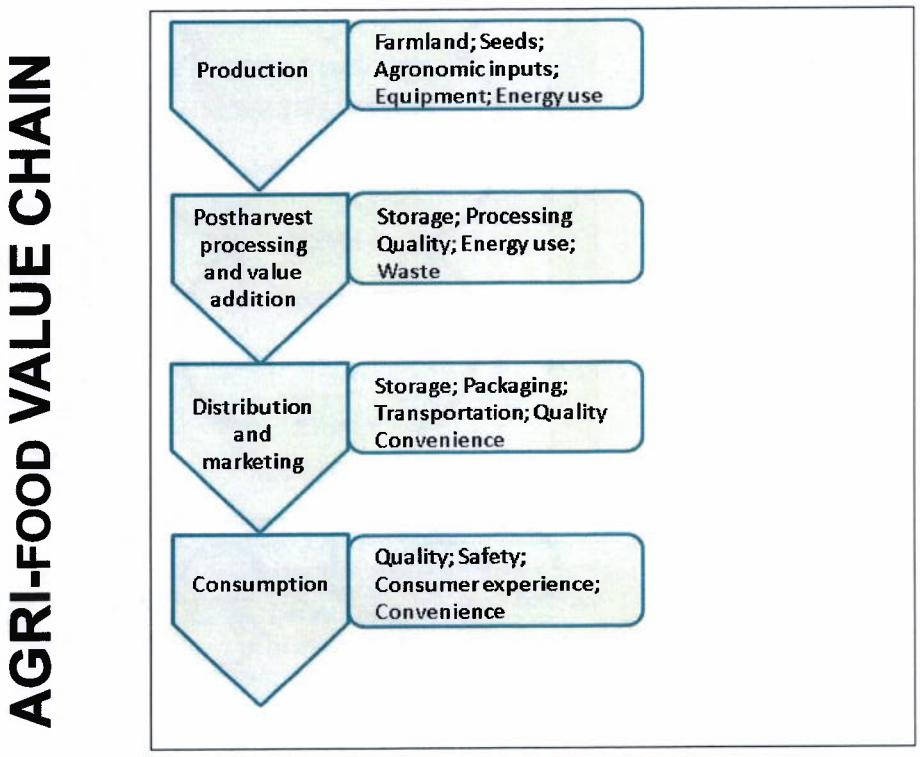

Figure 1: Value chain process

Value chains are mechanisms that allow Producers/Suppliers, Processors, Buyers, Sellers – separated by time and space- to add value to Products and Services as they pass from one segment of the chain to the other/next until the product gets to the consumer. The idea of the value chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and outputs.

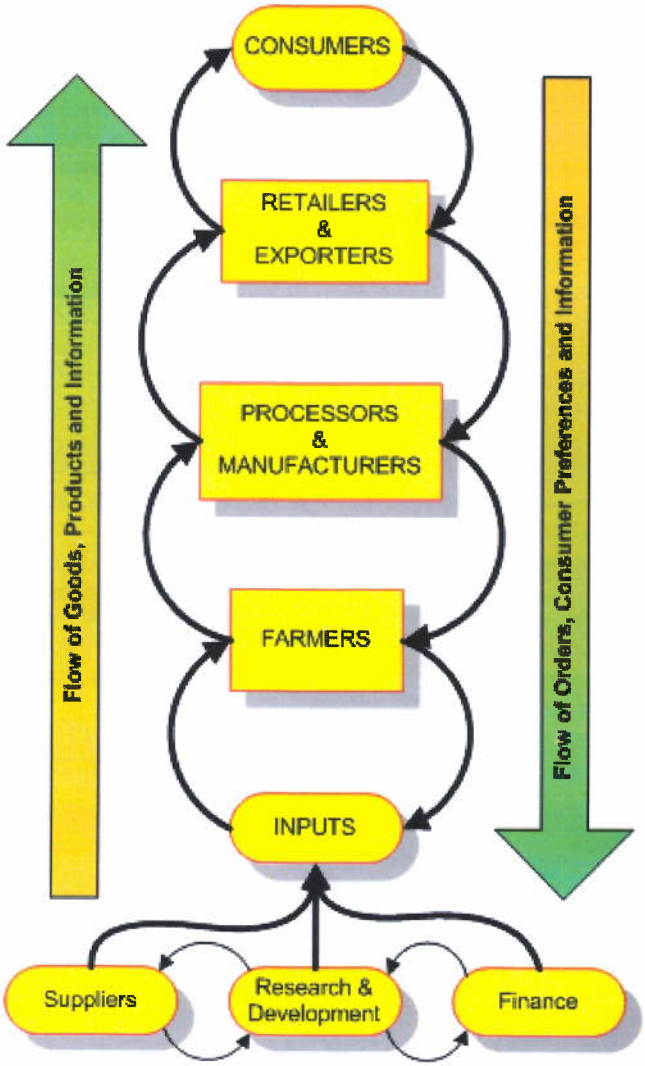

Figure 2: Value chain flow

The base of the value chain is the Market (demand)

