

Seed Quality



Course purpose, rationale and objectives

Purpose

This course

- examines the different factors that effect seed quality
- outlines the different seed classes
- explains how to measure seed quality
- outlines ways of improving seed quality.

Rationale

Seed is a living product and must be grown, harvested and processed correctly to maximize its viability and the subsequent crop productivity. Good quality seed must be sown to realize the yield potential of all varieties.

Objectives

On completion of this course, participants will be able to:

- measure seed quality
- understand the different factors that effect seed quality
- evaluate the need for good seed

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1. Introduction

Seed is a living product that must be grown, harvested and processed correctly to maximize its viability and subsequent crop productivity. For the yield potential of any rice variety to be realized, good quality seed must be sown. Good quality seed can increase yields by 5-20%. The extent of this increase is directly proportional to the quality of seed that is being sown. Seed quality can be considered as the summation of all factors that contribute to seed performance.

High quality seed enables farmers to attain crops, which have:

- the most economical planting rate
- a higher percentage of seeds
- emerging in the field
- a minimum of replanting
- a vigorous seedling establishment
- a more uniform plant stand
- faster growth rate, and
- greater resistance to stress and diseases and
- uniformity in ripening.



This manual deals with the practical field aspects of managing good and certified seed. For more detail on laboratory seed health testing, we recommend the publication: Mew, T.W. and Misra, J.K. 1994. A manual of rice seed health testing. International Rice research Institute. Los Banos, Laguna, Philippines. P.O. Box 933, 1099 Manila, Philippines.

Factors affecting seed quality

Seed quality is determined by a number of genetic and physiological characteristics. The genetic component involves differences between two or more genetic lines, while differences between seed lots of a single genetic line comprise the physiological component.

The genetic factors that can influence quality include:

- genetic make-up
- seed size and
- bulk density

The physical or environmental characteristics include:

- injury during planting and establishment
- growing conditions during seed development
- nutrition of the mother plant

- physical damage during production or storage by either machine or pest ,
- moisture and temperature during storage and
- age or maturity of seed

Deterioration in seed quality may begin at any point in the plant's development stage from fertilization onward. Seed quality depends upon the physical conditions that the mother plant is exposed during its growth stages, as well as harvesting, processing, storage and planting. Temperature, nutrients and other environmental factors also affect seed development and influence seed quality.

High quality seeds are the result of good production practices, which include:

- proper maintenance of genetic purity
- good growing conditions
- proper timing and methods of harvesting
- appropriate processing during threshing, cleaning and drying
- appropriate seed storage and seed distribution systems

2. Characteristics of Good Seed

Seeds of high quality should be true to its kind or variety, contain a minimum of impurities and have high establishment rates in the field. The main criteria for describing seed quality can be considered under the following:

- Varietal characteristics
- Seed lot characteristics
- Seed viability



Varietal Purity Characteristics

Varietal purity refers to the genetic or cultivar purity and can be described by its physical, chemical and crop attributes.

Seed factors

The true seeds of a variety have are characterized by specific traits such as the length and width, shape, size, color and aroma. Laboratory tests to quantify these characteristics include physical measurements of the length and width, 1000 grain weight, color measurements using the naked eye and colorimeter and smell tests both ocular and machine.

Chemical analysis

Various chemical tests can also be used to distinguish between varieties. Factors such as amylase content, alkali digestion color, gel consistency and brown rice protein help distinguish between varieties.

Crop factors

The crop characteristics that are normally consistent include plant height, time to maturity, plant color and plant growth habit. Slight variations may occur especially in harsher environmental growing conditions.

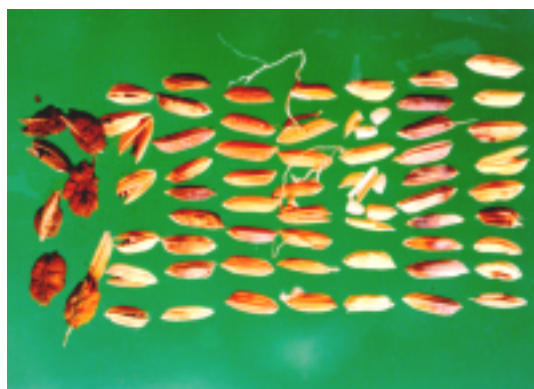
Seed lot characteristics

A description of the seed lot includes the level of impurities, seed size, and damaged, deformed or diseased seed.

'Impurities' is described by the degree of contamination through weed seeds, seeds of other crops or species, and inert material such as stones, dirt or twigs. Impurity is expressed on a percentage basis by weight.

