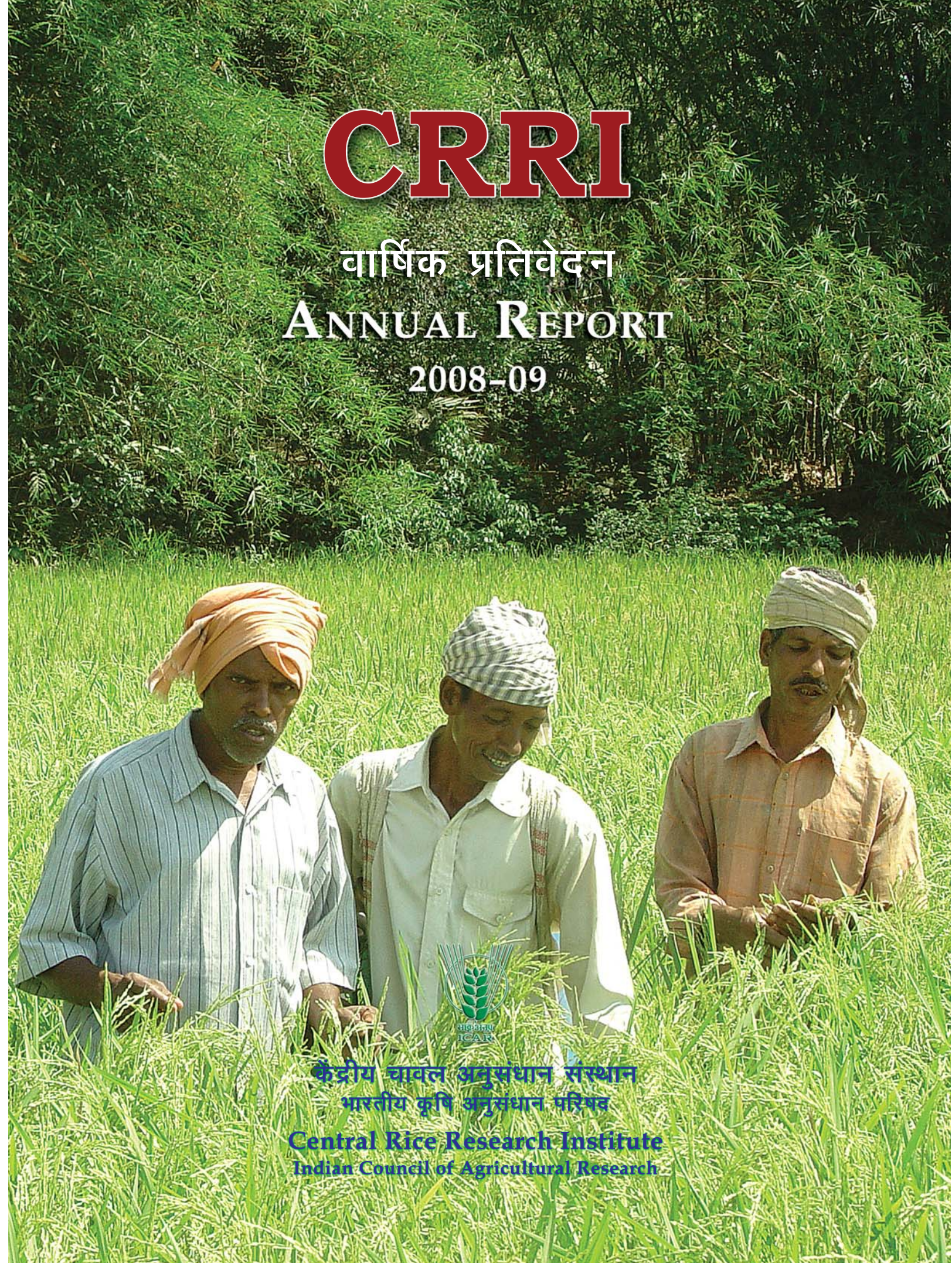
CRRI

वार्षिक प्रतिवेदन

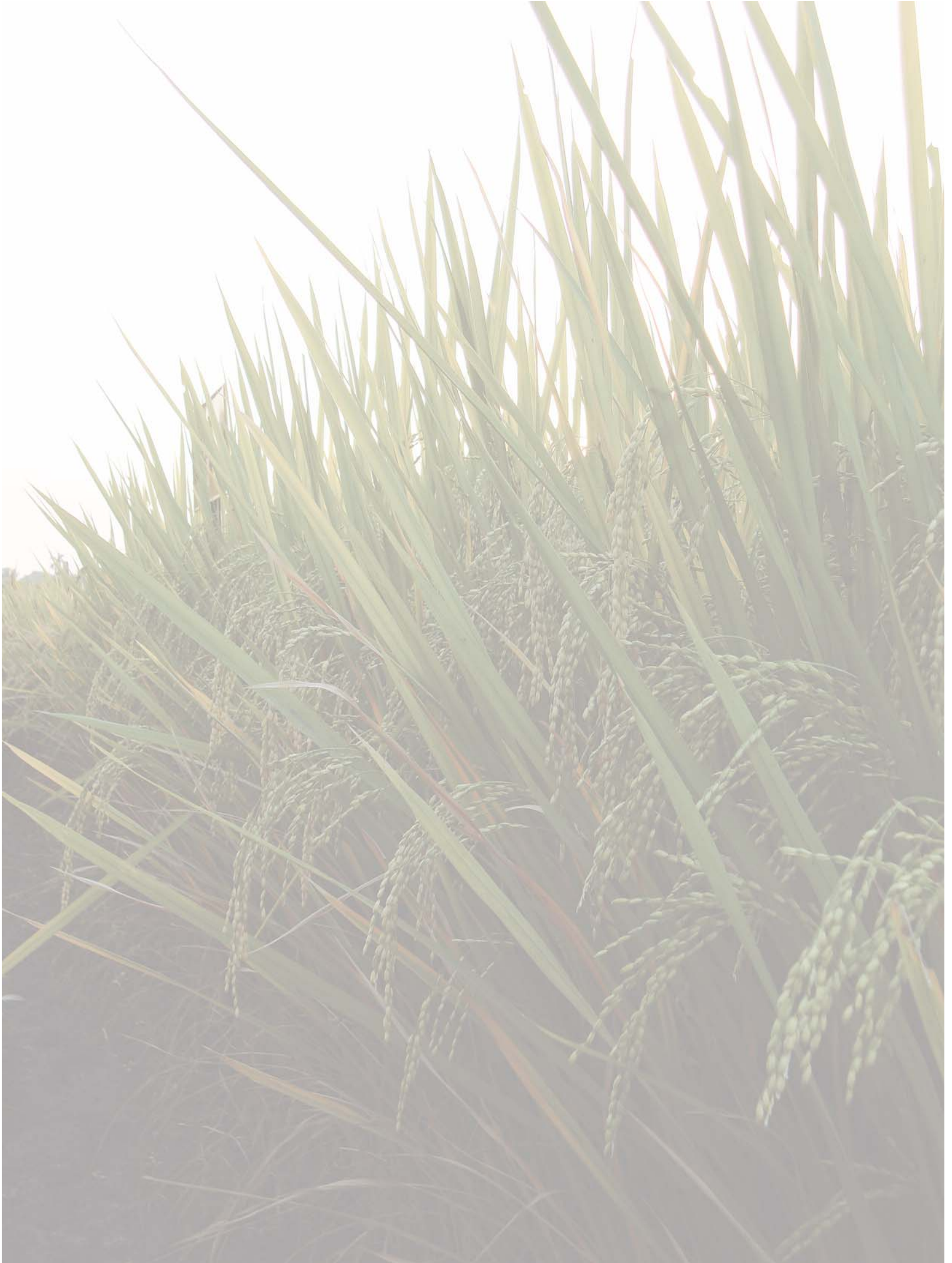
ANNUAL REPORT

2008-09



केंद्रीय चावल अनुसंधान संस्थान
भारतीय कृषि अनुसंधान परिषद

Central Rice Research Institute
Indian Council of Agricultural Research



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भाकृअनुप
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केंद्रीय चावल अनुसंधान संस्थान

भारतीय कृषि अनुसंधान परिषद

कटक (उड़ीसा) ७५३ ००६, भारत

Central Rice Research Institute

Indian Council of Agricultural Research

Cuttack (Orissa) 753 006, India

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Cover 1, 4: Farmers in village Pubapada of Jagatsinghpur district of Orissa examine their luxuriant crop of rice Naveen. They had adopted the environmentally-friendly CRRI technology of using botanical extract from bael against blast, and also the production technologies suggested by the CRRI. (Photo: Ravi Viswanathan)

Cover 3: Activities at CRRI. From top: Open top chambers at the CRRI are used to simulate the effect of climatic changes on rice productivity, soil nutrients transformation and structural and functional biodiversity of soil microorganisms; rice double haploids plants; screening of transgenic lines, the microbiology laboratory; botanical products under screening in the laboratory of natural plant products; a view of the library; the oryza museum; and the transgenic greenhouse. (Photos: Ravi Viswanathan)

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Preface

GLOBAL climatic changes have started impacting Indian agriculture by changing the method of cultivation in *kharif* (wet season) and *rabi* (dry season). The CRRI during the past few years has been reorienting its research programmes to ameliorate the hardships of the farmers by taking into account the rapidly changing climatic effects.

During the year the CRRI has evolved new rice varieties such as new plant types, and rice varieties for challenging ecosystems using state-of-the-art techniques . One of the techniques is the use of gene pyramiding using marker-assisted backcross breeding. This involved the incorporation of the bacterial blight resistance gene to develop varieties that can withstand the bacterial blight in endemic areas. Another technique involved the incorporation of the submergence gene *Sub1* in rice varieties to impart tolerance to submergence.

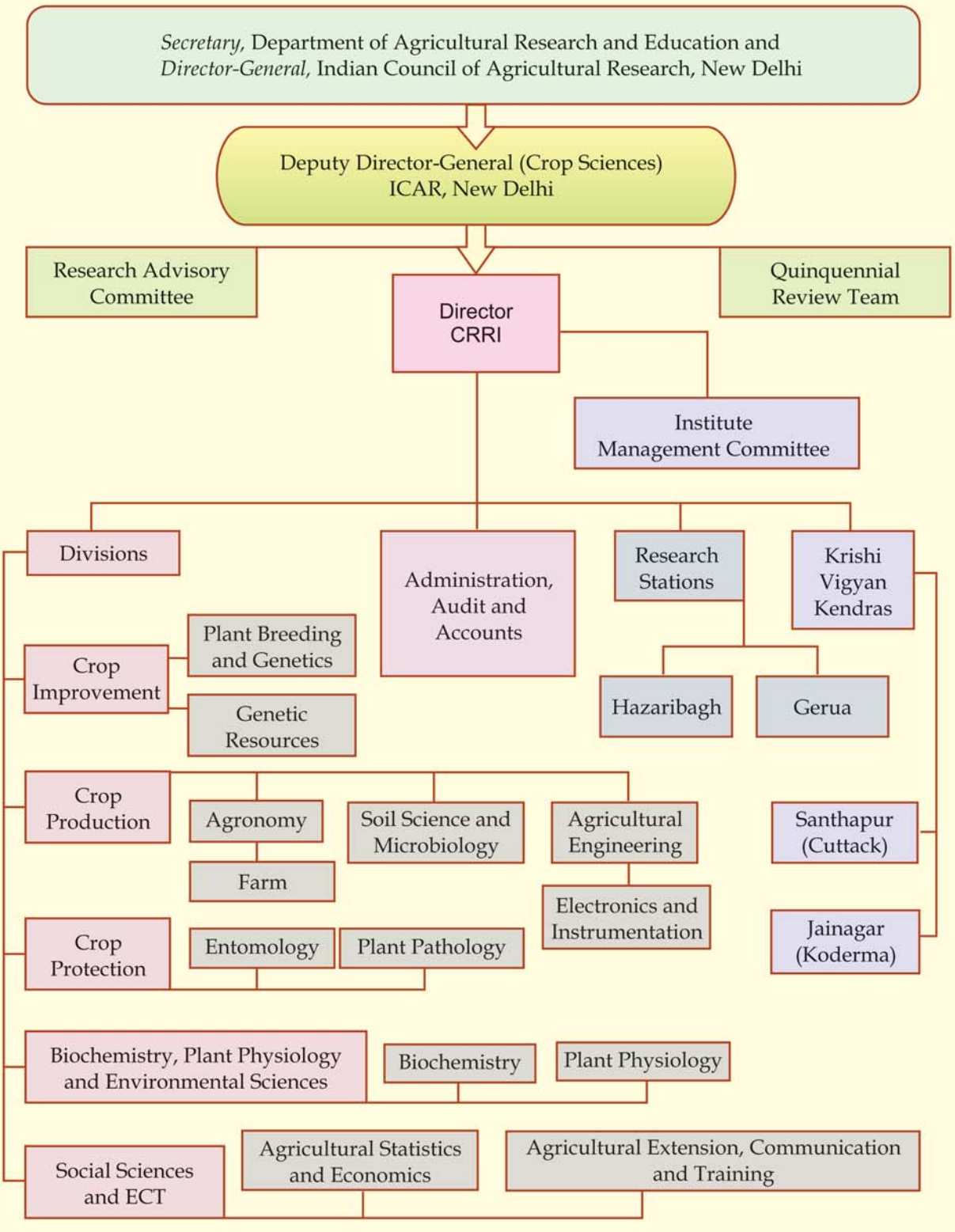
The CRRI is also reorienting its research to tackle resurgence of pests and diseases. Novel experiments in collaboration with national and international organizations are underway. Work on the application of technologies such as aerobic rice for tackling drought was refined. During the year the CRRI received funding from the National Agricultural Innovation Project for accelerating research in frontline areas of anticipatory climatic changes and crop adaptation strategies and allele mining of rice blast pathogen resistance genes. The CRRI Krishi Vigyan Kendras continued to cater to the needs of the farming community through its various programmes.

I am sure that this Annual Report will be useful to Research Managers, Researchers, Farmers and Students.

(T.K. Adhya)
Director

Organogram of

Central Rice Research Institute
Indian Council of Agricultural Research
Cuttack (Orissa) 753 006, India



Contents

The monsoon clouds hover over the CRRI experimental fields at Cuttack. (Photo: Ravi Viswanathan)

Executive Summary

कार्यकारी सारांश

RICE CRG 1190-1 (IET 18558) was identified as promising for *boro* in Assam, Bihar and West Bengal.

CR 2008-111 (IET 19189), a tall, non-lodging line was promising for semi-deepwater areas of Uttar Pradesh and Assam.

Five lines were identified as promising in the coastal saline tolerant variety trial (CSTVT). These are CR 2092-158-3 (IET 19472) for cultivation in Orissa and Andhra Pradesh, CR 2096-71-2 (IET 18697), CR 2093-7-1 (IET 19468) and CR 2095-181-1 (IET 19470) for Orissa and CR 2070-52-2 (IET 18692) for Puducherry.

Semi-dwarf and non-lodging CR 780-1937-1-3 (IET 19969) was identified as a promising culture for cultivation in the shallow lowlands of Orissa, Tamil Nadu, Andhra Pradesh and West Bengal.

