Government of Papua New Guinea

HANDBOOK ON RICE POST-HARVEST TECHNIQUES

UNDER Department of Agriculture & Livestock (NDAL) and
Japan International Cooperation Agency (JICA)
PROJECT ON PROMOTION OF SMALLHOLDER RICE PRODUCTION (PHASE2)

February 2015

FOREWARD

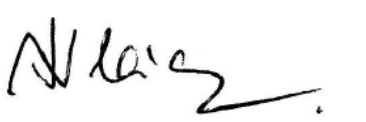
This Handbook on Rice Post-Harvest Techniques is a welcomed additional to the number of publication produced by the DAL/JICA Project on the Promotion of Smallholder Rice Production in Papua New Guinea (Phase 2). Production of rice grains in the field is incomplete when the grains harvested are not treated to the conditions that will make it available as food for the farming families' utilization, either for meeting the farming household's food requirement or for its trade and bartering in exchange for services rendered and for cash.

Post-harvest techniques for rice production system are a pre-requisite to the sustainable domestic rice production and the basis in which an industry can develop from it. The Department of Agriculture & Livestock is pleased to endorse this Handbook on Rice Post-Harvest Techniques for the development of smallholder rice production in the country. The Government is also keen to develop rice production as the commercial enterprise in the country to meet its growing demand for rice as food item and meeting is self-sufficiency level as its being doing for its other food items such as sugar, banana, sweet potato and other food crops. It is hope that this Handbook can contribute and lead to the PNG developing its rice industry.

This Handbook is designed as an extension and training tools for all the rural development officers whose work has been to support the smallholder rice farmers and growers in rice production.

Rice consumption is popular in PNG and whoever takes up rice as trade item will find the market share in PNG readily available. Post-harvest techniques like threshing, winnowing, drying and milling will find eagerly awaiting users who wish to take up rice cultivation, production and milling in a serious way.

Milling rice to meet the market expectation and to ensure quality control in their milled products will be challenge for the PNG rice grower and mill operators. This Handbook hopefully can enrich and guide those who wish to develop rice milling services, operate and manage rice milling service as a business; and for governments and communities development enthusiast, who are wanting to help their communities with procurement and provisioning of rice milling machines and units, will find this Handbook useful.



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Special mentioned is made for the stakeholders in the implementation of the Project, which was the bilateral technical cooperation between Department of Agriculture & Livestock (NDAL) on behalf of the Government of PNG and Japan International Cooperation Agency (JICA) on behalf of the Government of Japan.

The following are acknowledged in the order of the major stakeholders who have participated in the taskforce working group for devising and formulating this Handbook on Rice Post-Harvest Techniques.

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PREFACE

This handbook covers the important and essential topics for reading for those rural development officer and model-farmers whose roles and responsibilities are conducting training and instructions on appropriate rice post-harvest technologies or techniques. At each section, there are important point, information, knowledge and cautions for the rice grain processing, accompanied by a number of figures to illustrate the text in the handbook.

Among several rice-producing techniques in PNG, the least developed technical area is post-harvest treatment. The reason for this is because that if crops are not dried and stored appropriately by sensing unseen moisture and crop temperature, the storage stability of rice, which is better than other crops, cannot be adequately demonstrated. This ultimately causes poor results including the generation of substantial amounts of damaged rice, while taste also deteriorates, milling yield decreases, edible amounts do not improve, and farmer motivation for producing rice deteriorates. These are solely attributable to poor knowledge of appropriate techniques.

Post-harvest technique is not an independent technique. It starts with producing paddies as consistent in quality as possible when cultivating rice. The uniform quality of the paddies should not be damaged at any stage of post-harvest treatment. In particular, responding to requests from the PNG side, the introduction of mechanical milling has long been advised. When utilizing milling machines, compared with manual milling, maintaining a constant paddy quality becomes much more important. It can be said that this is the target to be achieved for increasing edible amounts of white rice and improving quality. It is recommended that this handbook be always kept at hand and utilized together with the *Handbook for Upland Rice Farming in Papua New Guinea*. By doing so, it may become easily understood that each technique is intended to produce and process paddies of uniform quality.

It is recommended that, by utilizing this handbook with other handbooks, farmers become engaged in more sound and efficient rice cultivation/post-harvest treatment, contributing to the continuous cultivation of rice as well as the improvement of their livelihood.

The post-harvest technologies are very important consideration for any local government and farmers groups to heed to as their failure or success will break and make rice production in PNG are success. This handbook can be used as a sub-manual for the daily operation work of the rice mill, too.

In conclusion, the use of this handbook should generally keep uniformity of rice grains and minimize post-harvest losses, giving incentives to farmers and mill operator to increase production, efficiency and effectives of the support services provided through the rice milling [service] stations.

At the end of each section, additional “Further Explanations” are added to give more explanation and description of the topic discussed. The handbook should be used by all serious rice development officers and farmers who wish to improve their rice cultivation and processing techniques.

