STEPS TO SUCCESSFUL SEED PRODUCTION OF RICE

APART

অসম চৰকাৰ
GOVERNMENT OF ASSAM

ARIAS Society
GOVERNMENT OF ASSAM
Assam Rural Infrastructure and Agricultural Services Society

ASSAM AGRICULTURAL UNIVERSITY

CGIAR

IRRI

STEPS TO SUCCESSFUL SEED PRODUCTION OF RICE

Kanwar Singh[1],
Rupam Borgohain[2]
Rahul Priyadarshi[1]
Virendar Kumar[1],
Jyoti Bikash Nath[1]
Vipin Kumar[1]
Vivek Kumar[1]
Suryakanta Khandai[1]
Sudhanshu Singh[1]
Neeraj Kumar Tyagi[1]
Kuntal Das[1]
Swati Nayak[1]
Sanjay Chetia[2]
Ashok Bhattacharyya[2]

[1]*International Rice Research Institute*
[2]*Assam Agricultural University*

Steps to successful seed production of rice

This product has been developed under the Assam Agribusiness and Rural Transformation Project (APART), funded by the World Bank through the Assam Rural Infrastructure & Agricultural Services (ARIAS) society.

Acknowledgements

We earnestly acknowledge the support of Dr. Ashish Kumar Bhutani, IAS, Additional Chief Secretary to the Government of Assam (Agriculture Department), Agriculture Production Commissioner & State Project Director, ARIAS Society, and Dr. Bidyut C. Deka, Vice Chancellor, Assam Agricultural University, Jorhat, Assam for their valuable suggestions and overall guidance. We sincerely thank all the scientists, professors, officers of AAU, IRRI and Dept. of Agriculture, Govt. of Assam, for providing much needed support and valuable information in developing the booklet "Steps to successful seed production of rice". We are also thankful to Mr. Baljeet Singh, Market Analyst-cum-Operations Specialist, APART, ARIAS Society, Govt. of Assam, for his continuous support during the development of this booklet.

First Edition 2022

www.rkbassam.in **E-mail: rkbassam2021@gmail.com**

CONTENTS

1. Introduction

Seed is an important component of agricultural crop production, on which depends the performance and efficiency of other inputs. Quality seed maintains high standards of genetic purity (containing seed of one variety only and having characteristics of targeted variety), physical quality (equal sized healthy seed, free from stone, soil, damaged seed, immature seed and weed seeds, etc.), physiological quality (high germination percentage and seed viability), pathological quality (free from disease-causing organisms and pests) with proper moisture content and weight. It is necessary to follow best management practices for seed production and its postharvest management to produce quality seed for the state and ultimately the farmers. Certified seed production has to pass through two phases:

(i) Production: Sowing to harvest, under ideal management to get healthy, weed-free seed, adopting certification standards i.e., isolation distance, periodic rogueing, inspection, etc. for maintaining genetic purity.

(ii) Post-production: Postharvest operations to maintain seed quality is known as seed processing. In agriculture, the term 'seed processing' includes cleaning, sorting, grading, drying, seed treatment, packaging and storage.

2. Importance of quality seed

The benefits of using quality seed are following:

- Minimization of seed/seeding rate, i.e., fast and uniform emergence of seedling
- Fast and uniform emergence of seedling
- Higher germination and minimal gap filling
- Less infestation of land with weed seeds/other crop seeds
- Vigorous establishment and less disease and insect problem
- Responds well to the applied fertilizer and nutrients
- Uniform plant population and maturity
- Prolongs life of a variety
- Gain yield prediction is very easy
- 15-20% higher grain yield
- Easy handling of postharvest operations
- High return per unit area
- Better value-added products
- High value of produce and better marketability

2.1. Seed quality characteristics

The main criteria for describing seed quality are:

- **Varietal characteristics** refer to the genetic or cultivar purity and can be described by the physical, chemical and crop attributes
- **Seed lot characteristics** include a description on the level of impurities, seed size, and damaged, deformed or diseased seed
- **Seed viability** is determined by the stored moisture level, germination potential and vigor

2.2. Seed lot characters

- **Impurity**: The degree of contamination through weed seeds, seeds of other crops or species, and inert material such as stones, dirt, or twigs is considered impurity. 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 matters. They should also be free from various types of mechanical injury that reduce germination and seedling vigor.

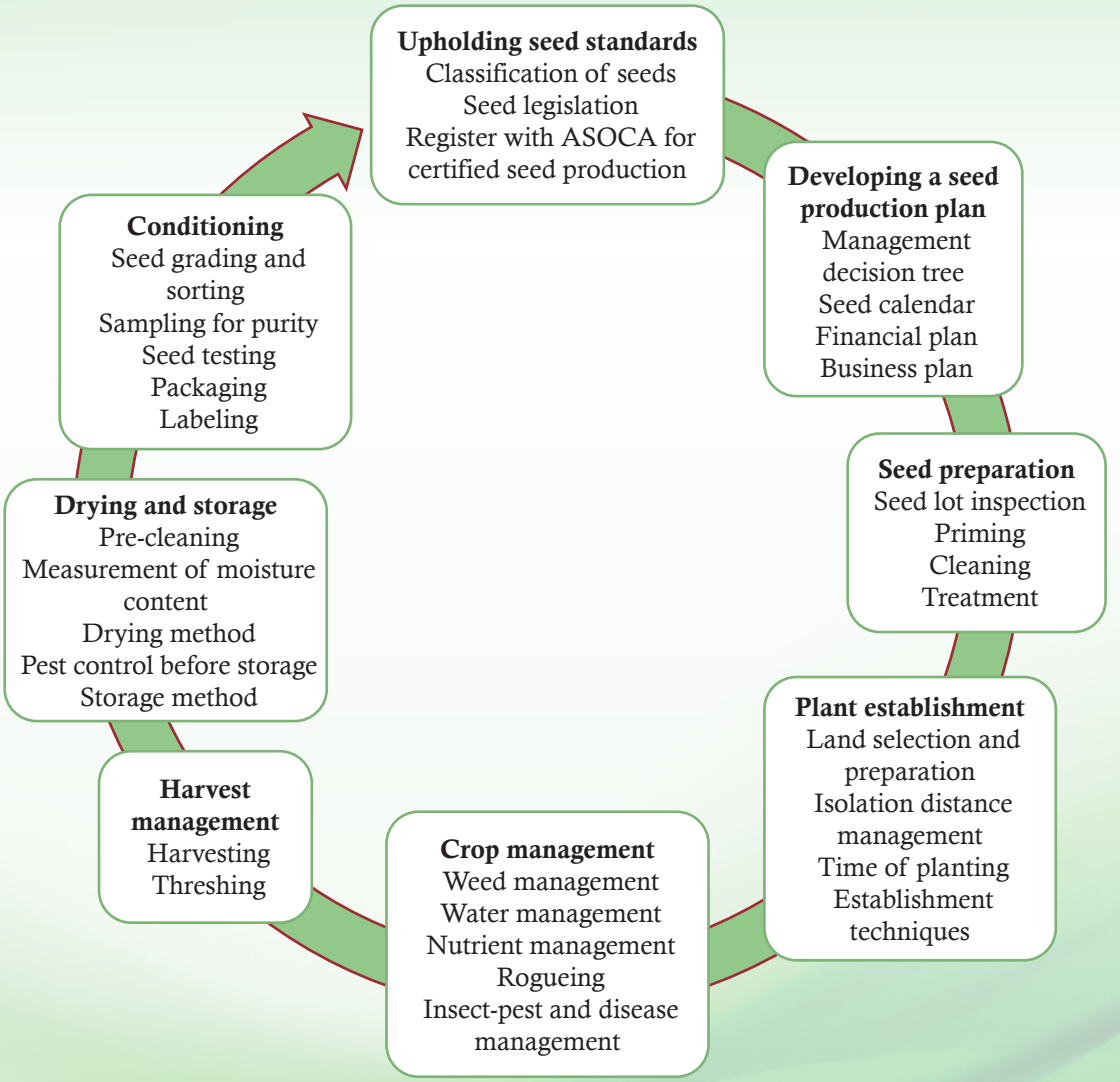
- **Seed viability**: Seed viability is the ability of seed to germinate. The viability of the seed in the field will be determined, to a large extent, by its stored moisture level, germination potential, and vigor.
- **Moisture content**: It has a marked influence on the life and vigor of the seed. Moisture content should be less than 14%, and preferably less than 12% for extended storage times.
- **Germination percentage**: It 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 seeds begin to fall/decrease rapidly after 6 months.