For shallow lowlands of Orissa, West Bengal, Tamil Nadu and Maharashtra, CR 622-2211-1-1 (IET 19913), a semi-dwarf and non-lodging culture was found suitable.

CR 2340-3 (IET 20151), a semi-dwarf, non-lodging culture was identified as promising for early transplanted conditions in Orissa and West Bengal.

A new plant type (NPT) line CR 2340-5 (IET 19816) was identified for cultivation under irrigated conditions in Maharashtra and Gujarat.

CRMAS 2231-37 (IET 20668) developed through marker-assisted backcross breeding having *xa5*, *xa13* and *Xa21* bacterial blight resistance genes was identified as promising for bacterial blight (BLB) endemic areas of Uttarakhand and Andhra Pradesh.

Developed through molecular marker-assisted backcross breeding CRMAS 2232-85 (IET 20672) having BLB resistance genes *xa5*, *xa13* and *Xa21* was identified as suitable for cultivation in BLB endemic areas of Gujarat and Maharashtra.

Hybrid rice CRHR 5 and CRHR 7 consistently performed well in the national trials under *boro*.

असम, बिहार तथा पश्चिम बंगाल में *बोरो* मौसम के दौरान खेती करने के लिए सीआरजी ११९०-१ (आईईटी १८५५८) चावल आशाजनक पाया गया।

सीआर २००८-१११ (आईईटी १९१८९) एक लंबा एवं न गिरने वाला वंश उत्तर प्रदेश तथा असम के अर्द्ध-गहराजल क्षेत्रों के लिए आशाजनक पाया गया।

तटीय लवण सहिष्णु किस्म परीक्षण में छः आशाजनक वंशों को आशाजनक पाया गया। उड़ीसा एवं आंध्र प्रदेश के लिए सीआर २०९२-१५८-३ (आईईटी १९४७२), उड़ीसा के लिए सीआर २०९६-७२-२ (आईईटी १८६९७), सीआर २०९३-७-१ (आईईटी १९४६८) तथा सीआर २०९५-१८१-१ (आईईटी १९४७०) और पुडूचेरी के लिए सीआर २०७०-५२-२ (आईईटी १८६९२) आशाजनक हैं।

उड़ीसा, तमिलनाडु, आंध्र प्रदेश तथा पश्चिम बंगाल की उथली निचली जमीनों में खेती के लिए एक अर्द्ध-लंबा एवं न गिरने वाला संवर्द्धन सीआर ७८०-१९३७-१-३ (आईईटी १९९६९) आशाजनक पाया गया।

उड़ीसा, पश्चिम बंगाल, तमिलनाडु एवं महाराष्ट्र की उथली निचली जमीनों में खेती के लिए एक अर्द्ध-लंबा तथा न गिरने वाला संवर्द्धन सीआर ६२२-२२११-१-१ (आईईटी १९९१३) उपयुक्त पाया गया।

उड़ीसा तथा पश्चिम बंगाल में शीघ्र रोपाई दशाओं के लिए एक अर्द्ध-लंबा एवं न गिरने वाला सवंर्द्धन सीआर २३४०-३ (आईईटी २०१५१) आशाजनक पाया गया।

महाराष्ट्र तथा गुजरात के सिंचित दशाओं में खेती करने के लिए एक नया पौध प्ररूप वंश सीआर २३४०-५ (आईईटी १९८१६) की पहचान की गई।

चिन्हक-सहायतित बैकक्रॉस प्रजनन द्वारा विकसित सीआरएमएएस २२३१-३७ (आईईटी २०६६८) जिसमें *xa5*, *xa13* एवं *Xa21* जीवाणुज अंगमारी प्रतिरोधी जीन हैं, उत्तराखंड एवं आंध्र प्रदेश के जीवाणुज अंगमारी आक्रांत क्षेत्रों के लिए आशाजनक पाया गया।

आण्विक चिन्हक-सहायतित बैकक्रॉस प्रजनन द्वारा विकसित सीआरएमएएस २२३१-८५ (आईईटी २०६७२) जिसमें *xa5*, *xa13* एवं *Xa21* जीवाणुज अंगमारी प्रतिरोधी जीन हैं, गुजरात एवं महाराष्ट्र के जीवाणुज अंगमारी आक्रांत क्षेत्रों में खेती करने के लिए उपयुक्त पाया गया।

बोरो के अंतर्गत राष्ट्रीय परीक्षणों में संकर चावल सीआरएचआर ५ तथा सीआरएचआर ७ का निष्पादन स्थिर रहा।

जम्मू एवं कश्मीर में एवीटी-२ (आईएम) में संकर सीआरएचआर २९ आशाजनक पाया गया।

Hybrid CRHR 29 was promising in AVT 2 (IM) in Jammu and Kashmir.

Hybrid CRHR 5 was identified as promising for Bihar and Andhra Pradesh in multilocational trials (MLT).

Hybrid seeds of 22 combinations were produced.

Seven promising NPT breeding lines were nominated for AICRIP trials to be conducted in *kharif* 2009 under four different ecologies (IVT-IME, IVT-E, IVT-M and IVT-L).

Various entries were screened in the national (AICRIP) trials under different ecologies.

Rice germplasm were collected from Punjab, Haryana and Orissa. This included rice from flood-affected areas of Orissa.

Germplasm were screened for identifying new sources of resistance / tolerance to pests and diseases.

In on-farm trials at Nuagaon in Orissa, rice Swarna-*Sub1* tolerated submergence for more than two weeks and gave the highest yield of 3.8 t / ha.

In trials under normal and simulated flash flood conditions cultivars with *Sub1* showed greater survival than cultivars without *Sub1* (8% to 33%). The survival was FR 13A (93%), Swarna-*Sub1* (92%), IR 64-*Sub1* (90%) and Mahsuri-*Sub1* (86%).

Agro-management strategies for sustainable crop and soil productivity under favourable lowlands were studied.

The winnower-cum-grader was refined for longer duration that resulted in an output of 8 q / h of clean paddy with 99% cleaning efficiency and 86% screen effectiveness.

Four combinations of seed powder against gall-midge were promising in the nethouse experiments.

IPM technology is under development for irrigated rice.

Benchmark survey of village Purbakachha of Cuttack district was conducted.

The Krishi Vigyan Kendras at Santhapur and Koderma continued with training programmes, frontline demonstrations (FLD) and on-farm trials for the farming community.

The meeting of the Research Advisory Committee (RAC), the Institute Management Committee (IMC)

बहुस्थलीय परीक्षणों के अंतर्गत बिहार एवं आंध्र प्रदेश के लिए संकर सीआरएचआर ५ आशाजनक पाया गया।

२२ समुच्चयों के संकर बीजों का उत्पादन किया गया।

चार विभिन्न परिस्थितियों (आईवीटी-आईएमई, आईवीटी-ई, आईवीटी-एम तथा आईवीटी-एल) में वर्ष २००९ के *खरीफ* के दौरान होने वाले एआईसीआरआईपी परीक्षणों के लिए सात आशाजनक एनपीटी प्रजनन वंशों का चयन किया गया।

विभिन्न परिस्थितियों में राष्ट्रीय (एआईसीआरआईपी) परीक्षणों में कई प्रविष्टियों का परीक्षण किया गया।

पंजाब, हरियाणा तथा उड़ीसा से चावल जननद्रव्यों का संग्रह किया गया। इसमें उड़ीसा के बाढ़-पीड़ित क्षेत्रों के चावल शामिल हैं।

नाशकजीवों तथा रोगों के प्रति प्रतिरोधिता/सहिष्णुता के नए स्रोतों की पहचान के लिए जननद्रव्यों का चयन किया गया।

उड़ीसा के नुआगांव के किसानों के खेतों में स्वर्णा-*सब १* चावल से दो सप्ताह से अधिक समय तक जल में डूबा रहने के बावजूद ३.८ ट./है. की सर्वाधिक उपज मिली।

सामान्य तथा उसी प्रकार की अचानक आने वाली एवं कम समय तक रहने वाली बाढ़ दशाओं के अंतर्गत किए गए परीक्षणों में *सब १* रहित कृषिजोपजातियों की अपेक्षा *सब १* वाली कृषिजोपजातियों की उत्तरजीविता (८%-३३%) अधिक पाई गई। एफआर १३ए की ९३%, स्वर्णा-*सब-१* की ९२%, आईआर ६४-*सब-१* की ९०% तथा मसूरी *सब-१* की उत्तरजीविता ८६% पाई गई।

अनुकूल निचली भूमि के अंतर्गत टिकाऊ फसल तथा मृदा उत्पादकता के लिए कृषि-प्रबंधन रणनीतियों का अध्ययन किया गया।

ओसाई-सह-ग्रेडर में अधिक समय तक कार्य करने के लिए सुधार किया गया जिससे ९९% सफाई तथा ८६% छलनी करने की क्षमता के साथ प्रति घंटे ८ क्विंटल साफ धान प्राप्त हुए।

जाली घर परीक्षणों में गालमिज के विरूद्ध बीज चूर्णन के चार मिश्रण आशाजनक पाए गए।

सिंचित चावल के लिए समेकित नाशकजीव प्रबंधन तकनीक विकसित की जा रही है।

कटक जिले के पूर्वकछा गांव में मानक सर्वेक्षण (बेंचमार्क सर्वे) किया गया।

कृषि विज्ञान केंद्र, संथपुर तथा कोडरमा द्वारा कृषक समुदाय के लिए प्रशिक्षण कार्यक्रम, अग्रिम पंक्ति प्रदर्शनों तथा किसानों के खेतो में परीक्षणों का आयोजन किया गया।

अनुसंधान सलाहकार समिति, संस्थान प्रबंधन समिति तथा कृषि विज्ञान केंद्र वैज्ञानिक सलाहकार समिति की बैठकें आयोजित की गईं।

सीआरआरआई का ६२वां स्थापना दिवस, वार्षिक समीक्षा तथा कई परियोजनाओं की योजना बैठकें आयोजित की गईं।

हिंदी पखवाड़ा २००८ तथा सतर्कता जागरूकता सप्ताह मनाया गया।

सीआरआरआई ने कई प्रदर्शनियों में भाग लिया।

and the KVK Scientific Advisory Committee (SAC) were held.

The 62nd Foundation Day of CRRI and Annual Review and Planning meetings of various projects were held.

The Hindi Fortnight 2008 and the Vigilance Awareness Week were also conducted.

The CRRI participated in different exhibitions.

The ICAR Award for Outstanding Inter-disciplinary Team Research in Agriculture and Allied Sciences for the biennium 2005–06 was given to a team that comprised of Dr P.K. Sahu of the CRRI, Cuttack.

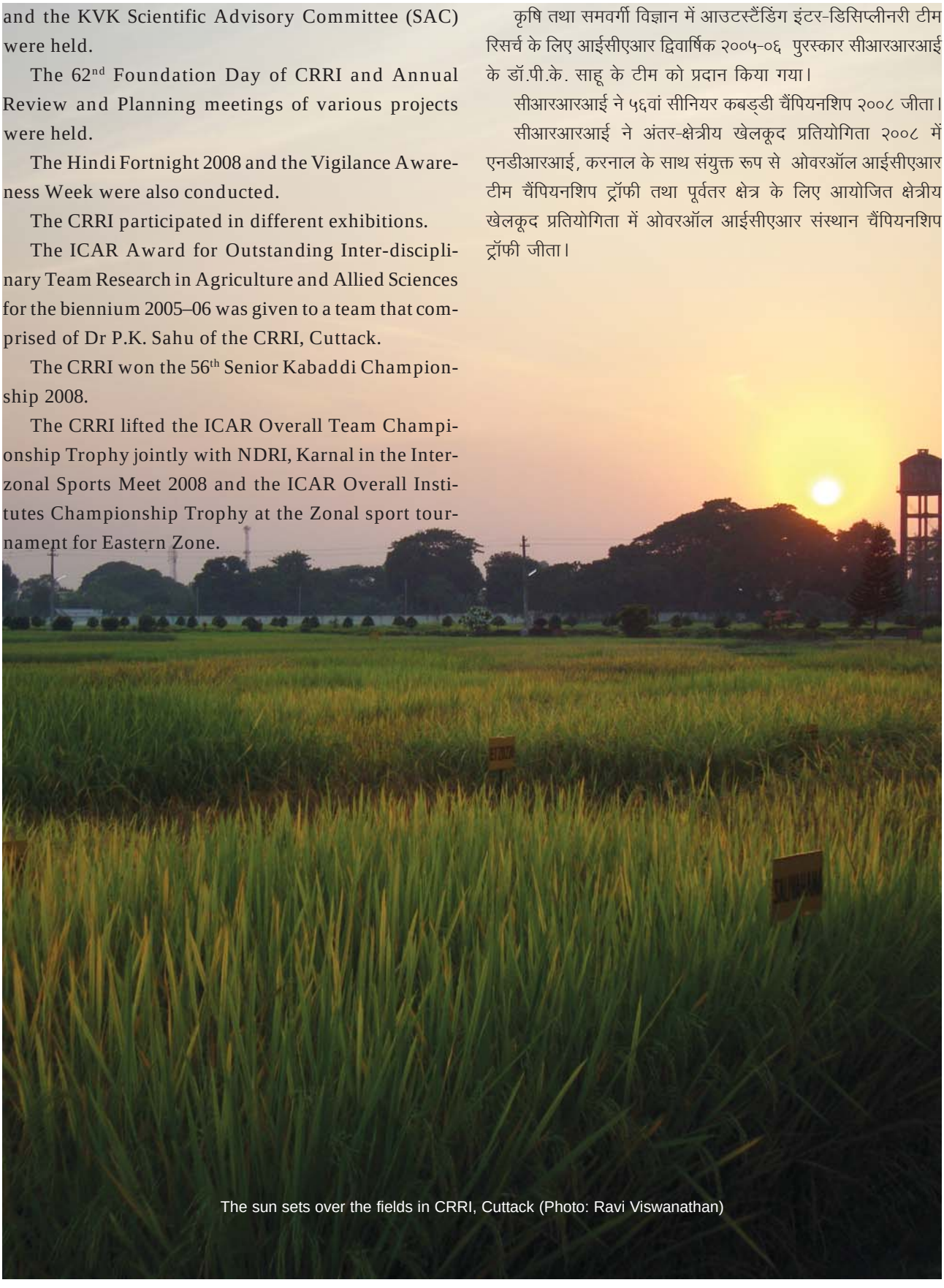
The CRRI won the 56th Senior Kabaddi Championship 2008.

The CRRI lifted the ICAR Overall Team Championship Trophy jointly with NDRI, Karnal in the Inter-zonal Sports Meet 2008 and the ICAR Overall Institutes Championship Trophy at the Zonal sport tournament for Eastern Zone.

