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Seed multiplication program at IITA and elsewhere

A.O. Abifarin

Seed production, seed multiplication, seed bulking or seed increase refers to the maintenance of a given improved variety for distribution either for a yield trial or large scale seed distribution to farmers. This will take the benefit of improved variety to the farmers. Therefore it is essential that an efficient and practical system is developed for the multiplication to enable the maintenance of seed purity and its dissemination.

Various steps or methods are used for seed multiplication. But in general there are four basic steps agreed to by breeders and agricultural agencies in many countries. At the Institute these four steps will be used with minor modifications.

1. Breeder seed

Breeder seed is obtained after several seasons of breeding selection and yield trials. Cultural practices would have been determined too. Usually trials begin around F_5- F_7 generation depending on the uniformity of the characters being selected for. Thus breeder seed is the purest in terms of varietal purity as it is produced by or under direct control of the breeder in charge. The breeder seed is the first stage of small scale seed increase. It is the continuous source of seed increase for foundation seed.

2. Foundation seed

After the breeder has named and/or released a variety the seed is designated as foundation seed. The foundation seed is grown or multiplied by foundation seed growers. Foundation seed growers could be an experiment station where

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the breeder seed was increased. It could be grown by Government agencies e.g. Ministry of Agriculture 1st phase multiplication or it could be increased by seed grower associations, approved by breeders and government ministries. In many West African countries foundation seed is grown by Ministries of Agriculture. IITA will also work with the Ministries but we are identifying some private farmers who might be used in future for growing foundation seed.

Whoever the foundation seed grower may be, production must be carefully supervised and approved by an agricultural experiment station. The foundation seed is the source of all other certified seed classes.

3. Registered seed

This is the third multiplication phase of seed. In some countries or with some seeds this phase is omitted. Registered seed is the progeny of foundation or registered seed. The production and handling must meet certain standards set up by Government agencies and breeders. Seed qualities must be up to the standard (see standards below) required for production of certified seeds.

4. Certified seed

This is the 3rd or 4th phase of seed multiplication for large scale distribution or sales to farmers. It is the progeny of foundation, registered or certified seed. Standards of seed certifying agents must be met.

Seed certification processes

The Institute will follow and recommend the following steps:

1. Approved variety of foundation, registered or certified seed must be grown. Only one variety will be grown on a given area or farm.

2. To avoid seed impurity the seed will be planted on a field which has not been cropped for some specified period to other rice varieties. There should be no weeds in the fields.

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3. Field inspections will be made by IITA staff and approved government staff. Rogues and weeds will be noted.

4. Inspections will be made to observe harvesting, cleaning, storage or labelling. Impurities, germination and quality factors will be checked.

5. Recommendation will be made for official tags to be properly affixed to each container.

General features of good seeds

1. True to type
2. Free from seeds of other varieties.
3. Free from seeds of other crops.
4. Free from weed seeds.
5. Free of inert matter
6. Free from diseases and pests.
7. Free from mechanical injury.
8. Good viability.
9. Reasonably priced.

The ensuing are more detailed practical informations for the execution of the above.

Exercise - Determining acreage needed for seed production

STEP 1. Determine amount of certified seed needed by farmers in accordance with market demand and/or government policies. Allow for a seeding rate of 40 kg/ha or modify to meet local practices.

STEP 2. Calculate acreage needed to produce this amount of seed. Allow for a final clean seed yield of 2/3 of normal production.

STEP 3. Determine acreage of registered seed needed to produce planting stock

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of certified seed. Allow for a final clean seed yield of 2/3 of normal yields.

STEP 4. Determine foundation seed acreage needed to provide the above amount of registered seed. Use the same seeding rate. However, allow for only $\frac{1}{2}$ the normal yields due to space planting and more stringent requirements.

Examples

Problem: Find the amount of certified seed required to plant 50,000 ha.

Solution: (Step 1) 50,000 ha x 40 kg/ha = 2,000,000 kg of certified seed needed.

