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Standard Operating Procedure for Breeder Seed Production of Pureline Varieties at ICAR-CRRI

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P R E F A C E

Rice is India's primary food crop and a key component of food security. The significant increase in food production during the Green Revolution, as well as its continued sustainability, was driven by the development of high-yielding varieties over several decades. These improved varieties, created by research institutes, are made available to stakeholders in the form of quality seeds, distributed through both public and private sectors.

Since inception, ICAR-Central Rice Research Institute (CRRI) has played a crucial role in providing seeds of improved rice varieties to farmers through a formal seed chain, which involves breeder-foundation-certified seeds. The institute has served as the official supplier of breeder seeds to seed-producing agencies. Additionally, CRRI has taken the initiative to multiply its own seeds for popularization programs through truthfully labelled (TL) seeds. As demand for seeds increased and more varieties were released, the institute expanded its seed production efforts by collaborating with external agencies, FPOs, and FPCs, while maintaining strict quality monitoring.

In light of these developments, there arose a need to establish standardized guidelines and procedures for Breeder seed production specific to the institute. This Standard Operating Procedure (SOP) for Breeder Seed Production outlines a comprehensive, step-by-step approach to ensure high genetic purity and seed quality. It covers all crucial aspects, such as variety selection, field management, roguing, harvesting, post-harvest handling, and quality testing for pureline varieties released by CRRI. By adhering to these guidelines, all stakeholders involved in seed production at ICAR-CRRI can improve the efficiency of Breeder Seed Production, contributing to a well-organized and resilient seed system.

Authors

Introduction

Breeder Seed (BS) is a crucial component in the seed production chain, ranking just below nucleus seed in terms of quality. It plays an essential role in producing other seed categories, including foundation and certified seeds, while maintaining the genetic purity and integrity of a crop variety. Typically derived from nucleus seed, BS can also originate from itself under certain conditions. When produced from nucleus seed, it is classified as Breeder Seed Stage-I, and the progeny from Stage-I becomes Breeder Seed Stage-II.

BS is vital for preserving the genetic traits of a rice variety, such as yield potential, disease resistance, grain quality, and other agronomic characteristics. Without pure breeder seeds, genetic contamination can occur, leading to a loss of these valuable traits. To ensure quality, breeder seeds are produces under close monitoring of breeder and field management. This ensures the production of high-quality seeds with strong germination potential, genetic purity, and a disease-free status.

As the foundation for producing foundation, certified, and commercial seeds, breeder seeds are critical in maintaining a consistent and reliable seed supply. Foundation seeds, produced directly from BS, are further used to create certified seeds, which are distributed to farmers. Without a steady and reliable supply of breeder seeds, the entire rice seed production system could be jeopardized. Therefore, the production of breeder seeds is vital for the long-term sustainability of rice varieties, enabling continuous propagation of high-quality seeds and ensuring that farmers have access to superior varieties for multiple planting seasons.

Objective

The goal of developing this Standard Operating Procedure (SOP) is to create a clear, standardized, and reproducible framework for producing breeder seeds of pureline rice varieties at ICAR-CRRI, ensuring the maintenance of their genetic purity and quality.

Scope

This SOP covers all activities involved in the production of breeder seeds for pureline paddy varieties, from seed sowing to harvesting, sampling, testing, and packaging. It is specifically designed for use at ICAR-CRRI to systematically monitor the production and handling of breeder seeds on an ongoing basis.

Standard Operating Procedure

Stages	Guidelines
Variety selection	The selected variety must be a released and notified by ICAR-CRRI through CVRC or SVRC. ➢ Early variety with < 115 days' maturity ➢ Medium variety with 116-135 days' maturity ➢ Medium late variety with 136-150 days' maturity ➢ Long duration variety with > 150 days maturity duration
Producing agency	The variety's parent institute or its original breeder, or a qualified breeder from the same institute, should oversee production. If the parent institute cannot produce the full BS quantity, the issue must be addressed at the AICRIP workshop, and another institute may be assigned to produce the remaining breeder seed.
Nucleus seed source	• The original breeder/ associated breeder/ nucleus seed maintenance unit of the institute will provide nucleus seed or BSS-1 seed (100% genetically pure) to the BS production unit, along with varietal details and related documents. • The original or associated breeder will monitor the BS plots at the institute or any assigned institute.