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1. What is Post-Harvest Technology?

This Handbook is about rice post-harvest techniques, and unlike tuber and root crops that many farmers in PNG are familiar with such as taro, yams, cassava, sweet potato; rice is a grain and how it is handled at harvest and after harvest is quite different. It must be handled with a different techniques and this require learning from those who have grown and harvested rice over many years, both in PNG and in rice growing countries.

A post-harvest technology is a series of processes as a part of rice cultivation cycle (referring to figure 1) and any handling techniques or treatments applied to the economic part of a crop just harvested from the field for the purposes of transforming it into a form, condition, or composition that adds value, makes it storable or prolongs its shelf-life, and makes it useable or edible.

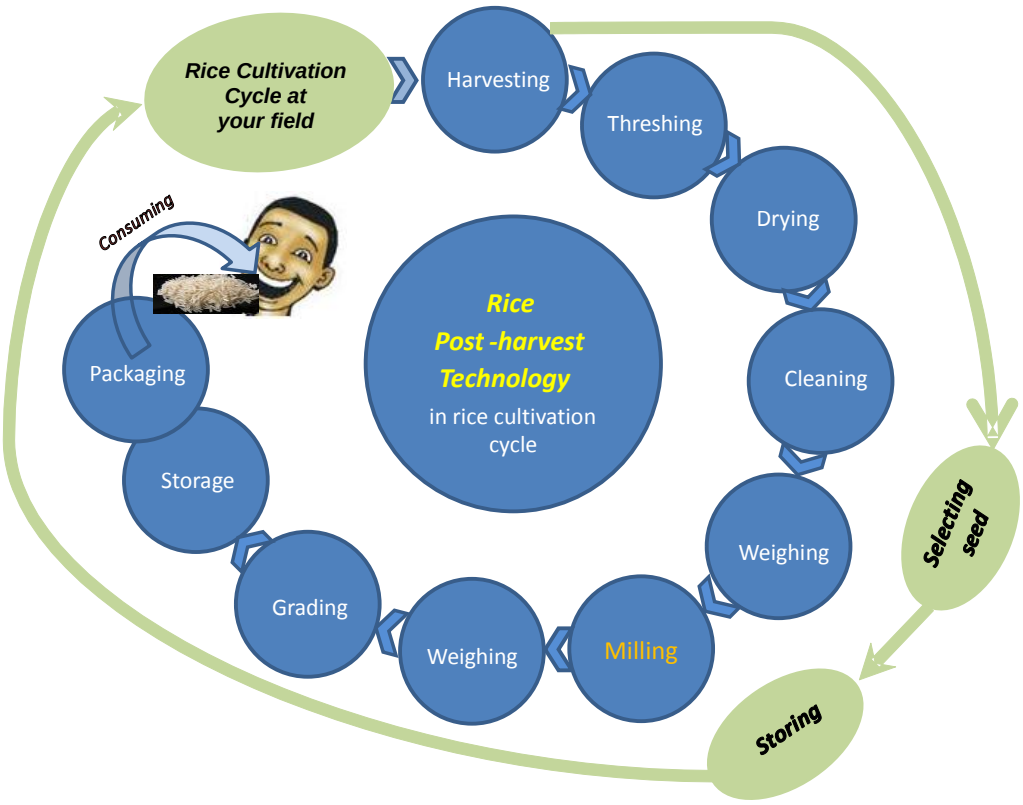


Figure 1: Illustration of different stages of rice post-harvest techniques and handling stages.

Rice is a grain crop and is not immediately available for cooking at the harvest time. Belonging to the grass family, it needs to be field-dried after been separated from its straw and panicles, cleaned of its chaff and any foreign matter in it, and further dried to the required moisture content before it can processed for it to be edible or dried to be stored away for future processing. The Figure 1

illustrates the number of stages in which the post-harvest handling and techniques are associated with it.

Several stages of post-harvest handling of rice grains includes field-drying, threshing, shed-drying, cleaning, grading, storing, weighing, and milling before making it fit for human consumption. It is important to observe carefully all the stages of post-harvest handling as each stage will affect the other to determine the quality of grain, mill recovery rate and the minimizes losses that can be controlled.

One important features of post-harvest handling is the harvest and treatment of selected grains for seeds to be used in the next cropping.

Check box for Confirmation:

Further Explanation:

(1) Producing good quality rice grains requires using appropriate post-harvest techniques and it helps reduce processing and grain-storage losses.

(2) Ensuring each stage of rice post-harvest processing is carefully managed is very important for producing high quality rice and seeds. Do not regard each stage as un-important and not necessary for your attention and management.

2. Harvesting

Harvesting is the process of obtaining plant parts or component of plant-parts that has reached its physiological maturity or at the stage of growth ideal for separating it from the stock plant. The act of harvesting can be picking, pulling, plucking, slashing, cutting, stripping and shaking the economic part of the plant that is of interest to the harvester. Time to harvest a crop is often determined by changes that takes place in the economic part of the crop and, in some cases, the entire plant. This change can be in the form of visual appearance, smell, colour, size, and the moisture content.