Problem: The normal yield of a farm is 4,500 kg/ha. How many hectares are needed to produce 2,000,000 kg of seed for certification?

Solution: (Step 2) Expected clean seed yields 4,500 kg/ha
x 2/3
3,000 kg/ha

Therefore

$$\frac{2,000,000 \text{ kg}}{3,000 \text{ kg/ha}} = 666 \text{ ha of seed for certification}$$

Problem: How many hectares of registered seed are needed to plant 666 hectares of yields to produce certified seed on a land which normally yields 4,500 kg/ha?

Solution: (Step 1) 666 ha x 40 kg/ha = 26,640 kg registered seed

(Step 2) Acreage required: normal yield 4,500 kg/ha
x 2/3
3,000 kg/ha

Therefore acreage needed is $\frac{26,640 \text{ kg}}{3,000 \text{ kg/ha}} = 8.89$ or approximately 9 ha

Problem: How many hectares of foundation seed are required to produce 9 hectares of registered seed?

Solution: Amount = 9 ha x 40 kg/ha = 360 kg/ha

$$4,500 \text{ kg/ha} \times \tfrac{1}{2} = 2,250 \text{ kg/ha}$$

$$\frac{360 \text{ kg}}{2,250 \text{ kg/ha}} = .16 \text{ ha (approximately)}$$

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Remark: Certified seed needs must be anticipated three crops in advance because of the time required to produce the foundation and registered seed.

Summary of example

1967 Breeder's seed produced

1968 Plant .16 ha with breeder's seed to produce 360 kg foundation seed.

1969 Plant 9 ha with foundation seed to produce 23,640 kg of registered seed.

1970 Plant 666 ha with registered seed to produce 2,000,000 kg of certified seed.

1971 Farmers can plant 50,000 ha with certified seed. In case of over-production, registered seed may be sold as certified seed but not vice versa.

II. *Roguing a Seed Field*

Roguing, namely the removal of off-types belonging to other varieties, diseased or damaged plants as well as weeds, should be done in seed fields. Observe the following rules in roguing:

1. Acquaint yourself with the characteristics of the pure variety.

2. Rogue as frequently as needed to remove weeds and/or diseased and insect-damaged plants. Seed production fields should be rogued frequently during the heading stage.

3. Walk slowly across the field at 2-meter intervals, searching for off-type plants, other varieties or weeds. The interval between walks for roguing may be widened if little roguing is required and the plants being rogued are easily detected.

4. Carefully examine plants which appear to be off-types or other varieties and destroy them if proven to be such. Pull up all weeds and carry them out of the field or dispose of them as desired.

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III. Field Inspection

Seed fields intended for certification are inspected by a representative of the certifying agency who will be concerned primarily with the following:

1. Varietal mixtures
2. Presence of seed-borne diseases
3. Weeds at the seed-bearing stage
4. Plants of other crops in the field being inspected
5. Isolation

The certification standards are established by the certifying agency.

Field Inspectors: Only those trained and qualified by the seed certifying agency will perform field inspection.

The inspector must be familiar with the characteristics of the variety to be inspected, especially such distinctive items as color of plant parts, awn, height, and shape of grain.

He must also be able to recognize diseases and insect pests or weeds which may decrease the value of the seed.

He should be able to advise the grower on any special cultural practices needed for seed production and special precautions needed in the harvest drying, handling and storage of seed.

He must know the standards required by the seed certifying agency and be able to interpret all rules and regulations.

He should be granted full authority to make necessary decisions in rejecting fields not meeting inspection standards.

Schedules. The field should be inspected shortly before and after all plants have headed out or are at the stage when varietal mixtures can best be identified.

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Each field should be inspected at least twice. All fields in a local area should be inspected at one time if possible. A schedule is generally developed with the help of local extension workers or others. The growers may be informed in advance so they can accompany the inspector in their own fields.

Equipment

1. Report form - Growers' name, variety, etc.
2. Map and/or description of field location.
3. Seed certification standards.
4. Variety descriptions, references of diseases, weeds or other agronomic information.
5. Writing materials, envelopes, etc.