SUMMARY OF FOOD INDUSTRY VALUE CHAIN

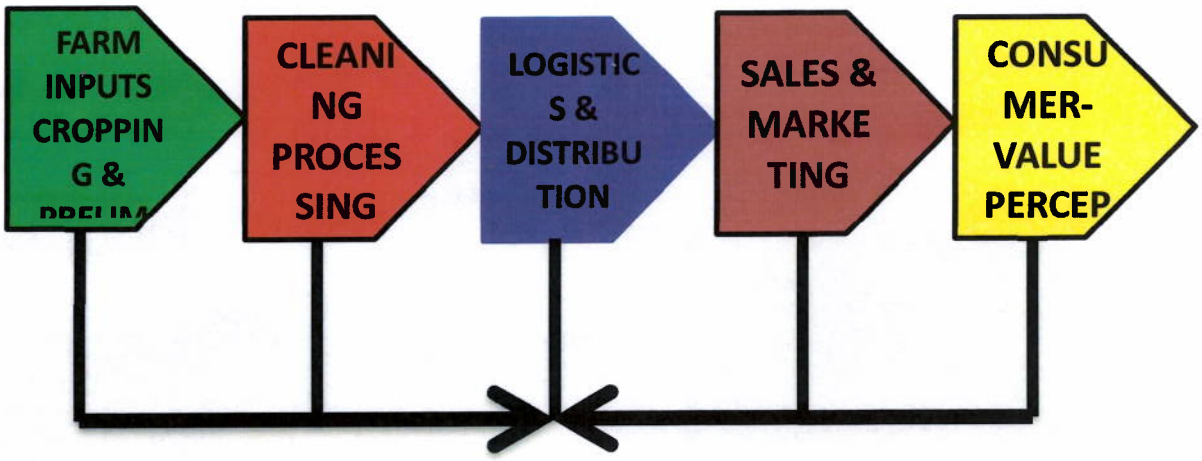

Figure 3: Food industry value chain

3-2. Product of rice value chain:

- Paddy (seed)
- Paddy for food
- Raw milled rice
- Parboiled rice
- Rice based-product

Photo 1: Rice paddy

3-3. Rice paddy process

Figure 4: Rice paddy process

3-4. Post-harvest losses

Postharvest loss can be defined as the degradation in both quantity and quality of a food production from harvest to consumption. Quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. In many African countries, the post-harvest losses of food cereals are estimated at 25% of the total crop harvested. For some crops such as fruits, vegetables and root crops, being less hardy than cereals, post-harvest losses can reach 50% (Voices Newsletter, 2006). In East Africa and the Near East, economic losses in the dairy sector due to spoilage and waste could average as much as US$90 million/year (FAO, 2004). In Kenya, each year around 95 million litres of milk, worth around US$22.4 million, are lost. Cumulative losses in Tanzania amount to about 59.5 million litres of milk each year, over 16% of total dairy production during the dry season and 25% in the wet season. In Uganda, approximately 27% of all milk produced is lost, equivalent to US$23 million/year (FAO, 2004).

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems.

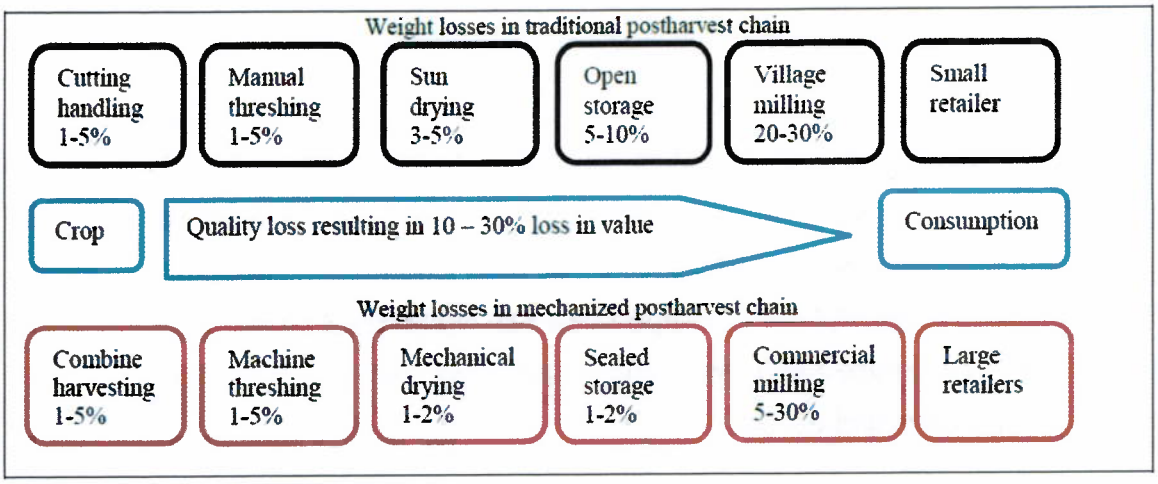

Figure 5: Estimated losses (weight and quality from postharvest chain for rice in south Asia)

Table 1: Key fact and figure on food and losses per continent

Stage	Examples of waste
1. Harvesting, handling at harvesting	*Edible crops left in field, ploughed into soil, eaten by pests; timing of harvest not optimal; crop damaged during harvesting*
2. Threshing	*Loss due to poor technique*
3. Drying, transport and distribution	*Quality and quantity loss of during drying, poor transport infrastructure; loss owning to spoiling/bruising*
4. Storage	*Pests and disease attacks, spillage, contamination; natural drying out of food*
5. Primary processing, cleaning, classification, hulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, milling	*Process losses; contamination in process causing loss of quality.*
6. Secondary processing, mixing, cooking, frying, molding, cutting, extrusion	*Process losses; contamination in process causing loss of quality*
7. Product evaluation and quality control	*Product disregarded /out-grades in supply chain*
8. Packaging	*Inappropriate packaging damages produces; grain spillage from sacks; attack by pests*
9. Marketing, selling, distribution	*Damage during transport; spoilage; poor handling; losses caused by poor storage*
10. Post-consumer	*Poor storage/stock management; discarded before serving; poor food preparation; expiration*
11. End of life disposal of food waste/loss at different stages in supply chain.	*Food waste discarded may be separately treated, fed to animals, mixed with other wastes/landfilled*

Postharvest losses vary greatly among commodities and production areas and seasons. As a product moves in the postharvest chain, PHLs may occur from a number of causes, such as improper handling or biodeterioration by microorganisms, insects, rodents or birds.

