TRAINING MANUAL OF IMPROVED RICE POST HARVEST TECHNOLOGIES (DRAFT)

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In order to increase incomes, to achieve food security and improve the social welfare of the population in the rural areas of Africa, many strategies and programs are being implemented and their main target is the improvement of the present economical situation and social indicators of Africa. The project for post harvest improvement of rice, cassava, sorghum/millet products in West Africa, which is a project lead by CORAF/WECARD, coordinated by the Songhai Regional Center and financed by USAID has this same preoccupation.

In the methodological plan for the concretization of priorities of the common vision among African countries and their technical and financial partners, we all agree that if we want agriculture to be the principal sector that stimulates economic growth, then agriculture has to go higher than just simple agricultural production and target the development of agribusiness and agro industries.

In fact, there is an umbilical cord which connects the matter of improvement of post harvest techniques to the development of agribusiness. We should note that agro processing contributes to food security by the following four main ways:

1. **Reduction of post harvest losses**: the estimates of this loss are about 30 percent in the case of cereals, 50 percent for root and tuber crops and up to 70 percent for fruits and vegetables.

2. **Extension of foodstuffs' preservation duration**: this enables the producers to take their products to urban areas where they can find the majority of the population who would buy their goods;

3. **Enhancement of products’ value**: increase of producers’ incomes, creation of employment

4. **Improving the quality**: assurance of food safety by setting up certification systems.

I. **CORAF’s option about agribusiness promotion**

It is very important to note that, CORAF in its development strategic plan aims generally at diversifying sustainable agricultural growth in Africa.
The specific objective includes option for integrating the improvement of the productivity and the development of agribusiness. In fact, for the period of 2007 to 2016, CORAF aims at promoting sustainable agriculture and the diversification of agricultural markets.

The training manuals on the improvement of post harvest quality of rice and cassava products in West Africa, elaborated in the scope of this project, should be used according to a progression of their pedagogic objectives by insisting on the meaning of value chains. The main reason for the users of this manual must be for the invitation of the processors to three characteristics that make up the value chain:

1. **Ambition**, for the definition of production objectives that stops odd jobs
2. **Leadership**, so as to stop unexpectations and wastages of resources and make place for a strict management that guaranties profit making and competitiveness.
3. **Cooperation** so that the mutualization of forces or relative advantages of one and other would lead to a regional economic integration, widening of the market and at last the enhancement of beneficiaries incomes.

In other words, the gamble at the end of each training session with this manual should be to have changed:

- The food specialist, scientist, extension workers from their initial status of « inventor » to a status of « manager »
- The cassava or rice processor from their initial status of « promoter » to a status of « entrepreneur »

We can all see that the optimization of the technical expertise capitalized in this manual cannot be realized unless the trainer is knowledgeable in entrepreneurial because we all know that only an entrepreneur can train another entrepreneur and a mason another mason. So each trainer has to teach his trainees the ways of taking economic decision.

Ways of promoting agribusiness by the manual: teach the participants the mechanism of the ways of making economical decisions.

The pedagogical orientation of this training session with these manuals must aim at guiding the listener to the necessity of:

1. Searching for the valuing of agricultural products, the best strategies and alternatives that would optimize the resources which are to be used, we don’t
have to process just because we have to process... the manual insists on the
taking over of adapted technologies and on the mastering of processing
procedures in conformity with the norms of quality and occupying a good position
in the market.

2. Upgrading the firm with the new knowledge we've acquired into a large scale of
production system.

As a result of this, the driving code from agribusiness requirement shows us the
following chronological steps:

- A good definition of the comparative advantages and opportunities, good
evaluation of the necessary needs, market segmentation and the outlining of the
product and pricing strategies,
- Definition of the special offers and the distribution strategies
- Definition of competing strategies, analyses of the profitability of the operation.

So if at least each participant leaves the training session with the conviction that he or she
can optimize his firm by making it a real agribusiness center, then there will be no doubt
that the training session done by using this manual has sowed seeds for agribusiness
development. The following eleven questions can help us to act as an agribusiness
promoter:

1. What am I suppose to change in my firm? (What are the problems in my firm)?

2. What am I losing by leaving the firm without improvement and what would I gain
by making necessary improvement?

3. What kind of changes or improvements should I make?

4. What are my strong and weak points in relation to the changes I want to make,
and what are the treats and opportunities?

