

## Azolla as a Green Gold Mine in Agriculture

U. Kumar

- *Azolla* is an aquatic fern that grows on the surface of water. Do you know *Azolla* leaves have some cavities that contain another organism known as cyanobacteria?
- These cyanobacteria get a secure place to live. In return, they provide essential nutrition to *Azolla* by fixing atmospheric nitrogen. This association helps to fix 1100 kg of nitrogen per hectare per year, which is higher than any other biofertilizers.
- Since nitrogen is necessary for all plants to produce their food, *Azolla* serves as a potential biofertilizer in agricultural crops, including rice. The use of *Azolla* helps us to minimize the application of chemical fertilizer. The fast growth rate and high nutritional value of *Azolla* also make it a suitable and sustainable livestock feed.
- ICAR-NRRI, Cuttack, is maintaining 102 strains of *Azolla* germplasms, probably the highest collection in the world. *Azolla* is really a “Green Gold Mine” because of its vast importance in bio-fertilizer, compost, livestock feed, heavy metals bio-accumulator, wastewater treatments, bio-fuel, etc.



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## Know Your Rice



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## Nucleus Seed Production of Rice

**R. K. Sahu**

- Nucleus seed refers to the seed produced by the breeder who developed the particular variety or any other breeder of the institute where the variety was developed.
- This is the initial seed of a particular variety used for the purpose of maintenance by the originating breeder and its further multiplication under his own supervision or the supervision of a qualified plant breeder in the same institute.
- Nucleus seed has 100% genetic & physical purity and high standards of all other quality parameters.
- Nucleus seed is multiplied and maintained by selecting individual panicles and growing individual panicle progenies row. This process is repeated continuously.



## High Protein Rice

**K. Chattopadhyaya**

- Many people satiate their hunger with only rice and do not get enough protein through their diet. White rice grain contains only 5-6% of protein.
- With that in mind, NRRI scientists have developed and released the country's first high protein rice variety, CR Dhan 310. It has almost 2 times more protein ((10.3%)) than regular rice varieties.
- Additionally, CR Dhan 311, a rice variety with high protein (10.1%) and moderately high zinc content (20 ppm), has also been released.
- Both the rice varieties can offer more nutritional value and contribute towards the better nourishment of millions of underprivileged children in India. Moreover, these rice varieties can also be used by the food processing industry for higher nutrition.



## Super Rice with >10 tons/ha Yield

**S. K. Dash**

- After the Green revolution, a yield ceiling of grain yield, i.e., around 6.0 tons/ha, is mostly reported in semi-dwarf inbred *indicas* in irrigated ecology.
- At ICAR-NRRI, we are in the process of developing super rice varieties/hybrids with a yield potential of 10 ton/ha either through inbreds or hybrid approach.
- This is being done based on the idealized plant type concept, through modification of plant architecture with higher photosynthetic efficiency for very high grain yield (>10 tons/Ha) for favourable land.
- The traits includes heavy panicle ( $\geq 5.0g$ ) with higher number of grains/panicle (250-300), higher biomass achieved through erect long and wide top three leaves, higher culm strength to support heavy panicles, moderately high effective tillers (8-10) in transplanted condition, higher grain fertility (90%) along with sufficient field tolerance to major diseases and pests with acceptable grain quality.



## Open Top Chambers (OTC) for Climate Studies

**K. Chakraborty**

- Open Top Chambers are field chambers with CO<sub>2</sub> and temperature elevation facilities to simulate near natural conditions to study the crop responses to changing climatic conditions.
- It is a fully automated system with CO<sub>2</sub>, temperature and humidity sensors with data logger and real time monitoring facility.
- Here we can elevate the CO<sub>2</sub> level up to 2000 ppm as against 400 ppm in normal air. Temperature can be elevated up to 3.5 degrees above ambient condition with the help of ceramic heater fitted inside.