कृषि तथा समवर्गी विज्ञान में आउटस्टैंडिंग इंटर-डिसिप्लीनरी टीम रिसर्च के लिए आईसीएआर द्विवार्षिक २००५-०६ पुरस्कार सीआरआरआई के डॉ.पी.के. साहू के टीम को प्रदान किया गया।

सीआरआरआई ने ५६वां सीनियर कबड्डी चैंपियनशिप २००८ जीता।

सीआरआरआई ने अंतर-क्षेत्रीय खेलकूद प्रतियोगिता २००८ में एनडीआरआई, करनाल के साथ संयुक्त रूप से ओवरऑल आईसीएआर टीम चैंपियनशिप ट्रॉफी तथा पूर्वतर क्षेत्र के लिए आयोजित क्षेत्रीय खेलकूद प्रतियोगिता में ओवरऑल आईसीएआर संस्थान चैंपियनशिप ट्रॉफी जीता।



The sun sets over the fields in CRRI, Cuttack (Photo: Ravi Viswanathan)

The CRRI: What is it and what it does?

THE CRRI was established by the Government of India in 1946 at Cuttack, as an aftermath of the great Bengal famine in 1943, for a consolidated approach to rice research in India. The administrative control of the Institute was subsequently transferred to the Indian Council of Agricultural Research (ICAR) in 1966.

The Institute has two research stations, one at Hazaribag, in Jharkhand, and the other at Gerua, in Assam. The CRRI-RRS, Hazaribag was established to tackle the problems of rainfed uplands, and the CRRI-RRS, Gerua for problems in rainfed lowlands and flood-prone ecologies. Two Krishi Vigyan Kendras (KVK) also function under the CRRI, one at Santhapur in Cuttack district in Orissa and the other at Jainagar in Koderma district in Jharkhand. The research policies are guided by the recommendations of the Research Advisory Committee (RAC), Quinquennial Review Team (QRT) and the Institute Staff Research Council (SRC). The CRRI also has an Institute Management Committee (IMC), for formulating administrative policies.

Mandate

The goal is to improve the income and quality of life of rice farmers in India. The objectives are:

❄ Conduct basic, applied and adaptive research on crop improvement and resource management for increasing and stabilizing rice productivity in different rice ecosystems with special emphasis on rainfed ecosystems and the related abiotic stresses.

❄ Generation of appropriate technology through applied research for increasing and sustaining productivity and income from rice and rice-based cropping / farming systems in all the ecosystems in view of decline in per capita availability of land.

❄ Collection, evaluation, conservation and exchange of rice germplasm and distribution of improved plant materials to different national and regional research centres.

❄ Development of technology for integrated pest, disease and nutrient management for various farming situations.

❄ Characterization of rice environment in the country and evaluation of physical, biological, socio-economic and institutional constraints to rice production under different agro-ecological conditions and in farmers' situations and develop remedial measures for their amelioration.

❄ Maintain database on rice ecology, ecosystems, farming situations and comprehensive rice statistics for the country as a whole in relation to their potential productivity and profitability.

❄ Impart training to rice research workers, train-

ers and subject matter / extension specialists on improved rice production and rice-based cropping and farming systems.

❄ Collect and maintain information on all aspects of rice and rice-based cropping and farming systems in the country.

Thrust Areas

❄ Germplasm collection, characterization of genetic diversity and gene function assignment.

❄ Designing, developing and testing of new plant types, super rice and hybrid rice for enhanced yield potential.

❄ Identification and deployment of genes for nutrient deficiency, tolerance to submergence, drought, salinity and biotic stresses and productivity traits.

❄ Intensification of research on molecular host-parasite / pathogen interaction to design suitable control strategy.

❄ Understanding the pest genomics for biotype evolution, off-season survival and ontogency for integration into a control strategy.

❄ Developing nutritionally enhanced rice varieties with increased content of pro-vitamin A, vitamin E, iron, zinc and protein.

❄ Improvement of short-grain aromatic rice and organic management of aerobic rice.

Research Achievements

Released a total of 70 rice varieties including two hybrids for cultivation in upland ecology, irrigated ecology, rainfed lowland ecology, medium-deep waterlogged ecology, coastal saline ecology and deepwater ecology.

Maintains more than 30,000 accessions of rice germplasm including nearly 6,000 accessions of Assam Rice Collection (ARC) and 5,000 accessions from Orissa.

Compiled Passport information on more than 30,000 germplasm.

Developed late duration varieties for rainfed lowlands including hybrids.

Developed interspecific hybrid derivatives including *O. sativa* and *O. longistaminata* with tolerance to bacterial leaf blight (BLB).

Used RFLP / RAPD and other DNA markers for genetic analysis of bacterial blight, blast and gall midge resistance.

Used marker-assisted selection for pyramiding BLB resistance genes and for developing BLB-resistant rice cultivars.

Developed a rice-based farming system including rice-fish farming system integrating multiple enterprise initiatives with a rationale for ensuring food and nutritional security, stable income and employment generation for rural farm family.

Knowledge-based N management strategy for increasing N-use efficiency for rainfed lowlands including use of integrated N management involving use of both organic and inorganic sources of N-fertilizer.

Developed several agricultural implements such as manual seed drill, pre-germinated drum seeder, multicrop bullock and tractor drawn seed drill, flat disc harrow, finger weeder, conostar weeder, rice husk stove, mini parboiler and power thresher with the sole aim of reducing both drudgery and cost of rice cultivation.

Evaluated, developed and tested several plant products with pesticide potential against field and storage insects and pathogens.

Developed non-destructive screening technique based on chlorophyll fluorescence spectrophotometry to identify submergence tolerant rice germplasm.

Identified biochemical and biophysical parameters for submergence and other abiotic stress tolerance in rice.

Developed crop modelling of G x E interaction studies that showed that simulation of crop growth under various environments could be realistic under both irrigated and favourable lowlands situations.

Developed suitable rice production technologies for rainfed uplands, lowlands and irrigated ecology including production technologies for hybrid rice and scented rice that were field tested and transferred to farmers.

Evaluated and popularized its varieties through frontline demonstrations (FLD) in farmers' fields.

Provided farmers' advisory service through regular radio talks and TV telecasts on rice production technologies.

Developed 15 training modules for farmers and extension workers.

Imparted short-term and long-term training for personnel from the State Departments of Agriculture, State Agricultural Universities (SAU) and other educational institutions.

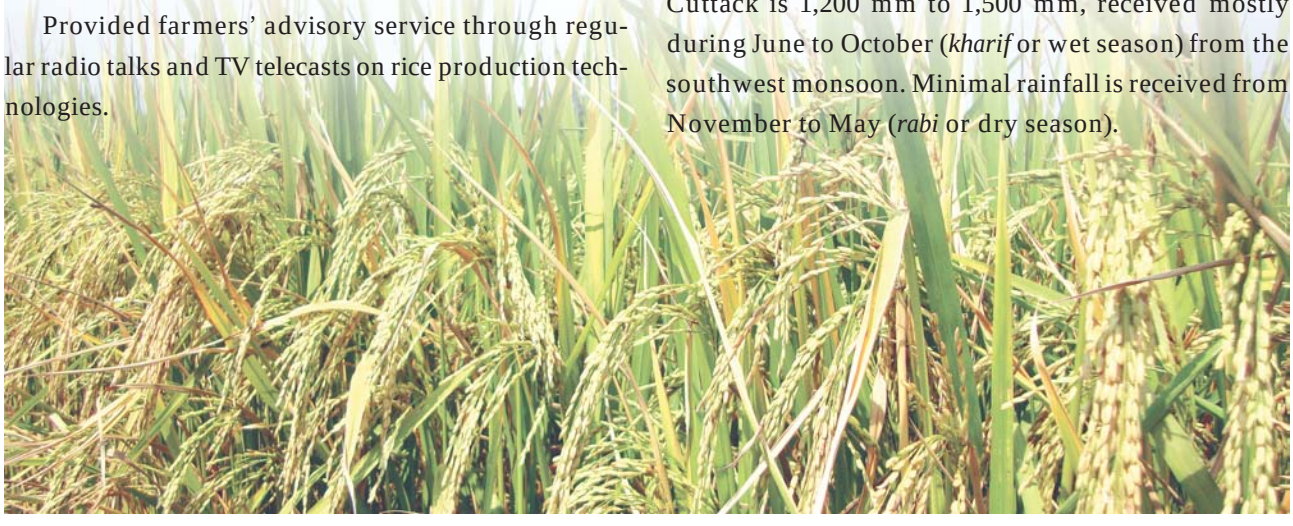
Imparted advance training and research leading to Masters (M.Sc.) and doctoral degrees (Ph.D.).

Linkages

The CRRI has linkages with several national and international organizations such as the Council for Scientific and Industrial Research (CSIR), Indian Space Research Organization (ISRO), SAUs, State Departments of Agriculture, and the institutes of the Consultative Group for International Agricultural Research (CGIAR), such as the International Rice Research Institute (IRRI), Philippines and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru.

Location

The Institute is located at Cuttack about 35 km from Bhubaneswar airport and 7 km from the Cuttack railway station on the Cuttack-Paradeep State Highway. The institute lies approximately between 85°55'48" E to 85°56'48" E longitudes and 20°26'35" N to 20° 27' 20" N latitudes with the general elevation of the farm being 24 m above the MSL. The annual rainfall at Cuttack is 1,200 mm to 1,500 mm, received mostly during June to October (*kharif* or wet season) from the southwest monsoon. Minimal rainfall is received from November to May (*rabi* or dry season).



Genetic Resources and Seed Technology

Genetic Resources

Exploration and Collection of Rice Germplasm

A total of 36 long slender basmati-type germplasm were collected in Punjab from the districts of Patiala, Fatehgarh Sahib, Ludhiana, Moga, Barnala, Bhatinda, Faridkot, Firozpur, Tarn Taran, Amritsar, Hoshiarpur, Kapurthala, Jalandhar, Nawanshahr, Ropar, Sangrur and Mansha and two districts of Haryana namely, Kurukshetra and Karnal.

A total of 26 aromatic short grain rices were collected in Orissa from the districts of Bhadrak, Balasore, Mayurbhanj and Keonjhar.

Germplasm Collection from Flood-affected Regions of Coastal Orissa

In a special exploration mission organized by the National Bureau of Plant Genetic Resources (NBPGR), 106 accessions of plant genetic resources of rice were collected. A total of 90 accessions of *O. sativa* and five of *O. rufipogon* were also collected after the flood. Germplasm accessions were also collected from flood-affected areas of Nayagarh, Boudh, Bolangir, Kalahandi and Gajapati in Orissa, comprising of 65 accessions.

Rice germplasm and varieties were grown to maintain purity and viability.

Ravi Viswanathan

Ravi Viswanathan

Rejuvenation of Rice Germplasm

A total of 3,110 accessions (1,911 repatriated Indian rice germplasm; 1,199 Orissa collections restored from National Gene Bank) were grown in the CRRI experimental fields to maintain purity and viability and to increase seed for supply to different researchers.

Characterization of Rice Germplasm including Wild Rice

A total of 471 accessions were characterized for 45 morpho-agronomic characters.

The leaf length varied from 25 cm (AC 21602) to 86.2 cm (AC 25170).

The leaf width varied from 0.5 cm (AC 22199) to 1.85 cm (AC 21674).

The ligule length varied from 0.8 cm (AC 21638) to 3.5 cm (AC 22150).

The culm height varied from 58.5 cm (AC 18626) to 185 cm (AC 21778).

The culm number varied from 6.5 cm (AC 21767) to 21 cm (AC 22177).

Long panicles (> 30 cm) were recorded in AC 21374, AC 21449, AC 21501, AC 25212 and AC 22765.

Heavy panicles were recorded in AC 24193, AC 23634, AC 21682, AC 24850, AC 21630.

The DFF varied from 70 (AC 21541) to 140 (AC 22250).

Maintenance of Landraces, Identified Donors and Pre-breeding Lines for Floodprone Ecosystem and *Boro* Rice

During *kharif* 2008, 840 accessions of lowland rice germplasm were maintained and observed for DFF, plant height, EBT, Panicle length, number of grains/panicle, grain yield and 100-grain weight.

Genetic Diversity Studies and Development of Core Collection

A set of 689 accessions of rice germplasm comprising of mostly donors for different agronomic, biotic

Rice germplasm were evaluated for different traits.

Table 1. List of varieties and number of panicle progeny lines grown.

Variety	Progeny rows	Elimination		Selected
		Field	Lab	
Kharif				
Savitri	240	5	2	233
Gayatri	240	1	2	237
Dharitri	240	6	2	232
Lunishree	240	15	3	222
CR 1014	240	1	0	239
Padmini	240	12	4	224
Tapaswini	240	15	3	222
Pooja	240	1	4	235
Sarala	240	2	7	231
Durga	240	0	2	238
Varshadhan	240	2	2	236
Ketekijoha	240	45	4	191
Rabi				
Ratna	380	162	42	176
IR 36	250	16	15	219
IR 64	240	38	14	188
Kalinga III	220	2	5	213
Annada	250	18	5	227
Dhala Heera	200	16	24	160
Kshitish	250	15	4	231
Satabdi	250	6	4	240
Naveen	250	36	8	206
Geetanjali	240	25	8	207

and abiotic stress tolerant traits, developed from 10,000 accessions of CRRI collections were grown in the field. The set was retrieved from the National Gene Bank and characterized for all the morpho-agronomic descriptors.

Seed Research

Maintenance Breeding of CRRI Released Varieties and Nucleus Seed Production

During *kharif* 2008, 12 varieties were subjected to maintenance breeding and seed was produced. In *rabi* 10 varieties were subjected to maintenance breeding and nucleus seed production.

Management of Storage Pest of Rice for Viability Enhancement

Mint oil (0.5% v / w) was effective against paddy moth, *Sitotroga cerealella* in paddy seeds (Nua Dhusara) stored for one year and provided 100% grain protection when tested under artificial infestation in sealed polyethelene bags. It did not adversely affect the seed viability.

Cosavet DF (water dispersible granules of micronized sulphur) 80% W / G was effective against *Sitotroga cerealella* in stored paddy (Ratna) seeds @ 2 g / kg of seeds and provided absolute seed protection under artificial infestation of the test insect. Cosavet did not show adverse effect on the seed germination of the effective treatment.

Seed Physiology of Rice

The accessions of *O. sativa* and *O. merridionalis* had the least (18 days) and *O. officinalis* had the highest (32 days) potential longevity. Seed dormancy was maximum in *O. longistaminata (*95.56%) and minimum in *O. nivara* (AC 100340 BP-42: 9.29%). The accessions of *O. barthii* had the highest seedling root length (12.5 cm) and *O. merridinalis* had the least (5.2 cm) in length. Seedlings of *O. barthii* had the highest (8.5 cm) and *O. officinalis* had the least (3.2 cm) shoot length. *O. latifolia* had the highest (0.993 g / 50 seedlings) seedling weight and *O. officinalis* had the least (0.35 g / 50 seedlings). *O. barthii* had the highest (29.3 g / 1,000 seed) seed weight

Table 2. Breeder seed produced at CRRI.