There are internal and external factors contributing to postharvest loss. The Internal Factors occurring at all stages in the food supply chain from the moment of harvesting, to handling, storage, processing and marketing.

The external factors of the food supply chain can cause significant postharvest loss. These factors can be grouped into two primary categories: environmental factors ic and socio-economic patterns and trends.

Environmental factors

Climatic conditions, including wind, humidity, rainfall, and temperature influence both the quantity and quality of a harvest.

Socio-economic factors

Social trend such as urbanization has driven more and more people from rural area to large cities, resulting in a high demand for food products at urban centers, increasing the need for more efficient and extended food supply chains. Other socio-economic factors are linked with grain importation which can introduce new insect species, hence posing a very significant problem. Not only is the imported grain at risk, but the native grain as well. For example, in 1980, the introduction of a new insect species to Africa along with grain importation created weight losses of up to 30% in just 3-6 months of storage.

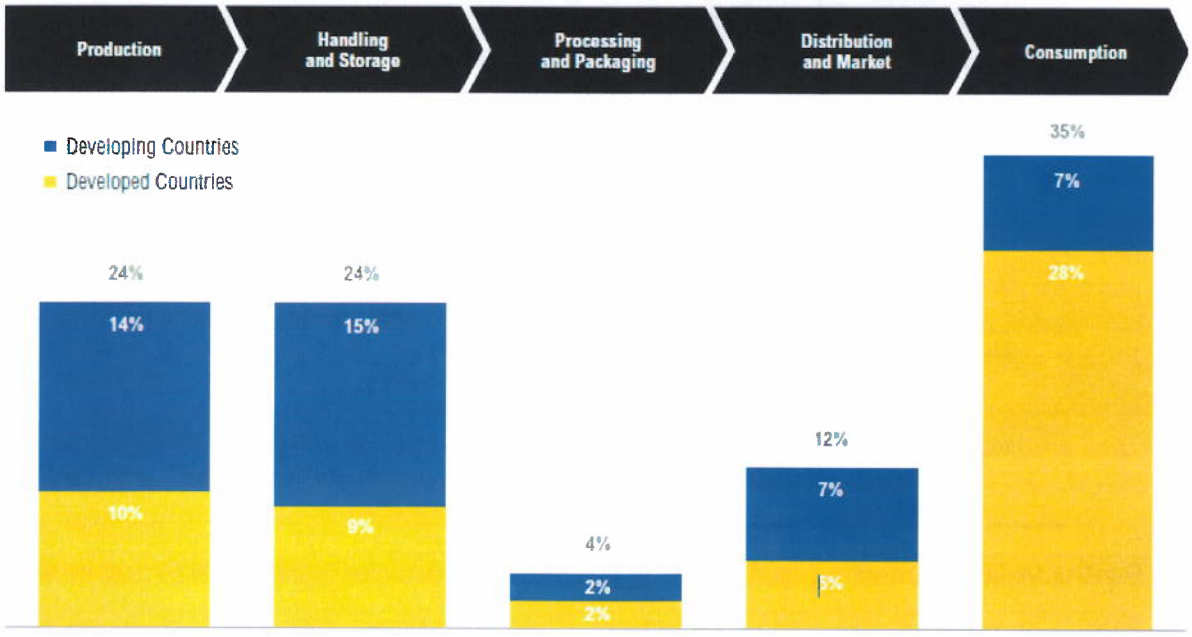

Figure 6: Level of waste according to the type country

4- Post-harvest operations

Post-harvest operations are classified in two group: First post-harvest operation et Second post-harvest operation.

The first post-harvest operations include six (6) key operations which are:

- Harvest
- Field drying
- Threshing
- Paddy Drying
- Cleaning
- Transportation

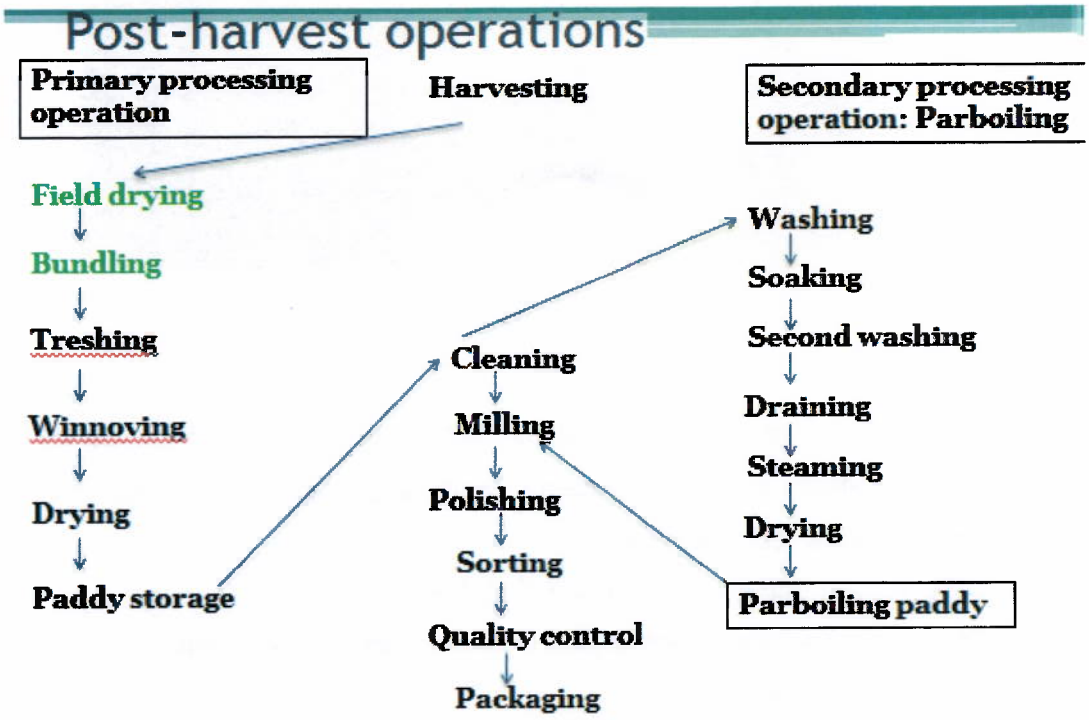

Figure 7: Post harvest operation

The second post-harvest operations include seven (7) key operations which are:

- Cleaning
- Milling
- Polishing
- Sorting

- Parboiling
- Marketing
- Transportation

4-1. First post-harvest operation

4-1-1. Harvesting

Photo 2: Rice field ready to be harvest

Harvesting is a crucial operation that can affect the quantity of the paddy. It can also compromise all efforts made subsequently to achieve good quality milled rice.