Field selection	Seed production plots should have proper irrigation and drainage facilities, be free of volunteer, weedy or wild rice, and have no record of such infestations in the past 03 years. Experimental plots in B, C, G and J blocks of CRRI will be engaged for BS production.
Registration of growers and plots	Before transplanting, nodal officer BS production must ensure entry/registration of seed production plots along with GPS map in seed portal, every season.
Sowing timeline	Breeder seed is typically produced during the *Kharif* season, though short and medium-duration varieties can also be produced during the *Rabi* season. The sowing must be completed within stipulated timelines as: *Kharif sowing:* • Long duration varieties during 20th to 30th May every year. • Medium duration varieties during 01st to 15th June every year. • Short duration varieties during 20th to 30th June every year. *Rabi sowing:* • Medium duration varieties during 10th to 20th November. • Short duration varieties during 20th to 30th November every year.
Nursery management	• Prepare raised seedbeds (5-10 cm height) of 1.0m width of any convenient length. • Provide drainage channels (30 cm) in between seedbeds to drain excess water. • Apply recommended fertilizer and manures (500: 500: 500g/100 m^2 N, P, K and 50 kg/100m^{2}FYM) to the nursery beds. Double the phosphorus dose where low temperature retards seedling growth and apply zinc sulphate @ 3-4 kg/1000m^2 in zinc deficient area. • Before sowing, seeds must be treated with recommended fungicides, insecticides as specified in the package of practices of the variety. • Sow pregerminated seed uniformly on the seedbed @ of 20-25g seeds/1m^2 area. • Manage the seedbed properly for getting healthy and vigorous seedlings for transplanting. • To avoid the fungal diseases in nursery, seed treatment with carbendazim 50% WP @ 4g/kg seed should be ensured. • For proper seedling growth, maintain the optimum moisture in nursery and apply urea @ 600-800g/100m^2 after 15 days of sowing.
Transplanting	➢ Transplant 21-25 days old seedling during *Kharif* and 30-35days old seedlings during *Rabi*. Transplanting must be completed within stipulated timelines as: *Kharif transplanting:* • Long duration varieties before 20th June (during 10th to 20th June). • Medium duration varieties during 20th to 30th June every year. • Short duration varieties during 10th to 20th July every year. *Rabi transplanting:* • Medium duration varieties during 10th to 20th December. • Short duration varieties during 20th to 30th December every year. ➢ Maintain 20cm x 15cm row spacing and transplant single seedling per hill. ➢ Breeder seed plot is transplanted in a particular field-procedure/ design, so before transplanting proper layout should be prepared.

	➢ Transplant 8 border row in each side of the plot, then after keep 60 gap to stop unwanted pollination from nearby plot. ➢ After the gap, transplant 8 lines (06 lines in tall varieties) in each rank and give a skipped row (leave one line) after every 8 lines, skipped row allows for the easy movement in the field for rouging. ➢ At both the sides, border row of 8 hills will be transplanted all along without any gaps. It will be continuously transplanted with the same 20 cm spacing between rows.
Gap filling	Gap filling is not recommended in BS plots.
Isolation distance	• Keep an isolation distance of 03 meters around BS plots. • Fifteen days' time isolation between adjacent plots is also best way to maintain seed purity in BS plots.
Rouging	Rouging must be carried out at three key stages of crop growth: tillering, flowering and just before harvesting. • At maximum tillering: Identify off-type plants by examining differences in leaf blade size, shape, and the color of the leaf sheath. • At flowering: Assess the duration of flowering, panicle shape, size, and stigma pigmentation. • Before harvesting: Focus on seed shape and size, fertility percentage and panicle exsertion.
Monitoring of plots	**Internal Monitoring** The Head, Crop Improvement Division will constitute an interdisciplinary team to monitor breeder seed plots. Internal monitoring team must visit BS field twice: once at maximum tillering and once at flowering. *Kharif season:* • 01st monitoring: 15th to 30th August • 02nd monitoring: 15th September to 20th October (mid November in case of long duration varieties) *Rabi season:* • First monitoring: 15th to 25th February. • Second monitoring: 10th to 30th March. The team must submit report within 05 days after monitoring **External Monitoring** Breeder seed quality is closely monitored by two external teams: • **National Seed Project (NSP):** Includes all Rice Research Institutes involved in rice varietal development and breeder seed production. The central NSP team oversees seed production and facilities at breeder seed centers. • **Joint Monitoring Team:** Led by the State Seed Certification Agency, this team inspects breeder seed production plots. It includes representatives from the State Seed Corporation, NSC, the State Agriculture Department, Agricultural University, and the breeding institute's officials.