Variety	Breeder seed (t)	Variety	Breeder seed (t)
Savitri	2.3	Lunishree	1.5
Gayatri	3.8	Ranjit	1.1
Annada	1.7	Ratna	0.5
Varshadhan	3.6	IR 64	2
Khitish	2.2	Tapaswini	0.1
Pooja	8.8	Dhanarasi	0.2
CR 1014	1.2	Heera	0.06
Padmini	0.3	Swarna-*Sub1*	0.03
Satabdi	11.8	Hazaridhan	0.06
Durga	1.3	Tulasi	0.09
Ketekijoha	0.9	Sahabhagi Dhan	0.05
Geetanjali	0.3	IR 20	1.7
Nua Kalajeera	2.7	Sadabahar	0.6
Anjali	0.3	Jarava	0.4
CR Boro Dhan 2 (Chandan)	1.2	CR Dhan 10 (Satya Krishna)	0.5
Moti	1.1	Pusa 44	0.06
CR Sugandh Dhan 3 (Nua Dhusara)	0.09	CR Dhan 70 (Hanseswari)	0.2
Naveen	6.7	Virendra	0.7
Sarala	3.5	Jaldidhan 6	0.3
Dharitri	1.4	Vandana	0.06
Utkalprava	0.5	IR 36	1.3
Samalei	0.2		

and *O. officinalis* had the least (6.67 g / 1,000 seed).

All the wild species showed 30% seed germination under saline conditions (10 dS / m). The percentage of germination decreased drastically below 20% at 15 dS / m. However, among the different species tested *Oryza rufipogon* (AC 100273) showed 50% germination even under 15 dS / m salinity.

Similarly, the wild species showed decline in the percentage seed germination with increasing osmotic potential (0 bar, -2 bar, -4 bar, -6 bar, -8 bar and -10 bar). All the species except *Oryza glaberrima* showed 50% reduction in the percentage germination at -4 bar. Even under -10 bar *Oryza glaberrima* showed 30% seed germination.

Seed Production

The quantity of breeder seed produced is given in Table 2. The details of TL seed produced is given in Table 3.

Table 3. TL produced at CRRI.

Variety	TL seed (t)	Variety	TL seed (t)
Savitri	0.5	Ketekijoha	1.2
Gayatri	11	Geetanjali	0.4
Annada	2.9	Moti	0.6
Varshadhan	7.8	Anjali	4.9
Kshitish	1.9	Naveen	16.6
Pooja	5.2	Sarala	8.5
CR 1014	0.2	Rajalaxmi	0.07
Padmini	1.7	Ajay	0.09
Satabdi	2.9	CR Sugandh Dhan 3 (Nua Dhusara)	0.1
Durga	6.2		

Genetic Enhancement of Yield

Varietal Improvement for Rainfed Uplands

Development of Varieties Suitable for Unfavourable Uplands

Hybridization, Selection and Evaluation of Segregating Populations: Thirty new cross combinations were made to improve the grain quality, drought tolerance, early vigour and blast resistance besides grain yield of upland rice varieties during *kharif* 2008. In the pedigree nursery for unbunded uplands a total of 2,334 progenies and 22 F_2 populations were grown, and 2,607 single plants and 203 uniform bulk selections were made from 205 crosses. In the F_3 generation 498 single plant progenies were selected from 24 crosses. Based on plant type, panicle characters, reaction to abiotic and biotic stresses, in F_4, F_5, F_6, F_7 and F_8 generations 391, 135, 166, 41 and 10 single plants were selected from 48, 47, 55, 6 and 21 crosses, respectively. Besides these 203 uniform bulks were also selected for preliminary yield testing. Advanced fixed lines were also screened for resistance to blast and brown spot in the nursery and 39 lines were resistant to blast and 17 lines were resistant to brown spot.

Observation Nurseries and Preliminary Yield Trials: Eight entries were significantly better than the best check Vandana (2.6 t/ha). The highest yielding entry was RR 498-4-1-1-1-B (5 t/ha) under unbunded transplanted condition.

In the INGER nursery IURON the top-yielding entries were WAB 880-1-38-20-23-P1-HB, WAB 880-1-38-18-18-P1-HB, WAB 450-11-1-2-P41-HB and WAB 880-1-38-18-20-P3-HB. These entries gave 16–44% higher yield than the best check Vandana.

Development of Varieties with Weed Competitiveness, Drought Tolerance, Nutrient Responsiveness and Better HI for Different Cropping Systems

Thirty promising genotypes were evaluated for early vegetative vigour, yield and yield component traits. Among these 10 genotypes were promising and were significantly superior to the best check (Vandana) for yield. Genotypes IR 74371-70-1-1, IR 72667-16-1-B-B-3 and IR 74371-54-1-1 yielded more than 4.5 t/ha and exhibited significant value for rest of the characters.

Development of Aerobic Rice for Favourable Soil Conditions

Development of HYVs for Aerobic Adaptation

OYT Aerobic (100–120 days; On-station-upland field), Rabi *2008–09:* The promising five genotypes were IR 839929-B-B-291-4-1 (6.4 t/ha), IR 83920-B-B-277-2-1 (6.4 t/ha), IR 83928-B-B-296-5-1 (6.3 t/ha), IR 83927-B-B-278-5-1 (6.3 t/ha), and IR 83871-B-B-240-5-1 (6.3 t/ha).

AYTAerobic (110–120 days), Rabi *2008–09:* The DFF of genotypes ranged from 72 days to 97 days. Promising genotypes were above 85 days except IR 84887-157-38-1, whereas, the flowering duration of the checks ranged from 80 to 90 days. Most of the promising genotypes were above 110 cm.

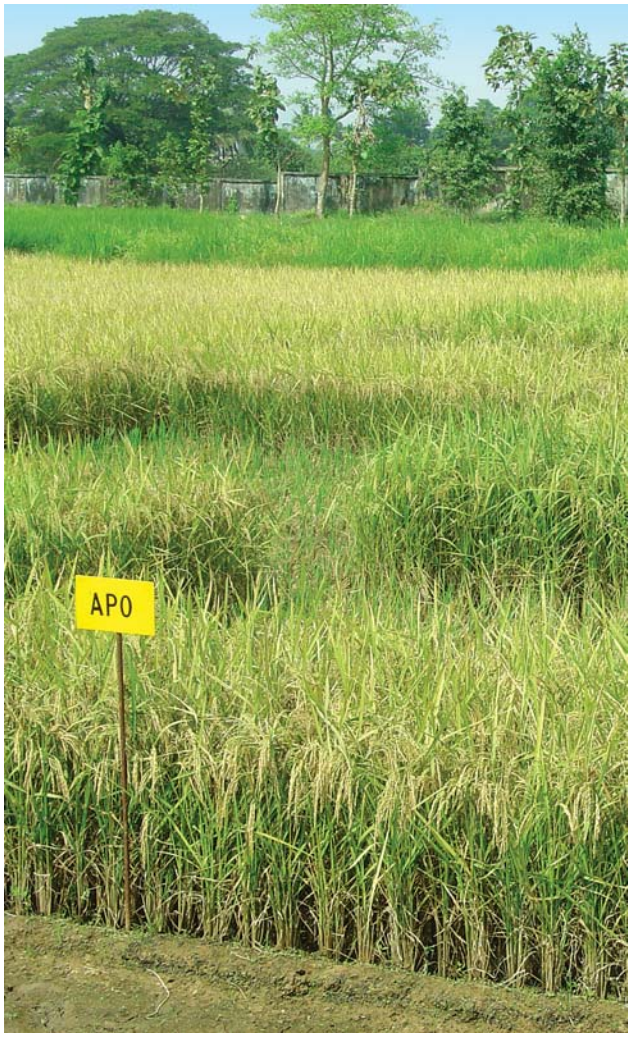
The maximum yielders in the trial in *rabi* 2008–09 were IR 83927-B-278-5-1 (5.3 t/ha), IR 84899-B185-16-1 (5.3 t/ha), IR 83922-B-173-2-1 (5.2 t/ha), IR 84898-B-171-32-1 (5.2 t/ha) and IR 84887-B-157-38-1 (5.2 t/ha).

Development of HYVs for Alternate Wetting and Drying Situation

AYT 1 AWD (100–110 days), Kharif *2008:* The top two entries were Apo (IR 55423-01; 5.4 t/ha) and B 6144-F-MR-6-0-0 (5.1 t/ha).

AYT AWD (110–120 days), Kharif *2008:* The DFF was from 76 days to 91 days. The top five entries were IR 84880-B-103-14-1 (5.7 t/ha), IR 84887-B-156-17-1 (5.6 t/ha), IR 83922-B-173-2-1 (5.5 t/ha), IR 84895-B-127-28-1 (5.2 t/ha) and IR 84899-B-185-16-1 (5.2 t/ha).

AYT 2 AWD (110–120 days), Rabi *2008–09:* The promising genotypes in yield were IR 70213-10-CPA-4-2-3-2 (6.3 t/ha), IR 72176-140-1-2-2-3 (6.1 t/ha), IR



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In AYT 1 AWD Apo was one of the top two entries and yielded 5.4 t/ha.

72875-94-3-3-2 (5.37 t / ha), CR 681-380 (5.1 t / ha) and PT 39 (4.6 t / ha).

OYT 1 AWD Rainfed Lowlands (100–120 days; on-station), Kharif *2008:* The promising five entries in descending order of the yield were IR 83867-B-B-251-3-1 (9 t / ha), IR 84882-B-120-46-1 (7.9 t / ha), IR 84881-B-135-8 (7.9 t / ha), IR 84880-B-103-14-1 (7.8 t / ha) and IR 84887-B-158-7-1 (7.7 t / ha).

Varietal Development for Rainfed Aerobic/Favourable Uplands

Hybridization, Selection and Evaluation of Segregating Populations

Twentyfive new cross combinations were made involving aerobic varieties Apo, IR 74371-70-1-1, Salumpikit and Sukhawan with locally adapted varieties for bunded uplands / rainfed shallow lowlands. The objectives were to improve the aerobic adaptation, drought tolerance, weed competiveness, blast resistance besides grain yield. Segregating populations of different generations were evaluated and selections were made based on maturity duration, plant height, panicle length, number of grains / panicle, sterility percentage and disease and pest reaction. Seven hundred and fifty single plant selections were made from 15 F_2 populations, 120 progenies from three crosses in F_3 generation, 96 progenies from five crosses in F_4 generation, 135 progenies from 11 crosses in F_5 generation and 10 lines in F_6 generations were selected for further evaluation.

Observational Nursery and Multilocational Testing

In AERON, IR 81429-B-31, IR 78908-193-B-3-B and IR 80508-B-57-3-B outyielded local check Anjali by 21-32% and were identified as highly promising.

The IVT-IME trial was conducted under both irrigated and rainfed stress conditions. Under irrigated condition R 1838-RF-41 (6.7 t / ha), WGL 326 (6.6 t / ha) and WGL 328 (6.6 t / ha) outyielded the best check, Lalat (4.4 t / ha). Under rainfed stress conditions, R 1838-RF-41 was identified as the most promising entry combining high yield potential with drought tolerance.

Varietal Improvement for Shallow Favourable Lowland and Irrigated Ecosystem

Development of Varieties for Different Seasons with Wider Adaptability

Promising Culture: Semi-dwarf, non-lodging, cold tolerant CRG 1190-1 (IET 18558; Jaya / IR 64) is promising for *boro* in Assam, Bihar and West Bengal. It yields 5.6 t / ha in 125 days. CRG 1190-1 produces medium slender grain and is moderately resistant to leaf blast, brown spot, blast, sheath rot and rice tungro virus.

Sixtythree fixed cultures from crosses Khitish / IR 72, IR 64 / Pusa 44, Khitish / Lachhit and Pusa 44 / Parijat were evaluated along with checks Naveen, Lalat, IR

64 and Pusa 44 in *kharif* 2008 and *rabi* 2008-09. Promising cultures were found in the crosses IR 64 / Pusa 44 and Pusa 44 / Parijat. In the F_5 generation of three crosses, Pusa 44 / Ratna, IR 64 / Parijat and IR 64 / WITA 12, 150 lines with high yield and good plant type were selected out of 400 lines.

In the station yield trial, 30 advanced cultures were evaluated under two replications along with checks Naveen, Lalat and IR 64. The promising cultures were CRK 18, CRAC 2222-533, CRAC 2221-43, CRAC 2224-1041, CRK 26-1-2-1 (IET 19351) and CRK 26.

In order to develop new breeding materials for irrigated ecosystem, the F_2 population of 12 crosses with rice Tapaswini, Khandagiri, WITA 12, Shatabdi and Naveen were grown during *kharif* 2008. Three hundred and fortyseven single plants with high yield, better plant type and good grain type were selected.

In shallow favourable lowlands, generation advance of 745 plant progenies belonging to 32 cross combinations in different generations were made, 854 single plants were selected and 43 lines were bulked based upon uniformity, grain yield and plant type.

In a station trial 19 advanced cultures were evaluated in a replicated trial along with checks Swarna and Gayatri. Genotypes CR 2547-62-316 and CR 2565-549 were promising with yields of more than 6.5 t / ha. These 19 cultures were nominated for national testing.

Development of Varieties with High Nitrogen-use Efficiency

Evaluation of Genotypes for High Nitrogen-use Efficiency: Forty irrigated rice cultivars were evaluated during *rabi* 2008-09, for N-use efficiency with proven efficient checks IR 36 and Lalat. Based on agronomic N-use efficiency (AE) (expressed in kg of grain yield / kg N application on ha basis), IR 8 was the most efficient (AE 25) with grain yield of 7.4 t / ha at N180 levels. Birupa (AE 22.88; 7.3 t / ha), Surendra (AE 21.11; 7.6 t / ha), IR 64 (AE 21.11; 7 t / ha), Pusa 44 (AE 20; 6.8 t / ha), Tapaswini (AE 18.88; 7 t / ha), Indira (AE 18.88; 6.5 t / ha), Vijetha (AE 18.88; 6 t / ha) and Prasad (AE 18.61; 6.45 t / ha) were more efficient than checks Lalat (AE 19.58) and IR 36 (AE 21.66) (5.6 t / ha) at N180 level.

Twentyseven genotypes each from early group (up to 125 days duration), medium group (126-135 days duration) and late group (more than 136 days duration) were evaluated along with two proven N-use efficient checks (Lalat, IR 36 early group, Lalat and Swarna for medium group, and Savitri and Ranjit for late group) and non-efficient Dubraj @ N 0, N 60 and N 180 levels during *kharif* 2008 keeping both P and K @ 30 kg / ha.

In the early group, none of the genotypes were better than the efficient checks. Only Shaktiman (20) was at par with the efficient checks IR 36 (AE 21.66) and Lalat (AE 19.58) with yield of 4 t / ha @ N 120 kg N level. However, some of the cultivars that were close to the checks were Pusa 44 (AE 19.66; 4.2 t / ha), Deepa (AE 17.08; 4.6 t / ha), Bhoi (AE 17.08; 3.9 t / ha), Sasyasree (AE 17.08; 3.6 t / ha) and Radhi (AE 17.08; 3.9 t / ha). IR 36 and Lalat yielded 4.6 t / ha and 4.3 t / ha, respectively, @ N 120 levels. Saket 4 and CR 2340-7 had the lowest AE of 6.25 and 7.91, respectively, with a grain yield of 2.7 t / ha and 2.9 t / ha @ N 120 level.