The farmer must harvest rice when:

- 80% at least of panicle reach to full maturity
- The rest of the rice grains should be in the hard dough stage.
- Panicles is straw-colored.
- Moisture content of grain: 20-22%
- Mature paddy grain color (yelow)
- White color of grain after removing of husk

Proper timing is an important factor in harvesting as it affects field losses and grain quality and then marketability. If harvesting is too early, the volume of immature paddy increases, broken rate during milling increase. If harvesting late, grains vulnerable to excessive shattering, or can crack during threshing, resulting in grain breakages during milling. Crop more exposed to attack by rodents, birds and insects;

How to harvest rice ?

Several methods of harvesting are used in SSA, depending on the type of rice ecology, size of field and the cultural practices of the ethnic group involved, or the production objectives that may be influenced by the operation cost. Rice on the farm should be harvest manually and mechanically. Improved methods of harvesting are mainly employed on big irrigated farms or lowland farms while the traditional methods are used on the upland fields, small irrigated farms and on undeveloped lowlands. Manual harvesting is slow, time consuming, labor intensive and full of drudgery. This leads to delayed harvesting which have serious implications for the quality of paddy and milled rice. In manual harvesting, sickles and knives are used while in mechanized harvesting combined harvesters are mainly used.

4-1-1-1. manual harvesting

Harvesting is done with sickle by smallholder farmers when grains are hard and are turning yellow or brown that is about 30–45 days after flowering.

Photo 3: Sikle

Photo 4: Manual harvesting

Manual harvesting involves the following operations:

- Cutting the stems with a sickle about 10–15 cm above the ground
- Or cutting the panicles.
- Drying the harvested crop in an upright position before threshing.

Try, as far as possible, not to place the paddy harvested on the ground to avoid mixing it with mud and small stones. The harvested paddy must be spread on:

- ✓ Plastic tablecloths
- ✓ Tarpaulin
- ✓ Traditional mats etc.

4-1-1-2. Mechanical harvesting

Mechanical harvesting should be with a reaper or a combine harvester

a) Harvesting with a reaper

The reaper represents an alternative to combine and manual harvesting (Fig. 4). However, they are generally unavailable to most farmers in the sub-regions although some countries have tried them. Trials need to the carried out on these in the other countries and disseminated fully in the sub-region.

These machines cut the crop and spray it on the ground. The harvesting rice generally has a moisture content of about 20 per cent. Harvesting during wet weather conditions should be avoided and done by adopting proper method. The water from paddy field should be drained about a week or 10 days before the expected harvesting, which helps in employing mechanical harvesters, avoid pest infestation prior to harvesting. Harvested material should be protected from rain and excessive dew by covering. It is important to avoid direct sun drying, which leads to an increase in breakage of the grains during milling.

Photo 5: Reaper

Photo 6: Harvesting with a reaper

b) Harvesting with combine harvesters

The combine harvester cut the crop, thresh it and deliver the clean grain in the grain tank. The combine harvested rice generally has a moisture content of about 20 per cent. To perform optimally the use of combine harvesters require the following;

- large farm sizes ;
- good level and dried surface area (not water logged) ;
- erect rice plants (not lodged) ;
- personnel trained in the use of the equipment ;
- availability of spare parts and machine repairs/maintenance.

Photo 7: Rice mini combine

Photo 8: Harvesting with mini-combine

4-1.2. Field drying

After manual harvesting or using the reaper, the field dryer is important to facilitates the threshing process and protects the product from mold and insect attack. It good for reduction of the water content of harvested rice, which provides protection against sudden re-wetting of the rain and other environmental factors that may affect the quality of rice.

The layering should last 2-3 days; It may take a little longer in some areas provided it does not affect the water content

4-1-3. Threshing

Threshing is a post-harvest operation which consists of separating the paddy grains from the rice straws. Threshing is very important operation in the production of rice. If it is badly done, it can result in broken or damaged kernels or a mixture with other things such as sand, small stones and other varieties of rice, which will cause problems during processing

4-1-3-1. Manual threshing

The most frequent threshing method is to beat the harvested stalks on a drum or with a stick. Threshing is best done on a clean tarpaulin and never on the bare ground. This avoids stones mixing with rice,

Photo 9: Manual threshing

4-1-3-2. Mechanical threshing

Different thresher were developed and introduced to the farmer to reduce the penibility of threshing and improved the quality of the paddy. We have already big scale

a) Big scale thresher ASI

Photo 10: ASI thresher

The ASI thresher-cleaner can play an important role in the economy of the country by increasing production, which is translated by a great quantity of rice threshed but also by reducing losses during threshing. This can lead to rice self-sufficiency and exportable surpluses. These economic factors can have impacts on local artisans, service providers and users of this machine.

