A Handbook of

Quality Seed Production of Stress Tolerant Rice

Manzoor H. Dar, M.A. Bari, D. Mackill & U.S. Singh
International Rice Research Institute

&

N.W. Zaidi
G.B. Pant University of Agriculture & Technology
Pantnagar, India

Published by

National Food Security Mission (NFSM)
Ministry of Agriculture & Cooperation, Government of India
Krishi Bhawan, New Delhi, India

&

Stress Tolerant Rice for Africa & South Asia (STRASA)
International Rice Research Institute
IRRI-India Office, CG Block, NASC Complex
DPS Marg, New Delhi, India

Contents

Rice is the staple food of more than 60 percent of the world population. About 90 percent of all the rice grain in the world is produced and consumed in Asia. In India alone, rice is cultivated on more than 44.6 million ha (Mha) with an average productivity of 3.0 t/ha. Often, we use the grains harvested in the previous season as seed for sowing. We are not aware of whether seeds saved from our own produce are good quality or not. Usage of seeds saved from our own produce for several generations may cause changes in varietal characteristics of seed resulting in reduced crop yield. Moreover, farmers are often required to procure seed at high cost from outside source and the quality of such seeds are not fully known. Since high quality seed is free from various diseases and has better seed health, it tends to produce healthy seedlings with no initial disease inoculums. It not only increases productivity per unit area, but also helps producing uniform crops without any admixtures. In this handbook, the process of quality seed production is discussed with special reference to stress tolerant rice. Before discussing the production practices of quality seed in detail, let us know about the seed.

What is seed?

A seed is defined as a living grain. Every seed is a grain but every grain is not a seed.

What is quality seed?

A quality seed is pure, clean and viable seed. Pure seed is without any mixture of other types or varieties whereas clean seed is free from weed seeds, litter, stones and diseased, damaged or deformed grains. Viable seed is a healthy seed with appropriate moisture content and high germination potential.

Seed quality

Seed quality means preserving and maintaining physical and genetic purity. Seed is an important and basic input for achieving higher crop yield. It is very important to maintain seed quality by understanding the right mechanism.

Why Quality Seed?

Use of quality seed is the foundation of success in rice farming. By using quality seed, the rice yield can be increased by 5-20%.

How?

- Need less seed due to high germination percentage
- Germination is high, no replanting needed
- Less weeds and use of herbicides
- Strong, uniform and pest/ disease tolerant plants
- Uniformity in maturity
- Less or no off types and mixtures
- Higher yields
- Good market price

qr In order to achieve higher seed yields, rice seed production should be undertaken in the most favourable areas where irrigation is guaranteed, and with adequate and balanced use of fertilizers together with integrated nutrient and pest management.

Steps towards Quality Seed Production

Some standardized seed production practices are described as follows;

Seed cleaning and treating

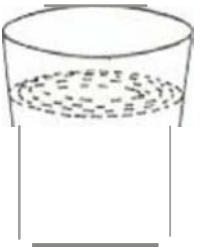
- Manual Sorting (Small quantity)
- Winnowing
- Using urea or salt solution

Cleaned and properly treated seeds prevent seed borne diseases and ensure a good harvest. Unfilled or partially filled grains, spotted or discoloured seeds, deformed, diseased or insect damaged seeds, inert material should be separated from the healthy seed by above given methods, however, mixtures of

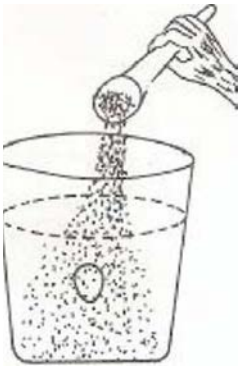
other varieties can be separated by manual sorting only. A solution of 1.5 kgs of urea in 40 litres of water may be used for seed cleaning. All the broken, unfilled and diseased seeds remain supernatant and should be removed by hands or sieves. The healthy seed from urea solution must be washed with clean water several times before drying in a shady place.

Hand sorting

Winnowing



Drop egg in water



Adding salt increases density of water and egg rises up

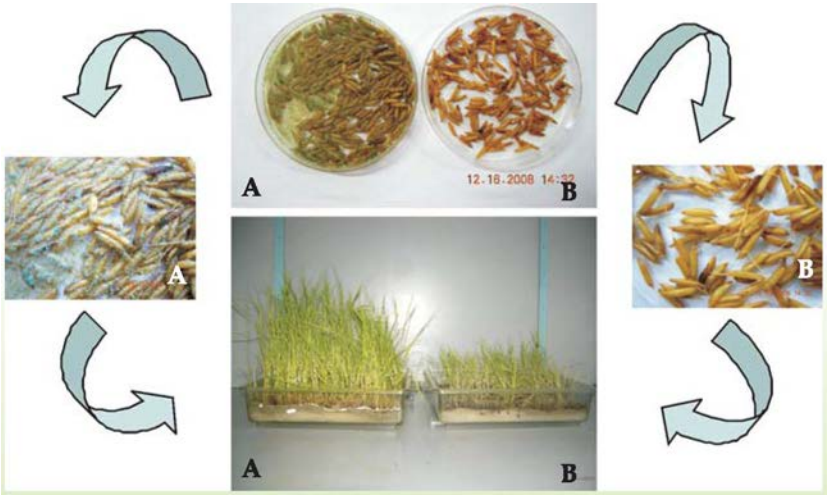
Egg reaches to top of the salt sultion

Preparation of urea/salt solution

Seed cleaning by urea/salt solution

Land selection (Nursery)

- Same variety land in preceding season
- Should permit easy and frequent inspection
- Medium fertile land
- Sunny and flood free location
- Homogenous plot
- Adequate Irrigation
- Proper drainage system



A: *Trichoderma harzianum* bio-primed rice seeds B: Normal rice seeds

Seed treatment

The seeds treated before sowing by fungicides like Carbendazim or Thiram @ 2g/kg is recommended. However, seed biopriming with *Trichoderma harzianum* and/ or *Pseudomonas fluorescens* (@5 g/kg) is an ecofriendly biological control method. For seed biopriming soak the seeds in water for 8 hours, decant water, mix with biocontrol agent and store as a heap covered with moist sack or polythene for 12-24 hours before sowing. This storage of treated seeds at high humidity allows the biocontrol agent to multiply on seed surface forming a layer all around the seed. Seed biopriming not only suppresses the seed borne diseases but also results in better seed germination and seedling growth.