Essential points in field inspection

1. Cover as much area as possible.
2. Check all corners and potential problem areas.
3. Cross all rows in the field.
4. Check adjacent fields for contaminating materials such as other varieties when necessary.
5. Make five detailed counts or inspection in the first two hectares and one extra count for each additional two hectares.

Procedure

1. Upon entering the field identify the variety. Make sure you are inspecting the correct field.
2. Check isolation to be sure that the field is clearly separated from other fields by levees, ditches or roadways.
3. Walk around the field in any method as shown below to check

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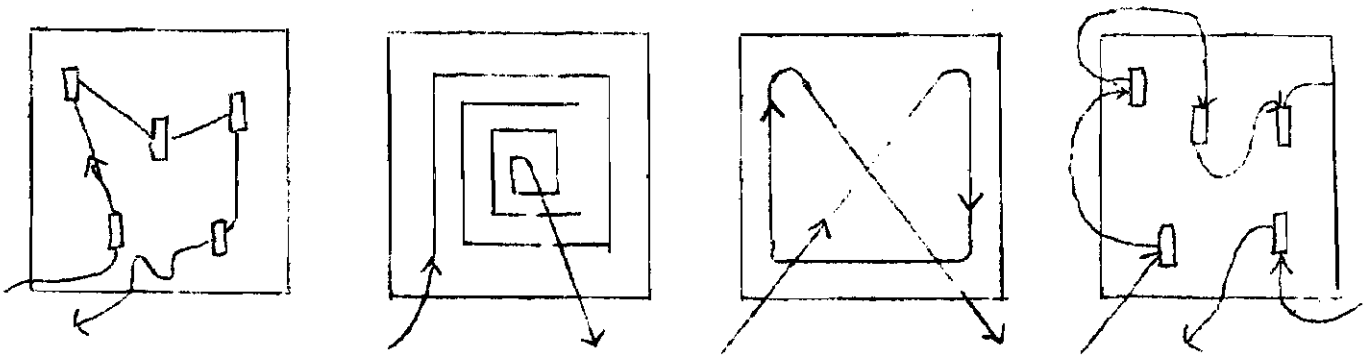
off type plants, weeds and diseased or insect-damaged plants. Record your findings.

Some Patterns in Field Inspection



[ ] Site of detailed inspections or counts (randomly selected).

Inspection techniques

Variety purity is the most important item. Inspect the plants to make sure

(a) Heading date of the pure variety is relatively uniform, and

(b) Plant height of the same variety is uniform.

Soil variability and moisture content will affect a & b especially under upland condition.

Inspect carefully plants of different heights, and pull them out if necessary to determine if they are separate plants or tillers.

Taller plants are easily distinguished in the seed field of shorter statured varieties, but when short varieties are mixed with taller plants they are not easily found, and great care should be taken during the inspection. For example, japonica varieties mixed with a tall indica variety are very hard to see. The maturity of plants on the seed farm may appear more uniform at one growth stage

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than at another. When most plants have reached the yellow maturity stage, the few plants found with green panicles should be rogued.

As you walk through the field, squat or bend periodically so that your eyes are even with the height of the panicles. Plants of different heights are easier to spot in this manner.

Field inspection is more effective if light comes down at an angle. Inspect in the earlier part of the morning or in the later part of the afternoon.

4. Determine if the field meets the certification standards. The following are the international standards; however, each country or province may set up its own standards according to local situations.

Field Certification Standards (Rice)

Factors	Maximum permitted in each class		
	Foundation	Registered	Certified
Other varieties	None	1 per 25^{m^2}	3 per 25^{m^2}
Red rice	None	1 per $1,000^{m^2}$	1 per $1,000^{m^2}$
*Objectionable weeds	None	None	None
Disease affecting quality of seed or transmissable through planting stock	None	None	None

*Designated by the certifying agency. 1954

5. After field inspection, the inspector will discuss harvesting, drying, cleaning and storage procedures with the grower. He will assist the grower to outline a procedure which will assure freedom of mixtures with other seed. He will inspect drying, cleaning and storage facilities as he deems necessary.