(1) For the rice crop, the harvest time is often determined by the visual appearance, colour, and moisture content of the grains. When the crop ripens, rice grains will be filled and tight, the grain colour change from green to olive-green to yellow and the moisture content drops between 18%w.b and 22%w.b. [on weight-basis].

(2) It is important to take note of the optimum harvesting time and crop maturity signs. Not taking note of the timing or missing the signs can cause the rice grains to remain in the field where the grain moisture content falls below 18%. When this occurs, any incidental wetting by rainfalls will cause the grains to absorb moisture and may germinate. Some rice varieties have shattering ability and any delay harvesting will cause yield losses through shattering. That is when ripen grains just fall to the ground when slight winds and rainfalls touch the crop; or when the farmer is moving through the field.

(3) Two main observations used to determine the correct harvest time for rice grains are:
Moisture content: Grain moisture content is ideally between 18 and 22%w.b. (wet basis). Grains should be firm but not crumbly when pressed between the teeth.

Ripe grains per panicle: The crop should be harvested when 80-85% of the grains on the field have changed colour from green to matured yellow.

(4) When harvesting the rice by sickle or knife, cut the rice straw 4-5 cm from the ground level and do not leave much bigger portion of its standing. (See Figure 2) Standing straws and straw stumps still remaining in the field can have stem-borer worms and adults to complete its life cycle. Always destroy the straw by cutting as low as possible to the ground and up-root and destroy the straw stumps and incorporate it into the soil by hoeing soon after the harvest and ready for the next season.

Figure 2: Grower harvesting rice with sickles at the plant height of 4-5 cm from the ground

(5) Do not allow the rice crop to extend its growing period by allowing secondary tillers with late panicles emerging when the main rice crop is about ripening. Overlap cropping allows the spreading of the flowering, grain-filling, grain ripening and harvesting period and timing, giving opportunity to pests like stem-borers and rice bugs to thrive.

(6) Overlap cropping will also result in harvest of immature and empty grains which can be the cause of extra volume and weight of rubbish, resulting in increased grain-fracture during milling when not winnowed and cleaned.

Check box for Confirmation:

Further Explanation:

(1) Some paddy can germinate in field crop before harvest if harvesting is delayed.

(2) In delayed harvest, standing crop's moisture content will fluctuate between drying and wetting period, causing the grains moisture content to fall below 18%w.b. and paddies might be eaten by birds;

(3) Transplanting is recommended because the crops will be uniform in its growth, flowing, and grains filling, giving little change for the lot of secondary panicles to emerge and not allowing the stem-borers to thrive.

3. Threshing

Threshing is the physical process of separating the grains from the rice straw and the panicles. Threshing of rice can be done by hand, foot, or simply by a swinging, beating and whipping actions against a framed object. Threshing can also be done with winnowing machines. In PNG agriculture, threshing grains is not a common practice, therefore, all new rice grower will need to learn the right operation and techniques for threshing. Threshed rice will contain a lot of chaff and foreign materials, therefore, after drying as shown above in Figure 6, cleaning needs to be carried out. The following steps are undertaking during the threshing:

(1) Harvested paddy should be threshed simultaneously on the day of harvest.

(2) Rice straws and panicles harvested that are wet from over-night rains or by the morning dew must be field-dried before threshing, often morning-half of the day is committed to harvesting and afternoon-half of the day is to do all the threshing.

(3) Use wide canvass or plastic sheets with the edges raised to catch all the grains being threshed through the beating-action as shown in Figure 4.

(4) Dry the paddy soon after threshing both in the outdoor and the in-door sheds to prevent grains from fermentation if the moisture remains in a heap or bag of grains for too long.

Figure 3: Wooden frame for threshing rice

Figure 4: Farmer threshing the rice, using wooden frame.

Figure 5: A grain threshing comb fixed on wooden frame.

Check box for Confirmation:

Further Explanation:

(1) Note that some rice varieties are easier to thresh requiring 2-3 beatings while others may require more than 4 beatings.

(2) Avoid heavy-handed actions or beating too strongly to prevent grains from cracking.

(3) Timing of drying: It is still good to thresh rice after drying if only panicles are dried.

4. Drying

Drying is the process that reduces the moisture content of the rice paddy down to a safe-level where rice can be properly milled and, importantly, put away safely for storage. Drying is the most critical operation after harvesting a rice crop. Any delay in the drying process, incomplete drying or ineffective drying will reduce the grain quality and result in post-harvest losses.

(1) Sun-dry the wet paddy by spreading the grains evenly on a plastic sheet or a canvass (see Figure 6) with the layer of about 4-5cm depth (see Figure 7). Turn-over the paddy every 30 minutes using a garden rake and by using hand and foot, tenderly spreading the grains as they dry. Slow-drying of the rice paddy will prevent cracking; and by contrast, quick and fast drying will cause the grains to crack and will result in lot of broken grains when milled.