5. Which objectives and results am I targeting by undertaking these changes?

6. What are the different possible alternatives and which are the best among them?

7. What are the priorities for the implementation of the improvement and according
to which program?

8. What are the necessary means for implementing the innovation?
9. What are the expected fall outs of this innovation? After the innovation, would the situation be better than the old situation?

10. What are the reel risks and the chances of success in the concretization of these innovations?

11. Which indicators would enable me to supervise and to readjust during the implementation of the different stages of the project?

The implementation of these steps composed by 11 points can be done by the trainer as an exercise of economical decision making by what we call « partial budget » which is the analyses made together with the participants by knowing in the case of innovations in our firms, the additional charges and the subtracted products.

To sum up, this manual has to transform our poor population not only into producers and processors but also into wealth creators because, whether we like it or not it is clear that the success of Africa depends mostly on the capacity of his entrepreneurs and heads of enterprises to create and retain wealth through private enterprises.

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The project, *Improving post-harvest quality and packaging of rice, sorghum/millet and cassava products to enhance marketability in West Africa* aims to put technological packages in the hands of rice producers and processors as a means of increasing food availability and incomes. It is funded by the USAID, managed by CORAF/WECARD and coordinated by the Songhai Centre.

In rice, poor post-harvest practices in the production system, such as floor-drying, parboiling, milling and bagging pose significant problems in quality decline that has rendered the rice sector low in marketability and profit-making to producers and processors. The project is mobilizing the strengths, expertise and resources for post-harvest technology development and transfer in West Africa to demonstrate appropriate post-harvest technologies for adoption. Improved techniques for rice milling, cleaning, de-stoning and par-boiling will be demonstrated, alongside packaging and labeling technologies. The project seeks to strengthen capacities of the target groups to enable them adopt the techniques in rice processing, whilst their access in the acquisition of simple processing equipment facilitated through relevant linkages to relevant institutions in the target countries, Senegal, Mali, Liberia, Nigeria and Ghana. The manual is an outcome of consultative effort involving key partners (agro-processing groups, particularly women, artisans, AfricaRice, the respective NARIs, NGO/Extension and micro-credit institutions). The training needs of target groups, their constraints and existing opportunities for capacity strengthening were identified through a consultative scoping study involving the actors.

The manual development team reviewed existing manuals on processing technologies and updated them with new technologies and information available. It is anticipated that this will contribute to the reduction in rice post-harvest losses and improve market quality to improve food security and increase incomes of rice producers and agro-processors in West Africa.

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INTRODUCTION

Rice is the most important cereal for human consumption. It is the staple food for over three (3) billion people, constituting over half of the world's population (Central and Reeves, 2002, Davidson et al., 1979). Abulude (2004) reported that rice is an economic crop which is used in household food security, ceremonies, nutritional diversification, income generation and employment. It is utilized mostly at the household level, were it is consumed as boiled or fried or ground rice with stew or soup. Rice is also used for cake biscuits noodles etc.

In sub-Saharan Arica rice is one of the most important crop and its production represents a significant part of the strategy to overcome food shortage and improve self-sufficiency for both local consumption and export. Despite the fact that rice is widely cultivated in sub Saharan Africa, there is an upsurge in the influence of foreign or imported milled rice into the region (Abulude, 2004).

Popular foreign and parboiled rice widely consumed in the region includes “Aroso” rice (Abulude, 2004). The Golden rice which was genetically engineered to contain beta-carotene, not present in the standard rice to combat the wide spread vitamin A deficiency and eradicating shininess in children of the developing world is already been marketed in several countries in the region (Beyer et al., 2002; Central and Reeves, 2002).

Rice, unlike most other cereals, is consumed as a whole grain. Therefore, quality characteristics and general appearance of a given rice variety is of utmost importance.