Note: Seed growers should be informed that it is their responsibility to have the field inspected prior to harvest. Then they should be able to

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communicate with the field inspector (certifying agency) through the local extension agents.

If the field is harvested before inspection, it shall be rejected.

IV. Sampling for Laboratory Analysis

A representative sample will be submitted to an official seed testing laboratory or the seed certifying agency. The sample will be taken by an official inspector of the appropriate government agency or a representative of the certifying agency.

One or more inspections and samplings of seed in processing or storage may be made at any time.

Procedure

1. Take samples. For bulk rice, use double-tube sampler (separate-compartment probe); for sack lots, use sack probe (trier) to get seed.

Seeds in bulk lots (in warehouse or on the dry ground) should be sampled in at least 10 locations with a 2-m long double-tube sampler. Samples taken are thoroughly mixed together on a sampling canvas, from which the required 1 kilogram of sample is taken.

For sacked rice. In seed lots consisting of 5 bags or less, sample each bag. When the size of the lot is 6 to 30 bags inclusive, sample at least every third bag, but not fewer than five bags. When the lot consists of 31 bags or more, sample at least every fifth bag, but not less than 10 bags. Samples taken are thoroughly mixed together to make the required amount of 1-kg sample.

2. Samples are placed in the containers specified by the certifying agency, and are sent to the seed laboratory with a record of variety name, crop season, name and address of growers, date of harvesting, lot number,

amount of seed, date, class of seed, agency sending the samples, and signature of inspector.

3. During the sample collection, the inspector will check to see if the seed lot is properly identified, if the lot is uniform from one sample to another, and if it is protected from mixtures with other grain or seed. He shall reject and/or report to the certifying agency any improper conditions.

Storage inspection. Seeds which have passed the laboratory test but have been in storage for a period of time should be inspected. The request for storage inspection is made by the storage agent to the inspection agency. The inspection includes the following items:

One or more inspections of harvested seed from inspected fields may be made at anytime or upon the request of the storage agent or of representative of the certifying agency. The inspectors shall have the authority to prohibit the storage of seed under conditions likely to result in mixtures, lack of identity or proper protection, or to reject any lot for the following causes:

The storage facilities had not been cleaned before the seeds were put in, or they are insufficiently protected against disease and insect, rodent and bird damage.

The storage facilities are not capable of keeping seeds dry and of protecting seeds from moisture and infection by molds.

The seeds are not frequently dried during the storage to keep seeds fresh and maintain the germination percentage.

A seed sample should be taken for germination test if the period of storage exceeds 6 months.