'Seed size', plumpness and/or fullness, are generally desirable seed characteristics. They indicate that the seed has the potential to produce vigorous seedlings under favorable conditions.

'Damaged, deformed or infected seed'. High quality seed should be free from seed-borne diseases, insects and other extraneous matter. They should also be free from various types of mechanical injury that reduce germination and seedling vigor.



'Red Rice' kernels are not acceptable in the rice market place. Kernels should not have more than 25% of its surface area colored red or red streaked.

'Discoloration' can be caused by fungi, bacteria or environmental conditions such as high humidity and temperature (e.g., 27-35°C). There are two types of discoloration on rice seeds, 1) spotting caused by certain diseases (brown spot) or insects (rice bug feeding damage) and, 2) discoloration on a portion or portions of rice seeds caused by *Curvularia* (black kernel) or sometimes by *Alternaria padwickii* (stackburn disease) or by sheath rot on certain occasions. Other rice diseases do not produce consistent discoloration. We consider any seed having more than 0.5% discolored or spotted seed surface as discolored. Discoloration can occur on fully or partially filled or empty grains. Laboratory tests are required to confirm whether the cause is fungal or bacterial. If the grain is discolored after milling, then the problem was most likely environmental.

Seed viability

The viability of the seed in the field will be determined to a large degree from its stored moisture level, Germination potential and its vigor.

'*Moisture content*' has a marked influence on the life and vigor of the seed. Moisture content should be less than 14% and preferably less than 12% for extended storage times.

'*Germination percentage*' expresses the proportion of the total number of seeds that are alive. It is determined through controlled tests and actual counts of the number of seeds that germinate. Many varieties have a dormancy period immediately after harvest. Stored under traditional open systems the germination rate of most rice seed begins to deteriorate rapidly after 6 months



'*Seed vigor*' provides a very good estimate of the potential field performance, and subsequently, the field planting value. While the speed of germination varies slightly across varieties, seeds should imbibe (absorb) moisture and within 2 days produce a root (radicle) and the first leaf (plumule) within 4 days. At this point the seed is considered to have germinated. The ability of the germinating seed to continue to grow and survive then determines crop establishment. Seed vigor has been defined as the sum total of those properties of the seed, which determine the level of activity and performance of the seed during germination and seedling emergence. Seed vigor is an important factor that often results in poor seedling establishment. Seeds low in vigor generally produce weak seedlings that are susceptible to environmental stresses. Whereas, a high level of vigor in seeds can be expected to provide for early and uniform stands which give the growing seedlings the competitive advantage against various environmental stresses.

3. Seed certification

The purpose of seed certification is to maintain and make available to farmers, high quality and genetically pure seeds of superior cultivars. Only those cultivars that are of superior genetic makeup, multiplied to maintain purity and identity, are normally eligible for government certification. Certified seed is high in genetic purity, high in germination and vigor, and of good quality (i.e., free from disease and from damaged or immature seeds).

Cultivar purity is the first consideration in seed certification, but other factors such as the absence of weeds and diseases, viability, mechanical purity, and grade are also important. One of the most effective ways to limit the distribution of

weeds is to plant weed-free seed. Planting disease-free seed can reduce losses in the same way. Properly, cleaned and graded seed is easier to plant and gives more uniform stand. Thus, seed certification has been designed not only to maintain genetic purity of superior cultivars, but also to establish and maintain reasonable standards of seed condition and quality.

Seed Testing - Seed samples are collected and submitted for laboratory analysis after drying and processing.

Tests conducted include:

- Varietal purity,
- Weed and other crop seed,
- Inert material
- Other varieties
- Red rice and
- Germination.
- Moisture content



For seed certification, field inspectors must check:

1. Crop land requirements (e.g., previous crop and isolation distances to ensure no pollen mixes and or volunteers from a different previously planted cultivar)
2. The source of the crop's seed (to ensure cultivar purity)
3. Sowing dates, pattern, spacing, and rouging (to ensure crop kept clean and free from contamination.)
4. purity of cultivar (i.e., no cultivar mixes)
5. Harvesting methods (to prevent mixtures)
6. Postharvest operations to ensure correct cleaning, drying, sampling, tagging, labeling and sealing

Classes of seeds

'Breeder Seed' - this is the seed of a new variety that has the highest purity, produced and developed, controlled and provided directly by the breeder or his/her institution for further multiplication.

'Foundation Seed' - this is the progeny of the breeder seed, produced by trained officers of an agricultural station in conformity with regulated national standards and so handled to maintain genetic purity and identity of the variety.