For the rice farmers, rice is a source of income and livelihood and therefore a high yielding variety is required. The rice miller bases his quality upon total recovery and the proportion of broken and head rice on milling. Consumer and homemakers base their concept of rice grain quality on the physical appearance, size and shape, the behavior upon cooking and taste, tenderness and in rare cases flavor of cooked rice(Merca and Juliana, 1981).
Rice grain quality can be affected by variety, environment, and processing (Juliano and Duff 1989). Environmental and handling conditions during ripening, harvest, postharvest, and processing can enhance or impair grain quality. Processing also increases the price of rice. Yields of head rice vary depending on many factors such as variety, grain type, cultural practice, drying, storing parboiling and milling conditions (Adar et al., 1973). National programs have increased efforts in breeding for rice grain quality, and projects now include characterization of important varieties and selected germplasm entries. However consumer demand studies show wide diversity in grain quality characteristics preferred. That parallel markets exits for locally produced rice and imported rice makes it imperative to re assess the quality of locally produced rice.
BACKGROUND:

There is urgent need for standardization of rice post harvest processes in the West African region. This is to harness the huge potentials of the rice business. Good quality milled rice (parboiled or not) that could effectively compete with imported rice would save a lot of scarce foreign exchange. It will boost local rice production and provide large employment for producers, processors youth and women etc.

The multiplier effect of such a breakthrough would certainly reposition the economic status of the large section of people involved in the rice production chain. Again sub Saharan Africa have greater potentials in terms of available arable land for cultivation, human resources and favorable climate conditions for rice production than the current exporters of rice. It therefore remains for SSA to translate the words of the Director of Songhai Rev Father Godfrey Nzamujo that “Time has reached for SSA to turn its comparative advantage to competitive advantage.” This dream can be realized by pulling all available resources to increase our production and by improving the post harvest processing, packaging and marketing which have been the weakest point of the production chain.
OBJECTIVES OF THIS MANUAL

The objectives of this manual therefore include:

1. To provide comprehensive information on the salient factors affecting processed rice quality
2. To give step by step guide lines on how to handle the identified challenges
3. To recommend appropriate intermediate technologies for production of high quality paddy and processed milled rice which can compete with imported rice?
4. To give appropriate packaging information for branding of milled rice.

METHODOLOGY

A team of subject matter specialists from Research Institutes, Academia Non Governmental organization, processors (Parboliers, Millers, co-operatives) and extension agents met at National Stake holders meeting to identify problems and proffer solutions in terms of training needs necessary for production of high quality paddy and milled rice. The outcomes of the national meetings were collated. A team of experienced hands on rice production and processing were assembled at the Songhai Center Porto Novo from the 6-17th Jan. 2010 to use the resolutions of the different national stake holders meeting to develop a training manual in which almost all the countries in the sub region can conveniently adapt to suit their situations and meet their training needs leading to production of high quality paddy and milled rice capable of meeting local consumer preference and competing internationally.

The expert committee adopted and reviewed the resolutions of the national stake holders meetings and adopted the following measures in arriving at this present manual.
(1) identified the limitations of the practices in the rice production chain which ultimately contributes to poor quality of paddy leading to poor quality of milled product since the quality of the raw material determines the quality of the finished product.

(2) Provide step by step guidelines to correct the identified challenges

(3) Recommended through experience intermediate technologies that if adopted would have very positive impact on the rice post production technologies in the states in the region.

(4) Made the manual serve the need of the trainers the NGOs, Women groups the youth producers and processors alike.

This manual is therefore prepared that its users would be agents of production processing and packaging of high quality branded rice capable of competing in the international arena.
This section discusses major post harvest operations that take place in the field. These operations involve harvesting, drying bulking threshing and drying.
INTRODUCTION

Availability and quality

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.

There are several pre-harvest operations that have a bearing on the grain yield and quality of both paddy and milled rice grain which should be taken into consideration in the training of farmers. These will involve good land preparation (appropriate tillage depth, good leveling) and other agronomic operations such as use of good quality seed (pure, uniform, with good germination rate etc), and other agronomic operations such as disease, weed and pest control, appropriate fertilizer application (appropriate amount and proper split targeting at critical growing stages), appropriate soil and water management that take into account the needs of all developmental stage.