Sampling in the storehouse should be carefully made of the top, middle

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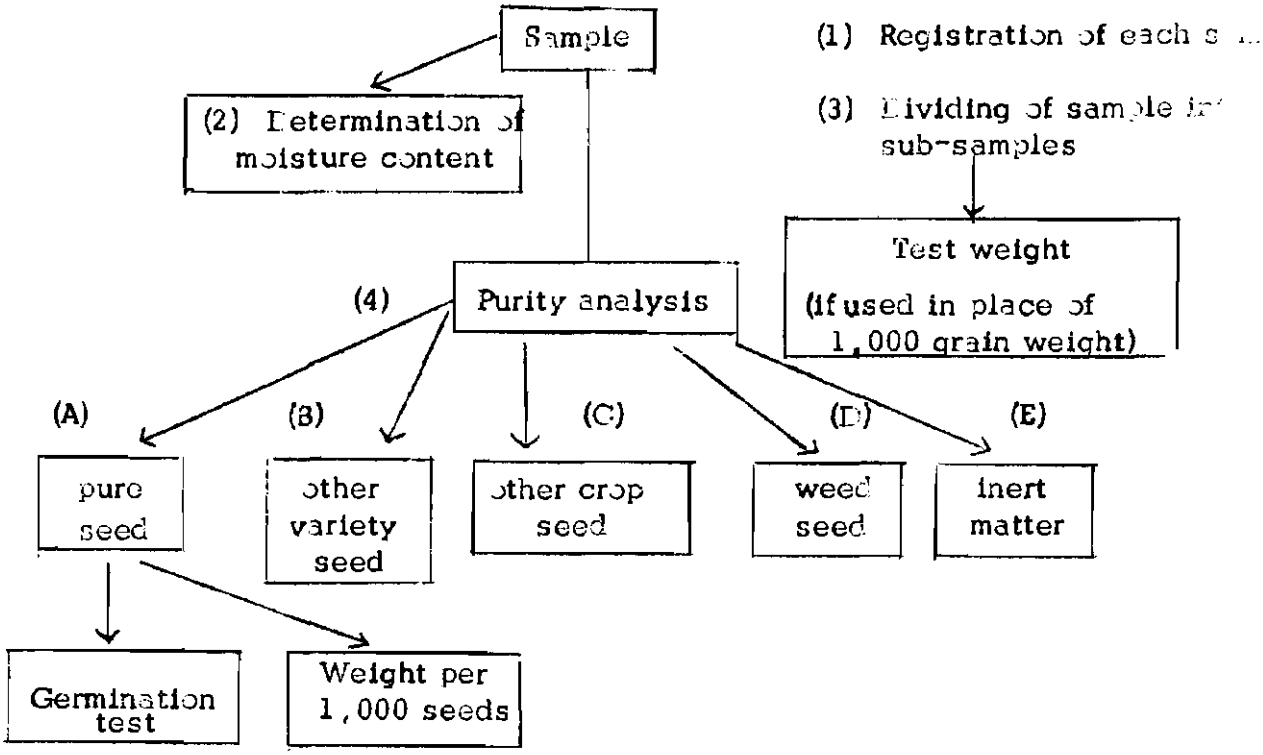
and lower portions of the seed lot with sampling probe 2-m long. Taking samples only from the front of the seed lot is inadequate.

V. Laboratory Analysis and Testing

A sample of laboratory procedure is shown below.



Procedure

1. Register sample upon receipt. Record the gorwer's name, identification of variety, lot number, date and other information as locally determined.

2. Determine the moisture content on the day of receipt, by instrument or by the oven-dry method, as specified in local regulations.

3. Divide sample by a mechanical divider to get representative working samples for purity analysis. The size of working sample for this, according to the International Seed Testing Rules, is 100 grams. The remaining portion of the sam-

shall be filed for future reference or for retest.

Alternative method. If no mechanical divider is available, place the seeds on a flat surface and continuously divide into two parts by a triangular board until the required amount of seeds is obtained.

4. Purity analysis: Inspect each grain under good illumination and separate a working sample into the following five categories: (1) pure seed, (2) seed of other varieties, (3) seed of other crops, (4) weed seed, and (5) inert matter.

Pure seed includes immature, diseased and wind-damaged seeds which are not fully developed and mostly green in color, or kernels of seeds which are larger than one-half of the original size. If varietal characteristics do not permit positive identification of off-types and other varieties, they will be included as pure seed.

5. Germination tests: International Seed Testing Rules require pure seed obtained from purity analysis for this test; four replications, each containing 100 seeds. Place moistened blotters or filter-paper in petri-dish and arrange the seeds on it about 1 cm apart. Moisten the substratum every day. Maintain the temperature for germination test at 20°C for approximately 16 hours per day and at 30°C for 8 hours per day. Count the germinated seed two times at 5 and 14 days after sowing.

In laboratory practices, germination is defined as the emergence and development from the seed embryo of those essential structures which indicate its ability to develop into a normal plant under favorable conditions. Thus germination in laboratory analysis requires that seedlings grow large enough that it will be possible to determine if they are equipped with all the necessary structures, and are healthy and strong. The emergence per se cannot be counted as germination.

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CAUTION: 1. Seed dormancy is sometimes encountered in rice. For breaking dormancy, treat seed at 50°C dry heat for 5 to 7 days or dehull the grains carefully.