Seed bed preparation and sowing

- Prepare raised seed bed about 1-1.5 m wide
- Level properly
- Keep 50 cm ally between two beds
- Timely sowing
- Treat the seed with chemical or biological fungicide
- Uniform seed sowing
- Seed sowing 5-7 hours after seed bed preparation
- 80-100 g per m^2

Rice which is to be transplanted into lowland puddled soil must first be nursed on seedbeds. The main reason for nursing rice is simple: to give

Raised seed bed

the seedlings a substantial head start on weeds. Always keep in mind that it is really very easy to raise healthy seedlings if you are prepared to take enough time to do the job properly. Success in raising healthy rice seedlings depends mainly on constant supervision of the seedbeds and proper management.

Soil preparation should always be very thorough. At least one ploughing and a careful puddling are necessary to loosen the soil as well as to facilitate the decomposition of organic matter. Work through the raised soil with your fingers, breaking up clumps and removing sticks, roots, and stones (this will facilitate uprooting the seedlings later on). Broadcast pre-germinated seed on the beds, being sure to achieve an even distribution. It is very important not to space the seeds too close, as they will crowd each other out when they begin to grow. When the seeds have been sown, smooth them over with your hands to cover with a thin layer of soil. This will help protect them against heavy rain or birds. It is extremely important to keep the beds moist at all times. Although water is usually not a problem with the wet bed, make sure to check the nursery at least twice a day. If it is not raining every day, moisten the beds morning and evening by splashing water up from the irrigation channels between the beds. The seedlings should be ready for transplanting after 14 days, depending on the variety and the conditions.

Seed sowing

An ideal seed bed

Advantages of the wet bed nursery

- Situated right in the field
- Irrigation water readily available
- Seedlings grow rapidly and easy to uproot
- Minimal disease and pest problems
- Excellent for dry season crop

It is essential to raise the nursery in a well-managed field if healthy and robust seedlings are to be obtained. Optimum seed rate should be applied and every seed must be utilized by adopting good nursery management practices. A sparse well-managed nursery gives healthy seedlings for the main field. The maintenance of the seed bed is very important.

A male farmer uprooting the seedlings

Women farmers on the job

Uprooting and Land preparation (main field)

Remember to flood the beds completely beforehand (submerge the soil, not the rice) to minimize damage to the seedlings. Uproot seedlings by holding a few at a time and pulling sideways. Always handle seedlings with extreme care. Seedlings which are handled gently during uprooting and transporting recover much more quickly when transplanted than those which are crushed, bruised, or allowed to dry out. Irrigate the field 7 days before ploughing to make soil soft and let weed and other unwanted seeds germinate. Ploughing several times followed by laddering makes field well puddled and uniformly levelled resulting homogenous stand by

receiving equal water and nutrients. It also ensures that the crop has a strong initial start over weeds.

Age of seedlings

Age of seedlings plays an important role in the growth of crop. A too young is more cumbersome to transplant and too old seedling leads to reduction of yield. Based on the duration of the varieties, the age of seedlings suitable for transplantation varies.

Varieties	Age of seedlings
• Short duration	• 13-22 days
• Medium duration	• 25-30 days
• Long duration	• 35-40 days

Transplanting

- Conventional high-yielding varieties may be transplanted after 25-30 days
- Transplant 2-3 seedlings per hill
- Do not give mixture of Zinc and Phosphorus as basal dose

Traditional transplanting

Row transplanting

Weed management

Weeds deteriorate seed quality by sharing nutrients and water with rice plants and mixing seeds. Weeds cause more yield

losses in rice field than any other pests. Transplanted crop is affected less by weeds than direct sowing method. Weeds act as alternate hosts for pests and diseases and reduce efficiency of irrigation system. Weeds grow vigorously and compete for resources. The crop weed competition varies with the type of rice culture, variety, cultural practices like plant density, fertilizer application, land preparation, time and method of planting, water management etc. Promote early vigorous plant growth by applying fertilizer in a balance and an adequate amount. Weeds can reduce rice yield varying from 20 to 80 per cent if not controlled even at early stage. However, crop damage depends upon the intensity of weeds and cultural practices adopted by the farmers. Allow to grow weeds by applying irrigation water if there is no rain. Plough the field twice at an interval of 20 days before transplanting so that the emerging weeds get incorporated well into the soil and are fully decomposed. This practice not only controls the weeds but also enhance the fertility of soil. Nicely puddling of fields at transplanting suppresses weeds effectively. In addition, make the nursery weed free. Apply well decomposed FYM and compost. Keep the water level up to 5 cm so that weed growth can be suppressed. Within three days after transplantation, herbicide butachlor@ 2.5 1per ha, mixed with 20 kg sand, should be applied to the field. Use rotary weeder from 15 DAT at 10 days interval. It saves labour for weeding, aerates the soil and root zone, prolongs the root activity, and improves the seed filling through efficient translocation of nutrients. After 30-35 days, a hand weeding is essential.

Rotary weeder

Hand weeding

- Keep weed free upto 30-40 days after transplanting
- Clean stubbles after laddering
- Keep the irrigation canals and levees free of weeds
- Keep tools and machinery clean
- Use effective weedicides like Glyphosate before transplantation
- Summer ploughing

Isolation

Isolation is the separation of a seed crop from all possible sources of contamination during the growing period and one of the main ways of maintaining varietal purity. Although rice is self pollinated crop, upto 5% cross pollination may occur due to wind or insects.

- Keep safe distance between seed production plot and nearby varieties
- Essential for varietal purity to prevent from cross pollination
- 3meters distance is compulsory for certified seed production

Isolation distance between two varieties

r:r It is better to have a small area of land for seed that is well managed than a larger area which is poorly managed.

Water Management

- Up to the third stage of panicle development: shallow (2-3 cm)

- From heading to grain filling: no shortage of water
- One week before harvesting: water drained out
- AWD (alternate wetting & drying) to maintain a mix of aerobic and anaerobic soil conditions

Since the water requirement of rice is higher than that of any other crop of a similar duration, assured and timely supply of irrigation water has a great influence on the yield of the crop. In the life cycle of rice plant there are certain critical stages like tillering and flowering, when rice crop should not be subjected to any moisture stress. Ensure enough water from panicle initiation stage to flowering (heading). Application of small quantities of water at short intervals to keep the soil saturated is more effective and economical than flooding at long intervals. The field should be irrigated or drained based on the growth stage of the crop. Too much water after the transplanting reduces the tillering ability resulting in less production. Similarly, at grain filling stage over watering deteriorate the seed quality. At tillering stage, alternate drying and wetting technique (AWD) can conserve water.