(2) It is preferable to dry your paddy in a sheltered area (sheltered from direct sun-light and any sudden rain-fall) over three days, and occasionally bringing it out to direct sun drying for at least 30 minutes each day.

(3) Ensure that the surface temperature of rice paddy being dried does not rise above 36℃ or must be kept lower than 36℃. High grains temperature will destroy the grain embryo if one is to keep the grains for seeds. In a stored grains, both in sacks or canvass bags with inadequate drying, the paddy rice temperature can suddenly rises above 36℃, this may mean there is a high moisture content and the rice paddy may germinate under such condition. However, the germination will be short-lived as all the seeds that sprout will be smothered within the storage sack or canvass.

(4) When putting the high moisture paddy into the bags, keep the mouth of bags open to all the air movement and the release the heat and dampness from bag (see Figure 8)

Figure 6: Rice paddy evenly spread on a canvass for sun-drying.

Figure 7: Using finger to measure depth of rice paddy spread on canvass.

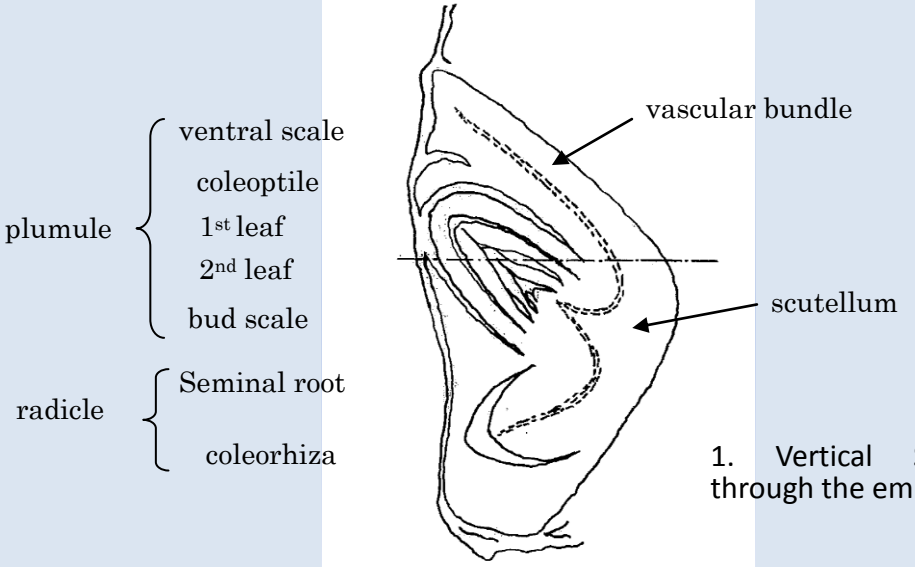
Figure 8: Rice paddy being stored away in poly-bags with the bag mouth left open to allow air movement.

Check box for Confirmation:

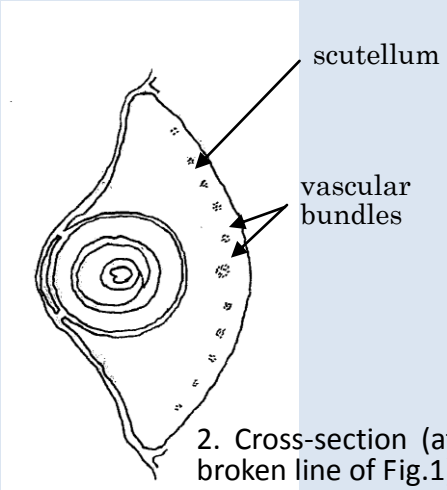
Further Explanation:

(1) Slow drying is preferable to avoid the cracking of rice grain.

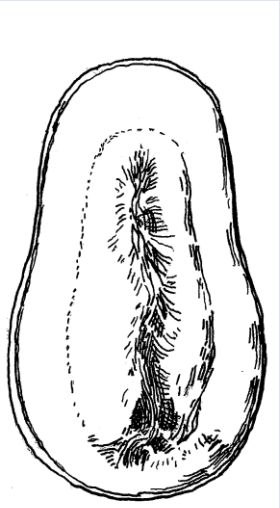
(2) Below are the rice embryo's figures. Baby leafs and root already exist in it. The enzyme activity to use starch of endosperm loses by high temperature over 36℃. [Adapted from 'THE GROWING RICE PLANT', Hoshikawa, NOBUNKYO]



1. Vertical Section through the embryo.



2. Cross-section (at the broken line of Fig.1)



3. Front view of the embryo.

a: Germinated seeds

(b) . Seeds exposed to high temperature will not germinate

(3) Don’t mix the paddy with 5%-different moisture content because it causes the production of fermentation and mold. Also, it is difficult to make the moisture of paddy evenly before milling.