In the medium group, Indira had the highest AE of 25 with a grain yield of 4.5 t / ha @ N 120 level followed by Prasad (AE 22.91; 4.5 t / ha), IR 72 (AE 22.08; 4.6 t / ha) and Tapaswini (AE 20.83; 5.9 t / ha).

In the late group, none of the cultivars were better than the checks Savitri and Ranjit. However, only Salivahana was at par with Savitri and Ranjit with AE of 26.25 and grain yield of 5.3 t / ha.

Varietal Improvement for Rainfed Unfavourable Lowlands

Development of High-yielding Varieties of Mid-late to Late Duration with Good Plant Type and Tolerance to Major Biotic and Abiotic Stresses for Medium-deepwater Areas

Promising Line for Semi-deepwater Areas: Tall (132 cm), non-lodging CR 2008-111 (IET 19189) developed from Savitri / Padmini by pedigree method was promising for cultivation in the semi-deepwater areas of Uttar Pradesh and Assam. It yields 4.5 to 5 t / ha of long bold grains. CR 2008-111 is moderately resistant to brown spot and is resistant to neck blast.

Screening for Tolerance to Waterlogging: Seventysix

germplasm were tested for tolerance to waterlogging with checks Varshadhan, Swarna, Swarna-*Sub1*, Gayatri and Sarala. Swarna-*Sub1* exhibited greater reduction of tiller number and panicle weight due to high sterility under waterlogged conditions. Sagarica, Mundi Ravana, Panikoili and Geetanjali were tolerant with high panicle weight under waterlogged conditions.

Evaluation of Advanced Breeding Lines (Station Trial): One hundred and sixty advanced breeding lines selected from different cross combinations were evaluated along with five checks Purnendu, Sabita, Sarala, Jal-lahari and Varshadhan for yield and other attributes during *kharif* 2008. Rice CR 2375-1-3-1-1 gave the highest grain yield of 5.3 t/ha followed by CR 2389-5-2-1-1 (5.1 t/ha) and CR 2389-7-2-1-1 (5 t/ha) as against 4.74 t/ha in the best check Varshadhan. Most of the entries flowered one week earlier.

Development of Varieties for Anaerobic Seeding

Screening for Anaerobic Seeding Tolerance: Seventysix germplasm lines were screened for anaerobic seeding tolerance. The cultivars that had more than 70% establishment were Panikoili, Pakhira, Baunsamuli, Biradia Bankoi and Geda Khuda. The establishment of the susceptible cultivars was between 10% and 15%. The plant height after 15 days of sowing was more than 25 cm in tolerant cultivars.

Generation of New Crosses and Advancement of Breeding Material: Ninetyfour single plant selections (F_4 and F_5 generations) were made from eight cross combinations developed for anaerobic seeding tolerance involving donors tolerant to anaerobic seeding (Panikekoa, EC 516602 and EC 516607) on the basis of plant and panicle characters. Besides these single plant selection, and three mapping populations (IR 42/Panikekoa, IR 42/AC 1631and IR 42/EC 516602) that were developed for anaerobic seeding tolerance were generation advanced from F_4 to F_5.

Rainfed Lowland Shuttle Breeding Programme for Eastern India

Observational Yield Trial (OYT): A total of 80 entries received from different cooperating center under the Shuttle Breeding Programme were tested under direct-seeded conditions. Among the different entries, CR 2008-111-4 produced the highest grain yield (6.8 t/ha) followed by CR 758-471-3 (6.3 t/ha) and IR 70153-TTB-9-3-3-1-3 (5.9 t/ha) as against the best check variety Swarna (4.15 t/ha). Most of the entries flowered during the third and fourth week of Oct.

AYT: Twentyfive entries including 20 promising lines that were selected from the earlier OYT were tested along with five checks IR 49830-0, Sabita, Purnendu, Jal Lahari and Sarala under medium-deep water conditions. Among the different entries OR 2329-13 gave the highest grain yield of 3.5 t/ha followed by CR 874-59-2-2 (3.5 t/ha) and LPR 07003 (3.4 t/ha) as against the best checks Sabita (3.3 t/ha) and Purnendu (3.2 t/ha). Most of the entries flowered during the third week of October.

Screening of OYT Entries for Submergence Tolerance: A total of 80 germplasm were screened for submergence tolerance. Among the different entries NDR 8659 and CR 2015-243 showed highest survival (100%) followed by NDR 8827, CR 2241-7-2-2-1, RAU 759-5-4 and CR 929-19 (96%). On the other hand, Swarna-*Sub1* gave 88% survival as against 23% in the susceptible variety Swarna.

Development of Suitable Varieties for Delayed Monsoon/early Flooding Situation

Sixteen advanced cultures were evaluated in replicated transplanted condition in *kharif* 2008 along with five checks Durga, Varshadhan, Gayatri, Pooja and Sarala. Under delayed seeding with normal seedling CR 758-16 was the highest grain yielder (5.2 t/ha) followed by CR 874-23 (5.1 t/ha) as against the best check Durga (4.8 t/ha). In case of planting with aged seedlings, none of the 16 entries could give better yield than the best check Varshadhan (4.6 t/ha). In general planting with aged seedlings delayed the flowering and reduced the grain yield. For generating new breeding material seven new cross combinations were attempted and F_1 seeds of six cross combinations involving Varshadhan, Gayatri, Durga and Swarna-*Sub 1* were harvested.

Development of Short Duration (100-110 days) and Salt-tolerant Variety for Coastal Saline areas in Dry Season

Attempts were made to incorporate saltol gene (FL 496, FL 478 and FL 378) to the existing varieties Naveen, Khandagiri, Annapurna and IR 29. F_1 seed were harvested.

One thousand one hundred and twentysix single plant progenies from 20 cross combination were harvested in the F_3 generation.

Thirtytwo promising short duration saline tolerant lines were evaluated in Ersama block. The highest yield was recorded in CR 2473-9-1-123-3 (4.5 t / ha) followed by CR 2472-1-6-2-1 (4.4 t / ha) and CR 2472-6-78-1 (4.35 t / ha) as against tolerant check IR 72046-B-R-3-3-3-1 (4.2 t / ha) and susceptible check Khandagiri (2.2 t / ha).

Varietal Development for Coastal Saline Areas

Thirty salt tolerant germplasm were tested in farmers' field at Ersama block in Jagatsinghpur district. The water EC ranged from 2.6 dS / M to 5.6 dS / M and the soil pH from 4.8 to 6.5. The highest yield was recorded in CR 2216-12-2-1-1 (3.8 t / ha), followed by CR 2468-326-148-4-1 (3.7 t / ha). The yield in the tolerant checks were 2.8 t / ha in Lunishree (2.8 t / ha) and 2.5 t / ha in SR 26B.

Coastal Saline Tolerant Variety Trial: Promising Entries

CR 2092-158-3 (IET 19472; Jaya/Lunishree): Yields 4.1 t / ha in 125 days with moderate resistant to sheath blight. CR 2092-158-3 was identified for cultivation in Orissa and Andhra Pradesh.

CR 2096-71-2 (IET 18697; Mahsuri/Orumundakan): Identified for cultivation in Orissa CR 2096-71-2 yields 3.5 t / ha in 125 days. It has moderate resistance to sheath blight and brown spot.

CR 2093-7-1 (IET 19468; IR 28/Chakrakonda): With resistance to blast and sheath blight it yields 3.1 t / ha in 128 days. CR 2093-7-1 has been identified for cultivation in Orissa.

CR 2095-181-1 (IET 19470; Mahsuri/Chakrakonda): Identified for cultivation in Orissa it yields 3.2 t / ha in 123 days, and is resistant to blast and sheath blight.

CR 2070-52-2 (IET 18692; Savitri/Lunishree): Identified for Puducherry with yield of 3.7 t / ha in 128 days duration, CR 2070-52-2 is resistant to blast, sheath blight and brown spot.

Salinity Screening

Sixtysix long duration cultures were screened in *kharif* 2008 in a simulating tank under EC 8-10 dS / M with soil pH of 6.8 in an augmented design. Ten germplasm showed good tolerance at seedling stage than the check SR 26B. Five lines showed 100% survival.

Thirtythree short duration cultures were screened in *rabi* 2008-09 with checks FL 496 (tolerant) and Khandagiri (susceptible) in simulating tank (control) under EC 8-10 dS / M with soil pH of 6.8 in an augmented design. Tolerance at seedling stage was observed in CR 2473-9-1-123-3, CR 2472-6-78-1, CR 2472-1-1-16-1 and CR 2472-1-39-1.

Breeding High-yielding Varieties for Deepwater Rice with Tolerance to Major Biotic and Abiotic (Drought) Stresses

Promising Cultures: Semi-dwarf and non-lodging CR 622-2211-1-1 (IET 19913) is suitable for shallow lowlands of Orissa, West Bengal, Tamil Nadu, and Maharashtra. It yields 5.2 t / ha in 145-150 days. It produces medium slender grain, 260-300 panicles / m^2 and has long panicles. CR 622-2211-1-1 is resistant to leaf blast, stem borer and leaf folder, glume discoloration and GLH. It produces medium-slender grain.

Semi-dwarf and non-lodging CR 780-1937-1-3 (IET 19969) is suitable for shallow lowlands of Orissa, Tamil Nadu, Andhra Pradesh and West Bengal. It yields 5.4 t / ha in 145–150 days. CR 780-1937-1-3 is resistant to leaf blast, stem borer and leaf folder. The grains are medium-slender.

During *kharif* 2008, 150 promising single plants were selected on the basis of moderate elongation ability, good kneeing ability, high panicle and grain number, flowering duration, plant height and low disease and pest incidence for advancement to F_3 generation.

The F_3 pedigree nursery was raised for selection of superior progenies from the segregating generation. Three hundred promising single plants were selected on the basis of moderate elongation ability, good kneeing ability, high panicle and grain number, flowering duration, plant height and low disease and pest incidence for advancement to F_4 generation.

One hundred and forty F_4 lines and 82 F_5 lines were grown under typical deepwater. Eightyeight promising single plants were selected from the derivatives of 28 cross combinations on the basis of moderate elongation ability, good kneeing ability, high panicle and grain number, flowering duration, plant height and low disease and pest incidence. Similarly, 42 promising single plants were selected from the 82 lines of F_5 generation segregating materials of 19 crosses.

Development of Pre-flood *Ahu* Rice (75-90 Days Duration)

During *ahu* 2008, 20 rice genotypes were direct seeded in dry soil. Rice Nilagiri (2.9 t / ha) gave significantly higher grain yield than local check Luit (2.1 t / ha) with similar crop duration. Traditional *ahu* rice Jeera (2.5 t / ha), Kalamanik (2 t / ha) and Hasakumora (2 t / ha) matured earlier by 12-14 days than Luit.

Development of Post-flood Rice Suitable for mid-September Planting

The highest grain yield was obtained in Dikhow (5.6 t / ha) followed by Kolong (5.5 t / ha) and Kapilee (5.3 t / ha). These varieties flowered between 77 days and 84 days.

CR 622-2211-1-1 (IET 19913) was identified for cultivation in shallow lowlands of Orissa, West Bengal, Tamil Nadu and Maharashtra. It yields 5.2 t/ha in 145–150 days.

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Semi-dwarf and non-lodging CR 780-1937-1-3 (IET 19969) was suitable for shallow lowlands of Orissa, Tamil Nadu, Andhra Pradesh and West Bengal. It yields 5.4 t/ha in 145–150 days.

Improvement of Rice for Floodprone Areas

In the pedigree nursery for rainfed lowland a total of 2,788 progenies and four F_2 populations were grown. In the F_3 nursery 318 single plants were selected. In F_4 and F_5 generations 925 and 618 single plants were selected from 15 crosses and 16 crosses, respectively based on plant type, panicle characters and reaction to biotic stresses under field conditions.

In a station trial for semi-deepwater condition, Sabita (5.6 t/ha), Simora (5.3 t/ha), Rongagatha (5.2 t/ha), Asra Varial 1 (5 t/ha) and Maruadhangi (5.6 t/ha) were significantly better than local check Tarkekoa (3.6 t/ha).

Development of Varieties for *Boro*

Seven new crosses Gautam/RR 165-645, Gautam/IR 57934-2, Gautam/CRM 49, Gautam/IR 72, Kajlaboro/IR 73688-82-3, Boro 1/IR 73688-82-3 and Pusa 44/IR 72 were made during *boro* 2008.

Evaluation of Rice Varieties for Flash-flood

Twenty semi-deep and deepwater genotypes were tried for tolerance to flash flood. The highest grain yield was recorded with Jalpriya (3.3 t/ha) and it was free from RTV. The yields were 3.2 t/ha in Jitendra, 3.1 t/ha in Purnendu, 3.1 t/ha in Swarna-*Sub1*, 3.1 t/ha in Swarna, 3.1 t/ha in Varshadhan, 3.1 t/ha in Sarala, 3 t/ha in Ranjit and 3 t/ha in Tapaswini.

Hybrid Rice Technology

Production and Evaluation of Test Cross Hybrids

About 650 test cross hybrids were evaluated in *kharif* 2008 and *rabi* 2008-09. Thirty promising heter-

Table 4. Promising test cross combinations identified.

Cross	Duration	Spikelet fertility (%)
CRMS 31A x CP138-03-24	132	>90
CRMS 32A x 29A / Gayatri 253	142	>90
CRMS 32A x 31A / Purnendu 1443	145	>90
CRMS 32A x 31A / Purnendu 1444	141	>90
PMS 10A x 31A / Purnendu 1448	145	>90
CRMS 31A x 31A / Purnendu 1495	146	>90
CRMS 31A x 31A / Hanseswari 1506	145	>90
CRMS 31A x CRL 32	142	>90
CRMS 31A x CRL 29	141	>90
CRMS 32A x CRL 30	145	>90
CRMS 32A x CP 138-30	131	>90
APMS 6A x CRL 3	140	>90
CRMS 31A x Gayatri / 25B-473	145	87
CRMS 31A x CRL 23-7	143	>90
PMS 10A x 31A / Hanseswari 1506	142	>90
PMS 17A x 31A / Hanseswari 07-162	140	>90
PMS 10A x 31A / Hanseswari 07-37	142	>90

otic combinations with high spikelet fertility, long panicles and good yield potential were identified in the 130–150 days duration. Few promising iso-cytoplasmic restorers with stiff culm and high spikelet fertility were identified from A x R crosses (Table 4). These were used to develop heterotic testcross hybrids.

Some of the lines identified as restorers were purified and multiplied for use in small scale hybrid seed production. The flowering behaviour of these lines were studied along with few promising CMS lines to plan seeding schedules for synchronous flowering of both the parental lines. Three hundred and twenty new test crosses were generated involving seven CMS lines for evaluation.

Maintenance and Evaluation of CMS Lines

Thirteen CMS lines including five CRRI bred CMS lines were evaluated for different agro-morphological characteristics and maintained. Six CMS lines including the long duration line, CRMS24A were multiplied on field scale in *kharif* 2008 and *rabi* 2008-09.

Ten CMS lines were evaluated in CMSEN nursery during *kharif 200*8 for different floral and morphological characteristics. Lines APMS 8A, APMS 9A, IR 79156A and IR 68897A were promising.