A practical way to implement AWD is to monitor the water depth in the field using the "field water tube". After an irrigation application, the field water depth will gradually decrease over time. When the water level (as measured in the tube) is 15 cm below the surface of the soil, it is time to irrigate and flood the soil with a depth of around 5 cm. Around flowering, from 1 week before to 1 week after the peak of flowering, ponded water should be kept at 5-cm depth to avoid any water stress that would result in potentially severe yield loss. The threshold of 15 cm is called "Safe AWD" as this will not cause any yield decline since the roots of the rice plants will still be able to take up water from the saturated soil and the perched water in the root zone. The field water tube helps farmers see this "hidden" source of water.

AWD irrigation can be used from a few days after transplanting (or a 10-cm-tall crop after direct seeding) till first heading. In the period of first heading to 1week after flowering, keep the

field flooded with 5-cm depth. After that, during grain filling and ripening, apply AWD again. When many weeds are present in the early stages of crop growth, the implementation of AWD can be postponed for 2-3 weeks until weeds have been suppressed by the ponded water. The potential benefits of AWD include improved rooting system, reduced lodging (because of a better root system) and periodic soil aeration.

Roguing

Purity of the Stress Tolerant Rice seed is top priority for the production of quality seed. Roguing of off-types and voluntary plants at several stages is essential for obtaining physical and genetic purity. Undesirable plants include off-types which can be identified by their morphological characters (eg. height, leaf size, leaf shape and colour, panicle shape, panicle size and pigmentation) in the late vegetative/early flowering period. Roguing at an appropriate time (flowering initiation) ensures good seed quality. Roguing is normally done from the vegetative to the flowering stage.

Off types

Roguing in Swama Subl

Off types can be identified by observing the characteristics of plants:

- taller or shorter than most of the population (main crop)
- with different colour leaves, sheath or straw
- presence or absence of awns
- angle of flag leaf

- earlier or later panicle emergence
- diseased or insect damaged plants

☞ Roguing should be done continuously over the whole growing season

Fertilizer Management

Since the seed crop requires more fertilizers than the grain crop, top dressing of nutrients is essential. After first weeding and during flowering stage, urea is applied and during milky stage, muriate of potash is applied. The dosage of fertilizer depends upon the duration of the crop. For production of bold and highly vigorous seeds, foliar nutrition plays a major role. Spraying 2% DAP results in higher seed yield with good quality seed. Depending upon the duration of the crop, the stage for DAP spray also varies.

Varieties	Days for **DAP** spray(from sowing)	
	First spray	Second spray
Short duration	60 days	80 days
Medium duration	80 days	100 days
Long duration	100 days	120 days

Disease and Pest Control

Usually preventive methods are practiced to control pests in seed production plot. The use of treated seeds, removing plants affected by diseases and balanced use of fertilizers are the major disease management practices. For important insect pests and diseases and their management, please see Annexure I.

☞ Observe proper disease and insect pest control by applying the IPM methods (see Annexure II).

Harvesting

Harvesting is the process when you cut and collect your mature crop from the field. To get the higher yield and market value, it is important to harvest the crop at the right time. Early or late harvesting will reduce the quality and quantity of the harvest. When harvesting a crop, we must pay utmost attention to ensure that the harvest produces quality and viable seed.

Women farmers harvesting paddy variety CSR 36

- When 80% of panicles turns straw colour
- Grains should not easily break (20-22 % moisture)

Early harvesting can lead to:

- Immature, less viable seed and low yield

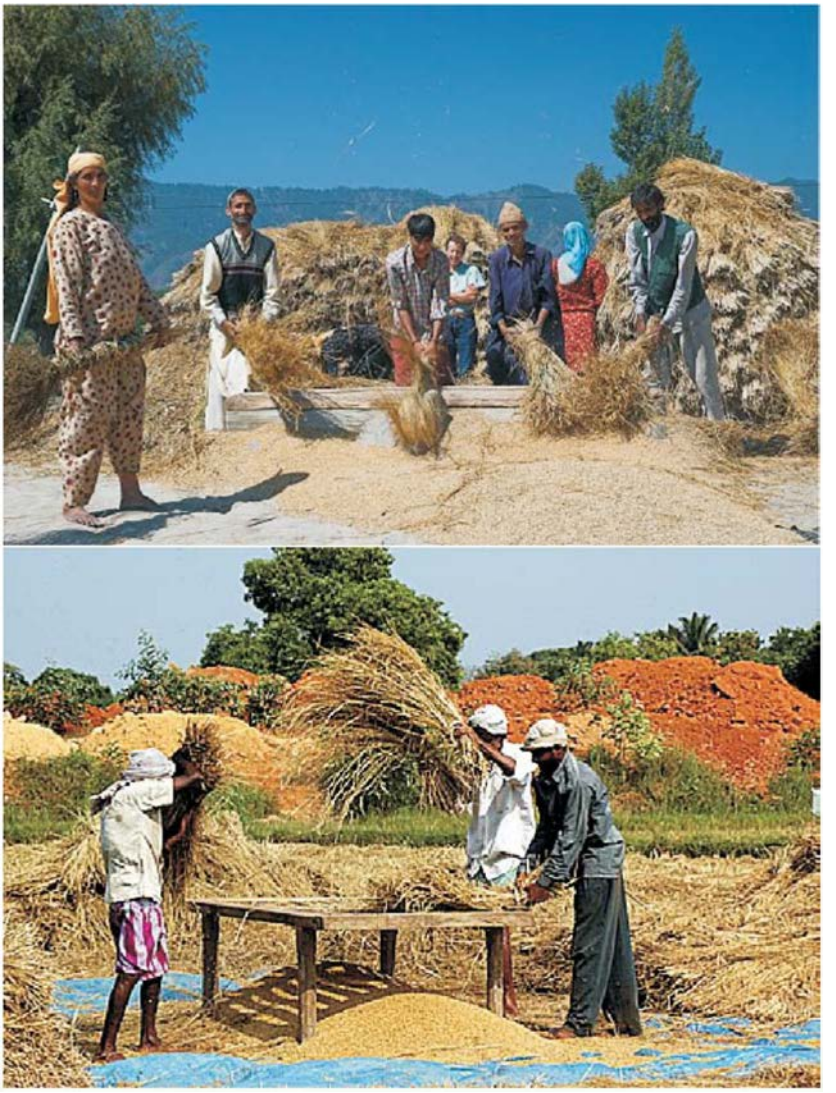
Late harvesting can lead to:

- Lodging and shattering
- Loss of aroma in scented rice
- More brittle seed
- More bird and rodent damage

<T Do a final inspection of the crop just before harvesting

Threshing

Dislodging seeds from the panicle is called threshing. It is important to thresh immediately after harvesting. During



Traditional methods of threshing

threshing care should be taken to avoid mechanical injuries on seeds. If threshing is done by beating the ear heads on stones or iron blocks, there are more chances for seed injuries. So threshing should be done on wooden blocks. The seed moisture content should be 15 to 18 per cent during threshing. If the seed moisture content is higher or lower than this level, the

chances of mechanical injuries are more. These invisible injuries may reduce seed viability and increase disease incidence on the seeds.