(4) Equilibrium moisture content of paddy is related with air temperature and relative humidity.

(5) When drying paddies under the sun, it is necessary to spread them and turnover continuously and evenly, maintaining a certain thickness (4–5 cm thick), and it is important to spread them evenly. It depends on the weather, but it is very important that the crop temperature doesn’t rise to or above 36℃ (roughly the human body temperature). For this purpose, though it depends on weather, it is necessary to watch crop temperature and to repeatedly turn paddies upside down (every 20–30 minutes). By doing so, paddy can be dried evenly without generating cracked or damaged rice.

5. Cleaning

Cleaning is the process to remove rice straw chaff, foreign matters and immature/empty grains within paddy after threshing and drying. High percentage of chaff, foreign matters include the soil piece, sand, small stones, metal debris, plastic or paper pieces, twig and branches, wood piece, weed seed, other grains, chemical and poisonous matters, etc., will unnecessarily increase the number of sack of rice and weight of paddy, which may cost the grower avoidable transport fees and milling fees paid the mill operator; and for the rice mill operator the cost of wear-and-tear and spoilage to his machine.

(1) The importance of cleaning is as follows:

① To remove foreign matter, broken and immature grains to gain high milling recovery rate [to reduce broken rice amount].

② To increase the milling efficiency [to reduce fuel consumption].

③ To decrease the damage of machine.

④ To decrease running cost due to less wear of consumable parts.

⑤ To increase more than 5% of mechanical efficiency and energy consumption if percentage of foreign matter, broken and immature grains is less than 1%.

⑥ To decrease post-harvest loss.

(2) Prevent broken rice. 5% broken rice decrease 10% on milling recovery.

(3) The immature grains are classified into impurity. Immature grains decrease the milling recovery rate and the mechanical efficiency of the rice milling unit and is the cause of broken rice grains.

(4) Use winnowing tray/ basket and mechanical cleaners such as manual winnower, oscillating sieves and aspirator. Small stone and sand that cannot be removed by winnowing can be removed hand picking.

Figure 9: Winnowing of grains using weaved bamboo-strip round tray.

Figure 10: Winnowing using drop-and-wind technique.

Figure 11: Hand-operators wooden-framed mechanical winnower.

Check box for Confirmation:

Further Explanation:

(1) Never feed the immature and empty grains into milling machine because of above reasons in the item of 3. (1).

Broken rice makes another broken rice as well as immature rice. Below data evidently show that milled rice, milling recovery and flow rate are all increased by winnowing paddy, both are 15kg of same quality paddy at first.

	Material process	Paddy (kg)	M/rice (kg)	Recovery(%)	Flow Rate(kg/h)
Test-1	No winnowing	15.000	5.954	39.7	47.2
Test-2	After winnowing	14.416	6.890	47.8	75.2

(2) Broken rice makes another broken; broken rice and immature grains give unnecessary higher milling pressure to the whole grains that will cause more broken because broken and immature grains get into the space between whole grains. Furthermore, this situation is quite an additional work for the milling unit to polish the surface area of broken rice grains, especially, its cross-sectional area, resulting in more mechanical load on the milling unit during operation.

6. Milling

Rice milling is the next important stage in the post-harvest chain of techniques. In here the good grain is milled through mechanical means to remove the outer skin, hull, and bran to reveal the white kernel and endosperm of the grain that is utilized as food product for human consumption. The by-products such as the germ and the brans can also be collected and utilized as a component to the formulation of stock feeds for poultry, other livestocks and aquaculture.

(1) When utilizing the rice milling units, feed only good, clean and fairly well dried rice grains into the machine. Avoid using paddy rice that is not cleaned, having lot of empty grains, panicle parts, and straw chaffs; especially, grit and sand-stones.

(2) The three common milling units used, sold and distributed, and possessed by communities in PNG are the following units in Figure 12 to 14.

Figure 12: Eagle RM150 Milling unit.

Figure 13: Impro: PS-80 (a copy of Satake SB10D).

Figure 14: Yanmar YMM20 milling unit.

Check box for Confirmation:

Further Explanation:

❖ **General cares for milling**

(1) The milling charges should applied on the quantity of paddy and not on milled rice.

(2) In case of the contamination of more than 3 - 5% immature grains, the milling recovery decreases suddenly and lowers the mechanical efficiency.

(3) The cost of both transporting paddy to the mills and fees charged for milling, together with the operational load on machines will be higher, if paddy rice are not cleaned.

(4) In case of Japanese milling center, they make effort to increase milling recovery by 0.5%. If their milling recovery decreases 2-3%, the center will make a loss and go into bankruptcy.

(5) Milling recovery is very important at commercial-based mill service and business.

(6) If clean paddy is fed into milling machine, the milling load, fuel consumption and lubrication oil use will be low or are decreased. This will ensure the mechanical efficiency is maintained and the consumable parts such as rubber rolls, screens and milling rollers can be used for a longer time.