'Registered Seed' - this is the progeny of the foundation seed grown by selected farmers, so handled to maintain genetic purity and identity and has undergone field and seed inspections to ensure conformity with standards.

'Certified Seed' - this is the progeny of foundation, registered or certified seeds, so handled to maintain sufficient varietal identity and purity, grown by selected farmers under prescribed conditions of culture and isolation and subjected to field and seed inspections prior to approval by the certifying agency. Harvest from this class is used for commercial planting.

Classes of seeds: Examples of standards

Different countries set standards for the different factors considered in certifying different classes of rice seeds.

Factor	Breeder	Foundation	Registered	Certified
Pure seed (%)		98	98	98
Other varieties (grains/500g)		None	None	2
Other crop seeds (max/500g)		None	None	2
All noxious weeds		None	None	None
Total weed seed (%)		0.03	0.03	0.08
Inert matter (max %)		2	2	2
Red rice (grains/500 g)		None	None	None
Germination (% minimum)		80	80	80
Moisture content (max %)		14	14	14

Table 1.Official Standards for Seed Certification in Arkansas

Factor	Breeder	Foundation	Registered	Certified
Pure seed (%)	98	98	98	97
Other varieties (grains/500g)	0	2	5	10
Weed & other crop seed (%)	0	0	0.05	0.1
Inert matter (%)	2	2	2	3
Red rice (grains/500 g)	0	0	1	2
Germination (% minimum)	80	80	80	80
Moisture content (%)	14	14	14	14

Table 2.Official Standards for Seed Certification in Philippines

Factor	Breeder	Foundation	Registered	Certified
Pure seed (%)	99	98	98	97
Weed seeds (no's/500gm)	3	5	10	10
Red rice (grains/500 g)	0	1	3	5
Germination (% minimum)	90	90	85	80
Moisture content (%)	13	13	13	13

Table 3 Standards for seed certification in Myanmar

4. Seed Production: Field Management

Planting Stock.

In most varieties, '*breeder seed*' must be planted to produce foundation seed. *Foundation seed* must be planted to produce registered seed and registered seed must be planted to produce certified seed. In varieties where there is no registered class, foundation seed must be planted to produce certified seed.

Field inspection

In most countries when a crop is intended for certification it must be inspected prior to harvest. A representative of the certifying agency inspects the crop at least once during the vegetative stage and normally once at pre-harvest stage. The crop may be refused certification due to unsatisfactory appearance caused by weeds, poor growth, poor stand, disease, insect damage and any other condition, which prevents accurate inspection or creates doubt as to the identity of the variety. Each country has field standards for the allowable number of off types, unacceptable weed types and numbers of diseased plants. The field standard for Myanmar is presented in Table 4.



General principles:

1. Inspect so observations are made from the top of the plants.
2. Have the sun at your back or side to increase visibility.
3. Inspect the field to maximize area seen
4. For foundation seed, at least two inspections are required between

flowering and harvest.

Factor	Foundation	Registered	Certified
Off types (%)	0.05	0.30	0.30
Inseparable other plants(%)	0.01	0.05	0.05
Objectionable Weed (%)	0.01	0.02	0.02
Diseased Plant/Head (%)	0.01	0.05	0.05

Table 4. Field inspection standards for Myanmar

Field selection and land preparation.

In most countries, fields used for growing certified seed must meet a number of criteria. These include:

- Not have grown rice for the previous year unless the rice was the same variety planted for



- certification and met inspection requirements for varietal purity
- Separation from other fields of same variety by a ditch, levee or roadway or barren strip of at least 3 meters distance must be maintained to preclude contamination through chance out crossing.
- Thorough land preparation should be done to eliminate volunteer plants and control weeds especially during the fallow or non-cropped period. Fields should be cultivated or chemically controlled with herbicides to ensure that weeds and volunteer rice plants do not seed.

Crop management

The management of the crop will influence the time and uniformity of crop maturity. Basic requirements of good crop management include good water, nutrient, and pest and harvest management.

Planting method and plant population

Establishing the correct number of plants is essential to maximize water and nutrient use. A target population that results in 4-500 panicles per m^{-2} is desirable. This means establishing at least 70-100 seedling m^{-2} when transplanting, or broadcasting 80-120 kg seed ha^{-1} when direct seeding.

Low populations may result in:

- increased tillering, which creates more
- variation in panicle maturity,
- increased weed populations and
- reduced yield potential of the variety.

High plant populations may reduce yield and quality by:

- competing for water and nutrients,
- mutual shading,
- lodging and reduced grain size.