Delayed threshing can lead to:

- Rapid deterioration of the seed
- Growth of molds, pathogens and insects
- Seed discoloration and germination

The combine harvester has become necessary in the places where shortage of labour is a problem. In order to avoid mechanical mixtures, before and after threshing of each variety:

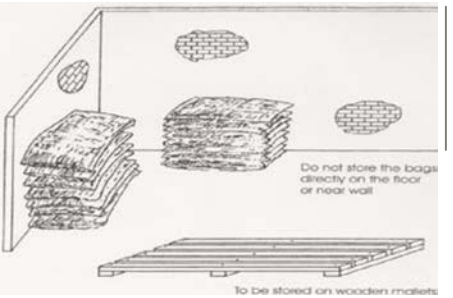
- Thoroughly clean the machine
- Remove all left over seed from nooks and crannies of the machine
- Thresh only one variety at a time
- Completely clean the threshing area

Seed being spread for drying

Mixing and turning

Drying

Seed drying is necessary to reduce the moisture content of the seed to a safe level for storage. Well dried seed retain their viability for longer periods under good storage conditions. Wet seed, on the other hand is more vulnerable to pest and disease infestation and to deterioration in physical quality. For drying, lay the seeds under the sun on a mat and spread them thinly. Mix and tum the seeds 4 to 5 times in a day. Repeat the process for about 2 to 3 days. On a hot sunny day, the seeds spread on a mat in the morning should be heaped for some time and again spread frequently to avoid sun-bum and damage of the embryo.



Seed storage method

- Dry immediately after threshing
- Dry in less humid atmosphere
- Seed life is doubled by each 1% reduction in moisture content below 14%.

Storage

The seed kept safely from season to season or harvest to marketting is called storage. The objective of the storage is to maintain seed quality. Like grains, rice seeds can not be stored immediately after threshing. Proper drying is essential before storage to maintain viability. After properly drying the seeds, clean them to remove all stones, malformed, broken, undersized and diseased seeds, weed seeds, other crop seeds, chaff and other debris. These seeds must now be stored properly. The ideal storage condition is that there is no exchange of air or moisture between the seed and the outside environment. Seeds with moisture in them become damp, moldy and vulnerable to insect attacks. Storing seeds in a cool dry environment keeps them viable for longer period. Before storage, seeds are treated with 2g/kg of Thiram. The seeds can also be treated with halogen mixture @ Sg/kg, which is non-toxic. Halogen mixture can be prepared by mixing calcium oxychloride (Bleaching powder) with calcium carbonate at 1:1 ratio, packing in an air tight container and leaving it for one week. After one week, the halogen mixture is ready for seed treatment.

IRRI Super Bag

The IRRI Super Bag is a farmer-friendly hermetic storage bag that allows cereal grains and other crops (eg, coffee) to be safely stored for extended periods. Relative to traditional storage systems, super Bags;

- extend the germination life of seed for planting from 6 to 12 months,
- control insect grain pests (without using chemicals}, and
- maintain high head rice recovery – often 10% higher than in traditional systems.

The Super bag fits as a liner inside existing storage bags (eg, woven polypropylene or jute bags). Super Bags reduce the flow of both oxygen and water between the stored grain or seed and the outside atmosphere. When properly sealed, respiration of grain and insects inside the bag reduce oxygen levels from 21% to 5%. The stability of controlled grain moisture inside the bag prevents wetting and drying of grain. This stability reduces the extent of grain cracking and so head rice recoveries are higher upon milling.

How to use

- Place the super bag inside an existing type of storage jute bags
- Fill the super bag with dried seed or grain
- Remove as much air as possible from above the grain
- Close the opening by twisting the free plastic portion above the grain and fold it in two
- Tie off the twist with a strong rubber band or adhesive tape
- Close the outer bag, taking care not to puncture the super bag
- Bags can be reused if not punctured
- Direct contact of the bags with floor should be avoided
- The bags should be placed on wooden pallets

What is dormancy?

Condition by which a viable seed is not able to germinate even under favourable conditions of soil, moisture, light and temperature is called dormancy. Normally, seed dormancy dissipates during dry storage of 30 to 45 days in the present day cultivated varieties. By the time, harvesting, threshing, cleaning and drying are completed, dormancy would have disappeared. If an unforeseen contingency of sowing fresh seeds immediately after harvest arises, mix 240 ml of nitric acid in 45 litres of water and 20 kg of seeds required for one acre is soaked in this solution for 12 hours and the seeds are washed 3-4 times in water and then used for sowing. Alternatively, seeds may be dried under sun for two or three days before sowing. This exposure to heat eliminates the dormancy.

Seed certification

It guarantees the quality of seed as it ensures that the certified seed has the genetic, physical, physiological and seed health qualities. Genetic purity means that the seed gives rise to a plant which conforms to the varietal characteristics of the variety. The physical purity means that the seed is free from stones, broken seeds, straw bits and leaf bits etc. Physiological quality is measured by germination and seed health envisages freedom from pest and diseases. Seed certification is being done at many stages. It starts from verifying whether seeds were obtained from authenticated source, verification of isolation distance and inspection during plant growth, flowering, harvesting, processing and bagging. Also seed samples are drawn from the seed lot and sent to seed testing lab to test whether the seeds possess required physical purity and germination. Then certification tag is issued. Colour of the tag is blue for certified seeds and white for the foundation seed. Only those seeds harvested from fields having prescribed field standards and possessing required seed standards are certified by the Certification Agency. Seeds thus certified are offered for sales.