(7) Only friction type milling machine is usually used in Papua New Guinea. There are two categories of its milling machine; blade type and rubber roll type.

(8) Micro Mill: RM150 is commonly suitable for milling a small lot of carry-in paddy.

(9) Note the difference of manual and mechanical milling as stated below:

	Manual Mill		Mechanical Mill
1	Uneven milling is ocurred.	1	Even milling can be done.
2	Milled rice quality is not uniform and constant.	2	Can produce uniform milled rice quality anytime.
3	It takes a long time for milling due to bad efficiency of equipment.	3	High efficiency and short milling time due to high capacity.
4	Equipment cost is cheap.	4	Initial cost is expensive compared with manual mill.
5	Anybody can use equipment because of easy mechanism.	5	Skillful engineer is needed to operate and maintain rice mill.
6	Can install anywhere and need a small space.	6	Need proper installation space depending on machine size.
7	No running cost and maintenance cost due to manual operation.	7	Running cost such as fuel, oil, consumable parts is expensive.
8	Can use by one person.	8	Operation can be made by plural persons.

❖ Understand completely the following difference between commissioned mill and commercial mill.

No	Point	Commissioned milling	Commercial milling
1	Operation efficiency	Milling amount per unit time small; operation intermittent; operation inefficient	Milling amount per unit time high; operation continuous; operation very efficient
2	Milling quality	As paddy quality varies from time to time, the quality of milled rice is not even.	Quality always even; stable quality of white rice can be produced
3	Milling yield	Milling quality not regarded important	Milling quality is regarded as important; possible to produce milled white rice meeting the market-required quality.
4	Degree of milling quality	Milling recovery not regarded important; paddy milled in line with customer's demand (or meeting machine capability)	As milling is done for profit, yield is regarded as important.
5	Operators' technical capabilities	As the fine-tuned adjustment of machines is not necessary, operators are not required to have high technical capability.	Machines require fine-tuned operational adjustment. Therefore, experienced operators are needed.
6	Initial investment	Initial investment not costly	Initial investment and running cost are likely to be expensive.
7	Composition of machines	Consisting mainly of small-scale milling machines	Consisting of more than two machines; for instance: Winnower → hulling machine → milling machine → pre-cleaning machine → gravel remover → measuring machine → packaging machine
8	Quality of paddy	Paddies brought into milling facilities differ in moisture content; some contain lots of foreign substances; the adjustment of milling is difficult.	Procurement of quality paddy material is needed. (Necessary to procure one variety of paddy; less damaged grain, less cracked rice, less foreign substances mixed in; paddy with a stable 14% of moisture)

❖ Fundamental of maintaining the soundness of the milling and post-harvest equipment that has transmission mechanism and many moving parts and gears:

1. Operate at least once or twice per month.
2. Clean machine inside and outside completely after operation at once.
3. Check abnormal noise, vibration, heat and odor.
4. Check bolts and nuts as well as belts.
5. Check lubrication oil, cooling water and grease.
6. Replace consumable parts at proper timing.
7. Keep a maintenance record by simplified format.

7. Grading

Grading is the process of sorting the milled rice grains into categories based on the visual observation and moisture content measurements. Visual observations will indicate whole grains, broken grains, off-types (grains of other variety), coloured grains, and presence of the un-milled paddy.

(1) The following are factors used for sorting and grading milled grains into several categories depending on the operator's end-use.

① Moisture content;

② Head rice and broken percentage;

③ Defectives;

④ Impurities [Foreign matters, vain paddy and immature grains]; and

⑤ Presence of un-milled paddy.

(2) Take care of moisture content of milled rice. If the moisture content of milled rice is high, the product gets mouldy.

(3) If rice is not consumed soon after milling, and rice is requiring long shelf-life or storage would need high milling degree for removing all the bran.

Check box for Confirmation:

Further Explanation:

(1) In case of commercial-based mill, the uniformity of milled rice (especially physical quality) at any production base is highly recommended and is required to meet market expectation.

(2) When packaging for retail sales, removal of small broken rice can upgrade the quality.

(3) The quality standard for the individual mill must be developed to keep the uniformity and quality control of rice, when you plan to sell as an original brand.

(4) If milling degree is low, some bran is still remained on rice kernel. Bran contains fatty acids and easy to oxidize. Then, the fatty acid of bran increases and reduces the fresh taste of rice.

(5) Avoid the sudden change of moisture and temperature of rice grains, because it results in the cracking even after milling.

(6) Packed samples of milled rice produced in East Sepik and Madang.