2. Seeds infected with molds should be removed as soon as they are noticed and recorded in the count.

3. When germination substratum is soil or sand, only the 14-day count is necessary.

4. , All germination tests should be made with seeds from the "pure seed" separation, and not from the original sample. If an estimated percentage of pure seed is higher than 98, seeds for germination test can be randomly taken from the original sample before purity analysis. However, if it is lower, pure seeds after purity analysis are used in germination test.

5. Normal seedlings include those that have (1) one primary root, usually with numerous lateral roots; (2) well-developed green leaves which ordinarily have broken through the coleoptile at the time the seedling is evaluated; and (3) slight infection by fungi, provided none of the essential seedling structures have been damaged. Each seedling should be carefully examined.

6. Errors should be prevented during the germination test, and conditions for each germination test should be identical.

Note: The germination rate under field conditions is generally 5 to 10 lower than that under laboratory conditions.

7. Calculate germination rates. If the difference between the maximum and minimum rates within the four replicates is higher than the maximum permissible difference (see below), repeat the test.

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Germination Tolerances

Average germination of four replicates	Maixmum permissible difference between the maximum and the minimum rates within 4 replicates
more than 90%	10%
80-90%	12%
less than 80%	15%

For example, the germination percentages of 4 replicates are 90, 85, 77 and 84, respectively, with the average of 84%. The difference between the maximum and minimum values is 90 to 77 equals 13% which is larger than its maximum permissible difference, 12%. The results of this test are not acceptable and should be repeated.

8. Check 1,000 seed weight. Unlike the above-mentioned steps, this step is not required by the International Seed Certification Rules. Minimum seed weight standards may be established for each variety.

9. Follow the standards, decide whether to certify the seed.

International Seed Standards (Minimum) - Rice

Factors	Standards for each class		
	Foundation	Registered	Certified
Pure seed (minimum)	98%	98.0%	98.0%
Red rice (maximum)	None	1 per 5 kg	1 per 2.5 kg
Other varieties (maximum)	None	None	2 per 0.5 kg
Inert matter (maximum)	2.0%	2.0%	2.0%
Total weed seeds (maximum)	0.05%	0.05%	0.1%
*Total objectionable weeds	None	None	None
Germination rates (minimum)	80%	80%	80%
Moisture content (maximum)	14%	14%	14%

* Designated by the certifying agency.

10. If the sample meets all requirements, a certificate will be issued the grower or owner. A notice of rejection stating the reasons is sent to the grower or owner of the seed.

VI. *Tagging Seed and Distribution*

Tagging certified seed. Seed sold as certified must be placed in a new sack or other container and bear the official certification tag of the certifying agency.

Certification tags. Seed certification tags are issued after all tests and inspection have been passed. The tags will be applied under the supervision of the certifying agency.

Distribution of seed. If the farmer is well-informed or educated, he will know the advantages of using certified seed. A policy to encourage farmers to use certified seed is of great help.

VII. Instructions for the Rice Seed Growers

The production of rice seed is a priviledge. The success of the program depends on the care and integrity of the seed grower and processor.

Certified seed of all classes is produced under the supervision of the certifying agency. If you have any questions, check with your extension agent or representative of the certifying agency.

Varieties eligible for certification. Only those varieties which possess superior agronomic characteristics and are approved by the certifying agency shall be eligible for certification.

Eligibility of growers. Anyone who is accepted by the seed certifying agency and who meets all the requirements for production and disposal of certified seed may grow certified seed.

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Eligibility of land. Seedbeds to be used must have not been grown to the same crop within a period of 6 months, and in all cases, regardless of data of previous crop, the field must be free from volunteer plants of the crop being grown for certification.

Application for growing certified seed. Application to grow certified seed shall be submitted to the local agricultural extension service for recommendations before being forwarded to the seed certifying agency for final decision. Application forms will be applied to the agricultural extension service by the seed certifying agency.