AfricaRice thresher ASI technical performance

- Capacity: 1,788 kg/h
- Fuel consumption: 0.74 ml/kg.
- Threshing efficiency: 100 %,
- Cleaning efficiency: 96.35%
- Seed damage: 7.88% and
- Seed loss : 2.45%
- ASI thresher 2 function: threshing and cleaning

b) Small scale threshers

The small scale threshers are adapted to the small farmer. They are more mobile and easy to run and maintain

Photo 11: Small scale thresher (straw none handle)

Photo 12: Small scale tresher (straw handle)

Small scale thresher technical performance

- Capacity: 300-500 kg/h
- Fuel consumption: 1.5 litre/h.
- Threshing efficiency: 100 %,
- Cleaning efficiency: 94.35%
- Seed damage: 5.88% and

- Seed loss : 2.11%

4-1-4. Cleaning / Winnowing

Clean threshed grain to remove impurities such as bulky straws, chaff, weed seeds, leaves, pods, sticks, stones and other foreign matter is very important to get a good quality of rice. Clean grain can improve storability, better milling output and quality resulting in a higher marketable value. This operation can be done manually without delay after threshing to avoid contamination and poor quality black rice. They is manual winnower and motorized cleaner.

Photo 13: Rice paddy cleaner

Photo 14: Rice paddy winnover

4-1-5. Drying

4-1-5-1. Importance of drying the paddy correctly

Paddy drying is one of the important operations necessary for the storage of good quality of paddy and milled rice. The drying is done to reduce the paddy moisture content to between 12 and about 14% depending on the envisaged time of storage. High paddy moisture content will encourage the growth of moulds thus affecting the quality of milled rice. Paddy dried for long time in high sun intensity would develop fissures inside and on parboiling and drying result to high breakage during milling.

Rice is harvested in the field at a moisture level of 20–22%. Attempting to store it in this condition will cause grain quality deterioration. To maintain seed quality during storage, paddy rice should therefore be dried to a moisture content of 12–14% (wet basis). Drying is the most important method in minimizing post-harvest losses. Temperature for drying paddy should not exceed 43.3 °C for seed and 54.4°C for food grain. Drying of grain should immediately follow threshing. The paddy dried for a long time in the sun at a high temperature tends to have cracks in the interior. The broken rate during the milling should be high. There are several methods of drying. Any delays in drying, incomplete drying, or uneven drying will result in qualitative and quantitative losses during:

- Yellowing or discoloration caused by mold development and heat build-up from respiration.
- Reduced milling yields caused by high temperatures and re-wetting of grains.
- Loss of germination and vigor from grain respiration, mold and insect activities, or from exposure to grains to temperatures above 42ºC.
- Damage caused by insects that are more active at higher MC levels.

4-1-5-2. Sun drying

Sun drying continues to be the preferred drying method by the farmer because of its low cost. However, it is labor intensive and control of grain temperature is difficult. Drying should be on: Tarpaulin, cemented floors or mats. Sun drying should be carried out gradually for the first few days to reduce breakage during milling. To reduce the introduction of sand pebbles and other foreign matter into the paddy, it is important to avoid drying on bare floors. The paddy is spread on the floor 10 to 30 mm thick layer by labour with the help of a plank. Then it is continuously stirred by a spiked plank. The paddy should be drying on the sun for

2 hours and later on the shadow or, after 3-4 hours of drying in sun, paddy is heaped and covered by mats for tempering for a period of 2 to 3 hours. Then the paddy is spread again for 2 hours in the sun to dry it to desirable moisture content.

For optimum quality:

- Spread the grains in thin layers (3 cm);
- Cover or collect the grains during rain;
- Mix frequently, at least every 30 minutes;
- Monitor the grain temperature ;
- Shade or cover when grain temperatures are above 50°C (42°C for seeds)

Photo 15: Sun drying on tarpaulin

Photo 16: Pady sun drying on cemment platform

4-1-5-2. Mechanical drying of paddy

a) **In-store drying** -

Paddy with MC below 18% can be slowly dried in storage bins using aeration with slightly pre-heated air (3–6K above ambient temperature). Farm to commercial level, capacity depends on storage structure. Drying time: days to weeks

b) Heated Air Drying

- **Fixed Bed Batch Dryer** - for farmers, contractors, small rice mills. Capacity: 1–10 t/batch. Drying time: 6–8 h. They are simple, cheap

Photo 17: Flatbed dryer

- **Re-circulating Batch Dryer** - for rice mills and cooperatives. Capacity: 4–10 t/batch. Drying time: 6–8 h. . Provide Even drying, automatic operation, affordable

- **Continuous Flow Dryer** - for large commercial facilities. Capacity: ~10 t/hour. Drying rate: 1–2% pass. High capacity, automatic operation

4-1-5-3. Some recommendations on drying the paddy

- Clean the grains before drying to avoid uneven drying and wet spots.
- Dry the paddy immediately after harvest; use the 18% MC if the paddy will be stored for a maximum of two weeks.
- When drying for milling, maintain the MC to 14% so the grain weight and milling yield won't decrease.
- When storing grains from 8–12 months, dry the grains up to 13% MC or less.
- For long term storage (1 year or more, maintain MC to 9%).
- Do not mix grains maintained at different MCs to avoid cracking.
- Always monitor the grain temperature and MC to prevent the grains from being exposed to excess temperatures and over-drying.

4-1-6. Storage

The paddy rice must not contain more than 13–14% moisture, and be handled in a way to avoid moisture absorption either from rainfall or the moist air.

- Paddy should be protected from insects and rodents.
- Hence, the storage structure must protect the paddy from :
  - ✓ extreme heat or cold,
  - ✓ moisture levels at which the seed will spoil and be subjected to microbial or fungal attacks,
  - ✓ insect, pests and rodent consumption damage

Photo 18: Bad practice storage of paddy

4-1-6-1. Bag storage

Bag storage is used by all sectors in storing paddy for both short and long duration although. It does not conform to the above criteria. It is recommended that this method be used for short duration of up to three months. When grain is stored longer, frequent inspection for any sign of rodent, insect, heating and mould on the stored grain.