Figure 15: Packaged milled rice from Maprik, ESP

Figure 16: Packaged milled rice by farmers in Madang province

(7) Use of by-product of rice:

There are some differences of market prices;

- Husk: charcoal husk, underground drain, fuel
- Bran: chicken feed, fertilizer (Bokashi)
- Fine broken grains can be fed to fish/ chicken feed

8. Storage

The purpose of grain storage facility is to provide safe storage conditions for rice grain in order to prevent grain loss caused by adverse weather, moisture, rodents, birds, insects and micro-organisms like fungi as shown in Figure 17.

(1) Grain moisture content should be maintained at 14%w.b. or less.

(2) Don't put rice bags directly on the floor. Those bags should be laid on the rack above 20cm above the floor;

(3) The longer the grain needs to be stored, the lower the required moisture content will need to be.

(4) Grain and paddy seed stored at moisture contents above 14%w.b. may experience the growth of molds, rapid loss of viability and a reduction in eating quality.

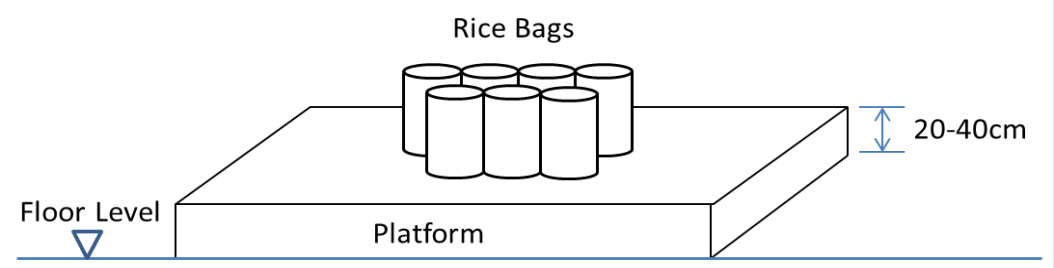
Figure 17: Village style rice storage house.

(5) If the moisture content of paddy inside bag is high, open all mouths of bags to release vapor and heat coming from the paddy itself. It's better to spread such paddy of high moisture content on plastic sheet for room conditions drying.

Check box for Confirmation:

Further Explanation:

(1) Adequate air ventilation is required in store rooms to prevent the moisture from floor or ground reaching the rice bags store on the floor.



(2) Losses from insects, rodents, birds and moisture uptake are usually high in bulk storage systems. Also, some shrinkage occurs by long term storage.

(3) Grain is protected from re-absorbing by rain or absorbing moisture from the surrounding air.

9. Weighing

Weighing is the method of determining the mass of the rice paddy produce and mass of the white or milled rice processed.

(1) The measurement of rice weight must be correct and precise. The platform scale is needed for measurement of paddy/white rice weight to calculate the correct milling recovery.

(2) Conduct the zero-adjustment of spring scale or table scale before starting the measurement of weight.

(3) Conduct the measurement of weight by putting paddy/rice on the scale. Read the weight graduation after the indicator is stable. Read the weight kg by round off to one decimal place by 100g.

(4) After measurement, don't forget to deduct the tare, which is the weight of bag/vessel.

Figure 18: Platform type of weighing scale.

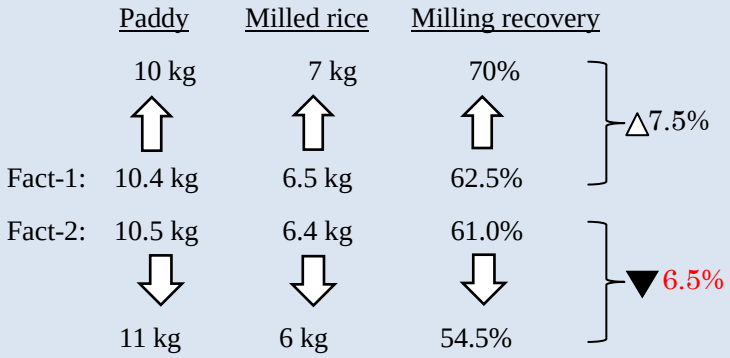
Figure 19: Reading mechanism for the platform type weighing scale.

Figure 20: Hanging type of scale 100Kg capacity.

Check box for Confirmation:

Further Explanation:

(1) Never round off /up to the closest whole number.



(2) Differences among each two milling recoveries are +7.5% and -6.5%. These differences are quite big when the performance of milling machine is evaluated.

(3) To know the percentage, it is important to read to 3 decimal places; i.e.

(4) Consider the above Fact-1. If 0.4kg is disregarded from 10.4kg, it becomes 10kg.

(5) Can you also disregard 40 kg in case of 1,040kg? Therefore, we need to read all whole numbers and if possible read to 3 or 4 decimal places for accuracy and when dealing with lots of individuals of values and measurements as cumulatively they will add up.

(6) The Hanging-type spring scale is not recommended because the inside spring becomes extended after continuous use and years of operation and the measured reading may give incorrect and reading errors.

10. Seed Selection

High quality seeds come from proper maintenance of genetic purity and good growing conditions. Appropriate timing and method of harvesting and proper processing during threshing, cleaning, drying and storage would ensure sustainable and continuous cropping successes.