Rice harvesting is mainly carried out in sub-Saharan Africa manually. The process involves cutting of the rice plants, at maturity stage pre-drying, threshing, winnowing, drying and bulking. Several of these post production activities have direct bearing on the quality of paddy available for processing. The steps involved with rice post harvest activities are considered below.

GENERAL OBJECTIVE: The objective of the section is to provide practical information on how and when to harvest by using visual indicators, in order to optimize the quantity obtained and the quality of the paddy.

SPECIFIC OBJECTIVE: At the end of the training period, the farmer should be able to harvest at the appropriate time using simple visual signs and methods and be aware of the exiting improved technologies for harvesting that can fit their production system.
HOW TO GO ABOUT IT?

Harvesting at the appropriate time will ensure optimum grain yield and high quality paddy for processing by:

- Avoiding lodging, over drying of grain, shattering, rodent/bird attack, and contamination when panicles touch the ground. These occur as a result of late harvesting.

- Avoiding lots of immature and discolored grains as a result of early harvesting.

This will ensure high paddy yield, a quality product for parboiling or milling and high milling recovery with low kernel breakage.

Appropriate time of harvest (avoiding early/late harvest) is very important in controlling the quality of harvested paddy. Appropriate time of harvest therefore become a matter for consideration in the rice post production technology.

Appropriate time for harvest is indicated by

- The period when at least 80% of the panicles have reached full maturity.

- The moisture content of the grains should be between 20-22%

- The color of the grain full ripened color (mainly yellow)

- When the grain husk is removed, the grain is white and hard

How to observe the paddy field in order to determine an optimum harvest time.

- Observe your field to notice when the panicles not the rice plant starts getting yellowish in appearance. Do not confuse the color of the straw with the yellowish color of the panicles. Yellowish color of the straw may result in early senescence of the leaves.
- Pay attention to the panicles and observe when individual panicles in different parts of the field, have up to 80% maturity in the upper part of the panicle.

- Harvesting should start immediately.

- Waiting for the remaining 20% to mature may lead to shattering of the upper grains which are very often better filled thus resulting in yield reduction.

Note: It is very difficult to convince farmers to harvest at the appropriate time. Trainers are encouraged to conduct simple demonstrations through comparison in a given area in the farmer’s field using these indicators. An area should be harvested at the optimum time and a similar area harvested at the period decided by the farmer. These should be threshed and milled separately for the farmer to observe the advantages in harvesting at the optimum time.
HARVESTING METHODS

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. 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.

MANUAL HARVESTING: The most common manual harvester is the sickle but sometimes the cutlass is used (manual harvesting operation using a sickle is shown in fig 2).

When the knife is used harvesting is panicle by panicle making harvesting more laborious and time consuming. This method is mainly used where traditional varieties with uneven maturity times are grown. When sickles and cutlasses are used in harvesting, the entire plant is cut as opposed to panicle by panicle harvesting with knives. In areas where sickle or cutlass harvesting is unavoidable farmers are encouraged to engage as much labor as possible so as to reduce the harvesting period.
As much as possible harvested paddy should not be put on bare floor to avoid contamination with stones and mud and mold growth. Harvested paddy should be spread on

- Plastic sheets
- Tarpaulins
- Traditional mats etc.

Fig 2: Manual harvesting using sickle
MECHANICAL HARVESTING:

Figs 3 (A and B) shows a full and intermediate combined harvesters in Uganda.

They have the advantage of threshing as they are harvesting.

Mechanical harvesting may be carried out by the use of combine harvesters or reapers. The problem with the combine harvester is the high initial and maintenance costs coupled with its unavailability and lack of spare parts in most areas in West Africa. Also when these are used in fields with well dried grains, many of the grains fall or are broken by the tines. Generally the use of combine harvesters is most appropriate on farms that are relatively large with good leveling and water control. The rice variety should be one that matures evenly and should not be of short variety.

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)
- Trained personnel in the use of the equipment
- Availability of spare parts and machine repairs/maintenance
INTERMEDIATE TECHNOLOGY

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 be carried out on these in the other countries and disseminated fully in the sub-region.