Seed Dormancy

Many rice varieties have a dormancy period immediately after harvest. This usually lasts up to 1 month during which time germination levels are low and variable. A number of different treatments are used both to break dormancy and improve seed establishment.

- Higher temperature. Seeds are exposed to higher temperatures, 40C –42C, for 1-2 days prior to sowing
- Seed priming increases the rate of seedling establishment. The seeds are soaked for 4-8 hours and then re-dried prior to sowing. Primed seeds can be sown through a mechanical seed drill but must be sown within 1-2days after priming.

- Pre germination where the seeds are soaked for between 24-48 hours then drained for 24 hours before sowing. Pre-germinated seeds have the radicle (root) protruding and can not be sown through a seeder

Water management

To be able to manage water, the fields must be level and the bunds or levees well maintained. Uniform water depth across the field will contribute to more uniform crop, higher seed yields and consistent moisture content in the grain sample. Reducing the variation in moisture content at harvested reduces the chance of seed damage from disease.

Good water management helps reduce weed competition, which not only increases yields but also improves seed quality by reducing dockage levels and reducing moisture differentials between weed seeds and grain. Wet spots in the seed due to uneven drying or weed seeds can lead to disease and loss of quality.



Nutrient Management

The application of the correct level and type of fertilizer for the variety and growing conditions is essential. The prudent application of nitrogen is essential to get an even maturing crop with full grain size. Excessive and uneven application of N can stimulate late tiller production, which results in heads on the main culm ripening a number of days faster than the tillers. This results in more immature and green heads in the sample as well as higher moisture content that increasing the chance of spoilage by disease. Conversely insufficient nitrogen can lead to reduced grain size and poor vigor.

Roguing

Every field should be rogued to remove off-types, any plants of another crop or variety and diseased plants. Characteristics that can be used to determine varietal purity under field conditions include plant height, pigmentation of plant parts, pubescence, awn characteristics and time of flowering. Roguing should be done at least once before flowering and once after flowering.

5. Seed Production: Post Harvest Management

Harvesting

The higher the quality of the seed the greater the care is required in harvesting and threshing the seed. Breeder seed should be hand



harvested and threshed with a mechanical self-cleaning thresher. Foundation registered and certified seeds can be harvested using machines that have been cleaned thoroughly to avoid mechanical seed mixture.

Timeliness

The optimal stage to harvest grain is between 20-25% grain moisture or when 80-85% of the grains are straw colored and the grains in the lower part of the panicle are in the hard doe stage. This is about 30 days after flowering. If the crop is harvest is too late, many grains are lost through shattering or drying out and are cracked during threshing. Cracked seed will not germinate. If harvested too early, there will be many immature seed grains and this will reduce quality. The immature rice kernels are very slender and chalky and this results in excessive amount of bran and broken grains. Threshing should occur immediately after cutting as the longer the cut panicles remain in a stack the higher the chance of discoloration or yellowing.

Machine settings

The correct drum speed settings are needed if seed quality is to be maintained and threshing losses minimized. Drum tip speeds for a peg tooth thresher should be between 12-16 m/sec or approximately 600rpm. Higher speed result in higher levels of seed damage while lower speeds increase the amount of seed retained in the panicle. The fan speed and oscillation speed should be between 800-850 rpm. The clearance between the peg teeth and concave should be about 25 mm.

Drying

Rice seed should be dried to less than 14% moisture as soon as possible after threshing. When seed is to be stored for long periods it should be dried to 12% or less and preferably placed in a sealed container. See Table 5.

Storage period	Required MC for safe storage	Potential problems
2 to 3 weeks	14 – 18 %	Molds, discoloration, respiration loss
8 to 12 months	13 % or less	Insect damage
More than 1 year	9 % or less	Loss of viability

Table 5. Seed storage life and moisture content

Drying and tempering the grain a number of times or in stages during the drying process will maintain seed quality. This means drying the grain on a drying pad for a number of hours or in the grain dryer and then tempering the seed by allowing it to cool down for a number of hours in a bin or in the bag. This process should be repeated at least a couple of times until the grain reaches 14% moisture or less



When sun drying the seed should be spread in thin layers (50-100mm) on the pad or floor and be turned and stirred 7-8 times per day. This will even up moisture distribution and increase the rate of drying. Temperatures on drying pads can exceed 50°C during the day and this can cause fissuring. To reduce fissuring the paddy may need to be covered during the very hot times of the day or dried over a couple of days.



Rice is also dried in mechanical batch dryers. The most common smaller dryers have a capacity of 1-3 tons per day with drying times of 6-12 hours. For drying of seed in tropical areas an air temperature of 40-42°C is normally used with a heater capable of raising the air temperature 10-15°C. An air velocity 0.15-0.25m/s is required and typical power requirements are 1.5-2.5 kW /ton of paddy. The efficiency of these dryers is also improved by stirring the grain.