Figure 21: Rice seed being hang onto the ceiling for safe-keeping

(1) Be careful on gradual drying process for seed paddy. Do not exposed seed grains to high temperatures over 36℃ [degree Centigrade].

(2) Select only sound and fully mature paddy for seed from rice panicle. Select clean grains free from insect and disease damage.

(3) Do not exceed over 30-40% of seeds per panicle when selecting grains for seed.

(4) Don't keep paddy seed over 36℃.

(5) Paddy seeds can be dried by hanging at string under shed as shown in Figure 21.

(6) Procure only grains of the center portion in an ear of rice, where will be the highest germination ratio. As shown in Figure 22, the circled parts (such as the ear tips or near the root) tend to exhibit deformed grain or immature rice, which should be removed when selecting seeds. As a rough standard, 30–40% should be selected and used for seeds. Then, the germination rate will exceed 90%, equalizing the growth of seedlings at rice nurseries.

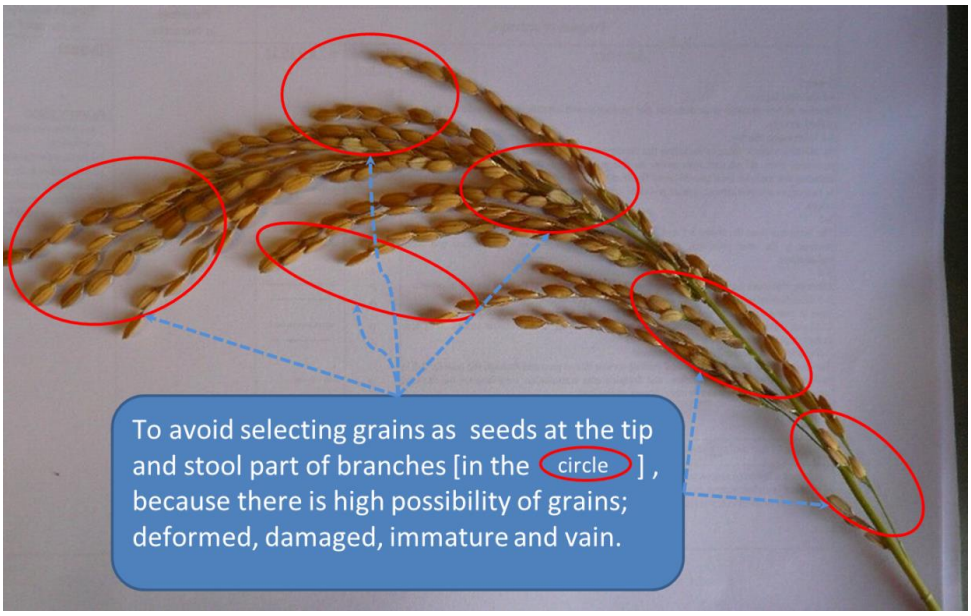


Figure 22: Part of panicle where grains are selected as seeds.

Check box for Confirmation:

Further Explanation:

(1) Deterioration in seed quality may begin at any point in the plant's development stage.

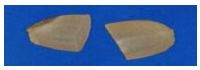
(2) Seed quality depends on the physical conditions that rice plant is exposed to during its growth stages, as well as at harvesting, processing, storage and planting.

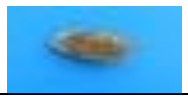
(3) Temperature, nutrients and other environmental factors can affect seed development and later influences on the seed quality.

(4) The use of superior grains for rice seed will results in high quality milled rice eventually.

ANNEX

List of Damaged Rice Kernel

Name	Whole grain	Large brokens	Small brokens (fine rice)	Poor ripening/ empty grain
Paddy				
Brown rice				Nil
Milled rice				Nil
Feature	Milled rice with length greater or equal to three quarters of the average length of whole grain.	Milled rice with length less or equal to three quarters but more than one quarter of the average length of whole grain.	Milled rice with length less than one quarter of the length of whole grain.	Poor ripening paddy which has empty or very poor kernel inside.

Name	Damaged grain				
	Disease grain	Insect damage grain	Spotted grain	Deformed grain	Rusty grain
Paddy					
Brown rice					
Milled rice					
Feature	A kernel which is damaged by fungus or virus, etc.	A kernel which is bitten or sucked by insect	After milling, kernel has discolored portion of less than Dia.1mm.	Embryo has a notch length is more than one quarter of the kernel width.	Kernel surface is brownish-red color.

Name	Cracked grain	Dead grain	Discolored grain	Immature grain (1)	Immature grain (2)
Paddy					
Brown rice					
Milled rice					
Feature	One or plural vertical/ horizontal cracks have on surface of kernel.	Most portion of kernel is chalky, matte and unripened.	In spite of shading, discolored portion is at kernel surface.	Totally poor and unripened kernel (milky-white kernel)	Green unripened kernel