## Submergence Tolerant Rice

*K. Chakraborty*

- Field submergence tanks are facilities to evaluate potentiality of rice plants to tolerate or withstand stresses imposed due to water stagnation.
- In case of complete submergence, the whole plants remain under water for several days leading to a completely anoxic condition for plant growth and metabolism. Although most of the rice varieties die after 4-5 days of complete submergence, there are few varieties which can withstand even 14 days of complete submergence.
- NRRI has released several rice genotypes that are tolerant to complete submergence viz., Tulasi, CR Dhan 505, CR Dhan 801, CR Dhan 802.



## Growing Rice Organically

*D. Bhaduri*

- To reduce the load on the environment by excess use of chemicals and to maintain the sustainability of rice production and soil health, this experiment carefully follows the approach of “no fertilizers-no pesticides.”
- Nutrients in the soil are being supplied through organic sources like farmyard manure, green manure, Azolla, and vermicompost.
- As organic rice and food products are high in demand, it can increase farmer's income. Moreover, the cost of cultivation through organic farming can be reduced by emphasizing more on low input agriculture. In the future, this should be a model field of ‘Zero Pollution.’



## Rice Under Low Light Intensity

*M. J. Baig*

- Eastern and northeastern India are the major rice-growing regions of our country. Still, productivity is the lowest in comparison to other areas of the country.
- The low incidence of solar radiation and fluctuating light due to cloudy sky during the wet season are the major reasons for the low productivity.
- By creating an artificial shade environment, we are selecting rice plants that show better productivity under low light. We are also studying the underlying mechanism on how they perform better than other rice plants.



## Management Practices for Improving Grain Quality of Rice

*A. Poonam*

- Micronutrients are essential mineral elements required for both plant and human development. However, micronutrients are often lacking in soils, crop, and food.
- Biofortification is a promising, cost-effective, and sustainable technique of delivering micronutrients to a population that has limited access to diverse diets and other micronutrient interventions.
- Agronomic biofortification is considered as a solution to complement genetic biofortification (breeding) for increasing the micronutrient content in the grain with sustainable approach.
- Micronutrients like zinc, iron, boron, selenium, and sulfur in rice grain can be improved through different fertilization approaches either in combination with macronutrient i.e., NPK or integrated soil fertility management.
- The combined application of organic inputs and mineral micro-nutrient has the potential to alleviate overall micronutrient deficiency in the soil with enhanced bioavailability thereby improving the nutritional quality of crop.





## Drought Tolerant Rice

*P. Swain*

- Most rice varieties are severely affected by abiotic stresses. Among several abiotic stresses, water deficit/drought is an important abiotic stress posing a widespread challenge to sustainable agriculture.
- Out of 43.2 million ha rice growing area in India, around 7.4 million ha of rainfed upland and rainfed lowland are drought prone, which happens due to irregularities in South-west monsoon and erratic rainfall pattern.
- At ICAR-NRRI, we have identified more than 50 promising rice genotypes that are tolerant to drought at different stages of the crop by screening more than 10,000 germplasm lines and studying the physiological mechanism responsible for tolerance to water deficit.



## Integrated Farming System

*P. K. Nayak*

- Integrated Farming System (IFS) is a mixed farming with combinations of crops, animals and related subsidiary enterprises to maximize the nutrients utilization and reducing the impact of these enterprises on environmental degradation.
- It reduces the use of chemical fertilizer and pesticides, utilizes the farm by-product and wastes, and enhances the farm biodiversity, soil health, energy use efficiency and farm productivity with reduction of weed and pest incidences and greenhouse gas emissions.
- Overall, IFS provides production sustainability, nutritional, economic, employment and environmental security to the farmers.
- At NRRI, we have developed Rice-fish-horticultural crops-livestock based integrated farming system for rainfed lowland farmers.



## Doubling Production with Maudamani Rice Variety

*S. K. Pradhan*

- Maudamani (CR Dhan 307) is a very high yielding variety producing upto 11 ton/ha.
- This is suitable for irrigated ecology. Maturity duration is 135 days. It has tolerance to many insect pests and diseases.
- The high yield is due to presence of yield components QTLs namely Gn1a, OsSPL14, Gw2, GIF1 & SCM2.
- It is suitable for mechanical harvesting due to its strong culm and resistance to lodging.