Seed certification in India is not mandatory. Any farmer can multiply the seed for own use or even for sale in the market as truthful labelled (TL) seed. However, in general certified seeds are more attractive for the farmers as certification guarantees the quality. However, if a farmer or seed producer wants to get the seed certified, he has to get registered with State Seed Certification Agency in advance after paying registration fee. Representatives from seed certification agency visit the field during the crop season and based on the source of the seed used for the multiplication, crop purity and seed quality issue the certification tag.

What is Certified Seed?

The first and foremost requirement of seed certification is that seed must be of an improved variety released by either the Central or a State Varietal Release Committee for general cultivation; this is essential for the seed to be certified.

Certified seed is seed of a known variety produced under strict seed certification standards to maintain varietal purity. Seed lots must also meet specified standards for other crops, inert matter, weed seeds, and germination. Certified seed is also free of prohibited noxious weed seeds. All certified seed must pass field inspection, be conditioned by an approved seed conditioning plant, and then be sampled and pass laboratory testing before it can be sold as certified seed.

Classes of Seed

There are four classes (generations) of seed. In order of genetic purity they are breeder, foundation, registered and certified seed.

Breeder seed is directly controlled by the originating plant breeder, sponsoring institution or firm which supplies the initial source. Breeder seed production means the increase of each inbred seed stock obtained from nucleus seed in an isolated field. Breeder seed is used for the production of foundation seed.

Monitoring team for the breeder seed is generally four members' team, i.e. crop breeder, seed production breeder or maintainer, one officer from National Seed Corporation and one officer from State Seed Certification Agency where the seed is being actually produced. This team visits the field at flowering time to check the uniformity and varietal purity. Although there is no prescribed field standard for breeder seed production, however, it should be genetically pure enough to guarantee that in subsequent generations i.e. certified foundation seed class shall conform to the prescribed standard of genetic purity. Tag for breeder seed is issued by the breeder himself following the recommendation of monitoring team.

Foundation seed is obtained from breeder seed by direct increase. Foundation seed is genetically pure and is the source of registered and/ certified seed. It is produced under the control of the originator or sponsoring institution or licensee. In India foundation seed is usually produced at government farms, agriculture university farms, at experiment stations or at cultivator's fields under strict supervision of research scientists and experts from National Seed Corporation (NSC).

Registered seed is produced from foundation or other approved seed stocks. This class of seed shall be of a quality suitable for the production of certified seed. This seed is usually, but not always, one generation from foundation seed. Registered seed is usually produced by progressive farmers according to technical advice and supervision provided by NSC. Often registered seed is omitted and certified seed is produced directly from foundation seed. This is the general practice in India.

Certified seed is produced from foundation, registered, certified, or other approved seed stocks. This is so known because it is certified by State Seed Certification Agency, to be suitable for raising good crop. This seed is produced by State Seed Corporations, NSC, State Farms Corporation of India (SFCI) or private seed companies, at their own farms or at farmers' fields, according to standard seed production practices.

To be certified, seed must meet certain rigid requirements regarding purity and quality. Certified seed is available for the general distribution to the farmers for commercial crop production.

Certified seed is two generations from foundation seed. Certified seed can not be used to produce certified seed again without the approval of the state certification agency, which can approve production only under extreme conditions.

Seed certification standards

Field standards	
Rogue / off-type (Maximum)	0.2 per cent
Weed (Maximum) Red rice varieties	0.02 per cent
Seed standards	
1. Pure seed (Maximum)	98 per cent
2. Inert matter (Maximum)	2 per cent
3. Seeds without husk (Maximum)	2 per cent
4. Other crop seeds (Maximum)	20 / kg
5. Other variety seeds (Maximum)	20 / kg
6. Objectionable weed seeds (Maximum)	S / kg
7. Weed seeds (Maximum)	20 / kg
8. Germination per cent (Minimum)	80 per cent
Moisture content (Maximum)	
Moisture pervious containers	13 per cent
Moisture impervious containers	8 per cent

Characteristics and management practices of few released stress tolerant rice varieties

1) Swama Subl : A flood tolerant rice variety

Varietal characteristics

Plant height (cm)	99-105	Kernel length (mm)	5.4
Plant type	Semi dwarf	Kernel breath (mm)	2.1
No of panicle /m2	300-350	L / B ratio	2.5
Flowering duration	122 days	Kernel appearance	White
Panicle type	Compact	Hulling recovery	79.0%
Panicle exertion	Well exerted	Milling recovery	74.0%
Awning	Awnless	Head rice recovery	66.0%
Apicules colour	Green	Alkali value	5.0
1000 grain weight	20.2 g	Amylose content	25.95%

The rice variety Swama (MTU 7029) is the most popular rice varieties of the rainfed lowlands in India. It is being cultivated in approx. 6 million hectares area in different parts of the country. Swarna Subl is the flood tolerant version of Swarna and has all the characters of original Swama. The only morphological difference is the husk colour which is lighter in case of Swarna-Subl, a character preferred by the farmers.

Suitable land

Like original Swarna, Swama Sub-1 can be cultivated in shallow low lands as well as in medium lands in the kharif season.

Cultivation Practices

Depending upon type and location of the land, this variety can be direct seeded or transplanted (raising seedlings).

(a) Sowing time: May - June

(b) Transplanting: 25 to 35 days old seedlings inthe month of July.

Seed Treatment

In areas having pest/ disease problem, it is advisable to adopt seed treatment. Treat the seed with Carbendazim (@ 2gper1 kg seed) or biorpime with *Trichoderma* and/or *Pseudomonas* based formulations of biocontrol agents (@ 5 g per kg seed) before seeding.

Seed Rate

(a) For line seeding @ 60 to 70 kg per hectare and for broadcasting @ 80 kg per hectare.

(b) For transplanting @ 30-35 kg per hectare to be used in seed bed for raising seedlings.

(c) In transplanted field, it is desirable to have 35 to 40 hills per square meter.

Fertilizer Application

(a) Use required amount of organic manure/compost in the nursery as well as at the time of land preparation.

(b) Nitrogen, Phosphorus and Potash @ 60:40:40/ha is recommended for Orissa, West Bengal and Assam in India, and for other states it could be 80:40:40. Basal application of Zn is recommended@ 25 kg/ha.