Source of seed. Growers producing certified seed must plant registered seed. No application for the production of certified seed will be accepted from growers by the seed certifying agency without registered seed allotments sufficient to plant the intended area. The seed certifying agency shall make these allotments. Local modifications of these regulations may be made.

Isolation of fields. All fields producing seed for certification must be separated from other fields by a distinct boundary such as a fence, a ditch, a levee, a roadway, or a barren strip.

Field inspection. Crops being grown for certification will be inspected before harvest by a competent inspector authorized by the seed certifying agency. It shall be the responsibility of the grower to notify the appropriate agency before harvest and to request inspection.

The standards for field inspection are defined by the certifying agency. In addition, poor stands, poor growth, lack of uniformity, disease infections, excessive weeds, or any other conditions which are likely to make field inspection inaccurate or to bring certified seed into disfavor shall be adequate cause for rejecting a crop for certification.

Harvesting and threshing. Harvesting and threshing must be carried out in

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such a manner as to avoid mixtures and maintain seed identity. Only new sacks adequately labelled shall be used.

The seed certifying agency representative or other authorized personnel may, at any time, inspect the harvesting and threshing operations to insure the maintenance of purity and identity of the crop.

Processing. Recleaning or other processing must be supervised by the seed certifying agency representative or other authorized personnel. The recleaning and processing must insure the purity and identity of the seed to the satisfaction of the inspector. It shall be the responsibility of the grower or owner of the seed to notify the inspector and request inspection at the time of cleaning.

Movement of unprocessed seed. Seed intended for certification shall not be moved from the farm unless the designated authorities have been notified. A permit must be issued for all movement of seed from the farm where it is produced if such seed is to remain eligible for certification.

1. Rogue or remove off-type plants. In addition to the standard method of rice culture, the off-type plants on seed farms should be pulled out (rogued) before heading.

2. Prevent mixture of other varieties. The following are some of the possible causes of mixtures of other varieties:

a. Volunteer plants from previous rice crop in seed bed and field.

b. Seeds of other varieties floating in irrigation water.

c. The occurence of natural cross-fertilization. The percentage of natural cross-fertilization in rice is estimated to be 0.3 to 1.0, even though rice is considered a self-fertilized plant.

d. Mechanical seed mixtures during harvesting.

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e. Mechanical seed mixtures during drying when more than two varieties are being dried together at the same time or when the same equipment is used.

f. Mixtures during packing and storage.

g. Contaminations due to used seed containers

h. Spontaneous mutations in nature which cause off-types to be produced.

It is desirable that each seed grower produce only one variety. If he grows more than two varieties, separate fields for each variety and thorough cleaning of the processing equipment between varieties are required.

Maintaining Genetic Purity.

In the increase of breeder's seed and of foundation seed, it is essential to plant the seedlings in one-seedling hills, in order to facilitate the selection of true-to-type plants. In the case of a directly seeded crop, use wide spacings and a low rate of seeding. Since contamination comes largely from dropped seed of the previous crop, it is advisable to use the same field continuously in the seed multiplication a pure variety. One seed field should be separated from that of a different variety by an appropriate distance and preferably by a broad levee or road. Do not harvest the border plants for seed. Use only new containers for seed.

When it becomes necessary to repurify an established variety, mass selection in the form of selecting hundreds of true-to-type plants, followed by roguing off-type plants in the succeeding generation, and bulking the seed would be adequate in purifying a slightly mixed variety. The above process may be repeated for one or more generations.

In a badly mixed variety, purification on a plant or panicle-to-row basis will be necessary. In such an operation, selected panicles from true-to-type

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plants should be planted in individual rows. Selection in the succeeding generation will be made first on a row basis and then among plants within selected rows. The seed from selected plants can then be bulked to form the new seedstock. In extreme cases of mixtures, two cycles of the above operations may be needed. However, this process is not generally recommended except for experienced and competent workers, as rigid selection on a line basis, especially when the number of lines involved is small, may result in an appreciable change in the genotypic constitution of the population with respect to some not readily detected but important traits, such as disease resistance to individual races and component features of grain size and quality.

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