Fig. 4 : Reaper
Chapter 2 : BULKING

Bulking is an operation that facilitates the process of threshing and to secure their produce from rodent and other predatory attacks. Correct bulking results in reduction of the moisture content of the harvested rice, protection from sudden rewetting from rain and other environmental factors which affect milled rice quality adversely. If paddy is pre dried and moisture content drops from 20 to about 16%, after bulking it is further dried slowly to about 14%. At this moisture content threshing is easier. This is however dependent of the environmental condition. Bulking should last for 2-3 days. It could be either a little bit longer in some areas while not affecting the moisture content much.

A good bulk should be:

- Conical with the panicle bending inwards (Fig. 5)

![Fig. 5: Correct Bulking practice](image)

- The straw should be outwards such that in the case of sudden rain the run-off effect will be on the straw (Fig 6).

- The surrounding space should be cleaned especially of grass to avoid fire out brake and other contaminating agents.
Chapter 3 : THRESHING

Threshing is the post harvest operation of separating the paddy grains from the rice straw. This is a very important operation in rice post harvest handling which if not handled properly results in broken/damaged grains and mixing with other foreign matter including sand, stones and other rice varieties which present more challenges for processing.

Threshing is usually done either manually or mechanically.

Mechanical threshing can be carried out by use of combine harvesters. In areas where the farm sizes and outputs are small the use of combine harvesters is difficult. Although this ensures efficient threshing the problems associated with the use of combine harvesters in harvesting as already stated above also apply here hence the use of combine harvesters are limited.

In manual threshing several methods are available. In some places threshing is done using legs to march on the straw, others beat the straw against drums others put the straw in bags and beat it against tree trunks stones etc while others use sticks to beat rice straw heap.

PROBLEMS OF MANUAL THRESHING

This method is time consuming, laborious, slow and output is quite low. Contamination of paddy with sand, stone, immature grain and other foreign materials is high. There is also loss of grain leading to reduction in overall output.
INTERMEDIATE TECHNOLOGY

There is however and intermediate technology for rice threshing. This involve the use of semi motorized and completely motorized rice threshers. These are already available in several places in sub Saharan Africa, particularly in irrigated areas or developed low lands.

There is the technology of threshing which uses a pedal thresher (Fig 7A). The pedals are attached to an overhead drum that is perforated to create fingers. As the machine is pedaled and the straw placed on the drum the resulting centripetal forces loosens the grain from the straw. The output is about 500kg per day. This is an improvement over the manual threshing. However the pedal thresher is very laborious have limited output and suited for only small farms. It also requires the winnowing of the paddy after threshing.

There is already an improvement on the pedal thresher (Fig.7B). This pedal is replaced with a motor such that the operator stands and places the straw over the exposed spike like drum. It gives higher output and is less drudgery but still suited for small farms.
The motorized thresher is a machine linked to a motor drive device carrying a perforated drum with metal or plastic paddles under which lies beneath a sieve system. The drum turns the paddles loosen the grains from the straw. By aspiration while the straw and other dirt’s are blown out through the exhaust pipe while the grains fall under the drum through the sieve (Fig 7C).
The thresher provides clean paddy without creating damage on the grain because of its axial flow system. This thresher which is an IRRI model was modified and adapted by WARDA in collaboration with Senegalese NARS.

There are different designs of motorized threshers. The only difference is that some have winnowing capacity added to their threshing power. Some can thresh up to eight (8) tons per day (Fig.8).

![Fig. 8: Improved motorized thresher/cleaner (ADRAO/SAED/ISRA, Senegal)](image-url)
Chapter 4: WINNOWING

This is the process of removing rice straw, sand small stones, weeds, chaff, and other extraneous materials from the harvested paddy. Winnowing is an important step for obtained clean paddy for storage and further processing. This is necessary to avoid contamination of the milled product with insect parts, stones, chaff, etc. It also protects the machine from dust, stones, etc., prolonging its life. Winnowing could be done by aspiration manually and mechanically.

Good winnowing practice involve

- Use of plastic sheets / traditional mats (tarpaulins etc)
- A clean environment
- The operator should not re-contaminate the winnowed grains with dust, sand etc.