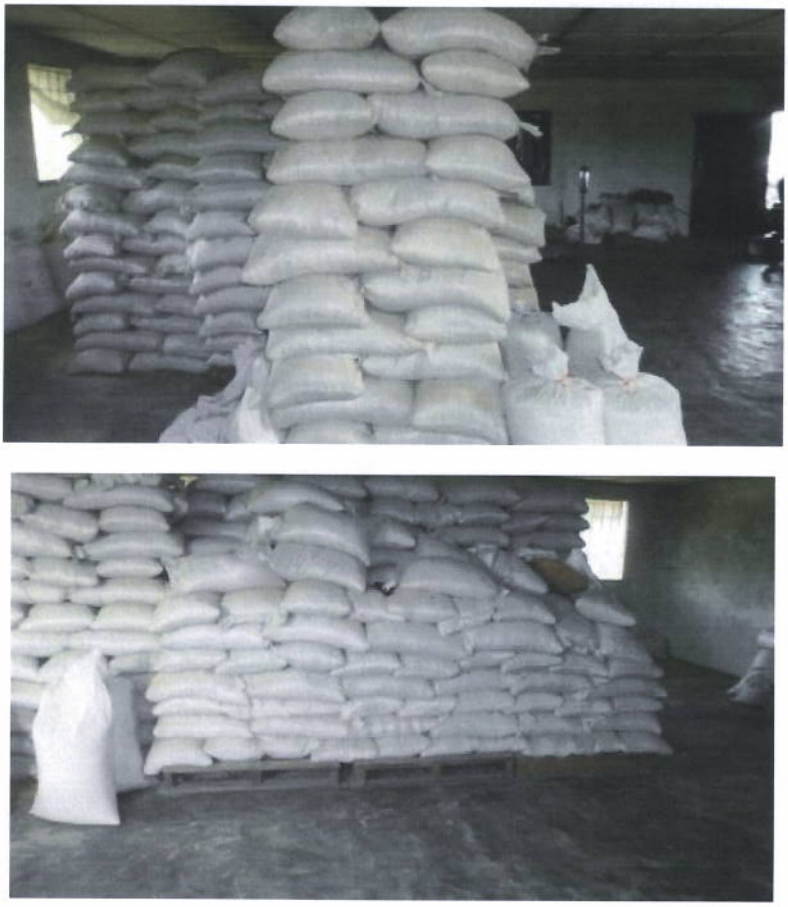

Photo 19: Good practice storage of paddy

For a good storage of paddy for milling and for steaming, it is necessary that:

- The warehouse is clean and disinfected before the introduction of the paddy.
- The paddy is spread on clean and disinfected pallets
- The paddy bags should be stored at a distance:
    - ✓ 50 cm from the wall,
    - ✓ 50 cm to 1 m from the roof,

- ✓ 50 cm to 1 m between the pallets
- ✓ Volume of the

- The windows of the warehouse (provided with mosquito nets) remain open
- The paddy bags should be placed alternately on the pallet (to allow air to circulate between the bags.

The paddy must be removed according to the first-in, first-out (stock rotation) principle.
In the case of long storage periods, the paddy bags must be returned by removing the whole stock and exposing it to the sun on plastic tablecloths, tarpaulins or traditional mats.
During this period, the warehouse must be disinfected with neem, pepper and other local chemicals available against insects and rodents.

Others storage structure

- Mud bin,
- Metal drums
- Gunny bags
- Improved structures include different types of
- improved bins,
- Brickbuild godowns,
- Cement plastered bamboo bin
- CAP (cover and plinth storage)
- Most advance silos

4-1-7. Toxins in Rice

Aflatoxin and fumonisin: mycotoxins in rice. The aflatoxin is a type of mycotoxins, which are derived from the fungi, which affect human health. Aflatoxins are produced by Aspergillus flavus, Aspergillus ochraceus and Aspergillus parasiticus. Contamination of Aflatoxins occurs at any stage from field to storage, whenever environmental conditions are conducive for fungi. The fungie are generally regarded as storage fungi, Fungie grow under conditions of relatively high moisture/humidity. It causes severe liver damage and both liver and intestinal cancer in humans. Generally, milled rice contains low levels. Prevention and Control of Aflatoxins: The paddy/rice should the stored at safe moisture level. Prevent the

growth of fungi by drying of grains. Use proper and scientific storage method. Prevent insect infestation by adopting chemical treatment to avoid fungus contamination. Separate the infected grains.

4-1-8. Concept of Paddy Rice Quality and Overview of the International Standard for Paddy Quality

Several interrelated features determine the quality of paddy including: moisture content, purity, varietal purity, cracked grains, immature grains, damaged grains and discolored/fermented grains. The characteristics are determined by the weather conditions during production, crop production practices, soil conditions, harvesting and post-harvest practices.

4-1-8-1. Moisture content (MC)

This influences all aspects of paddy and rice quality, making it essential that rice be milled at the proper MC to obtain the highest head rice yield. Paddy is at its optimum milling potential at an MC of 14% wet weight basis. Higher moisture contents are too soft to withstand hulling pressure, which results in breakage and possible pulverization of the grain.

4-1-8-2. Crack Grain

Exposing mature paddy to fluctuating temperatures and moisture conditions can lead to the development of fissures and cracks in individual kernels. Cracks in the kernel are the most important factor contributing to rice breakage during milling. This results in reduced milled rice recovery and head rice yields. Grain should be harvested at about 20% to 24% moisture or about 30 days after flowering. If harvest is too late, grains are lost through shattering or dry out and are cracked during threshing, which causes grain breakage during milling. Grain that is too dry is brittle and has greater breakage. MC and drying temperature also is critical, because it determines whether small fissures and/or full cracks occur in the grain structure.