Equilibrium moisture content

In storage, the final moisture content of seed depends on the temperature and relative humidity of the air that surrounds the grain. The final grain moisture content resulting from storage is called the 'equilibrium moisture content' or EMC. The following table shows the EMC of paddy under different storage conditions. The underlined & colored areas represent the desirable environmental conditions for storage of paddy for food purposes in the tropics. If grain is not protected against humidity in the air, in particular in the rainy season when the relative humidity may reach 95%-100%, grain moisture content will rise leading to quality deterioration.

Relative Humidity	Storage Temperature (°Celsius)						
	22°C	24°C	28°C	32°C	36°C	40°C	44°C
50%	11.2	10.9	10.7	10.5	10.2	10.0	9.9
55%	11.7	11.5	11.2	11.0	10.8	10.6	10.4
60%	12.3	12.0	11.8	11.6	11.4	11.2	11.0
65%	12.7	12.6	12.4	12.2	12.0	11.8	11.6
70%	<u>13.5</u>	13.3	13.1	12.8	12.6	12.5	12.3
75%	14.3	<u>14.0</u>	<u>13.8</u>	13.6	13.4	13.2	13.0
77%	14.6	14.3	<u>14.1</u>	13.9	13.7	13.5	13.4
79%	14.9	14.7	14.5	14.3	<u>14.1</u>	<u>13.9</u>	13.7
81%	15.3	15.1	14.9	14.6	14.5	14.3	<u>14.1</u>
83%	15.7	15.7	15.3	15.1	14.9	14.7	14.5
85%	16.1	15.9	15.7	15.5	15.3	15.1	15.0
87%	16.6	16.4	16.2	16.0	15.8	15.6	15.5
89%	17.2	17.0	16.8	16.6	16.4	16.2	16.1
91%	17.9	17.7	17.5	17.3	17.1	16.9	16.7

Cleaning

Threshed seed contains all kinds of trash. This trash can be vegetable, such as chaff, straw, empty grains and foreign seed as well as mineral materials such as earth and stones. Seed should be cleaned as soon as possible after harvesting and certainly before storage.

The simple traditional cleaning method is winnowing, which uses wind or a fan to remove the light elements from the grain.



Mechanical winnowers that incorporate a fan and several superimposed reciprocating sieves or screens are now used in many countries. These can be manually powered or motorized and have capacities from 100 kg to 2-3 tons per hour. Where combine harvesters are used, there is a trend towards using large capacity centralized seed cleaners. These are normally equipped with a series of vibrating sieves and are capable of 10-30 tons per hour.

Storage

If grain is to be stored safely for extended periods it must

- have less than 13- 14% moisture,
- be protected from insects and rodents and
- be restricted from reabsorbing moisture either through rain or the surrounding atmosphere.

When seed is traditionally stored in 20-50 kg sacks it must be periodically fumigated to control insects and in some high humidity



environments the seed must be re-dried during the storage period. Some farmers use granaries, which are made from timber or mud/cement or large woven baskets and these are very prone to insect and rodent damage.



Sealed or hermetic storage is an option that has a lot of potential in the tropics. If seed is dried to 14% or less and stored in a sealed storage it reduces the risk of insect and rodent damage and the grain will not absorb moisture from the atmosphere or be damaged by rain. Sealed storage systems can come in all shapes and sizes. They may range from a sealed 200-liter oil drum to the more complex and costly sealed plastic commercial storage. Most large

commercial steel and concrete silos being used in western countries can be sealed for fumigation.



Seed treatments

Seed treatment can be a physical or chemical process.

Physical seed treatment

Heat treatments are somewhat rare in rice, but can be accomplished using hot water, dry heat or steam to kill seedborne pests and pathogens. Heat treatment can injury or kill the seed, especially if it is old, injured or has a low heat tolerance. Hot water treatment at 52-57°C for 15 minutes can eradicate seedborne *Aphelenchoides besseyi*.

Chemical treatment

Fungicides, bactericides, insecticides, and nematicides can be applied as gases, liquids or powder. No broad spectrum fungicides exist, so mixes may often be used. While chemical seed treatment is not widely practiced, the most common chemicals used are Benlate T and Homai. Seed treatment may be used to control pests that are not actually seedborne.