MANUAL WINNOWING

In manual winnowing, the threshed materials are thrown up along the flow of the wind blowing away all the chaff and lighter materials. In manual winnowing, materials of the same density with the rice grains are also retained. The process requires much labour, is slow and low in output.

MECHANICAL WINNOWING

In mechanical winnowing, blowers and cyclones (hand operated and motorized) are available (Fig. 9). With hand operated blowers, the operator winds the machine to generate a centripetal force which separates the grains from the chaff. The grains drop to the bottom while the chaff is blown out through the exhaust. This has a larger output than the manual winnowing and the problem of recontamination is eliminated. The motorized winnowers
operate the same way but have increased output. They are however more expensive and are limited in availability. There is also the problem of the cost of fuel, maintenance and spare parts.

Fig. 9 : Motorized winnowers (Rep of BENIN)

INTERMEDIATE TECHNOLOGY

Hand operated aspirators for winnowing can be improved upon by adding an engine to increase the winnowing capacity.

The principle of the ASI thresher has been used to develop paddy cleaners in rice mills and this can be fitted with wheels to be used as winnowers with intermediate capacity in the field.
Chapter 5: DRYING

This is one of the important operations necessary for the storage quality of paddy and milled rice in case of raw-milled rice. This 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. There are several methods of drying. Refer to drying after parboiling.

Chapter 6: SECONDARY POST HARVEST OPERATION

This section discuss majors post-harvest operations that take place after field operation and involve, storage, parboiling, milling, packaging and marketing.

I- STORAGE: Storage should be properly carried out to ensure high quality paddy for milling and parboiling.

HOW TO STORE

Paddy rice is packed in 50-100kg jute bags and placed on pallets and stored inside the ware houses. Paddy can also be stored in bulk storage in the ware house or silos. The ware house should be well ventilated with windows facing north and south(this is to avoid penetration of sunlight). However many farmers do not place paddy on pallets neither do they store in ventilated places.

For proper storage of paddy for milling and parboiling, it is recommended that;

- The ware house should be properly treated and disinfected before introducing the paddy.
- Paddy should be placed on clean disinfected pallets

- Paddy should be stored a distance (50cm) away from the walls, (50cm-1m) away from the roof, (50cm) between pallets and (1m) for the walkway.

![Figure 10: Facilities for rice storage](image)

- The warehouse windows (screened) should be left opened

- The paddy should be packed in alternation on the pallet (Fig. 10). This is to allow circulation of air within the bags.

- The paddy should be removed according to the principle of first in first out.

- For long periods of storage paddy should be turned by removing the entire stock and exposing them in the sun on plastic sheets, tarpaulin or traditional mat.

- During this period the warehouse should be disinfected with neem pepper or other locally available chemicals against insects, microorganisms and rodents.
II- PARBOILING:

Parboiling is a processing procedure in which the paddy is soaked in warm or cold water followed by steaming and drying before milling. This procedure is carried out in some but not all the countries of West Africa. Parboiling has the following advantages:

- To reduce breakage during milling
- To improve the nutrient content of the milled rice
- To change the cooking qualities (taste, appearance aroma texture etc) of the rice

OBJECTIVE

- To educate parboilers on the critical steps in the process that may affect quality of the product so as to ensure a better quality end-product.

The problems associated with parboiling include:

- The uniformity of the paddy available for parboiling
- The properties of the rice variety being parboiled
- The type of equipment available particularly for steaming
- The form of available energy used for steaming and drying
- Quality of water for parboiling processes.
PARBOILING METHODS

Operations involved in parboiling include cleaning, paddy washing, soaking, steaming draining and drying. Each of these steps has direct bearing on the quality of the final milled rice. The parboiling process is shown in diagram below.

Diagram: Improved Parboiling of paddy

**WASHING**; washing is necessary as a means of removing straw, immature and shriveled grains mud and other extraneous contaminants. It gives the paddy the first level of hydration (tempering) necessary for proper steaming.

Washing is carried out in spacious open containers (plastic aluminum stainless steel etc) (Fig. 11).
Depending on the quantity of paddy and the vessel, paddy is soaked in water enough to submerge the grains and then rubbed in between the palms. The immature, unfilled grains, straw, etc are floated off. Removal of the immature grains will also avoid discoloration of the milled products and reduce breakages during milling.