4-1-8-3. Purity

Purity refers to the presence of dockage (materials other than paddy) including chaff, stones, weed seeds, soil, rice, straw, stalks and other debris. The impurities generally come from the field or the drying floor. Unclean paddy means a longer cleaning and processing time for the grain. Foreign matter in the grain reduces milling recoveries and the quality of rice, and it also increases the wear on milling machinery.

4-1-8-4. Admixture

Mixing paddy varieties can cause problems during milling, resulting in reduced capacity, excessive breakage, lower milled rice recovery and reduced head rice. Different sized and

shaped grains makes it difficult to adjust equipment such as hullers, whiteners and polishers. This results in low initial husking efficiencies, a higher percentage of re-circulated paddy, non-uniform whitening and a lower quantity of milled rice. The amount of immature paddy grains in a sample greatly impacts the head rice yield and quality. The immature kernels are very slender and chalky, which results in excessive production of bran, broken grains and brewer's rice.

4-1-8-5. Grain size and shape

Grain size and shape, or the length-width ratio, is different for the varying paddy varieties. Long, slender grains typically have greater breakage than short, bold grains and therefore have a lower milled rice recovery. The dimensions dictate to some degree the type of milling equipment needed. For example, Japanese-designed equipment may be better suited to short, bold grains whereas Thai-made equipment is more suitable for longer, slender grain types.

4-1-8-6. Damaged grains

Grains can be damaged by water, insects and heat exposure. The paddy deteriorates through biochemical changes in the grain, the development of off-odors and changes in physical appearance. Yellowing is caused by over-exposure to wet environmental conditions before the paddy is dried. The grains contain partly gelatinized starch cells and resist the pressures applied during milling. The fermented grains do not impact milling yields, but do downgrade the quality of the milled rice because of the appearance. Insect or mold-damaged grains often have black spots around the germ end of the rice kernel. During milling, the black spots are only partly removed, which increases the presence of damaged grains.

4-2. Second post-harvest operation

4-2-1. Milling

Milling technically refers to the removal of the husk to obtain 'brown rice' and gently polishing off the bran to obtain a whole milled grain. It involves hulling and polishing. While hulling involves removing the husk from the paddy with minimum damage to the grain and separating the husk from the paddy to produce brown rice. Milling combines a series of mechanical processes that may remove the hull, the outer layers and the embryo of the rice grain. Milling is accomplished by friction and abrasion processes that remove the bran layer

from the brown rice grains; friction between the grains breaks and peels off the bran, while with abrasion, a rough surface peels off the bran.

The objective of milling includes to remove the rice husk ; to remove the rice bran and polish the rice kernel to increase appeal and to improve packaging and storage.

The efficiency of a rice mill should be evaluated on the basis :

- ✓ Capacity (200 kg/h – 2 T/h); (2T/day – 15t/day
- ✓ Milling rate (99,5-100%)
- ✓ Broken rate (15-50%)
- ✓ Milling yield (65-75%)
- ✓ Dehulling Index (0,6-0,85),
- ✓ Cleaning efficiency: 99-100%
- ✓ Fuel consumption: 9-12 litre/tonne paddy

The most critical factors that control optimum milling recovery (ratio of milled rice output to paddy input) include:

- ✓ Moisture content: no more than 13–14%
- ✓ Purity: the presence of impurities reduces the milling recovery and quality
- ✓ Cracked grain: this breaks easily during milling and whitening, thus reducing milling quality
- ✓ Varietal characteristics: varieties differ in their milling abilities.
- ✓ Immature grain – the husk content of immature grain can be as high as 40%

4-2-1-1. Milling equipment

Different milling equipment exist to separate white the white rice from the bran and the husk. Those equipment are:

a) Mortar and pestle (hand pounding) is still common;
b) Small scale rice mille, type Enguelbert: 100-300 kg/h;
c) Roller rice mille :2-3 tonne per day ;
d) Big rice mill : capacity : 10-30 tonn per day.

Photo 20: Small scale impoved rice mill (type Enguelbert; with winnover)

Photo 21: Roller rice mill

Photo 22: Rice mill factory

4-2-1-2. Component of big rice mill

- Destoner
- Cleaner
- Husking machine
- Densimetric table
- Polisher
- Grader
- Color sorter
- Packaging

4-2-2. Grading

It is important to separate mill rice by size. This in aim to get different broken rate: 5%; 10%; 15%; 25%; 100% broken rate. Grader integrated in a big rice mill. For small rice mill, a manual calibrator designed and fabricated.

Photo 23: Manual mill rice grader (capacity 350-400 kg/h; 3 tonn/day)

Photo 24: Motorised rice grader (capacity : 7-8 tonn/day)

4-2-3. Packaging and labelling

4-2-3-1. Packaging

Packaging and labelling of local rice is usually not carried out in many countries in SSA. The usual conception is that it is only imported rice that is properly packaged and labelled. Another reason why local rice is neither packaged nor labelled is the lack of standards and laws compelling producers to do so in SSA countries. In instances where local rice has been well packaged and labelled, it has been sold for higher prices. However, even where local rice is packaged and labelled, the quality of the packaging material is low and the labelling not properly done. Local rice is often no packaged nor labeled. The quality of the packaging material is not good and the labeling is not done adequately. The processor should package rice in bag of 1kg, 5kg, 25 kg, 50 kg.

The bag should be in :

- ✓ plastic;
- ✓ Polyethylene
- ✓ Jute bag

Photo 25: Rice package

Good packaging provides :

- ✓ Convenient handling in transportation and storage but
- ✓ Attracts consumers to pay more.