- **Seed vigor**: This seed quality characteristic provides a very good estimate of the potential field performance, and subsequently, field planting value.

2.3. Seed quality assurance

Quality seed is high in genetic purity, high in germination and vigor, and of good quality (i.e., free from diseased, deformed, damaged or immature seeds). Quality seed can belong to three classes - breeder, foundation and certified seed. Quality seeds from the informal sector also can be termed truthfully labeled and/or good seed.

3. Steps for paddy seed production- At a glance



The farmers should follow the following activities step by step for successful seed production -

(3.1.) Upholding seed standards (3.2.) Developing a seed production plan (3.3.) Preparing the seed (3.4.) Plant establishment (3.5.) Crop management (3.6.) Harvest management (3.7.) Drying and storage (3.8.) Conditioning.

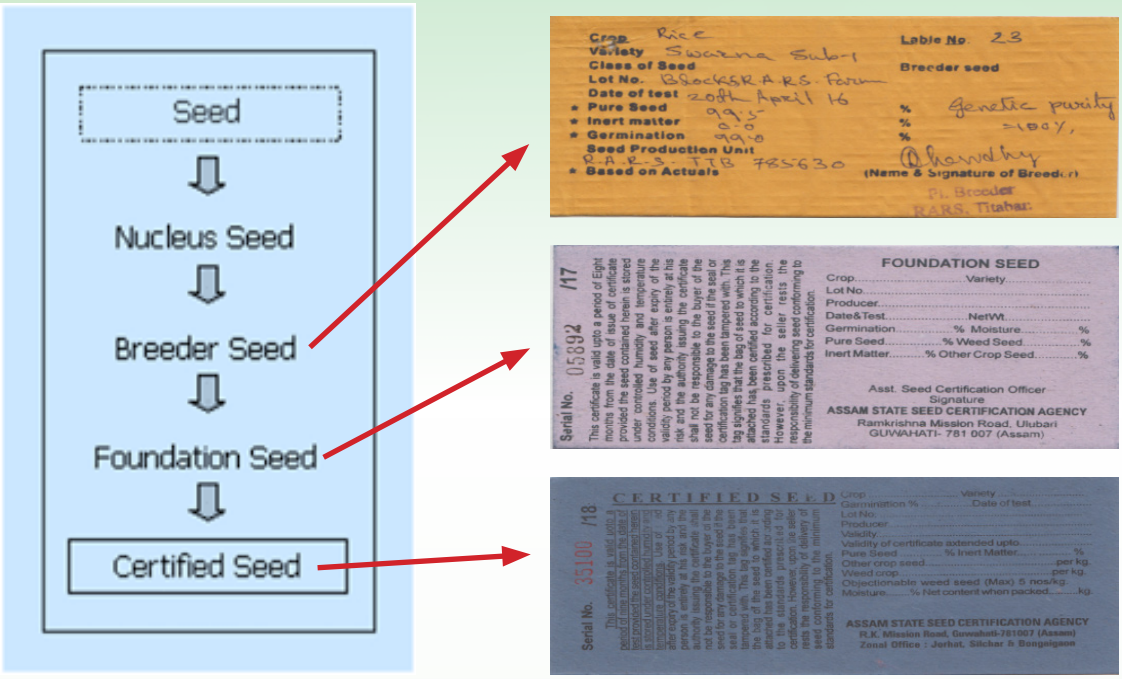
3.1. Step 1: Upholding seed standards

The purpose of seed certification is to maintain high quality and genetic purity of seeds of superior cultivars. Certified seed is high in genetic purity, high in germination rate, vigor and good quality (i.e., free from diseased, deformed, damaged or immature seeds).

3.1.1. Classification of seeds

- **Nucleus seed:** This seed is normally held by the plant breeder and not available to the farmers. It is the base for the variety selection by the breeder from the individual plant, and all seeds remain true to the variety. The genetic purity of nucleus seed is 100%.
- **Breeder seed**: This is the seed of a new variety that has the highest purity, and produced, developed, controlled and provided directly by the breeder or his institute for further multiplication. The genetic purity of breeder seed is 100%. The color of breeder seed tag is golden yellow, and its size is 12 cm x 6 cm.
- **Foundation seed:** This is the progeny of the breeder seed, produced by trained officers of an agricultural station, seed co-operative, farmer producer organization (FPO), farmer producer company (FPC), or progressive/ trained farmers in conformity with regulated national standards and handled to maintain genetic purity and identity of the variety. Official standard of genetic purity of foundation seed by Assam Seed and Organic Certification Agency (ASOCA) is 98%. The colour of foundation seed tag is white and its size is 15 cm x 7.5 cm.
- **Certified seed:** This is the progeny of foundation or certified seed Stage I, handled to maintain sufficient varietal identity and purity, grown by selected farmers, farmer producer organization (FPO), farmer producer company (FPC) 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. Official standard of genetic purity of certified seed by ASOCA is 98%. The colour of certified seed tag is azar blue and its size is 15 cm x 7.5 cm

For seed to be certified, the fields must be inspected by a certifying officer at least three times, at vegetative, flowering and grain filling stages, and the seed must be submitted to seed testing laboratory for testing of purity, cleanliness and health. The composite sample is divided into three equal parts, and one part is sent for analysis to the zonal seed testing laboratory, the second part to the seed producer and third part may be kept by the Assistant Seed Certification Officer (ASCO) as a guard sample. The specimen tags of breeder seed, foundation seed and certified seed are presented below:



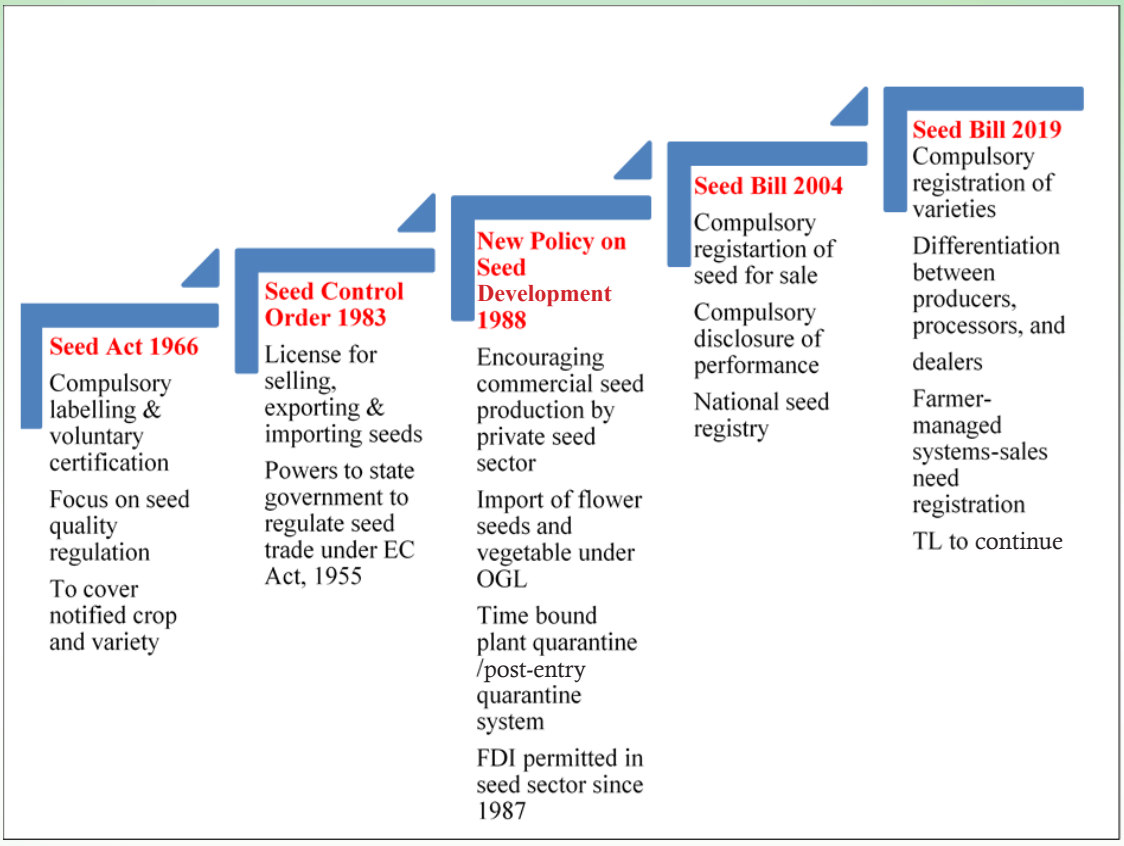
3.1.2. Seed testing

Seed samples are collected and submitted for laboratory analysis after drying and processing. Tests are conducted for physical and genetic purity of the variety, presence of weed seeds, other crop seeds, inert matter, other variety seeds, germination and moisture content. Maximum size of seed lot is 20,000 kg and sample submission size for paddy is 400 g to analyze the seed quality. The testing report needs to be completed within 30 days from the date of receipt of samples, unless the seed is subjected to such tests which require more than thirty days for completion.

3.1.3. Seed legislation

Due to rapid development of agricultural production with introduction of hybrid varieties of maize, sorghum, pearl millet, dwarf wheat and paddy necessitated the

enactment of Seed Legislation on December 29, 1966; the Seed Act was passed followed by Seed Rules in 1968. Both were adopted during 1969 by all the states of India, except Sikkim. The information of seed act 1966, seed control order 1983, new policy on seed development 1988, seed bill 2004 and seed bill 2019 are presented below:



Seed certification agency: The Government of Assam has established an autonomous body Assam State Seed Certification Agency (ASSCA*) on January 1, 1985 under Seed Act 1966 – Registered under the Societies Registration Act, 1860 to carry out the certification process of foundation seed and certified seed.

Grant of a certificate by the certification agency: Any person can apply to the certification agency for a certificate to sell, offering to sell, or keep seeds of any notified variety; and the agency may supply it, if the seeds satisfy the minimum limit of germination and purity as specified. The validity of seed certification tag is for nine months from the date of test at the time of initial certification. The validity period could be further extended for another six months provided on re-testing, seed conforms to the recommended standards in respect of physical purity, germination and insect/pest damage, etc.

* Now Assam Seed and Organic Certification Agency (ASOCA)

Revocation of certificate: The Seed Certification Agency may cancel the certificate if the certificate holder fails to comply with the conditions or obtained it through misrepresentation.

Seed inspector: The government appoints a seed inspector and defines the area within which such an appointee shall exercise his jurisdiction.

Import and export of seeds: Any person can import or export seeds on condition that such seeds conform to the minimum limit of germination and purity, and that the container of such seeds bears, in the prescribed manner, the mark or label containing the correct particulars of those seeds. However, the imported seed lot must be routed through ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR) for validating the purity. The directives of ICAR-NBPGR includes supervision and promote viable use of plant genetic and genomic resource of agri-horticultural crops and carry out related research; coordination of capacity building in plant genetic resources (PGR) supervision and policy concerns governing access and benefit sharing of their use, and molecular profiling of varieties of agri-horticultural crops and genetically modified (GM) detection technology research.

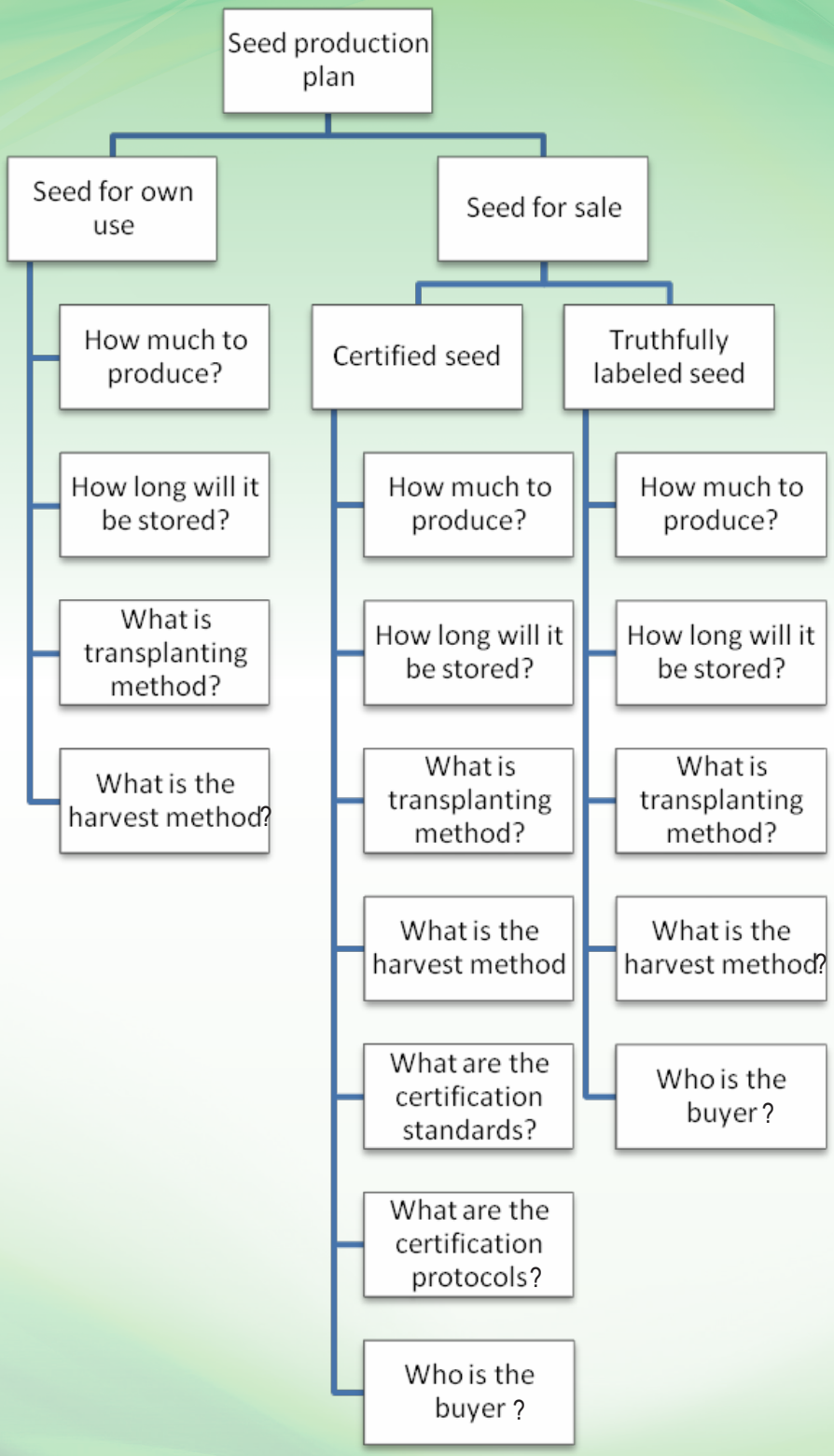
To produce certified seed, the seed growers/farmers should have to register with Assam Seed and Organic Certification Agency (ASOCA) and must follow its guidelines for certified seed production.