Transfer of Characters into CMS Lines

Transfer of characters into the parental lines was taken up for BLB resistance, stigma exsertion and *eui* gene for better outcrossing. F_1 hybrids of CRMS 31B and CRMS 32B with Tapaswini pyramided lines with BLB resistance genes, *xa 5, xa 13* and *xa 21* were tested and BC_1 and BC_2 hybrids with the recurrent parents were developed. Crosses were also made between IR 42266-29-3R and the donor for BLB resistance genes (3 gene pyramid). F_1 hybrids were developed. Selections were made for the recurrent parent types with exserted stigma. F_1 hybrids between CRMS 31B, CRMS 32B and *eui* gene donor were produced and BC_1F_1 hybrids with the recurrent parents, CRMS 31B and CRMS 32B were generated.

Pyramiding of Rf genes into potential partial restorers their exploitation as restorers was taken up. Crosses were made between partial restorers, Mahalaxmi, Gayatri and PK 06-1 with IR 42266-29-3R. F_1 hybrids were grown. The F_1s were tested for hybridity and backcrosses with the recurrent parents were generated. The backcross F_1s were tested for presence of Rf genes. Selections were also made in F_2 generation for ideal plant types.

Status of Backcrossing to Develop New CMS Lines

Twentyfive backcross progenies (BC_2-BC_7) were evaluated for pollen and spikelet sterility. These were carried forward to develop new CMS lines in two WA and Kalinga I background. Eleven new backcrosses were initiated during *kharif* 2008 that also included crosses with some short duration varieties such as Virendra to develop CMS lines in early and mid-early

Table 5. New backcrosses initiated in *kharif* 2008.

Line under conversion	Pedigree	CMS Source	Cytoplasm	Generation
32B / DRR 6B-157	CRMS 32A / CRMS 32B / DRR 6B-157	CRMS 32A	Kalinga I	BC_1
31B / DRR 8B-302	CRMS 31A / CRMS 31B / DRR 8B-302	CRMS 31A	WA	BC_1
244B / DRR 8B-PR-08-169	CRMS 31A / CRMS 244B / DRR 8B-PR-08-169	CRMS 31A	WA	BC_1
CR 2234-1693	CRMS 32A / CR 2234-1693	CRMS 32A	Kalinga I	BC_1
IR 71591-923	CRMS 32A / IR 71591-923	CRMS 32A	Kalinga I	BC_1
CRMP 1 / DRR 7B-PR-08-14	CRMS 31A / CRMP 1 / DRR 7B-PR-08-14	CRMS 31A	WA	BC_1
Abhishek	CRMS 31A / Abhishek	CRMS 31A	WA	BC_1
CR 2234-1114	CRMS 31A / CR 2234-1114	CRMS 31A	WA	BC_1
Satabdi	CRMS 31A / Satabdi	CRMS 31A	WA	BC_1
Virendra	CRMS 32A / Virendra	CRMS 32A	Kalinga I	BC_1
CR 2234-1112	CRMS 32A / CR 2234-111	CRMS 32A	Kalinga I	BC_1

group. The promising new backcrosses are given in Table 5.

Seed Production of CMS Lines and Hybrids

Hybrid seed of 22 combinations (14 long duration) including that of the two released hybrids Ajay and Rajalaxmi were produced. Twelve long duration hybrid combinations were produced. These were nominated for evaluation in SLHRT 2008 at seven locations during *kharif* 2008. Seeds of five CMS lines (CRMS 8A, CRMS 24A, CRMS 31A, CRMS 32A and CRMS 45A) were produced on field scale that are being used for further multiplication of 'A' line and for hybrid seed production. The two promising CMS lines, CRMS 31A (0.2 t) and CRMS 32A (0.2 t) were produced.

Restorer and Maintainer Breeding

Population Improvement: Five random mating maintainer populations and three restorer populations were grown in *kharif* 2008. Selections were made from each of the populations and were grown in pedigree method (Table 6). Test crosses were made with some of the promising selections to identify maintainers and restorers. Two new populations, one each for maintainer (CRMP 3) and restorer (CRRP 2) involving 10 highly promising maintainers and 12 newly identified long duration restorers respectively were constituted during *rabi* 2008-09. Four maintainer crosses were added to CRMP 3 (RTN 3B for MS grain, IR 79156B for panicle exsertion, APMS 6B for stiff culm and high grain number and DRR 6B for stigma exsertion). Three restorers were added to CRRP 1 (CRL 15, CRL 22 and

Table 6. Population improvement of restorers and maintainers (*kharif* 2008).

	Number of selections	Generation
Maintainer population		
IR 71590	12	F_9
IR 71591	9	F_9
CRMP 1	57	F_7
CRMP 2	39	F_6
CRMP 3	125	F_2
Restorer population		
CP 138	15	F_9
CP 139	5	F_9
CRRP 1 (long duration)	55	F_5

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Hybrid seed of rice hybrid Rajalaxmi was produced.

CRL 34 for grain type, plant height, stiff culm, growth duration and pollen shedding ability).

Recombination Breeding: About 1,065 selections in F_2-F_7 generation from 39, B x B, R x R and A x R crosses were grown in pedigree nursery. Crosses were made with few selections from highly fertile progenies of A x R crosses and R x R crosses on CMS lines to identify heterotic combinations.

Evaluation of Hybrids

National Hybrid Rice Trial—Shallow Lowland Hybrid Trial (SLHRT): Seventeen hybrids (12 from CRRI) were tested at six locations in replicated trials (SLHRT) during *kharif* 2008. CRHR 41 was the top yielder (6.1 t / ha) on overall mean basis with a yield advantage of 25.9% over the best inbred check Salivahana and 33.9% over the hybrid check KRH 2. This was followed by CRHR 33 (6 t / ha; 22.6% and 30.4% over best inbred and hybrid) and CRHR 46 (5.8 t / ha; 18.7 and 26.2% over best inbred and hybrid). Although, many of the hybrids exhibited the required yield advantage, hybrids CRHR 46 and HRI 166 were promoted to AVT-1 (L) based on the flowering duration.

National Hybrid Rice Trial—Multilocational Trial of Hybrids: Sixteen released hybrids were evaluated with six inbred checks and one national check. PA 6201 was the best entry with a yield of 7.4 t / ha followed by Suruchi (5.8 t / ha). None of the hybrids tested in the medium duration group outyielded the check variety Tapaswini.

Performance of Hybrids in National Trials and Nomination of Hybrids for National Trials: Based on the performance in the different hybrid trials / breeding trials during 2008, CRHR 5 (Rank 1) and CRHR 7 (Rank 2) showed consistently good performance under *boro* in the National Trials.

CRHR 29 was promising in Jammu and Kashmir in AVT 2 (IM).

From the MLT hybrids CRHR 5 was identified as promising for Bihar and Andhra Pradesh.

CRHR 32 was promoted to AVT-2 (late).

CRHR 46 was promoted to AVT-1 (L).

CRHR 5 was promoted to third year of testing in AL and ISTVT.

Hybrids (long duration, CRHR 32, CRHR 33, CRHR 34, CRHR 35, CRHR 36, CRHR 37, CRHR 38, CRHR 39, CRHR 40, CRHR 41 and CRHR 42) were nominated for SLHT during *kharif* 2008.

Studies on Quality Characteristics of Hybrids

Nineteen hybrids along with two HYVs grown at CRRI Farm during *kharif* 2008 under MLT of hybrids were evaluated for milling, cooking, eating and nutritional quality.

The results indicated that all the hybrids were long slender (LS) except JKRH 2000 (LB), HSD 1 (MS) and Suruchi (MS). Hybrid HSD 1 had the highest HRR (64.5%) followed by Rajalaxmi (62.5%), Ajay (61.75%), Sahayadri 3 (59.5%) and Suruchi (58.75%).

All the hybrids exhibited intermediate amylose content (20-24.91%) except Ajay and Rajalaxmi. There

Hybrid rice CRHR 32 was promoted to AVT-2 (late).

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was little variation in alkali spreading value. Iron was highest in Ajay (7.64 ppm) followed by HSD 1 (6.58 ppm) and Rajalaxmi (6.42 ppm). The content of Zn was highest in DRRH 2 (21.1 ppm) followed by CORH 3 (19.85 ppm) and Sahayadri 3 (19.53 ppm). Promising hybrids for grain quality were Rajalaxmi (LS), Ajay (LS), PHB 71 (LS), DRRH 2 (LS), HSD 1(MS) and Suruchi (MS).

Development of Super Rice for Different Rice Ecologies

Critical Investigations on Morpho-physiological Traits for Designing Super Rice for different Rice Ecologies

Identification of Parental Lines/donors for Various Morphological Traits for Shallow Lowlands: During *kharif* 2008, 80 germplasm lines comprising of exotic collections, accessions from Assam rice collections (ARC), new plant type lines and improved varieties were evaluated to identify promising donors possessing superior traits for shallow lowland situation. The donors identified for various traits were:

Thick and sturdy stem: AC 38606, AC 38599, AC 38687 and AC 38679.

More spikelets / panicle: PDKV Sriram, AC 38669, AC 38687, AC 38600 and AC 38603.

Upright, thick and broad leaf: AC 38679, AC 38700, AC 38597 and AC 38671.

Long panicle, high seed test weight: AC 38606, AC 38687, AC 38679 and AC 38699.

Development and Evaluation of Super Rice to Raise Yield Ceilings in Irrigated/shallow Lowlands

Promising Culture: Semi-dwarf, non-lodging CR 2340-3 (IET 20151; IR 42241-80-2-3-1 / IR 52533-62-1-2-3-1) is promising for early transplanted conditions in Orissa and West Bengal. It yields 4.8 t / ha in 115 days. CR 2340-3 produces long slender grains and is resistant to stem borer and leaf folder, and moderately resistant to leaf blast, brown spot, neck blast, sheath rot, BPH and WBPH.

Selection and Evaluation of Segregating Materials: During *kharif* 2008, F_3 pedigree nursery was raised for selection of superior progenies from the segregating generation of 15 cross combinations involving high-yielding *indica* varieties and tropical *japonica* parental lines. Seventy promising single plants were selected on the basis of high grain number, long and heavy panicle, high grain filling percentage, intermediate plant height, leaf characters, strong culm and low disease and pest incidence for advancement to F_4 generation.

Table 7. Promising NPT lines nominated for AICRIP trials during *kharif* 2009.

Designation	Duration (days)	Yield (t / ha)	Trials
CR 2642	125	6.7	IVT-IME
CR 2463	127	6.5	IVT-IME
CR 2617	110	5.1	IVT-E
CR 2618	110	5.1	IVT-E
CR 2496	135	6.6	IVT-M
CR 2495	134	5.1	IVT-M
CR 2498	141	7.3	IVT-L

New Plant Type

Identified for Release: CR 2340-5 (IET 19816), was recommended for irrigated conditions in Maharashtra and Gujarat. It yields 4.9 t / ha in 135 days. The grain is long-slender with 65.7% HRR and 24.8% intermediate amylose. CR 2340-5 has resistance to leaf-folder and dead heart, and is moderately resistant to leaf blast, neck blast, sheath rot and white-ear head.

Twentyone NPT breeding lines were evaluated in *kharif* 2008. Seven promising lines were nominated for AICRIP trials under four different ecologies (Table 7).

Development and Evaluation of Superior Plant Types for Deepwater Ecosystem

Selection and Evaluation of Segregating Materials: During *kharif* 2008, 150 superior single plant progenies (F_5 generation) of 45 inter sub-specific derivatives were planted to select superior deepwater plant types. In the inter sub-specific crossing programme, three HYVs namely Gayatri, Vandana and Chakaakhi of lowland were used as female parents and 15 tropical *japonica* lines possessing traits such as more spikelets / panicle,

thick upright and broad leaf, long panicle and high seed test weight were used as male parents for generating 25 F_1 hybrids. Selection was carried out within and between 190 populations and 40 superior lines were advanced to F_6.

Biotechnological Approaches

DNA Fingerprinting of Rice Varieties, Hybrids and other Unique Germplasm and Development of Database

Thirtythree selected microsatellite primers were used to amplify 48 drought-tolerant genotypes. A total of 104 alleles were amplified with an average of 3.1 alleles / primer. Thirtytwo out of 33 primers amplified polymorphic alleles. Polymorphisn information content (PIC) varied from 0 (RM 189) to 0.964 (RM 444) indicating usefulness of microsatellite markers in evaluating diversity among the drought-tolerant genotypes. Based on the bands / alleles amplified by 33 microsatellite loci, each genotype could be differentiated and were grouped into four major groups at 50% level of genetic similarity. Genetic similarity varied from 0.261 in CR AC 224-969 (K 21) and in IC 516585 to 0.957 in RR 270-5 and G 22. DNA fingerprint (profiles) was developed.

Promising Lines for Resistance to BLB

CRMAS 2231-37 (IET 20668) developed through marker-assisted backcross breeding from IR 64 / IRBB 60 carries all the three important bacterial blight resistance genes, *xa5, xa13* and *Xa21*. It showed resistance to BLB over different locations and yielded 4 to 4.5 t / ha. It has all the agro-morphological and quality characters of IR 64. CRMAS 2231-37 was promising for BLB endemic areas of Uttarakhand and Andhra Pradesh.

Suitable for BLB endemic areas of Gujarat and Maharashtra, CRMAS 2232-85 (IET 20672) developed through molecular marker-assisted backcross breeding from Swarna / IRBB 60 yields 4.5 t / ha. CRMAS 2232-85 has the BLB resistance genes, *xa5, xa13* and *Xa21*. CRMAS 2232-85 has all the agro-morphological and quality chraacters of Swarna.

Gene Pyramid Development through MAS

Using marker assisted selection in three generations of backcrosses followed by two successive inter-crosses and two generations of selfing, gene pyramids with seven different genes were developed in the genetic background of four rice genotypes—Swarna, Tapaswini, IR 64 and Lalat.

In Swarna, seven plants homozygous for the alleles of seven resistance genes (*xa5 + xa13 + Xa21 + Pi2 + Pi9 + Gm1 + Gm4*), were isolated.

In Tapaswini, five plants homozygous for the alleles of seven resistance genes *(xa5 + xa13 + Xa21 + Pi2 + Pi9 + Gm1 + Gm4)* were identified.

The numbers of pyramid lines were comparatively less in IR 64 and Lalat. In Lalat, two plants homozygous for the alleles of seven resistance genes *(xa5 + xa13 + Xa21 + Pi2 + Pi9 + Gm1 + Gm4)* were isolated, only one homozygous plant for all seven resistance genes *(xa5 + xa13 + Xa21 + Pi2 + Pi9 + Gm1 + Gm4)* was isolated in IR 64.

Screening of Gene Pyramids

Tagging and Mapping of Tungro Resistance Gene: Out of an analysis with 583 SSR markers used for parental polymorphism survey, 84 showed polymorphism between the parental lines Tapaswini and IET 16952. Marker RM 297 located on chromosome 1 also co-segregated with the trait phenotype in the subset mapping population. To saturate the map information, seven SSR markers (RM 6569, RM 3709, RM 3632, RM 1216, RM 11701, RM 11702 and RM 11703) in the vicinity of the map location of the gene i.e. RM 297 were selected. Out of seven markers, in addition to RM 297, three SSR markers showed parental polymorphism (RM 6569, RM 11701 and RM 11702).These markers also exhibited clear co-segregation with trait phenotype. The map based sequence of rice genome indicated that the map position for Tungro resistance gene is around these SSR markers.