The process is repeated several times depending on the dirt on the paddy. Sand and small stones are removed with the soak water. Washed grains are put in perforated baskets to drain off the water. This operation should last long enough to remove all the wash water.

This washing operation should be done with clean water. It should not be pond or stagnant water or water already used for similar purposes. This is to avoid discolorations introduction of odour and other contaminations.

**SOAKING:**

Soaking is the full submerging of washed paddy in water and allowing the paddy to fully hydrate. Usually paddy is soaked in cold water and heated to varying temperatures (usually 70 to 90C). The fire is then removed and the paddy allowed to soak for 12 to 16 hours. The soak water is about 90C when it is too hot to touch but not boiling.

If it is possible to keep the soak water at a constant temperature of 70C, the soaking period can be reduced to about 5 hours. The soaked paddy may be rewashed up to 2 times with fresh water and then drained as before.

![Fig. 12: Soaking of paddy in hot water](image-url)
**STEAMING:** This is the major parboiling operation. It is the actual steaming of soaked paddy till full gelatinization takes place. Optimal gelatinization may be indicated visually when the husks of a majority of the grain split open.

This operation is very vital because most of the rice nutrient migrates during this operation from bran into the kernel. As gelatinization proceeds internal cracks on the rice kernel due to over drying or impact of harvesting or other handling processes are closed up and sealed ensuring low kernel breakage during milling thus increasing the milling returns.

Steaming is done in different vessels as shown in figure

![Parboiling Equipment](image)

**Fig. 13 : Parboiling Equipment**
EQUIPEMENT FOR PARBOILING

Several improved parboiling equipment for rice exists in the West-African countries like Mali, Burkina, Ghana, and Benin. The one below was made by the Program for Agricultural and Food Technology of National institute of Agricultural Research of Benin (PTAA-INRAB) (Houssou and Amoussou, 2004). The utilization of this device improves qualitatively and quantitatively the parboiled rice during dehulling as compared with traditional method. Moreover, it is to multiple purposes. It can be used to cook several dishes that go steaming processing. The main component of the improved parboiling equipment (PTAA-INRAB) consisted of moulded aluminium alloy pot and parboiling vat. This vat was constructed at metal workshop and it is made up galvanized iron sheet. To properly achieve steaming, the vat was perforated at the base and around ¼ of its body from the base.

![Fig. 14: Vat showing the perforation at the base and around ¼ of its body from the base](image)

III- DRYING

This is the reduction of the moisture content of the steamed paddy for milling purposes. Parboiled paddy is mainly sun dried. Only in very large commercial ventures drying is done mechanically. The average moisture content of the steamed paddy is over 30%. Drying is thus the process of gradually bringing the moisture to about 12-14% for effective milling.

DRYING METHODS

Steamed paddy is manually dried by spreading under the sun for about 2 to 3 hours and then placing under the shed to equilibrate the moisture gradient and gradually dry down to 12 to 14 % moisture. However millers are encouraged to have moisture meters to effectively ensure that the moisture content comes to about 12 to 14%.
Mechanical dryers exits but are mainly found in huge commercial rice milling concerns. This is due to the cost of these dryers and the expertise to maintain them.
IV- MILLING

This 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 (Little et al., 2002) milling combine a series of mechanical process that may remove the hull, the outer layers and the embryo of the rice grain. Polishing on the other hand refer to the process of removing the “Subaleurone layer after whitening to give the rice grains a shiny appearance. 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 peel of the bran

OBJECTIVES OF MILLING : The objective of milling includes

✓ To remove the rice husk
✓ To remove the rice bran and polish the rice kernel to increase appeal
✓ To improve packaging and storage

EQUIPMENT FOR MILLING :

Most of the types of milling machines currently in use in Sub Sahara African (SSA) countries have capacities between 100kg/h to over 1 ton/h. They may either be rubber roll mills or single pass “Eengelberg” hullers. Rubber roll mills – may have pre-cleaners, destoners, graders including rotary sifters. Rubber rolls wore out very fast and maintenance is not very easy as compared with Engelberg mills that are easy to maintain. Engelberg hullers have no pre-cleaner; they are single pass, with no graders. The Engelberg mills have to be redesigned to include aspirators. If paddy have to be milled using rubber rolls it should be free of sand stones and other impurities that contribute to
the deterioration of the rolls. The paddy should also be of a moisture content of between 12 to 14%.