3.2. Step 2: Developing a seed production plan

A seed production calendar is a picture of the rice-growing season for seed production from fallow period and land preparation, to crop establishment and maintenance through timely harvesting and proper storage facility. The seed production plan enables a farmer to plan for input purchase and use, develop cash-flow budget for the year, determine credit need and period of requirement, determine labor requirements and plan for peak usage times, organize contractors for land preparation and harvesting, prepare the seed inspection and field standards (if producing certified seed) and investigate marketing and selling options and linkages. There are three steps to finalize the seed production plan: (i) Creating a seed production calendar, (ii) Creating a financial plan, and (iii) if selling the seed, creating a marketing plan.

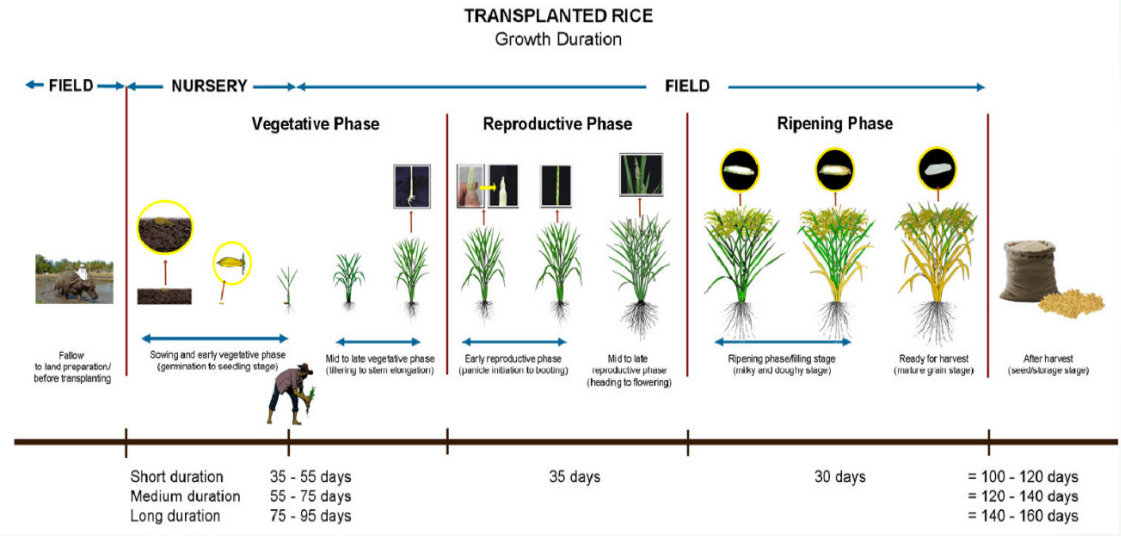
There are certain decisions to be made before the seed production plan is created. Use a decision tree to arrive at some conclusions before you proceed with the seed production plan.

Steps to successful seed production of rice



3.2.1. Creating a seed production calendar

- Determine the best date to plant. This information can be taken from local experience, scientists, agricultural advisors, and leading farmers in the district.
- Determine the time the variety takes from planting to harvesting.
- Most rice varieties take 60-65 days from panicle initiation to harvesting.
- Mark on the calendar the date of nursery sowing and when other operations need to be done (ploughing, transplanting, rogueing, weeding, fertilizing, harvesting).
- Determine how much labor and equipment will be required at each step during the growing period.
- Pin the calendar at a prominent place to remind you when things need to be done.



3.2.2. Creating a financial plan

For a farmer to make informed decisions, s/he must understand the basics of financial management and be able to analyze her/his business financially to plan future activities and compare enterprises. Understanding the differences between gross income, fixed and variable costs, gross margins, and return to management investment, is important. The total cost to produce a rice crop, is a combination of variable or operating costs and fixed or overhead costs. By understanding these costs, a farmer can determine what commodities s/he should produce, what grain yield and prices s/he needs to attain to make a profit, and what financial return s/he can get that is commensurate to her/his investment and personal efforts.

3.2.3. Creating a business plan

Follow these 5 steps to create a business plan:

Step 1: Begin with a snapshot of your current situation that defines what type of seed you are capable of producing and processing, who your competitors are and at what price you can actually produce the seed ?

Step 2: Describe your target audience; understand who the buyer is and what is the classification of seed they require, where are they located, when they will require seed and how much ?

Step 3: What are the legal requirements associated with producing seed in the state/country ?

Step 4: How are you going to maintain quality control ?

Step 5: Establishing and maintaining markets.

3.3. Step 3: Preparing the seeds

The use of certified seed is a prerequisite for increasing the seed yield and successful production of a good quality crop. There are a few steps to be followed before planting the seed. The certified seed purchased must be used to grow the quality seed by the farmers for two years. To maintain the quality of purchased certified seed to be used for two years, the farmer should follow the seed production process. Seeds might be certified or purchased from a credible and trusted source, but a few simple steps will help to ensure that the seed being used is of the required quality.

3.3.1. Seed cleaning

The seed cleaning should be done in salt solution at a concentration of 200 g common salt per litre of water for 1 kg of seed. To check optimum concentration of the solution, put a potato/egg in solution, and go on adding salt till the egg/potato floats. After that, seed should be poured into the prepared solution for cleaning. The light and diseased seeds, which float on the prepared solution, should be removed. The seeds settled at the bottom should be washed three times with plain water to remove any traces of salt that may hamper germination.


Clean water, salt and Seed
Preparing salt solution (200gm/Litre)
Put egg in water
Egg floating on water
Put seed in solution
Damage seeds will float
Remove floating seeds
Collect the seed remained on bottom and wash the seeds with clean water
Clean seed
After seed cleaning soak the seed for 12 hours
Put the fungicide in clean seed
Mix the fungicide properly
Keep for incubation for 48-72 hrs
Ready to sowing

3.3.2. Seed treatment

The cleaned seed should be kept for 12-24 hours in water before the fungicidal treatment. Seed treatment prevents seed from soil-borne diseases and avoids incidence of damping off, wilt and root-rot diseases in the seedling stage. It improves germination, seedling vigor, and thereby crop productivity. Then the seed is treated with fungicide Carboxin @ 2.5 g/kg of seed.

Alternatively, the seed treatment can also be done using biocontrol agent *Trichoderma* spp. @ 10 g/kg of seed. For this, first soak the seeds in water for 12 hours, then decant water and thoroughly mix with the biocontrol agent and store as a heap covered with moist gunny bag for 6-12 hours before sowing.

The method of seed cleaning and seed treatment is exhibited in the ffigure.

3.3.3. Safety precaution

Plastic gloves should be used while handling chemicals to avoid ill-effects on health.

3.4. Step 4: Plant establishment

3.4.1. Land selection and preparation

Fields used for growing certified seed must have to meet a number of criteria:

- Fields should not have grown the same crop in the previous year unless the crop was of the same variety planted for certification and met inspection requirements for varietal purity.
- Separation from other fields of the same variety by a ditch, levee or roadway or barren strip of at least 3 meters. Fields should be free from flooding and shade, and be relatively fertile. Upland area should be used for seed production in Assam.
- A well-prepared and leveled field aids rapid seed establishment and gives a uniform, healthy crop that can compete with weeds, uses less water and gives higher yields at a lower cost.

A well-prepared seedbed has:

- Many small soil clods to give good seed-soil contact. This means that many of the soil particles and seed should be of similar size.
- No weeds.
- Level and smooth soil surface after working.
- Well-constructed bunds with drainage lines inside the bunds or levees.

3.4.2. Preparing the field

- **When possible, plough the field immediately after the previous harvest,** especially if the soil is still moist.
- **Primary tillage**: Use a disc or moldboard plough to kill weeds and incorporate trash at a depth of 10-15 cm, at least 30 days before planting.
- **Secondary tillage**: Plough across the field with the disc or tine harrow at least twice to produce small-sized soil clods. Second ploughing should be 14-20 days before planting, and the last harrowing or puddling 7 days before planting at a depth of 5-8 cm.
- **Repair bunds:** Destroy rat burrows and repair any holes and cracks, and re-compact the bunds. Bunds should be at least 0.4 m high and 0.8 m wide.
- **Leveling the field** will give better water coverage, better crop establishment and better weed control. A level field should have 1cm slope per 100 m length, and 1 cm side-slope.