## Conservation Agriculture

*Md Shahid*

- Conservation Agriculture (CA) is defined as a sustainable agriculture production system comprising a set of farming practices adapted to the requirements of crops and local conditions of each region.
- The farming and soil management techniques protect the soil from erosion and degradation, improve its quality and biodiversity, and contribute to the preservation of the natural resources, water and air, while optimizing yields.
- At ICAR-NRRI, we are developing site specific resource conservation technologies and quantifying the effect of CA on crop productivity, soil and crop health, carbon sequestration and greenhouse gas emission.

## Rice Crop Cafeteria

*R. P. Sah*

- A rice crop cafeteria is the demonstration of identified efficient rice varieties in an agro-metrological region offering an opportunity to the farmer to choose a suitable crop.
- In NRRI rice crop cafeteria, 52 varieties are being grown with a crop duration ranging from 110-150 days. Apart from farmers, scientists are also using these varieties in their crossing programmes.
- Every year thousands of farmers and curious student like you visit our Crop cafeteria. In this way, we disseminate our technology and varietal information.

## Low Light Tolerance in Rice

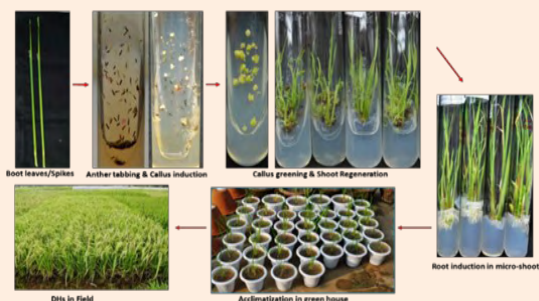
*L. Behera*

- Low light intensity due to cloudy sky in the rainy season causes about a 35% reduction in rice yield in the eastern and northeastern regions of India.
- NRRI scientists have identified few rice genotypes, Purnendu, Swarnaprabha, VLdhan 209, Sashi, Laldhan, Barhabalidhan, Chamarmani, and Santhi, which are less affected by low light intensity.
- Most of the characters are controlled by specific regions of the DNA of an organism. Scientists at NRRI have studied the genetic regions that control or help the rice plant to survive well under low light conditions and found that eight genetic regions are associated with grain yield and related traits under low light conditions.
- Identification of these regions is benefiting scientists to develop high-yielding rice varieties suitable for the low light regions of India.

## Doubled Haploid in Rice Improvement

*S. Samantaray*

- Doubled haploids (DH) are the diploid lines which are obtained by doubling the chromosome number of a haploid line. Doubled haploids are completely homozygous lines that can be produced in both self-pollinated and cross-pollinated species.
- This is a rapid method of producing pure lines. The pure lines can be produced from a heterozygous parent in one generation. The development of pure lines or inbred lines by conventional methods takes 3-5 years. Doubled haploids are homozygous and homogeneous populations, and hence, their produce is highly uniform.
- Anther culture is one of the most efficient techniques to produce doubled haploids in rice.



## Agrometeorological Observatory

*B. S. Satapathy*

- Agromet Observatory located at the farm of ICAR-National Rice Research Institute comes under the B Class category and covers in an area of 60x40 sq meter. The observatory has the following agromet instruments to record different weather variables on a daily basis. Instruments are installed in a descending order of height from north to south keeping the stuffiest space between them.
- **Sunshine Recorder** (Campbell strokes type)- measures daily sunshine hours; **Wind Vane**- measures the direction of the wind flow; **Cup Counter Anemometer**- measures wind speed (km/hr); **Stevenson screen**- Dry bulb, Wet bulb, Minimum thermometer and Maximum thermometer are accommodated inside the box; **Maximum and Minimum thermometer**- records minimum and maximum air temperature; **Wet bulb and Dry bulb thermometers**- helps in measuring the relative humidity of the atmosphere; **Soil thermometers**- to measure soil temperature at different depths; **Rain gauge**- to measure rainfall
- **USDA Open Pan Evaporimeter**- to measure evaporation