6. Evaluation – Is a seed program necessary?

The use of good quality seed increases crop yields, decreases the number of seeds that need to be sown and reduces the carry over of weeds, insects and diseases. The extent of the yield increase tends to be greater the poorer the quality of the seed that is presently being used by farmers. The question then arises how does a farmer know if using certified or good seed will financially reward him. This can only be answered by doing two key things:

1. Collecting samples of the farmers seed and evaluating the present quality and
2. Testing the field performance of “certified” or “good” versus farmer’s seed

Is good seed affordable?

Based on the cost difference between “Certified”, “Good” and “Farmers ” seed, the amount of extra grain needed to cover the cost of using improved seed can be readily estimated. For example, in the Philippines, the cost difference between certified seed and paddy is:

Certified seed	= 17.5 P/kg
Farmers/Paddy	= 9.3 P/kg
Difference	= 8.3P/kg

The extra harvest required to cover the cost of certified seed, based on different seeding rates is given in the following table.

Seed rate (kg/ha)	Extra_cost (P/ha)	Extra yield needed to pay for seed (kg/ha)
40	328	35
80	656	71
120	984	106
160	1,312	142
200	1,640	177

Table 6. Yield increases needed to cover extra seed cost.

If the ‘yield gain’ were 5%, then on a 3 t/ha yield, the yield gain would be:

$$3,000 \times 0.05 = 150 \text{ kg/ha.}$$

This means that a farmer who presently plants at 160 kg /ha would be better off using certified or good seed rather than paddy or farmer seed. With better quality seed, sowing rates and pest problems will also be reduced and therefore the total returns will be even greater.

7. Methods for Evaluating Good Seed

Moisture content

There are two methods that can be used to measure moisture content:

The primary or direct method, often called the drying oven method.

This method weighs a sample of the paddy and then removes all the moisture by heating the sample in an oven. After the moisture has been removed, the sample is re-weighed.



The secondary method uses electronic moisture testers.

This method uses meters that measure the moisture content either by measuring the resistance or capacitance of a sample of the paddy.

Drying oven method

The drying oven method takes longer to perform but provides the most reliable measure of moisture content.

- (1) Set the oven at 130°C.
- (2) Weigh three 100-gram seed samples [A].
- (3) Place the three samples inside the oven and leave for 16-24 hours.
- (4) Measure the final weight of each sample after the 16 to 24 hours [B].
- (5) Compute the moisture content for each sample using the equation:

$$MC = \frac{\text{Initial Weight}[A] - \text{Final Weight}[B]}{\text{Initial Weight}[A]} \times 100\%$$

- (6) Compute the average over three samples to obtain a reliable measure of the moisture content.

Electronic Moisture Meters

- (1) Read the operator's instructions
- (2) Turn the moisture meter on
- (3) Ensure the machine is set for paddy
- (4) Fill the tray or bowl of the moisture tester with a sample of the paddy to be tested
- (5) Turn or press the knob until the moisture reading is displayed
- (6) Test at least three samples and calculate the average of the three readings

Moisture meters are most reliable after they have been calibrated. To do this, use the drying oven method to determine an accurate moisture content reading for a sample of paddy. Test a sample from the same batch of paddy using the moisture meter and compare the results.

Germination test

A germination test is often the only test a farmer can conduct on the seed before planting. Monitoring the time taken to germinate will also give an indication of vigor. This procedure is easy, inexpensive and portable.

Sampling

To obtain a random sample for testing it is always best to take samples from different parts of the bag or container. If the grain to be tested is from a seed lot contained in more than one bag, sample must be taken from several bags. A good rule of thumb for determining how many bags to sample is to take samples from a number of bags that represents the square root of the lot size. For example, if the lot contains nine bags, then sample at least three bags. If the lot contains 100 bags, then sample from at least 10 bags.

Equipment

To conduct this test you will need the following:

- Waterproof tray. A flat-sided water bottle, cut in half lengthwise makes a good tray.
- Water absorbent material. Tissues or cotton wool are ideal.
- Seeds.

- Water supply.

Procedure

- 1) Place water absorbent material inside the waterproof tray
- 2) Take random sample from each seed lot and mix in a container
- 3) Take at least three seed samples from the mixed grain
- 4) Count out 100 seeds from each sample and place on absorbent material inside the tray
- 5) Carefully saturate the absorbent material
- 6) For each of ten [10] days
Each day check that absorbent material remains moist
Record the number of germinated seeds
- 7) Compute germination test for five [5] days and for ten [10] days

The rate of germination is an indicator of vigor. Rapid seed germination increases the chance that seed will establish in the field.

Calculating the germination rate

Germination rate is the average number of seeds that germinate over the five and ten day periods.