Doubled Haploid Breeding

Doubled haploids derived from seven different hybrid rice varieties were evaluated in the field (unreplicated) and 30 highly promising DH were iden-

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Using marker assisted selection in three generations of backcrosses followed by two successive inter-crosses and two generations of selfing, gene pyramids with seven different genes were developed in the genetic background of IR 64.

tified for further evaluation. The promising DH includes CRAC 2222-533, a derivative from PA 6201 that yields 5.5 t/ha in 140 days. DH CRAC 2224-1041, a derivative from KRH 2 yielded 4.5 t/ha in 118 days.

Morpho-physiological, Molecular Characterization and Development of Database for BLB

Ninetyseven bacterial blight isolates were collected from West Bengal and Orissa and maintained in the laboratory and in the nethouse. Thirty isolates were artificially inoculated for virulence on IR 8, IR 20, BJ 1, DV 85, Java 14 and Semposelak. On the basis of the reaction on the cultivars, pathotypes *xa 5, xb 1, xa17, xc 1, xb 9, xb 3,* and *xc 7* were identified. Pathotypes *xa 5, xb 1,* and *xa 17* were the most virulent types showing susceptible reaction on five cultivars out of six. Pathotypes *xc 1, xb 9* and *xb 3* were less virulent types showing susceptible reaction on four differentials. Pathotype *xc 17* was an avirulent type showing susceptible reaction only on two differentials.

Genomics and Biotechnology of Environmental Microbes

Characterization of cry *and* cyt *genes of* Bt: The eubacterial 27f and 1492r primers produced one 3 kbp size DNA of 71 Bt and proved their eubacterial identity. Out of 31 Bt, the CJl-1/CJI-2, cry10Aa1/cry10Aa2, cry3Aa1/cry3Aa2 and cry1Ac1/cry1Ac2 primed amplicons were *cry1, cry10, cry3* and *cry1Ac* of 2.1-2.4 kbp, 2-3 kbp, 2.5-3.5 kbp and 4-5 kbp sizes of 31 *Bt*, 4 *Bt*, 16 *Bt* and 15 *Bt*, respectively. The results proved that these would be effective against the lepidopteran, dipteran and coleopteran insects. The CJ4/CJ5 primers amplified *cry1Abc* gene in two bacteria of about

2.2 kbp sizes that differentiated from other *Cry1* toxin producing Bt isolates. The V(-)/V(+) amplified 3 kbp amplicons *cry1I* gene of 5 Bt. The gral-cyt(d)/gral-cyt(r) amplified 2.4-2.8 kbp amplicon *cyt1* gene in seven bacteria indicating effectiveness against the dipteran pests. The anti-nematode *cryV* gene could be detected from one bacterium measuring 1 kbp size by gral-nem (d)/gral-nem(r) primers.

Identification of Brown Spot Resistance and Deployment

Identification of Brown Spot Resistant Donors and Elite Germplasm: One thousand and six hundred lines comprising of germplasm, segregating breeding lines, advanced breeding lines coordinated nurseries (NSN1, NSN2, DSN and NHSN) were screened against brown spot in the nursery in *kharif* 2008. The disease intensity in nursery was high in check susceptible variety with score of 8-9. Entries CR 234067-9, G.P.Dhan, BAU GVT-435-06 Sasyashri and Nidhi were resistant among the early and very early group of entries in NSN 1 and CRR 393-2, CRR 375-1, CRR 455-109, CR 451-1-B-2 and CR 508-721-1-B were resistant in NSN 2.

Identification of QTLs Associated with Drought Tolerance: Development of Mapping Population

To identify QTLs for drought tolerance two populations of recombinant inbred lines (RILs) are being developed with Kalinga III as susceptible parent and Salumpikit and Moroberekan as donor parents (Kalinga III/Salumpikit and Kalinga III/Moroberekan). About 250 F_3 derived lines in each cross were generation advanced through single seed descent method.

Mapping and Functional Analysis of Genetic Loci Associated with BPH Resistance

Thirty two polymorphic microsatellite

Table 8. Top entries in different AICRP trials.

Trials/Number of entry	Promising entry/grain yield (t/ha)/flowering (days)	Best check (t/ha)
I VT-E Aerobic DS/24	IET 21182 (4.3/70) IET 21187 (4.9/70)	Annada (3.3)
IVT-IME Aerobic-DS/25	IET 21205 (4.7/68) IET 21213 (4.5/67)	Anjali (3.8)
AVT 1-E Aerobic-DS/6	IET 20623 (4.1/67) IET 20628 (4.3/64)	Naveen (4.1)
IVT-IME DS/81	IET 20991 (4.5/87) IET 20992 (4.1/86) IET 20973 (4.7/88) IET 21017 (4.3/111)	Lalat (4.3)
IVT-E DS/49	IET 21093 (4.3/92) IET 21097 (4.1/92) IET 21112 (3.8/97) IET 21082 (3.5/97)	Virendra (3.8)
AVT-VE DS/20	IET 19851 (4.3/58) IET 21053 (4.1/69)	Naveen (4.3)
AVT 1- E DS/7	IET 20405 (4.1/81) IET 20410 (3.9/76)	Satabdi (3.7)
AVT 1-IME-Aerobic DS/6	IET 20653 (4.7/67) IET 20655 (4.5/69)	Anjali (4.1)

Table 9. Top entries in AICRIP trials for irrigated ecology.

Trials/Number of entry	Promising entry/grain yield (t/ha)/flowering (days)	Best check (t/ha)
AVT 2 IME/7	IET 19741 (5.4/90) IET 19738 (5.2/88)	Naveen (LC) (4.9)
AVT 1 IME/25	IET 20426 (5.4/88) IET 20427 (5.4/90) IET 20561 (5.3/86)	Lalat (RC) (4.8)
IVT IME/81	IET 21018 (6.7/121) IET 21041 (6.2/91) IET 21017 (6.1/111)	IR 64 (NC) (4.5)

LC: Local Check. NC: National Check. RC: Regional Check.

markers were used to scan genomes of 175 F_3 lines of the cross TN 1/Salkathi and scored for segregation. For each co-dominant SSR marker, the individuals were coded as homozygous for the TN 1 allele, homozygous for Salkathi allele and heterozygous for both the alleles. The expected segregation ratio of codominant SSR markers of 1 : 2 : 1 (1 Homozygote with TN 1 allele: 2 Heterozygotes with alleles of both TN1 and Salkathi: 1 Homozygote with Salkathi allele) was tested with the observed ratio.

Simstat statistical package was used to analyze marker-trait association by linear regression method. The maximum percentage of death was 100 on the sixth day of infestation in TN 1, whereas, in Salkathi the maximum death was 29.33 on the sixth day. Death progresses as the days of exposure increases that reached a maximum on the sixth day of exposure. The percentage of death in F_3 lines displayed a non-normal distribution (skewness exceeding 1) on the third day and fourth day of exposure with individuals skewed towards the resistant parent. Eighteen markers showed negative regression with phenotype (% of death) at different days of infestation, whereas, 14 markers showed positive regression with phenotype on all days, from the third to the seventh day of infestation. The chi square test at nine loci out of 32 loci for observed ratio differed significantly from the expected ratio and skewed towards one or the other parent under study. These are the probable regions of segregation distortion. Further analysis showed five markers: RM 252, RM 470 (chromosome 4), RM 202, RM 286 (chromosome 11) and RM 432 (chromosome 7) are associated with resistance phenotype in Salkathi. The contribution of these markers, RM 252, RM 470, RM 202, RM 286 and RM 432 to the phenotype (% of death) was 8.27%, 8.71%, 1.32%, 1.48% and 2.97%, respectively. All these five markers in combination contributed to 14.5% of phenotype. Further contribution by two, three and four markers were analyzed.

Trials

Uplands

During *kharif* 2008, none of the entries were better than the regional check Vandana in terms of drought tolerance score or grain yield under stress in AVT-VE. But in IVT-VE, entries CRR 617-B-47-3, CRR 270-4, CRR 455-109, CRR 646-B-60-B and CRR 646-B-12-B gave more yield than the check Vandana under very severe reproductive stage stress with comparable drought

Table 10. Top entries in IVT-Deepwater trials in *kharif* 2008.

Entries	Plant height (cm)	DFF	Submergence tolerance	Elongation	Kneeing ability	Phenotypic acceptability	Yield (t/ha)
IET 20695	158	135	3	5	5	1	4.7
IET 20696	168	134	3	3	5	1	4.7
IET 20700	155	134	3	5	5	3	4.7
IET 20692	161	136	5	5	5	3	4.5
IET 20705	165	134	3	5	5	3	4.5
Jalmagna	163	137	3	3	5	1	3.3
Dinesh	156	136	3	3	5	1	3.4
Durga	152	140	3	3	3	1	3.5
CD 5%							NS
CV (%)							16.6

Table 11. Top entries in AVT 1 deepwater rice in *kharif* 2008.

Entries	Plant height (cm)	DFF	Submergence tolerance	Elongation	Kneeing ability	Phenotypic acceptability	Yield (t/ha)
IET 19646	166	138	3	3	3	1	4.5
IET 20220	148	132	3	3	5	1	4.5
IET 20214	148	127	3	3	3	1	4.4
IET 20216	147	134	3	3	3	5	4.2
IET 20217	152	135	3	3	5	3	4.2
Jalmagna	164	137	5	3	5	1	3.3
Dinesh	158	137	5	3	5	1	3.3
Durga	154	140	3	5	3	1	3.5
CD 5%							NS
CV (%)							15.9

tolerance score. These were identified as promising entries for rainfed uplands.

National (AICRIP) Trials

Two hundred and eighteen genotypes were evaluated in eight different trials. The top ranking two genotypes along with the best checks in different trials are given in Tables 8 and 9.

Table 12. Top entries in NSDWSN, *kharif* 2008.

Entries	Plant height (cm)	DFF	Submergence tolerance	Elongation	Kneeing ability	Phenotypic acceptability	Yield (t/ha)
IET 21142	148	138	3	7	7	3	5.7
IET 21121	132	132	3	7	7	3	4.9
IET 20389	135	127	3	5	5	3	4.7
IET 21165	152	127	3	7	7	3	4.5
IET 21166	148	106	3	7	9	5	4.4
Sabita	154	128	3	5	7	3	2.7
Purnendu	164	132	3	5	5	3	3.1
Durga	154	139	3	3	3	1	3.7
CD 5%							1
CV (%)							14

Table 13. Top entries in AVT 2 SDR, *kharif* 2008.

Entries	Plant height (cm)	DFF	Submergence tolerance	Elongation	Kneeing ability	Phenotypic acceptability	Yield (t/ha)
IET 19189	132	127	3	7	7	3	3.9
IET 20366	145	118	3	5	7	3	3.8
IET 19163	137	124	3	5	7	3	3.7
Sabita	142	124	3	5	7	3	3.2
Purnendu	152	128	3	5	7	3	3.2
Durga	148	136	3	5	3	3	3.4
CD 5%							NS
CV (%)							14.8

Lowlands

Initial Variety Trial Deepwater Rice: Initial deepwater rice trial was direct seeded during *kharif* 2008. The performance of the promising entries is given in the Table 10.

AVT 1 Deepwater Rice: Results of the promising entries of the AVT 1 (deepwater) conducted in *kharif* 2008 is given in Table 11. One test entry was in the third year of testing and the other five in the second year.

National Semi-deepwater Screening Nursery (NSDWSN): NSDWSN trial was direct seeded during *kharif* 2008 to evaluate the promising entries under semi-deepwater situation. The trial had 71 entries and three checks (Sabita, Purnendu and Durga). The performance of the promising entries is given in Table 12.

AVT-2 Semi-deepwater Rice: Result of the direct seeded trial in *kharif* 2008 is given in Table 13.

Improvement of Grain and Nutritional Quality

Breeding for Quality Rice

Hybridization

For improvement of aromatic rice through hybridization, 1,550 single plant progenies from 58 crosses in F_2 to F_7 generations were selected for advancement of generation. Three hundred and eightynine F_1 single plants were harvested from 23 crosses.

In order to generate new recombinants, 25 new crosses were attempted between selected donors (Sarala, Pooja, Gayatri, Swarna, IR 64/Chinikamini, Dhusara, Kalajeera, Katarani and Dubraj) and F_1 seeds were collected.

Mutation Breeding

Selection from gamma irradiated population of Dubraj, Kalanamak, Kalajeera, Ketekijoha and Chinikamini resulted in identification of 85 mutants from M_5/M_6 generation. These mutants had reduced height, reduced maturity period with erect plant type than the parents while retaining their unique grain quality.

Evaluation

Evaluation of 135 purified aromatic rice collections from Orissa and seed increase of 323 aromatic collections from Uttar Pradesh was carried out to record

In the aromatic short grain observation nursery various lines were evaluated.

Ravi Viswanathan

agro-morphological traits of the landraces for further purification. Wide variation exists among the aromatic landraces tested for the traits of plant height (110-190.1 cm), DFF (90-132 days), panicle length (18.1-32.2 cm), EBT / m^2 (180-350) and yield / ha (1.6-4.8 t / ha).

AICRIP Trials

APEDA: Aromatic trial (APEDA) was conducted to assess and compare the grain quality of eight aromatic and one non-aromatic rice varieties in three rice growing zones of the country at 16 locations. At CRRI, BPT 5204 was the highest yielder with 3.9 t / ha, followed by Geetanjali (3.2 t / ha), Pusa Basmati 1 (3.1 t / ha) and Vasumati (3 t / ha).

ASGON: The Aromatic Short Grain Observation Nursery (ASGON) trial consisted of 23 genotypes including eight aromatic landraces. At Cuttack, the top five were: IET 21059 (5.2 t / ha), IET 21053 (4.6 t / ha), IET 21058 (4.4 t / ha), IET 21062 (4.2 t / ha) and IET 21057 (3 t / ha).

The promising aromatic short grain entry CR 2616-3-3-3-1 (IET 21044) developed from Pusa 44 / Dubraj was promoted to IVT–ASG based on overall yield superiority of 10.99% over Ketekijoha, 18.6% over Kalanamak and 26.15% over Badshahbhog. It yields 3.7 t / ha in 118 days. CR 2616-3-3-3-1 has aromatic medium slender translucent kernel, with excellent desirable quality attributes.

Nomination to ASGON: The five promising aromatic cultures were CR 2613-1-5-2-7-2 (Ketekijoha / Randhuni Pagal) with 3.6 t / ha in 120 days, MS grain; CR 2613-1-5-2-5-2 (Ketekijoha / Randhuni Pagal) with 4.3 t / ha in 120 days, MS grain; CR 2664-1-8-2-1-2 (CR 689-116-2 / BR 9) with 3.6 t / ha in 125 days, SB grain; CR 2665-7-2-3-1-5-3 (CR 689-116-2 / Sitabhog) with 3.8 t / ha in 110 days, SB grain; and CR 2666-14-11-2-1-3 (BPT 5204 / Kalanamak) with 3.9 t / ha in 110 days, MS grain.