Puddling of rice field should be done at least 1-2 days before seeding to allow the soil to settle.

3.4.3. Isolation distance management

The "isolation distance" between a seed crop of a particular variety and a crop of a different variety is a space separating the crops large enough to prevent cross pollination. A safe minimum isolation distance from neighboring crops of different inbred rice varieties is 3 meters. The larger the seed plot, the less the danger of out-crossing. The isolation distance is compulsory for certified/quality seed production by seed growers.

3.4.4. Time of planting

Planting the crop on time will help to produce a fast growing, uniform crop that will have higher seed yield and will be better able to compete with weeds and pests.

3.4.5. Establishment techniques

Transplanting is better than other approaches for seed production. Transplanting can be done manually, either in rows or randomly, or by machines. Rice varieties suitable for direct seeding can be sown using a seed-cum-fertiliser drill or through drum seeder, otherwise transplanting should be preferred for other varieties during seed production.

Manual transplanting

Machine transplanting

3.5. Crop Management

3.5.1. Weed management

Weeds compete directly with the rice plants and reduce rice yield. Each 1 kg dry matter of weeds is equivalent to 1 kg of grain loss. Weeds cause most yield loss within the first 20-50 days after crop establishment. Weeding after panicle initiation may also be important to prevent weed-seed shedding at later stage.

3.5.1.1. Cultural management

- **Ploughing and harrowing in fallow** should be undertaken at least 10-14 days apart or after rain.
- **Good land leveling** reduces weed growth because most weeds have trouble germinating under water.
- Only recommended varieties should be selected for seed production.
- **Use clean rice seed** which is free of weed seeds.
- **Apply permanent water at early stage** - weeds cannot germinate under water.
- **First hand weeding** is done 3 weeks after establishment, and the second in another 3 weeks.
- Weeding should be done before fertilizer application.

3.5.1.2. Using herbicides

- **Identify the weeds correctly** and use the appropriate herbicides as recommended on the label.
- **Pre-emergence herbicides are** applied within 2-3 days of transplanting in 3-5 cm standing water in transplanted rice before emergence of weeds.
- **Post-emergence herbicides are** applied 15-25 days after sowing/transplanting after draining out standing water, when the weeds attain 2-4 leaf stage.

The list of herbicides to be used is presented in below table.

When does it kill weeds	Chemical Name	Dose (ai, g/ ha)	Type of weeds it kills		When to apply	Commercial dose (g or ml/ha)	Commercial dose (g or ml/*bigha*)
Pre-emergence	Pretilachlor 50% EC	750	Narrow leaf	Some broadleaf	0-3 DAT	1500 ml	200
	Pyrazosulfuron Ethyl 10% WP	18.8	Narrow leaf (sedges)	Some broadleaf	0-3 DAT	187.5 g	25
	Oxadiargyl 80% WP	100	Narrow leaf	Some broadleaf	0-3 DAT	125 g	16.6
Post-emergence	Bispyribac-sodium 10% EC	25	Narrow leaf (grasses + sedges)	Some broadleaf	15-25 DAT	250 g	33
	Chlorimuron ethyl 10%WP+ Metsulfuron methyl 10% WP	4 (2+2)	Broad leaf	Some sedges	15-25 DAT	20 g	3
	Pyrazosulfuron Ethyl 10% WP	25	Narrow leaf (sedges)	Some broadleaf	15-25 DAT	250 g	33

DAT= Days after transplanting

Given below are some of the recommended herbicide-combinations. Depending on weed-flora, follow the application timing and doses as per above table:

- Pretilachlor (PE) *fb** Bispyribac-sodium (PoE)
- Pretilachlor (PE) *fb** Bispyribac-sodium + Pyrazosulfuron (PoE)
- Pretilachlor (PE) *fb** Bispyribac-sodium + Pyrazosulfuron (PoE) *fb** Spot hand weeding

*fb**: followed *by*

3.5.2. Water management

Water availability largely determines the potential yield of a crop. To continue growth, a crop requires water supply similar to or a little above evapo-transpiration. In an efficient system, each 1 kg of rice seed produced will require a minimum of 2000 liters (2 m^3) of water in the field. Good water-control increases crop yields as well as seed quality and improves the efficiency of other inputs such as fertilizer, herbicide, and pesticides. In the absence of rain, application of 5 cm irrigation water 3 days after disappearance of standing water is recommended in medium and heavy soils.

Water quality

Good quality water is necessary to maximize crop growth. In some parts of Assam, iron is found predominantly in irrigation water. To reduce the intensity of iron problem, irrigation water needs to be passed through the long grassy channels with bumpy route allowing the water to oxidize either by trampling, and/or releasing the ducks in rice fields. Applying undecomposed cow dung or potassium can also decrease the intensity of the iron toxicity problem. The practices that increase the water use efficiency in the main field are depicted below:

Effect of uneven fields, Remedy: Land leveling | Cracks cause large water losses before soaking | Shallow tillage to fill cracks before land soaking | Close rat hole | Strong bunds avoid seepage losses

3.5.3. Fertilizer management

Fertilizer needs to be applied to increase crop yield. In some cases, fertilizers are also added as amendment to improve the soil physical condition. The amount and type of fertilizer applied are determined on the assumption that 1 ton of paddy seed will remove 15 kg nitrogen, 2-3 kg phosphate and 15-20 kg of potash. These base rates need to be modified according to the soil type, season, crop condition, prevailing weather conditions and efficiency of application. For efficient fertilizer use:

- Use **organic fertilizer** (manure, compost, straw, husk, plant leaves) whenever possible especially in nurseries and incorporate into the soil. Use 3-1-2 g $N\text{-}P_2O_5\text{-}K_2O$ + 2000 g manure per m^2 i.e., equivalent to 3-1-2 kg $N\text{-}P_2O_5\text{-}K_2O$ + 2 tons manure in 1000 m^2 of nursery area for one-hectare main field.

When?	What?	How much? (g/m²)		How much? (kg/1000 m²)		Application method
		Through DAP	Through SSP	Through DAP	Through SSP	
Basal (Same day as sowing)	Manure	2000	2000	2000	2000	Soil incorporation
	Urea	5.6	6.5	5.6	6.5	
	DAP	2.2	-	2.2	-	
	SSP	-	6.3	-	6.3	
	MOP	3.3	3.3	3.3	3.3	

- The Fertilizer recommendation per hectare is **60-20-40-5 N-P-K-Zn** for *Sali* season rice and **60-30-30-5 N-P-K-Zn** for *Boro*/early *Ahu* season rice in Assam. The base nitrogen dose is split into 3 equal applications - about 1/3rd as basal, 1/3rd at tillering, and 1/3rd at panicle initiation. Under submerged condition during *Sali* season, additional 20 kg N and 20 kg K_2O is applied 5-7 days after recession of flood water to facilitate regeneration, and boost recovery from flood-shock. 25 kg $ZnSO_4$ per hectare should be used once in 3 years in the same field.