There is in existence several medium and large scale milling machines.

The medium types are about 3 tons per hour capacity. The are combined with destoners cleaners dehuller using rubber rolls with polisher and grader (alveolar grader and rotary sifters) and automatic weighing balance and bagging system. Some of the machine depending on the make may not have all these accessories but minimally the have paddy cleaner, dehuller, polishers and grader.

The large scale commercial milling have all the processes with all the accessories listed above including sometimes large silo for storage and mechanical dryers. The output is more than 5 tons per hour.

**INTERMEDIATE TECHNOLOGY:**

Single pass milling machine is wide spread over West Africa. For small scale rice milling using the single pass improvement can be made by adding to it a paddy cleaner and a grading system.

This improvement can be locally done by artisans.

The paddy cleaner can be fabricated locally in most countries in the region.
THINGS TO NOTE:

- Rubber roll mill houses should have a reliable source of good spare parts,
- They should also be sited in locations were experienced mechanics to maintain them are available
- Mill operators should have a basic knowledge of record keeping and planning of operations particularly during peak seasons.
- Millers should keep simple moisture meters to check grain moisture content before milling.
- Mill operators should have a schedule for changing bearings, belts and rolls that constantly wear out.
- Where electric motors are used, their capacities should correspond to that of the equipment in use.
- Training of mill operators. – Operation, repair and maintenance, grading.
Packaging and labeling 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 labeled. Another reason why local rice is neither packaged nor labeled 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 labeled, it has been sold for higher prices. However, even where local rice is packaged and labeled, the quality of the packaging material is low and the labeling not properly done.

Although packaging and labeling adds extra cost to the final product, the higher price at which it can be sold on the market will more than compensate for the packaging and labeling costs.

**OBJECTIVES**

- To give identity and brand locally milled rice
- To strengthening the competitiveness of the local brands against the imported brands.
- To encourage the local adoption of standard weight and measures.

**Packaging requirements**

- Rice may be packaged in sizes of between 1kg and 50kg. The actual size will usually depend on the market for which it is being prepared.
- Plastic and jute are usually used for package in SSA. Whatever the material used, the following measures are recommended:
- The density of packaging material and the appearance should be appropriate. In case of propylene material the size of the tape should be maximum 2 to 2.5 mm width with density of 40 tapes per 10 cm. This will ensure solidity and protection against contamination.

- Size should be 55 x 95 cm to package 50 kg of rice or 45 x 75 cm for 25 kg of rice.

- For packaging of one to five kg, either polyethylene or even jute could be used. Those packaging material should well design to facilitate the handling and transportation by consumers.

**Labeling requirement**

Labeling 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. Labeling involve the use of logo necessary information using attractive color and design.

The following information is required for good labeling:
<table>
<thead>
<tr>
<th>Type of information</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product name</td>
<td>RIZ de Montagne</td>
</tr>
<tr>
<td>Trade mark</td>
<td>Logo, Design mark</td>
</tr>
<tr>
<td>Variety</td>
<td>Gambiaka</td>
</tr>
<tr>
<td>Type of product</td>
<td>Whole rice, Broken rice etc</td>
</tr>
<tr>
<td>Origin</td>
<td>Niono</td>
</tr>
<tr>
<td>Rice mill</td>
<td>DELTA LINGUERE etc</td>
</tr>
<tr>
<td>NET WEIGHT</td>
<td>50 kg</td>
</tr>
<tr>
<td>Production</td>
<td>Year or season</td>
</tr>
<tr>
<td>Milling</td>
<td>Year or season</td>
</tr>
<tr>
<td>Best before date</td>
<td>15/02/2015</td>
</tr>
</tbody>
</table>
Fig. 17: Example of labeling