(c) Apply the entire amount of Phosphorus and Potash fertilizer at the time of seeding (dry) or transplanting (basal dose). For Nitrogen, 1/3'd of the fertilizer to be used as basal dose (along with P&K). Of the remaining 2/3'd, half of it (total 1/3'd) to be applied at 45-50 days age of the crop and the remaining 1/3'd to be applied at panicle initiation (PI stage) i.e. about one week before booting stage of the crops.

Post-flood application

Application of N @ 20 kg/ha one week after the receding of flood water helps in faster recovery of the crop.

Pests

Swarna Sub1is less affected by disease and pests, compared to Swama. If required, the chemicals used for Swarna could be used for Swama Subl also (see Annex I & II)

Harvesting

- Harvest the crop at about 30 days from flowering (when 80-85% of the grains are straw-colored)
- Sun-dry the grains properly before storing

2) Sahbhagi Dhan : A drought tolerant rice variety

Varietal characteristics

Maturity group	Early (105-110 days)	Kernel length (mm)	2.13
Panicle length (cm)	22.1-25.4	L/B ratio	2.91
Hull colour (mm)	Golden	Grain type	LB
Grain length (mm)	9.09	Kernel colour	White
Grain width (mm)	2.67	Head rice recovery	64.7%
1000 grain wt (g)	22.80	yield (t/ha)	3.8-4.5
Plant height (cm)	85-90	50% flowering	75-80 days

Release of early, drought tolerant rice variety Sahbhagi dhan for bunded uplands and rainfed drought prone shallow lowlands of Jharkhand and Orissa has made it possible to reduce losses from intermittent drought while ensuring stable rice yields in a drought year. Sahbhagi dhan matures in 105-110 days in the plains of Orissa and 110-115 days in the plateaus. Depending on moisture availability and soil type, it can be direct sown or transplanted. Direct seeding in dry soil saves about 30% of water. It can be done with a zero till machine or a seed drill if they are available, or seeds can be sown behind the plough. CRURRS, Hazaribagh has developed a package of practices for successful cultivation of Sahbhagi dhan. The details are listed as follows;

Off-season ploughing

One deep ploughing at the beginning of summer months helps bury weed seeds at a depth that prevents their germination. It also helps kill insects or pathogens in the soil.

Land preparation

For dry seeding, plough the field after receipt of monsoon rain 2-3 times to get a fine tilth as the land should be properly levelled for uniform germination and crop stand. In case of transplanting, prepare seedbed during middle of June to early July.

Seed priming

Seed priming can also be done by soaking seeds in water or a solution containing seed invigorators or fungicides. Please see the decision tree to select suitable crop establishment method.

Crop establishment

In case of dry seeding, sow the seeds 20 cm apart in rows either by seed drill or behind the plough with a seed rate of 80 kg/ha. In transplanted crop, plant twenty five days old

seedlings in 20cm x 15 cm spacing with 2-3 seedlings/hill. In wet seeding, dibble sprouted seeds (soaked in water for 24 hours and incubated for 48 hours) using drum seeder or manually by July 15 with a seed rate of 60 kg/ha.

Fertilizer management

Follow soil test-based fertilizer recommendation for best results. In the absence of it, apply 30 kg P_2O_5 and 20 kg K_2O at final land preparation. Compact the soil by laddering or wooden planks to conserve moisture before sowing. Apply 60 kg N in 3 splits at basal, 3 and 7 weeks after sowing.

In case of transplanted crop, apply N at 60 kg/ha in 3 splits; *1h* as basal and the rest in two splits at 3 weeks and P.I. stage. If *Sesbania* green manuring is done, first dose of N could be reduced by 10 kg/ha.

Weed management

Cultural methods to manage weeds can begin early if pre-monsoon showers allow 1-2 ploughings. Allow first flush of weeds to germinate which can be ploughed down at final land preparation. For herbicidal weed control, apply Butachlor at l.5kg/ha or Pretilachlor at 800g/ha or Pyrazosulfuron ethyl at 20g/ha in a thin film of water in transplanted rice field at 3 – 6 days after transplanting (DAT). It can be done either by spraying or broadcasting granules or even by mixing EC formulations with sand @ 50 kg/ha and then broadcasting the same. Pre-emergence application of butachlor (3 – 5 days after sowing) @ l.25kg/ha or Pretilachlor @ 800g/ha in moist surface soil effectively controls the first thrust of grassy weeds and sedges in direct seeded rice. Chemical weed control should be followed by mechanical weeding or light manual weeding before topdressing nitrogen.

Plant protection

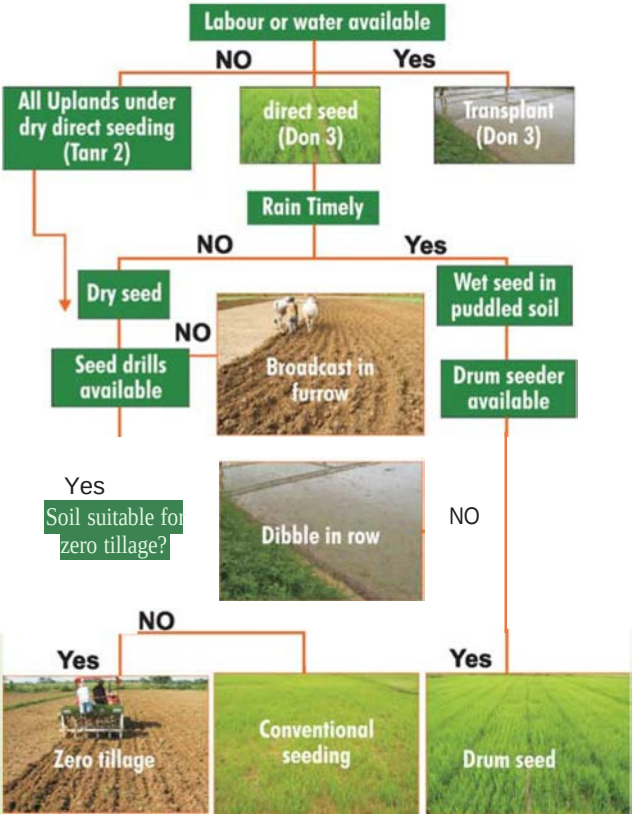
Need-based application of insecticides/fungicides may be taken up under epiphytotic conditions.

Harvesting

Harvest the crop when 75-80% of the grains are mature.