The detailed schedule and method of applying all nutrients in *Sali* season is given in the table below:

Stage of fertilizer application	Name of fertilizer	Fertilizer application (kg/ha)		Fertilizer application (kg/bigha)		Application method
		Through DAP	Through SSP	Through DAP	Through SSP	
Basal (Same day at transplanting)	Urea	23.0	40.0	3.1	5.3	Broadcast & incorporate in soil at the time of field preparation
	DAP	43.0	-	5.7	-	
	SSP	-	125.0	-	16.7	
	MOP	66.7	66.7	8.9	8.9	
	$ZnSO_4$	25.0	25.0	3.3	3.3	
Tillering, after first weeding	Urea	45.0		6.0		Broadcast
Panicle initiation, after second weeding	Urea	45.0		6.0		Broadcast
5-7 days after flood water recedes	Urea	45.0		6.0		Broadcast
	MOP	33.0		4.4		

The detailed schedule and method of applying all nutrients in *Boro*/ early *Ahu* season is given in the table below:

Stage of fertiliser application	Name of fertilisers	Fertiliser application (kg/ha)		Fertiliser application (kg/bigha)		Application method
		Through DAP	Through SSP	Through DAP	Through SSP	
Basal (Same day at transplanting)	Urea	18	43	2.4	5.7	Broadcast & incorporate in soil at the time of field preparation
	DAP	65.2	-	8.7	-	
	SSP	-	187.5	-	25.0	
	MOP	50	50	6.7	6.7	
	$ZnSO_4$	25	25	3.3	3.3	
Tillering after first weeding	Urea	43	43	5.7	5.7	Broadcast
Panicle initiation after second weeding	Urea	44	44	5.9	5.9	Broadcast

- For production of healthy and vigorous seeds, foliar nutrition plays a major role. After first weeding and during flowering stage, foliar application of urea (2%) is beneficial.
- During milk stage, apply 0.5% potassium using 1.0% muriate of potash (KCl). Spraying 2% DAP results in higher seed yield with good quality seed.
- Stop urea broadcast, in case bacterial blight symptoms appear.
- Apply zinc sulphate ($ZnSO_4$) in soils deficient in Zn, once in three years.
- As far as practicable, drain out standing water before fertilizer application.
- Keep the field weed-free, especially at early crop growth stage. Weeds do most damage in early crop stage. But later control is also important to prevent seed setting/shedding by weeds.

3.5.4. Rogueing

Rogueing is the removal of all off-types or mixtures of plants from the seed production field. Rogueing is extremely important to prevent pollen from off-type plants causing damage to the crop through cross-pollination. Plants with heterogeneous characters in a seed production plot are off-types.

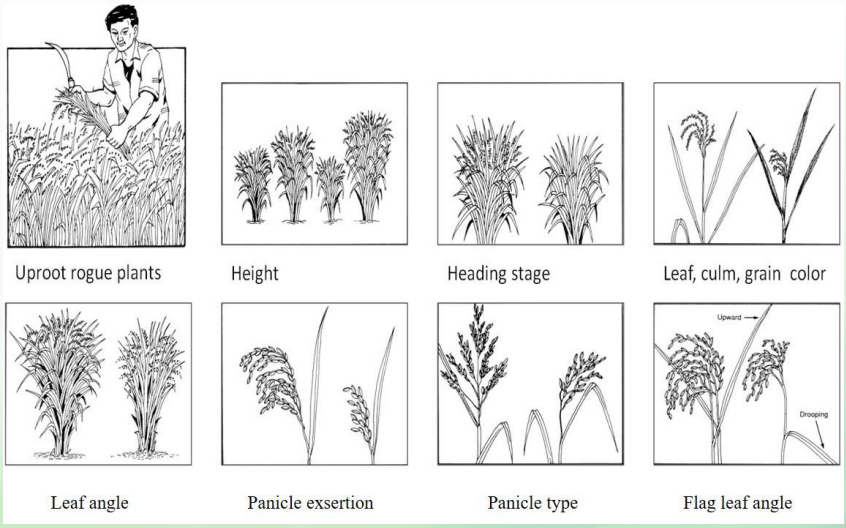
Sources of off-types

- Volunteer plants from a previous crop.
- Natural out-crossing or mutation.
- Minor genetic variation in the seed used.
- Developmental variation.
- Mechanical mixtures during postharvest of the seed production.

Identifying off-types

Off-types can be identified by observing the characteristics of plants such as -

- Plants taller or shorter than most of the population.
- Plants with different colored leaves, sheaths or straw.
- Presence or absence of awns: If the existence of awns in a plant is different from the rest of the population, it is an off-type.
- Plants with earlier or later panicle emergence are off-types: Only plants that flower within 2-3 days should be kept.
- Angle of the flag leaf: If erect flag leaves are dominant in a crop, then horizontal or droopy leaves are off-types.
- Inconsistent size, shape or color of grain: If most of the panicles have long grains, then those with medium grains are off-types. If slender grains are dominant, then bold grains are off-types.
- Diseased or insect-damaged plants.



3.5.5. Pest and disease management

Rice crop should be checked regularly for insect and disease outbreaks. Control measures should only be adopted when pest number reaches an economic threshold level (ETL). Integrated pest management (IPM) is a sustainable approach of managing pests by combining cultural, mechanical, biological, and chemical tools in a way that minimizes economic, health and environmental risks. Some examples of integrated pest management are presented in the figures depicted below. The integrated crop management is a better approach to control insect-pests and diseases in the seed production field.

Hanging dead poultry to repel gundhi bug

Seedling tip clipping to avoid stem borer attack

Tricho card attachment in field to control stem borer

Seedling root dip treatment

Stem borer trapping using delta pheromone trap

Installation of bird perch in field

The major insect-pests/diseases and their control is presented below –

S. No.	Insect-pest/ disease	Treatment/control
1	Stem borer	• Clipping of the seedling leaf tips before transplanting, harvesting close to ground and flooding fields after harvest of the crop. • Installation of light traps and pheromone traps @ 1 trap per bigha for monitoring the pest. • Installation of bird perches @ 3 no. per bigha and removal before ripening of the crop. • Biological control – Tricho cards having *Trichogramma japonicum* should be installed @ 7000 eggs/bigha 5 to 6 times at weekly intervals starting from 30 days after transplanting. • Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water or Cartap hydrochloride 50% SP @ 2 g/L of water.
2	Leaf folder	• Elimination of alternate grassy weed hosts. • Avoid use of excessive nitrogenous fertilizer. • Drawing of a kerosene-soaked rope across fields to dislodge/ kill the larvae. • Field release of *Trichogramma chilonis* @ 7000/bigha starting from 35 days after transplantation with 3 repetitions at fortnightly interval. • Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water or Cartap hydrochloride 50% SP @ 2 g/L of water.
3	Rice gundhi bug	• Hanging some foul-smelling dead frog or dead poultry in the field which attracts the gundhi bug towards the foul smell and then it can be easily destroyed. • Spraying of NSKE 1500 ppm @ 3-5 ml/L of water, Neemazal 1% @ 2-3 ml/L of water.
4	Swarming caterpillar	• EDigging of trenches around fields to check the spread of the caterpillars. • Flooding of the field to expose the hiding larvae to the surface. • Installation of bird perches @ 3 no. per bigha. • Release of ducks into the field to feed on the larvae. • Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water. Spraying is advocated only during evening hours.
5	Caseworm	• Practice alternate wetting and drying method of irrigation to kill the larvae. • Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water.

S. No.	Insect-pest/ disease	Treatment/control
6	Brown spot	• Proper fertilization and correction of nutrient deficiencies in soil. • Spray Propineb 70% WP @ 3-4 g/L or Chlorothalonil 75% WP @ 2 g/L of water, and the spray may be repeated after 10 days.
7	Blast	• Seed treatment with Chlorothalonil 75% WP or Tricyclazole @ 2 g/kg of seed or with biocontrol agents, *Trichoderma harzianum* or *T. viridae* @ 10 g/kg of seed or Pseudomonas fluorescens @ 10 g/kg of seed. • Reduced application of nitrogenous fertilizers with more number of splits. • Field should not be drained in case of disease incidence. • Spray Tricyclazole 75% WP @ 0.6 g/L or Isoprothiolane 40% EC @ 1.5 ml/ L of water.
8	Bacterial Leaf Blight (BLB)	• Seed treatment by mixing 0.025% solution of Agrimycin-100 + 0.05% wettable Ceresan, and then transferring the seed to hot water at 52-550C for 30 minutes. • When the disease is noticed, stop or reduce the further application of nitrogenous fertilizers. • Spray a ready-mix combination of Streptomycin sulphate 90% + Tetracycline hydrochloride 10% SP @ 100-150 ppm. • **Indigenous Technical Knowledge (ITK):** For controlling bacterial blight in rice, prepare a slurry of 20 kg cowdung in 200 liters of water, and filter it through a gunny bag. Dilute the filtrate with 50 liters of water and allow it to settle. The filtered water is then decanted, strained & sprayed on healthy plants to check the spread of disease.
9	False smut	• Use of good quality and disease free seeds. • Spray Chlorothalonil 75 WP @ 2 g/L or Azoxystrobin 23% SC @ 1ml/L or Tebuconazole 25.9% EC @ 1 ml/L of water.
10.	Sheath blight	• Seed treatment with *Trichoderma harzianum/ T. viridae* @10g/kg of seed. • Spray Hexaconazole 5% @ 2ml/L. • Spray Validamycin 3% L @ 3-4ml/L of water.