Packaging is essential :

- ✓ to avoid spoilage and to prolong the quality.
- ✓ for long-term storage to fulfil the demand of old
- ✓ rice in the market,
- ✓ for labelling and branding

The graded rice should be packed in new, clean, sound and dry:

- ✓ jute bags,
- ✓ cloth bags, polywoven bags,
- ✓ polyethylene, polypropylene,
- ✓ high molecular high density polyethylene paper packages or
- ✓ in other food grade lastic/packaging materials.

- The packages shall be free from :
  - ✓ insect infestation,
  - ✓ fungus contamination,
  - ✓ deleterious substances and undesirable or obnoxious smell.

4-2-3-2. Labelling requirement

Labelling of the packaging material is very important to promote the product. It gives the major information to consumers in decision making and also helps to trace the product. Labelling involves the use of logo, necessary information using attractive colour and design. The following information is required for good labelling:

- Name of the product
- Logo
- Variety
- Broken rate
- Origin
- Weight
- Year production
- Year milling
- Expiration date
- Contact

Each package shall be securely closed and suitably sealed The marketing of the produce is one of the most important operations. Need to developed well marketing system engaged in rice marketing various agencies like :

- wholesale merchants and commission agents;
- village merchants;
- rice mill agents;
- co-operative organizations and
- government organisations

4-2-4. Transportation

There are different modes of transport used in paddy/rice transportation. Road and rail transport are normally used for internal markets, whereas, for export markets, the mode of transport is by Sea. Road transport is the most predominant mode of transport used in the movement of paddy/rice. Road transport is used in right from the producing fields to the ultimate consumer. Railway is one of the most important means of transportation of paddy/rice.

4-2-5. Rice parboiling

4-2-5-1. Advantages of parboiling

- ✓ Reduces grain breakage during milling and hence higher head rice recovery.
- ✓ Improved milling yield
- ✓ Parboiled rice is nutritionally richer than raw rice
- ✓ During cooking there is less loss of solids in the gruel than raw rice.
- ✓ Cooked parboiled rice has better digestibility ratio by reason of its texture and firm consistency.
- ✓ Bran from parboiled rice contains 25-30% oil as compared to 15-20% from raw rice.

4-2-5-2. Different steps of rice parboiling

Step 1: Washing of paddy

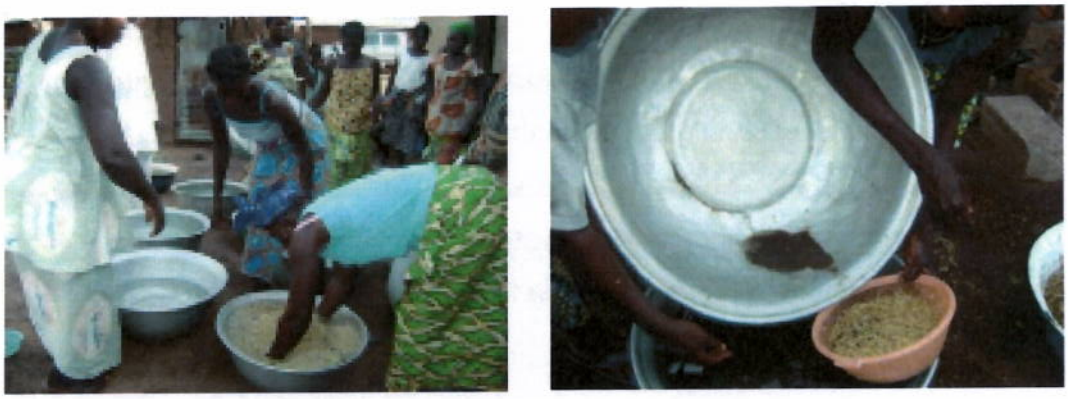

Photo 26: Paddy washing

Paddy is washed in a basin containing a large quantity of water (about 3 liters of water to 1 kg of paddy rice).

Immature grains floating at the surface during washing are collected using a small basket or a sieve.

Step 2: Draining

✓ Pour the clean paddy into a basket for the water to drip (5 min)

Photo 27: Paddy draining

Step 3: Soaking

- ✓ The paddy is poured in an aluminum or stainless pot containing clean water.
- ✓ The water level should be above the paddy rice.
- ✓ The water is then heated to approximately 70°c. (At this temperature, the processor can hardly dip her/his fingers in the water as it is very hot).
- ✓ The pot is then removed from the fire and kept for 12 hours

Photo 28: Paddy soaking

However, If the temperature can be maintained constant at 70°C, the duration of soaking is 4 h.

Step 4 : Second washing and draining

- ✓ After 12 hours of soaking, the paddy is drained and washed.
- ✓ This second washing is necessary to avoid fermentation and remove impurities.
- ✓ After the washing is completed the paddy is transferred to a clean basket for draining.

Step 5: Steaming of paddy

- ✓ The drip-dry paddy is poured in the steaming pan
- ✓ The water contained in the pot is heated to its boiling point and the vapor/steam generated passes through the holes of the screen to pre-cook the paddy rice.
- ✓ This process will end when it is observed that the husks of some paddy grains have burst or a heavy sound is heard when tapping the grains using the palm of one's hand.

✓ Duration of this process is about 20-30 min

Photo 29: Paddy steaming

Step 6: Drying of paddy

✓ Steamed paddy is first dried in the sun for about 2 h, then collected and dried in the shade for the remaining period, which can last for about 16 hours before hulling takes place.

✓ Drying of parboiled paddy from 45-50% (wb) to 14-16% (wb) needs to be done for proper milling and storage.

✓ For uniform drying, paddy is spread in 2-3 cm thickness layer and stirred at an interval of half hour.

Photo 30: Paddy drying

Conclusion

With a good application of the improved post-harvest practice, good understanding of the operating principle of well-designed equipment, it is expected that production capacity will increase and product quality will improve in Liberia. It is important to respect all the steps of rice processing, from harvesting to packaging.