## DUS Testing

*B. C. Patra*

- DUS testing is a way of determining whether a newly bred variety differs from existing varieties within the same species (the **Distinctness** part), whether the characteristics used to establish Distinctness are expressed uniformly (the **Uniformity** part) and that these characteristics do not change over subsequent generations (the **Stability** part).
- DUS testing is useful for identification of varieties, registration of varieties, and for plant variety protection (PVP) Act, for varietal information system and classification of varieties into different groups, and for genetic resources.
- For a DUS test, over two successive growing seasons, a number of morphological characteristics are recorded both on the new (or candidate) variety and on check varieties.

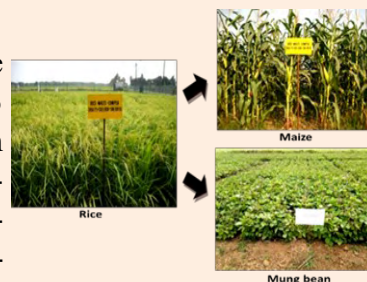




## Ecological Intensification of Rice-based Cropping Systems

**B. B. Panda**

- Ecological intensification (EI) is the process of improving both yields and environmental performance of crop production with a focus on precise management of all production factors and maintenance or improvement of soil quality
- Although management practices are available for individual crops, farmers cultivate 2 to 3 crops that have carryover effects upon each other in a single year. Therefore, NRRI developed cropping system based management practices to reduce the cost of cultivation and increase the productivity and profitability of rice-maize and rice-green gram cropping system following zero tillage, direct seeding, residue mulching and optimal nutrient management.
- An effort has also been made to improve the productivity of the system through introduction of short-duration varieties and proper phosphorus management in rainfed conditions and bring back the fallow areas under cultivation.



## NRRI Rice Gene Bank

**B. C. Marandi**

- In the gene bank, seeds are stored to preserve genetic diversity and make them available to the public when there is a need.
- Gene banks are extremely valuable to allow faster recovery from any natural disaster, which may cause a huge loss of biodiversity. At NRRI, Gene bank facility is created for medium term storage (MTS) and the seeds are kept viable for 6-8 years.
- The seeds of each of the accessions to be stored are dried to reduce the moisture content upto 10-12% and kept in 3-layered aluminium foil pouches for MTS at  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$  &  $33\% \pm 5\%$  relative humidity.
- We have more than 12000 germplasm accessions stored at our gene bank.



## Quality Rice for Better Nutrition and Profitability

**S. Sarkar**

- Aromatic rices are rated best in quality and fetch much higher price than high quality non-aromatic rice in international market thus making an important commercial commodity.
- At ICAR-NRRI, we are working towards improving the aroma, nutrition and grain quality aspects of rice which are directly related to higher profitability of farmers.
- Most of the aromatic varieties are tall which easily fall to the ground leading to huge yield loss of this high valued commodity. Our institute is developing shorter versions of the popular aromatic varieties of this zone like Gobindbhog, Banspatri, etc. while improving their yield potential.
- Black rice is one of the promising and emerging areas of research due to their high antioxidant content restricts the growth of cancerous cells in the body. Due to the medicinal property black rice fetches 10 times higher price in market, giving better returns to its producers. Moreover, inclusion of such rice in our diet will help to reduce the incidence of cancer in our nation.



## Hybrid Rice

**R. L. Verma**

- Usually, in rice plants, pollen from the male reproductive organ arrives at the female organ of a flower of the same plant. But, hybrid rice is developed by artificially transferring pollen from one rice plant to the female reproductive organ of a distinct rice plant.
- Hybrid rice is the first generation (F1) product of the cross-pollination of two genetically different parents. They are 15-25% superior in physical health and yield over their parental lines.
- In India, so far, 105 rice hybrid varieties have been released for cultivation, which contributes ~ 4.5 million tons of additional rice to the food basket in the country. ICAR-NRRI, Cuttack, has released three popular rice hybrids, Ajay (matures in 125-130days), Rajalaxmi (125-130 days), and CR Dhan 701 (145 days).