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds on tray}} \times 100$$

For example, If 86 seeds germinated in a tray of 100 seeds after 10 days, then

$$10\text{-day germination (\%)} = \frac{86}{100} \times 100 = 86\%$$

Seed lot purity

The impurities measured to test the purity of the seed batch are

1. weed and other crop seed, and
2. inert matter.



Procedure

- (1) Select at random a sample of the seed. 100gm is a good sample size.
- (2) Weigh the sample **[A]**
- (3) Remove all of the weed and other crop seeds and the inert matter
- (4) Weigh the weed and other crop seed matter removed. **[B]**
- (5) Compute the weed percentage as follows:

$$\% \text{ Weed} = \frac{\text{Wt of weed}}{\text{Total wt of sample}} \times 100$$

- (6) Weight the inert matter removed from the sample **[C]**, the inert matter percentage is calculated using the formula:

$$\% \text{ Inertmatter} = \frac{\text{Wt of Inertmatter}[C]}{\text{Total wt of sample}[A]} \times 100$$

Varietal purity***Grain dimensions***

The grain size and shape (length-width ratio) is a very stable varietal property that can be used to measure the varietal purity of a sample. Comparing the length-width ratio of the sample with the published ratio for the variety indicates the varietal purity of the grain sample. Significant deviation indicates that the sample is impure – that is, it is either a different variety or a mixture of varieties.

SCALE (Length)	
1	Extra long (more than 7.5 mm)
3	Long (6.6 to 7.5 mm)
5	Medium (5.51 to 6.6 mm)
7	Short (5.5mm or less)

Scale	Shape	Ratio
1	Slender	Over 3.0
3	Medium	2.1 to 3.0
5	Bold	1.1 to 2.0
9	Round	Less than 1.1

Procedure

- (1) Obtain a random sample from the seed batch.
- (2) Collect twenty grains at random from this sample of seed
- (3) Use a Vernier caliper or photographic enlarger to measure the dimensions of each of the twenty grains. The pictures below illustrate the process.
- (4) Place these dimensions in the table below.

Grain	Length (mm)	Width (mm)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Total		
Average [total/20]	[A]	[B]

(5) To obtain the seed shape, the length width ratio, the following equation is used

$$\text{Length to width ratio (L / W)} = \frac{\text{Average seed length}[A]}{\text{Average seed width}[B]}$$

1000-grain weight.

A second characteristic that measures varietal purity is the 1000-grain weight. Each variety has a published weight for 1000 grains. If the 1000-grain weight calculated from the sample departs from this, it may be an indication that the sample contains a mixture of varieties.

Procedure

- (1) Select a random sample from the seed batch
- (2) Count 1,000 **whole** grains from the sample.
- (3) Weigh the 1,000 grains.

This is the 1,000-grain weight.

Red grains

A grain is considered to be red if more than 25% of its surface area is red colored or streaked.

Procedure

- (1) Select a random sample of the milled rice. 25gm is a good sample size.
- (2) Weigh the sample **[A]**.
- (3) Select and separate the red grains from the sample. The red kernels are those that have 25% or more of the grain red as shown in the diagram below:
- (4) Weigh the red grains separated from the sample **[B]**.
- (5) Calculate the percentage of red grains in the sample using the formula:

$$\% \text{ red grains} = \frac{\text{Wt of red grains}[B]}{\text{Total weight of sample}[A]} \times 100$$

8. Seed health tests

For more detail on laboratory seed health testing, see: Mew, T.W. and Misra, J.K. 1994. A manual of rice seed health testing. International Rice research Institute. Los Banos, Laguna, Philippines. P.O. Box 933, 1099 Manila, Philippines.

Fungal contaminants

The primary seedborne fungi causing yield loss are: Blast (*Pyricularia oryzae* CAV.), Brown spot (*Helminthosporium oryzae* Breda de Hann) and Bakanae (*Fusarium moniliforme* Shel).

Blotter procedure:

Blotter and agar plate methods are a simple and inexpensive way to detect seedborne fungi that respond to sporulation.

1. Use 9.5 cm Petri plates made of pyrex glass or clear plastic to allow NUV light to penetrate. In each dish, place 2 or 3 layers of good quality white or colored blotting paper moistened with distilled water.
2. Place seeds from the sample (with or without pre-treatment) equidistantly on the petri plate at 25 seeds/plate.
3. Incubate seeds at 22°C under 12-h light and 12-h dark cycles with NUV light.
4. Express results as a percentage of the number of total seeds.