Grain yield of Sahbhagi dhan ranges from 4-5 tons/ha in direct seeded/transplanted conditions when the crop establishment is timely and the crop is moderately fertilized. Nitrogen may be top dressed when soil moisture is adequate and weeding is done. Sahbhagi Dhan tolerates intermittent dry spells better but it may not tolerate cold as well as others, hence very late transplanting is not advised. It is also not suitable for boro cultivation.

Rainfed rice crop establishment
in drought prone upper toposequences:
decision tree



3) CSR 36 : A salinity tolerant rice variety

Varietal characteristics

Parentage	CSR13/Panvel 2/IR36
Recommended ecology	For sodic soils of Haryana, U.P. and Pondicherry
Plant height	Intermediate plant type (115-120 cm)
Maturity (50% Flowering)	100-105 days
Seed to seed	130-135 days
Tillering	Medium (10-19 tillers/plant)
Culm Strength	Strong culm (Non lodging type)
Panicle Exertion	Well Exerted
Threshability	Intermediate non shattering type
Phenotypic Acceptability	Excellent under normal and deteriorated salt affected soils.
Spikelet Sterility	Fertile under normal conditions while less than 15%sterile spikelets mainly on tips are recorded under very high salt stress conditions.
Grain Yield	Under moderate deteriorated salt affected soils, it ranges from 4.0-5.0 t/ha.
Salt Injury	Growth nearly normal but there is some reduction in tillering and plant height. Negligible tip burning is noticed.
Panicle Type	Compact and droopy
Awning	Absent
Stigma Colour	White
Brown Rice	Length–Long Type (6.76 -7.66 mm) Shape- Slender (L/B over 3.2)

Seed coat colour	White
Salt stress adaptability	Sadie (pH 2-10)
Disease/ insect pest incidence	Resistant to tungro disease and sheath rot. Moderate resistance to blast, bacterial blight, green leaf hopper, white backed plant hopper and leaf folder

Management practices

Same as other high yielding varieties except for the following in sodic soils:

- Nitrogen dose higher (150 kg per hectare).
- Seed rate 20% more.
- Spacing 15x15 cm.

Characteristics of some stress tolerant rice varieties which are in the process of release or at advanced stage of evaluation

i. Submergence tolerant

Name

IR64-Subl
(IR07F102)

Characteristics

Days to flowering (50%) = 100-103
Days to maturity = 129-132
Plant height = 90-95 cm
Amylose = 22%
Gel consistency = 75 (soft)

Samba Mahsuri-Subl(IR07F101)

Days to flowering (50%) = 116-120
Days to maturity = 136-140
Plant height= 101-107 cm
Amylose = 25%
Gel consistency = 33 (hard)

CR1009-Subl (IR07F91)

Days to flowering (50%) = 131-133
Days to maturity = 161-163
Plant height= 112-120 cm
Amylose = 25%
Gel consistency = 90 (soft)

Pest and Disease Management

SI. No	Disease/ Insect pest	Management Practices
1.	Brown leaf spot *Cochliobolus miyabeanus*	• Balanced application of NPK • Seed treatment followed by foliar application of fungicides like Mancozeb / copper oxychloride (2.5 g/kg seed or 2.5 kg/ha) or Carboxin (1 g/kg sed or 2.5 kg/ha) both in nursery and also in field after appearance of disease or Seed biopriming (5 g/kg) and spray (5 g/l) of *Trichoderma harzianum* and/ or *Pseudomonas fluorescens* based formulations (3-4 sprays at weekly interval)
2.	**Sheath Blight Complex** *Rhizoctonia solani R. oryzae* and *R. oryzae-sativae*	• Balanced application of NPK • Avoid excessive use of nitrogenous fertilizer • Two sprays of Propiconazol or Carbendazim (@ 1 kg or 11/ha) at 10 days interval beginning at symptom appearance or Spray of *Trichoderma harzianum* and/ or *Pseudomonas fluorescens* based formulations (@ 5 g/l; 3-4 sprays at weekly interval)
3.	**Blast of rice** *Magnaporthe grisea*	• Balanced use of NPK Avoid excessive use of N • Spray of *Trichoderma harzianum* and/ or *Pseudomonas fluorescens* based formulations (3-4 sprays at weekly interval) or

	• Two sprays of of Propiconazol or Carbendazim (1 kg or 1l/ha) at 10 days interval beginning at symptom appearance
4. **Sheath Rot** *Sarocladium oryzae*	• Burning of infected stubbles • Two sprays of Propiconazol or Carbendazim (1 kg or 1l/ha) at 10 days interval beginning at symptom appearance or Spray of *Trichoderma harzianum* and/ or *Pseudomonas fluorescens* based formulations (3-4 sprays at weekly interval)
5. **Bacterial Leaf Blight** *Xanthomonas oryzae* pv. *oryzae*	• Avoid over use of nitrogen fertilizer • Avoidance shade and water stagnation in field • Spray of Streptocycline + Blitox -30 (6 g + 2 Kg/ha) in infected patch and surrounding area subject to symptom appearance.
6. **Yellow stem borer** – *Scirpophaga incertulus*	• Collection and destruction of egg masses & adult moths • Perching for insectivorous birds • Burning or ploughing down of T. Aman stubbles • Use pheromone traps (20 traps/ ha; 5 mg pheromone per lure; 20 x 25 m distance). Replace lure after 30 days. • 3 to 4 releases of *Trichogramma japonicum* (150000 parasitoids/ha) in case of severe attack. Need based • Spray of fipronil (50 g a.i. per ha). Need based

7.	**Rice Cutworm** *Mythimnapseudaletia*	• Establish nursery away from weeds and grasses. • Remove weeds from areas close to the field. • Plough all fallow lands, Dust BHC 10% at 20 kg/ha or spray Chlorpyriphos or Monocrotophos at0.05%.*
8.	**Leaf roller** *Cnaphalocrocismedinalis*	• Split nitrogenous fertilizer application • Higher infestation occurs where the field is shaded by trees. Remove grassy weeds from the field and surrounding areas. Spray • Monocrotophos at 0.05%.*
9.	**Gall midge** Orseolia oryzae	• Adopt seedling root dip technique with 0.02% Chlorpyriphos. Remove grassy weeds. • Plough field after harvest. • Keep fallow land free of off-season plants. • Complete planting as early as possible. • Use only moderate amount of N_2 in split applications. * Apply Carbofuran (0.75 kg ai/ha)
10	**Brown plant hopper** *Nilaparavata lugens*	• Light trapping • Using wider plant spacing • Draining out of water • Avoidance of top dressing of N fertilizer in endemic areas • Need based spray of imidacloprid @ 25 g a.i. /ha or fipronil @ 50 a.i. /ha. Spraying should be directed towards basal part of the plants. Fipronil (50 g a.i. per ha) is also effective against stem borer