3.6. Harvest management

Care should be taken to ensure that the genetic purity of the seed crop is maintained, to avoid mixtures when harvesting more than one variety. The higher the quality of the seed, the greater the care is required in harvesting and threshing. Breeder seed is often hand-harvested and threshed with a mechanical self-cleaning thresher, while the foundation and certified seeds can be harvested using reaper.

3.6.1. Pre-harvest

- Inspect the mature crop and remove any off-types prior to harvest.
- Inspect and clean all equipment prior to harvesting.
- Harvest only one variety at a time to avoid seed mixing.
- When more than one variety is being harvested, completely clean all equipment and shake-off all seeds hidden in your clothing and shoes.

3.6.2. Harvest

Check crop moisture levels: The optimal stage to harvest rice seed crop is between 20-25% seed moisture or when 80-85% of the seeds are straw-colored and the seeds in the lower part of the panicle are in the hard dough stage.

- Reaper may be used for harvesting in the seed production field.
- Dry as soon as possible after harvest.
- Do not let the seed come in contact with the soil or water.

3.6.3. Threshing

Seed is separated from the panicle by impact or stripping from the panicle. This can be done either manually or by machine. Machines are more efficient for threshing at high seed-moisture content but also have the potential to cause damage if not set correctly. Machine threshers are best used for seed at 20-25% moisture while manual threshing is easier when moisture content of seed ranges from 14-18%. Engine operated open-drum thresher can be used for threshing operation of seed varieties to avoid mixing, reducing cost and early threshing. For the large-scale threshing of paddy seed, the axial flow thresher with drum rpm of 500-600 should be considered. Before shifting from one rice variety to another rice variety, the covered threshing drum and sieve should be cleaned by air blower or vacuum compressor pump.

3.7. Step 7: Drying and storage

It is important to dry the seed as soon as possible after harvest, and store safely.

3.7.1. Drying

- Ensure that the panicles and seeds do not touch the ground or lay in water during drying.
- Dry the seed within 24 hours of harvesting.

- Reduce moisture contents to 12% as soon as possible.
- Do not heat the seed above 42^{0}C during drying.
- When sun-drying, turn or stir the seeds at least once every hour to achieve uniform drying.
- Sun-dry on tarpaulins or clean drying pads, not on clay pads.
- Keep the thickness of the grain layer at 3-5 cm.
- On hot days, when temperatures go above 42^{0}C, cover the seed during mid-day to prevent over-heating, and also cover the seed immediately if it starts raining.

Pre-cleaning

Where possible, clean the seed before drying.

3.7.2. Drying methods

Traditional drying systems are still practiced in many areas of Assam because of their low cost and ease of management.

These methods include:

- **Sun-drying:** This process is spreading seeds or grains in open under the sun, on mats and pavements.
- **Mat drying:** This method is used in small- and medium-scale drying where threshed grains are placed on mats, nets, or canvas.
- **Pavement drying:** This is often used in large-scale drying for seed or grain collectors and millers, where grains are laid on pavements specifically made for drying.
- **Field drying and stacking:** This method is practiced for pre-drying of hand-harvested crops before threshing where farmers cut rice panicles in the field and stack them in small piles on top of the crop stubble.
- **In mechanical drying systems**: dryers are used to remove water from wet grains by forcing either ambient air or heated air through the grain bulk. Different types of dryer such as batch dryer, flat bed dryer, reversible air flow flat bed dryer, columnar dryer and solar bubble dryer may be used for drying. These dryers use high temperatures for rapid drying.

The drying process is terminated when the desired final moisture content is reached.

3.7.3. Measuring moisture content

Moisture content (MC) is the weight of water contained in paddy or rice expressed in percent. MC is usually calculated on the wet basis, meaning that the total weight of the grain including the water (MCwb).

Why is measuring the moisture content important?

Accurate moisture content testing is important in managing and marketing seed, because depending on the purpose, seed and paddy have different ideal moisture contents. Inaccurate moisture content measurements lead to:

- Extra drying cost and harvesting loss, if paddy is harvested at higher moisture content.
- Spoilage, if the seed is too wet in storage.
- Extra drying cost and loss of quality, if paddy is dried too far.

How to measure moisture content?

Moisture content of seed can be measured by two methods:

- Primary method, based on weight measurements like (a) oven method or (b) infrared moisture balance, or
- Secondary method, using an electronic instrument that uses electrical characteristics of the seeds.

3.7.4. Pest control before storage

Disinfesting the storage system

Disinfestation requires a systematic and thorough cleaning of all sources of infestation before storage.

Storage containers, structures and equipment can be treated with application of Neemazal 1% @ 2-3 ml/L or NSKE 1500 ppm @ 3-5 ml/L.

All second-hand bags should be examined, and wherever necessary, treat them with either a fumigant, insecticide, or dip in boiling water. Solutions of Neemazal 1% @ 2-3 ml/L or NSKE1500 ppm @ 3-5 ml/L can be used for dipping the bags.

3.7.5. Storage methods

The optimum moisture contents of rice seed stored up to 1 year is <12% but rice seed stored for more than one year should have optimum moisture content < 9%. Seeds can be stored safely for extended periods, if it is:

- Protected from insects and rodents.
- Restricted from reabsorbing moisture either through rain or the surrounding atmosphere.
- Sealed in hermetic systems at low oxygen levels to control insects and maintain germination potential for longer periods.

Seed storage facilities take many forms depending on the quantity of seed to be stored, the purpose of storage, and the location of the store. Storage can be through bags, in bulk, or hermetic containers.

Hermetic storage: In this system, seed is stored in an airtight container, so the moisture content of the stored seed or grain remains the same as when it was sealed. This system of storage can extend germination life of seeds, control grain pests, and improve head rice recovery. Examples include (i) super bag, cocoon - commercially available. Hermetic super bags are also available to the farmers at low cost, (ii) other locally available containers which are useful in rural settings and can be easily converted into hermetic storage systems.

Stacking of seed bags: The following point should be considered for stacking of seed bags: (i) Seed bags preferably be stacked on a wooden pallet (platform), (ii) Avoid steel hook on bags as it causes spillage of seeds, (iii) Leave alley (moving space) between stacks and walls for inspection or sampling, (iv) Only 50-60% space should be utilized for seeds and (v) New harvest should not be stored with old stock.

3.8. Step 8: Conditioning

Conditioning of paddy seed is very much essential. Seed processing plant should be used for processing of seed to maintain its quality. As per ASOCA, the processed seed through seed processing plant should be certified as foundation seed and certified seed. The following process is considering in the seed processing plant: (i) Seed should dry up to 12% moisture content before going for seed processing through the seed processing plant (ii) Cleaning (removal of dust, soil, straw and stones) through seed processing plant (iii) Grading (removal of non-seed and chaffy grain) through seed processing plant (iv) Gravity separator (removal of non-seed and broken grain) to get equal-sized quality seed through seed processing plant.

Malformed, discolored, germinated, broken or moldy seed in seed lots can severely impact seed quality, viability and vigor.

3.8.1. Seed cleaning

A seed cleaner uses a combination of components for winnowing, including a fan to remove lighter particles (e.g. empty grains/seeds) and sifting with sieves on an oscillating screen to remove particles that are smaller (e.g. weed seeds) and larger (e.g. straw).