Agar plate procedure:

Detects seedborne fungi through colony characteristics exhibited as they grow on the agar

1. Take 400 seeds as a sample. Pretreat seeds with 1% sodium hypochlorite for 10 minutes.
2. Drain off excess liquid. Place seeds (10 per agar dish) on the agar plates (in 9.5 cm Petri dishes)
3. Incubate at 22°C for 5-8 d, either under alternate cycles of NUV light and darkness, or in darkness.

Identification

1. Prepare slide mounts of spores or other bodies in a drop of water or lactophenol blue and examine under a compound microscope for shape, size and color.
2. Compare results with published data.

Bacterial contaminants

Two species of bacteria – *Pseudomonas* and *Xanthomonas* are the primary bacteria of concern. Seed borne *Xanthomonas* can cause Bacterial leaf blight. Bacteria have to be extracted, purified, isolated and then identified.

Nematodes

Only one of the more than 100 nematode species (*Aphelenchoides besseyi*) is known to be seed borne. Nematodes are unsegmented round worms. They are microscopic and transparent. They can live in the roots or in aerial plant tissue. For practical seed testing, the “modified Baermann funnel method” is considered suitable. Seeds are soaked and incubated before nematodes are counted in the water extract.

Viruses and mycoplasma-like organisms

Of the 21 rice viruses and mycoplasma-like organisms, only two (wrinkled stunt virus and witches' broom virus) are confirmed as seed transmitted. They have only been confirmed in Surinam and seed health testing has not been established.

9. Recording the quality of your seed batch

Take the sample of seed provided and conduct the range of quality tests described in the earlier lessons. Use the test results to complete the following table:

Characteristic	Sample 1	Sample 2	Sample 3	Value
Moisture [%] content (Oven or Meter)				
Grain dimension [L-W ratio]				
1000-grain weight [gm]				
Impurity [%] inert matter, weeds, etc.				
Red grains [No]				
Other varieties [No]				
Germination [%]				

From the table of information above, describe, in your own words, the quality of this batch of seed

Compare the quality of this sample with the national standards detailed in earlier lessons.

10. Definitions

1. Pure seed	The true seeds of the variety based on seed shape, size, coloration, usually the majority of seeds. Other rice seeds appearing as off-types should be placed under rice varietal mixture.
2. Best seeds	The pure seeds that are bold or fully filled having no or low amount of discoloration (<0.5% discolored seed surface). Half-filled and empty will fall under partially filled or unfilled.
3. Spotted	There are two types of discoloration on rice seeds, one is spotting caused by certain diseases (brown spot) or insects (rice bug feeding damage) and, two is discoloration on a portion or portions of rice seeds caused by <i>Curvularia</i> (black kernel) or sometimes by <i>Alternaria padwickii</i> (stackburn disease) or by sheath rot on certain occasions. Other rice diseases do not produce consistent discoloration. We consider any seed having more than 0.5% discolored or spotted seed surface as discolored. Discoloration can occur on fully or partially filled or empty grains.
4. Discolored	
5. Partially filled	seeds that are not fully filled due to immaturity at harvest or due to infection of seeds by certain diseases or insect damage.
6. Deformed seeds	seeds with non-normal shape due to mechanical pressure during grain formation or due to seed infection (sheath rot) or infestation white tip or stem nematode.
7. Germinated seeds	could be genetic in nature when there is no dormancy (vivipary) or when panicles come in contact with paddy water before harvest.
8. Smutted seeds (Seed diseases)	generally are due to infection like false smut (<i>Ustilaginoidea virens</i>) or kernel smut (<i>Tilletia barclayana</i>) [organ specific diseases].
9. Unfilled seeds	Glumes without endosperms could be due to several factors for failure of some spikelets to fertilize and form endosperm, abortion of ovary due to early infection (ex. brown spot, sheath rot, white tip nematode, black kernel, bakanae, etc.)
10. Other species	Seeds other than <i>Oryza sativa</i>
10a. Rice varietal mixtures	Mainly discriminated from true seed of the variety by difference in seed size, shape, seed coloration, awn, pubescence of lemma and palea, and seed coat color. Usually minor in numbers.

11. Weed seeds	One of the seeds of the other species; vary in size from big (<i>Rottboella</i> & <i>Ischaemum</i>) to small (<i>Scirpus juncooides</i>) are reported as number of seeds in the working sample.
12. Other plant parts	Usually are present in improperly processed seedlot having pieces of broken leaves, stem or panicle branches.
13. Inert matter	Refers to soil, sand, etc. attached or with the seeds
14. Insect damage	Seed infested by storage insects could be reported by counting the number of insect damage seeds.

11. References

AEU Fact sheets on Storage, Land leveling and Variety characteristics

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12. Contributors

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