	The Nodal Officer Seeds, ICAR-CRRI will schedule external monitoring dates in consultation with both Central and State Monitoring Teams to ensure the breeder seed plots meet field quality standards (Checklist and proforma attached as *Ann-I & II*). They will also prepare the monitoring report (BSP-III), signed by all team members.
Harvesting and Seed Processing	Breeder seed (BS) plots should be harvested in time to allow for testing of seed purity parameters and to make the seeds available for sale to stakeholders for immediate use in the next season's cultivation. **Harvesting time:** Harvest the crop at the proper stage of maturity, when 80-85% of the grains are fully matured. Harvesting must be completed within stipulated timelines *Kharif season:* • Early duration varieties during the 01st week of October. • Medium duration varieties during 2nd and 3rd weeks of October. • Long duration varieties during last week of October to the 3rd week of November. • Long duration varieties latest by 01st week of December. *Rabi season:* • Early varieties during 04th week of March. • Medium duration varieties by 3rd week of April. After monitoring, matured varieties will be harvested as follows: • First, harvest the 8-lined border, bundle it separately, and set it aside (this will not be used as seed). • Next, harvest the rest of the plot, bundle it, and take it to the threshing floor for threshing. Dry the seed to a minimum of 13% moisture content and grade it. • Collect seed sample and test it for quality parameters in the Institute's seed testing laboratory. If the seed meets quality standards, it is designated as breeder seed, and the nodal officer seed will issue tags for the bags. • Treated breeder seed will be packed in 20 kg or 30 kg bags, each tagged with all relevant information regarding the seed lot. • Store the seed on an elevated wooden platform in a well-ventilated room, ensuring no water entry from seepage or rain.
Tags for Quality Seed	Seed lots that meet BS quality should be packed and sealed with a golden yellow tag of 12 cm x 6 cm dimension during sale. Details of tag is attached in (*Annexure III*)
Record maintenance	Incharge BS production must have records of all activities related to seed production, including field history, seed source, planting details, crop management practices, roguing, harvesting, processing, and bagging should be kept in a standard proforma. It must be made available to monitoring teams on demand.
Special requirements	• For near isogenic lines (NILs) or varieties with known genes for specific traits, random samples should be taken from seed panicles and tested with markers. If any deviation is found, the seed lot must be rejected.

	• Spraying the respective herbicides at the recommended dose, as specified in the package of practices, is mandatory for herbicide-tolerant (HT) varieties during seed production. • Seed samples from each pack of HT varieties must be tested for herbicide tolerance through grow-out tests and certified accordingly, with signed tags securely attached to the bags to prevent tampering. • Strict monitoring of NILs and HT varieties under the supervision of respective breeders is essential.

By following the procedures mentioned above, the quality and integrity of breeder seeds will be maintained, ensuring they are suitable for further multiplication and distribution.

Annexure I

Checklist for BS monitoring in fields

Name of variety:
Year of release:
Area of recommendation:
BS production plot:

Stage	Parameters	Remarks
Nursery Transplanting	Variety details record as per the proposal	
	Nucleus Seed Purity Certificate from the developer	
	Sowing to be completed as per the SOP for both season	
	Seed Treatment done before sowing	
	The plot selection for Breeder Seed done as per the SOP?	
	Sowing Plan (Date of Sowing, Number of Panicle Shown, Number of lines shown for each variety)	
	Seedling health	
	Specific remark	
	Transplanting Time as mentioned in the SOP for both season followed or not	
	Isolation: Time isolation/ isolation distance maintained or not.	
	SOP for Breeder Seed transplanting to be followed	
	Seedling age at the time of transplanting	
	Date of Transplanting?	
	Planting method and row spacing as per the SOP	
Field management	Irrigation, Weeding and Fertilizer application as per the SOP	
Rouging	How many times the variety has been rouged out.	
Monitoring	What was the flowering status in the field?	
	Off type plants present or not.	
	Whether management details after transplanting recorded?	
	What is the disease and insect-pest status in the field?	
	Specific remarks, if any?	

Annexure II

Proforma for BS Monitoring Report

Variety	:	
BS plot ID	:	
Transplanted Area (m^2)	:	
No. of rows with length (m)	:	
Crop Stage at monitoring	:	
Monitoring report	:	Satisfactory/ rejected
Insect Pest Incidence (if any)	:	
Expected Yield (kg)	:	
Remarks (if any)	:	

Annexure III

Information on the Breeder Seed Tag

While supplying the Breeder seed as per DoAC allotment, a golden yellow colour tag is stitched with the bag with certain mandatory information's written on it. The mandatory information's are as follows:

- Name of the crop
- Tag No.
- Name of the variety
- Class of seed
- Lot No.
- Date of test
- Pure seed (%)
- Inert matter (%)
- Germination (%)
- Genetic purity (%)
- Source
- Signature of the Breeder
- Seal

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