3.8.2. Seed grading

For commercial seed processing, seed should have uniform size and weight. A variety of commercial equipment can be used to achieve uniformity in seed size and shape. These include gravity tables, rotary screens, indented cylinders, and length graders.

3.8.3. Seed purity

Maintain seed purity by preventing mixture with other varieties, and contamination with other species.

3.8.4. Samples, and sampling of seeds

Soon after completion of the seed processing or after seed treatment, as the case may be, the Certification Agency shall draw a representative composite sample as per procedure specified in Seed Testing Manual. The quantity of seed samples so drawn shall be sufficient to provide three samples of the size of submitted sample. The composite sample is divided into three equal parts: one is sent for analysis to a notified Seed Testing Laboratory, the second to the seed producer, and the third is retained as a guard sample.

3.8.5. Seed analysis report

The Seed Testing Laboratory analyzes the seed samples in accordance with the prescribed procedure and delivers the Seed Analysis Report to the Certification Agency as soon as may be, but not later than 30 days from the date of receipt of the samples unless the seed is subjected to such tests which require more than 30 days for completion of the test.

3.8.6. Seed standards of genetic purity

All certified seed lots should conform to the following minimum standards for genetic purity unless otherwise prescribed:

Class	Standards for minimum genetic purity (%)
Foundation	98
Certified	98
Hybrids	95

Grow-out test

The Certification Agency shall conduct grow-out test to determine genetic purity of a seed lot whenever it is a pre-requisite for grant of the certificate, and also on the seed lots where a doubt has arisen about the genetic purity. The grow-out test can be complemented by certain related laboratory tests. The grow-out test shall be conducted as per the procedure specified.

3.8.7. Recleaning, resampling and retesting

When a seed lot does not meet the prescribed seed standards, the Certification Agency, on the request of seed producer, may permit recleaning, resampling and retesting. The recleaning, resampling and retesting shall be permitted only once.

3.8.8. Seed standards for insect damage

A seed lot under certification shall not have apparent or visible evidence of damage by insects for both Foundation and Certified seed classes in excess of 0.50% for the seeds other than maize and legumes, unless otherwise prescribed.

3.8.9. Seed moisture content

Seed standards in respect of seed moisture shall be met at the time of packing of seed.

3.8.10. Downgrading of seed class

If a seed field or a seed lot is not found meeting prescribed standards for the class for which it has been registered but conforms to the prescribed standards to the immediate lower class, the Certification Agency may accept such seed fields/seed lots for certification to the immediate lower class, provided the request has been made to this effect by the seed producer. However, downgrading of the seed class shall not be applicable in case of hybrids and their parents.

3.8.11. Specification of the certification

Packing, tagging, sealing and issuance of the certificate

a. On receipt of Seed Analysis Report and the results of the grow-out test wherever prescribed, and if seed lot has met prescribed standards, the Certification Agency shall ensure packing, tagging, sealing and issuance of certificate expeditiously. An authorized official of the Certification Agency shall endorse the signature on the reverse of each certification tag and shall affix rubber stamp indicating the official's name and designation. Containers to be used for packing of the certified seeds shall be durable and free from defects.

b. Advance tagging may be permitted at the discretion of the Certification Agency with proper safeguards.

4. Official standards of Indian seed certification for paddy

Factor	Foundation	Certified
Pure seed (%, maximum)	98	98
Inert matter (%, maximum)	2	2
Huskless seeds (%, maximum)	2	2
Other crop seeds (Number of seed/kg, maximum)	10	20
Other distinguishable varieties (Number of seed/kg, maximum)	10	20
Weed seeds (Number of seed/kg, maximum)	10	20
Objectionable weed seeds (Number of seed/kg, maximum)	2	5
Seeds infected by paddy bunt (Neovossia horrida (Tak.) Padwick & Azmatulla Khan (%, maximum)	0.10	0.50
Germination (%, minimum)	80	80
Moisture content (%, maximum)	13	13
Moisture content for vapor proof container (%, maximum)	8	8

Knowledge Management Committee

Sl. No	Name	Designation	Department
Assam Agricultural University			
1	Dr. Ashok Bhattacharyya	Director	Directorate of Research (Agri.), AAU, Jorhat
2	Dr. Mrinal Saikia	Assoc. Director of Research	Directorate of Research (Agri.), AAU, Jorhat
3	Dr. Rupam Borgohain	Principal Scientist and Nodal officer	Directorate of Research (Agri.) and OPIU_AAU Jorhat
4	Dr. Debanand Das	Principal Scientist and Alternate Nodal officer	Directorate of Research (Agri.), AAU, Jorhat
5	Dr. Ranjit Kr. Saud	Assoc. Director of Extension Education (P&I)	Directorate of Extension Education, AAU, Jorhat
6	Dr. Ramani Kanta Thakuria	Principal Scientist	Horticulture Research Station, Kahikuchi, AAU, Jorhat
7	Dr. Kalyan Pathak	Professor and Head	Department of Agronomy, AAU, Jorhat
8	Dr. Kulendra Nath Das	Professor	Department of Soil Science, AAU, Jorhat
9	Dr. Bipul Deka	Principal Scientist	AICRP on Water Management, Department of Soil Science, AAU, Jorhat
10	Dr. Khagen Kurmi	Principal Scientist	AICRP on Weed Management, Department of Agronomy, AAU, Jorhat
11	Dr. Phuleshwar Nath	Senior Extension Specialist	Directorate of Extension Education, AAU, Jorhat
12	Dr.Sanjay Kumar Chetia	Chief Scientist	RARS, Titabor, AAU
13	Dr. Pulin Patgiri	Principal Scientist	AICRP on Post-Harvest Technology, Department of Agriculture Engineering, AAU, Jorhat

Sl. No	Name	Designation	Department
14	Dr. Sailen Gogoi	Principal Scientist	AICRP on Vegetables, Department of Horticulture, AAU, Jorhat
15	Dr. Surajit Kalita	Junior Scientist	Directorate of Research (Agri.)
16	Mr. Manash J Barooah	Assistant Professor	AICRP on Farm Implements and Machinery, Department of Agriculture Engineering, AAU Jorhat
17	Dr. Sundar Barman	Assistant Professor	Department of Extension Education, AAU, Jorhat
18	Mr. Apurba Das	Assistant Professor	Department of Plant Pathology, College of Sericulture, AAU, Jorhat
International Rice Research Institute			
19	Dr. Kanwar Singh	Senior Associate Scientist II - Precision Agronomist & Resident Project Coordinator	
20	Dr. Virendar Kumar Yadav	Consultant	
21	Dr. Suryakanta Khandai	Associate Scientist (Post harvest & Rice Value Chain)	
22	Ms. Suranjana Bhaswati Borah	Senior Specialist - GIS & Remote Sensing	
23	Mr. Jyoti Bikash Nath	Specialist - Agriculture Research & Development (Agriculture Extension)	
24	Mr. Vipin Kumar	Specialist - Agriculture Research & Development (Crop & Natural Resource Management)	
25	Mr. Vivek Kumar	Specialist - Agriculture Research & Development (Agriculture Extension)	
26	Dr. Lisa Mariam Varkey	Specialist: Socio-Economics	
27	Dr. Rahul Priyadarshi	Specialist - Agriculture Research & Development	
Assam Rural Infrastructure and Agricultural Services (ARIAS) Society			
28	Mr. Baljeet Singh	Market Analyst cum Operations Specialist	
29	Dr. Pranab Mahanta	Agri Adviser, APART	
Department of Agriculture, Govt. of Assam			
30	Mr. Madhuram Patiri	Nodal Officer, APART, DoA	

Seed production in Assam by a Farmer Producer Company (FPC)

Participants of seed stakeholder meeting, 2022

অসম চৰকাৰ
GOVERNMENT OF ASSAM

ARIAS Society
GOVERNMENT OF ASSAM
Assam Rural Infrastructure and Agricultural Services Society

ASSAM AGRICULTURAL UNIVERSITY
विज्ञान लोकसेवारतम
1969

CGIAR

IRRI