11. **Rice Gundhi bug** *Leptocorizaacuta*	• Eliminate grassy weeds from rice fields and surrounding areas. • Adopt clean cultivation • Dust BHC 10% @ 25 ka/ha or One spray of neem seed kernel extract (5%). To prepare this soak 12.5 kg neem seed kernel overnight in 25 1 water, filter it, add 500 g detergent power and suspend in 250 1 water for spray in 1 ha area.
12. **Rice hispa** *Dicladispa armigera*	• Adopt clean cultivation • clip off leaf tips at the time of transplanting; dust 5% BHC • Cultivation of tolerant varieties

IPM Module for rice

Major Problems:

Panicle blast, brown spot, sheath rot, sheath blight, stem borer, leaf folder, plant hoppers.

Treatments:

- Recommended dosage of NPK.
- Avoid overuse of N fertilizer.

In nursery

- Seed biopriming with PsF (@5g per kg).
- Apply one pheromone trap for stem borer per 100 m^2 nursery area.
- Release *Trichogramma japonicum* or *T. chilonis* (150000 parasitoids /ha).

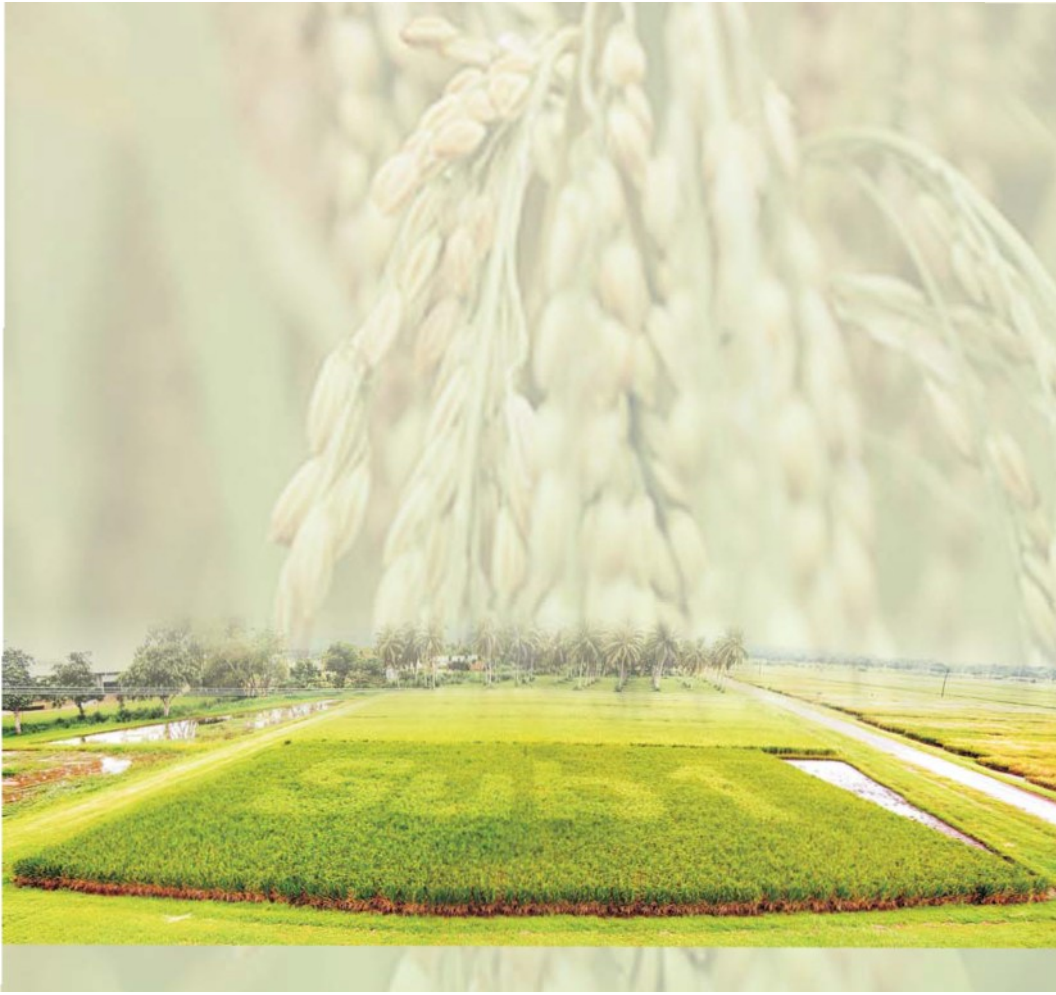
During transplanting

- Drenching of PsF (5 g/ m^2) in nursery soil one day before uprooting of seedlings.
- Do not plant under full or partial shade to avoid bacterial blight (BLB). Once BLB attacks plants in shade these plants become source of inoculum for remaining field.
- Transplant 2 to 3 seedlings.
- Follow proper row to row and plant to plant spacing.
- Apply herbicide to manage weeds.

After transplanting till maturity

- Use pheromone traps (20 traps/ha; 5 mg pheromone per lure; 20 x 25 m distance). Replace lure after 30 days.
- 3 to 4 releases of *Trichogramma japonicum* (150000 parasitoids/ha) in case of severe attack. Need based.
- Drain off water to check spread of sheath blight and bacterial blight

- Two sprays of PsF + TH (5g/1) or Propiconazol/ Carbendazim (lg/I), at 10 days interval, beginning at symptoms appearance, for sheath blight, sheath rot and neck blast. Need based.
- Spray of Streptocycline + Blitox 30 (6 g + 2 kg/ha) against bacterial blight in infected patch and surrounding area subject to symptom appearance. Need based
- If BPH incidence is observed spray imidacloprid @ 25 g a.i. /ha (100 ml Confidor or Tatamida per ha) or fipronil @ 50 a.i. /ha (Regent 5 SC 11per ha). Spraying should be directed towards basal part of the plants. Fipronil is also effective against stem borer. Need based.
- For rice bug 1spray of neem seed kernel extract (5%). To prepare this soak 12.5 kg neem seed kernel overnight in 25 1water, filter it, add 500 g detergent powder and suspend in 250 1water for spray in 1ha area.



Rice Science : for a Better World