Development of HYVs with Good Grain Quality with Special Reference to Slender Grain

Three hundred and fifty F_1 single plants from 16 crosses were grown in the nethouse utilizing selected donors (Pusa 44, Gayatri, AC 39944, IRRI 55, IR 72, PR 111, Sarala, PR 113, PR 118 / Mahsuri, WGL 14, PKV HMT, AC 39944, Padmakeshari, Banskathi and Satabdi) and harvested. Selections from recombinant population generated from seven crosses in F_3–F_7 generations resulted in the collection of 338 single plants on the basis of semi-dwarf plant stature with slender grains.

Specialty Rices Nutritional Enrichment of Elite Genotypes with High Iron, Zinc and β Carotene

To develop high-yielding micronutrient dense varieties, selected varieties Pusa 44, Gayatri, NDR 359, PR 118, BPT 5204, Sarala, Swarna and MTU 1071 were hybridized with identified donors with high Fe / Zn in the kernel (Jalamagna, Basmati 370, Dhusara and Chinikamini). Three hundred and eightyfive F_1 plants were grown in the greenhouse and each plant was harvested individually for advancement of generation.

Grain Quality and Biochemistry

Biochemical Basis of Grain Quality Enhancement through Organic Management Practices

The experiment was carried out during *kharif* 2008 with the long slender scented variety Geetanjali grown under seven different organic treatments *viz.*, FYM, GM, FYM + GM, FYM + Azolla, crop residue (5 t / ha) + GM, Azolla + GM and crop residue (2.5 t) / ha (providing 60 kg N / ha) to assess the effect of different sources of organic nutrients on rice grain quality parameters. These treatments were compared with untreated control (NPK @ 0 : 0 : 0 t / ha) and the recommended dose of NPK @ 60 : 40 : 40 t / ha.

The results revealed a significant enhancement of grain quality over control due to application of different organic fertilizers (Table 14). There was no adverse effect of treatments on grain aroma. It was concluded that the treatments FYM alone and FYM + Azolla were helpful to improve rice grain quality.

Evaluation of Rice Germplasm and Advanced Breeding Lines for Grain Quality and Aroma

Five entries of advanced variety trial-2 Basmati (AVT-2 BT), 25 test entries of IVT-BT and three checks from the trials conduced during *kharif* 2008 at Kaul

Table 14. Grain quality parameters of long slender scented variety Geetanjali treated with different organic fertilizers.

Name	HRR (%)	WU (ml/100 g)	Amylose (%)	Amylopectin (%)	Amylose digestibility (%)	Sugar (%)	Starch (%)
T_1 Control	52.5	138	24.97	51.73	84.95	0.89	76.6
T_2 FYM	58.5	140	24.49	53.02	84.89	1.04	77.51
T_3 GM	58.5	127	24.95	49.2	87.81	0.99	74.15
T_4 FYM + GM	54.5	112	25.21	48.29	89.23	0.93	73.5
T_5 FYM + Azolla	60	145	24.49	51.82	91.11	1.34	76.31
T_6 Crop residue (5 t/ha) + GM	51.5	135	25.01	49.16	87.24	0.9	74.17
T_7 Azolla + GM	57	122	25.11	51.60	89.42	1.03	76.71
T_8 Crop residue (2.5 t/ha) + GM	55	112	25.32	52.48	87.75	1.39	77.80
T_9 Chemical	56.25	110	26.48	50.04	90.31	0.96	76.51
G Mean	55.91	127	25.11	50.81	88.08	1.05	75.93
CD at 5%	1.41*	4.7*	0.22*	1.01*	1.11*	0.03*	0.99*

were analyzed for 15 quality traits. The overall acceptability of the entries tested by a panel indicated that entry IET 20847 from IVT-BT was the best followed by IET 20834, IET 208420, IET 20830 and IET 20827. Among the entries of AVT-2BT, entry IET 19783 was the best followed by IET 19784 and IET 20292.

Eightyfive lowland rice genotypes under OYT from the Eastern-India Rainfed Lowland Shuttle Breeding Network, grown during *kharif* 2008 at CRRI, Cuttack were analyzed for quality features, cooking quality and chemical composition. The genotypes comprised of 16 long slender (LS), 20 long bold (LB), 22 medium slender (MS) and 22 short bold (SB) grain types along with five checks Savitri, Sabita, Swarna, Swarna-*Sub1* and Sarala. The study identified the following with the requisite quality characteristics LS cultures, CN 1357-1-3, NDR 8659 and NDR 8712; LB type cultures; CR 2008-111-4 and CR 2015-243; MS cultures OR 1234-18, NDR 8760 and LPR 08003; and SB cultures, CN 1343-3, CR 2241-7-2-2-1 and RAU 1421-1-3-1.

Biochemistry of High Protein Rices

Two high protein rice ARC 10075 and ARC 10063 from traditional ARC had 15.27% and 16.41% crude protein (%N x 5.95), respectively, in the grain on dry weight basis. SDS-PAGE of grain proteins showed that only one band was significantly thicker in the high protein cultivars, whereas, the others were similar to those present in the low protein cultivar ARC 10069. The cultivars were analyzed for individual protein fractions also. ARC 10075 and ARC 10063 had an additional slow moving globulin band. Besides one additional band, three glutelin polypeptides were found to be highly expressed in both the high protein cultivars. These additional bands might contribute to high grain protein content.

Biochemical Characterization of Rices for Micronutrients

Five hundred rice accessions from the CRRI Gene Bank were analyzed for Zn in the grain a variation of 15.28 ppm (ARC 12093) to 46.63 ppm (Subhadra) in

grain Zn content was observed among the cultivars / accessions screened. Notable among the accessions were Kakeri, ARC 12066, ARC 13192, ARC 11770 and Subhadra, which showed 40 ppm to 46 ppm Zn in the grain.

Cultivars differed widely with respect to the extent of Zn loss during milling, which ranged from 0.14% to 23.12% @ 5% milling and 6.56% to 27.56% @ 10% milling).

The least milling loss was observed in Kani Kuji (0.14% @ 5% and 6.56% @ 10% milling), whereas, Cha Cha (ARC 11922) showed highest loss of 23.12% @ 5% and 27.56% @ 10% milling.

The difference between 5% and 10% milling losses ranged from 2.12% (Yasoghi ARC 12901) to 19.37% (Kala Muli).

Identification of Upland Rice Germplasm for Suitability for Making Value Added Products (Beaten Rice and Puffed Rice)

A set of 13 upland rice germplasm comprising Kalinga III, RR 366-4, RR 366-7, RR 366-8, RR 385-249, RR 388-1-12, RR 388-2-7, RR 363-5, RR 361-2, RR 361-3, Pusa Basmati 1, RR 383-3 and RR 388-5 for value added product indexing and puffed rice were studied for variation in quality parameters. The puffed rice was prepared from the parboiled rice following the conventional procedure. The quality parameters used for the determination of puffed rice (*muri)* were lengthwise elongation (7.33-10.25 mm), breadth (2.5-3.56 mm), length / breadth ratio (2.47-3.49), 1,000-puffed rice grain weight (16.27-28.79 g), volume expansion (263.14-371.1 ml / 100 g) and appearance (2 to 3 in both whiteness and straightness). Puffed rice recovery varied from 69.84 -76.81%. Maximum recovery was recorded from Kalinga III followed by RR 383-3 and RR 388-2-7. Rice Pusa Basmati 1 was identified as the best one for the volume expansion trait (371.1 ml / 100 g).

Iron Metabolism in Rice Plant (*Oryza sativa* L) with Emphasis on its Translocation and Assimilation

Five hundred rice accessions were analyzed for grain Fe content. A variation of 3.26 ppm (ARC 12836) to 19.82 ppm (Samalei Bhog) in grain Fe content was observed among the cultivars / accessions screened. Jata Bhojan, Bargudi and ARC 12896 contained high (15-20 ppm) grain Fe.

ARC 11849, Ganjei Jota, Lata Sal, ARC 11563, Radha Bhog, Subhas Chandan, Basana Bhog and Senka had intermediate grain Fe content (12-15 ppm)

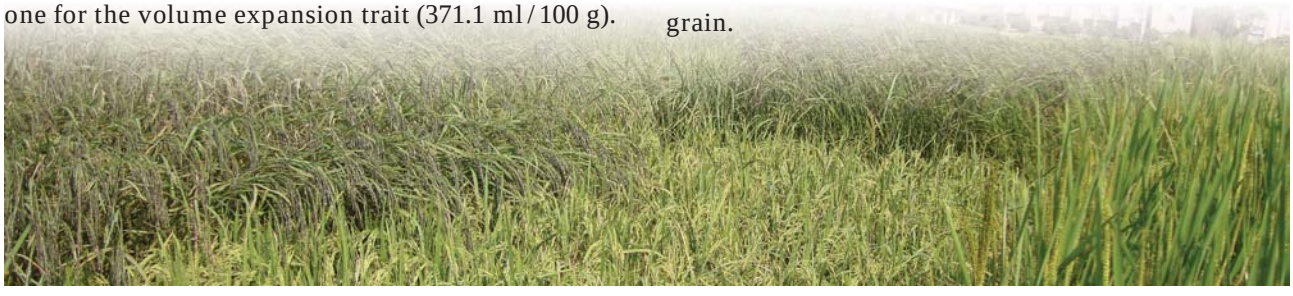
ARC 12836, ARC 12263, ARC 11833, ARC 11489, ARC 12764, ARC 11770, ARC 12976, EC 33602 and EC 291258A were poor in grain Fe content (3-5 ppm).

Cultivars differed widely with respect to the extent of Fe loss during milling (23.24% to 60.67% @ 5% milling and 36.43% to 76.87% @ 10% milling).

The least milling losses were observed with Kani Kuji @ 5% (23.24%) as well as 10% milling (36.43%), whereas, Lata Sal showed highest milling loss (60.67%) @ 5% as well as 10% (76.87%).

The difference between 5% and 10% milling losses ranged from 3.86% (ARC 13027) to 25.64% (ARC 13192). As compared to Swarna, Kalinga III that contains moderately high quantity of grain Fe was found to have higher quantity of Fe in the leaf (fully expanded young leaf), flag leaf and rachis. It appeared that both the cultivars had Fe in the vegetative parts in very low levels in the rachis and grain.

Ferritin levels varied in different plant parts. Kalinga III that had higher grain Fe content also had higher level of ferritin in the leaf (fully expanded young leaf), flag leaf and grain. The level of Fe in the vegetative parts of Kalinga III increased when it was grown in growth media containing up to 10 ppm Fe but no such response was observed in Swarna beyond 1 ppm; the situation however, was opposite with respect to grain.



Breeding for Resistance/tolerance to Biotic, Abiotic and Environmental Stresses

Identification of New Sources of Resistance/Tolerance to Pests and Diseases

Identification of New Sources of Resistance/ tolerance to Major Insect Pests

White-backed Plant Hopper (WBPH): Out of 70 germplasm including susceptible check TN 1 that was tested against WBPH under nethouse conditions. AC 837 was resistant (score 1) followed by AC 1477 moderately resistant (score 3) and the remaining entries were highly susceptible to WBPH.

A total of 120 entries from the CRRI genetic resources were evaluated against BPH. RM 5-209 were resistant with score 1. RM 5-205, RM 5-207, RM 5-208, RM 5-217 and RM 5-218 were moderately resistant (score 3). Out of 80 released varieties obtained from CRRI Division of Crop Improvement, IR 64 MAS and Hazaridhan scored 1, whereas CR 1980-1, Lalat MAS and CR Dhan 10 (Satya Krishna) had resistance score 3.

Identification of New Sources of Resistance/ tolerance to Blast

One thousand eight hundred and fourteen rice germplasm consisting of NSN 1 (193), NSN 2 (622), NHSN (76), DSN (43), CRRI collections (452), CRRI breeding materials (65), scented rice (143), hybrid rice (17), HYV (80) and IRRI materials (123) were screened against blast disease of rice in the UBN in *rabi* and *kharif* 2008. The most promising germplasm resistant / tolerant to blast are in Table 15.

Identification of New Sources of Resistance/ tolerance to Bacterial Blight

One thousand six hundred and eight germplasm

Table 15. Identification of new sources of resistance / tolerance to blast.

Source	Entries	Score
NSN 1	IET 19795, IET 20535, IET 20545, IET 20317, IET 20313, IET 20293, IET 20316, IET 20303, IET 20317, IET 20108	1
NSN 2	IET 20701, IET 20705, IET 20761, IET 20762, IET 20764, IET 20031, IET 20843, IET 20918, IET 21030, IET 21031,IET 21062, IET 21110, IET 21111	1
NHSN	IET 20734, IET 20735, IET 20736, IET 20742, IET 20743, IET 20722, IET 20731, Swarnadhan	1
DSN	None resistant / tolerant	-
CRRI HYVs	Shaktiman	1
	Utkalprava, Anjali, Panidhan, IR 64 Dhalaheera, Gurjari, Savitri, Ajay, Chandrama, Abhishek, Naveen, PR115, Samalei, Khira, Pathara, Tulasi, Vandana, Virendra and IRBB 60	2
CRRI hybrids	CRHR 26, CRHR 29, CRHR 34, CRHR 35, CRHR 38, CRHR 41	2
CRRI breeding materials	CR 2421-2, CR 2421-9, CR 2421-28, CR 2427-26, CR 2427-28, CR 2427-31, CR 2428-6, CR 2428-11, CR 2429-5, CR 2430-6, CR 2430-9, CR 2430-10, CR 2430-11, CR 2450-5, CR 2450-9, CR 2450-10, CR 2450-13, CR 2450-15, CR 2450-19	2
CRRI scented rice	None resistant / tolerant	-

Table 16. Identification of new sources of resistance / tolerance to bacterial blight.

Source	Entries	Score
NHSN	IET 20751, IET 20723	3
Virulence monitoring set (AICRIP)	IRBB 21, IRBB 50, IRBB 51, IRBB 52, IRBB 53, IRBB 54, IRBB 57, IRBB 58	3
CRRI collection	Chandan, Gautam, Krishna	3
CRRI breeding materials	CR 2424-9, CR 2421-10, CR 2421-16, CR 2421-27, CR 2421-28, CR 2421-31, CR 2423-10, CR 2427-26, CR 2427-28, CR 2427-31, CR 2428-1, CR 2428-6, CR 2428-15, CR 2428-20, CR 2429-11, CR 2429-12, CR 2429-13, CR 2430-6, CR 2430-7, CR 2430-9, CR 2430-10, CR 2430-11, CR 2449-1, CR 2450-2, CR 2450-7, CR 2450-12	3
DRR trial AVT-2	CRMAS 2231-36, CRMAS 2231-37, CRMAS 2231-48, CRMAS 2232-66, CRMAS 2232-71, CRMAS 2232-85, CRMAS 2621-7-2, CRMAS 2621-97, CRMAS 2621-12-9, CRMAS 2622-2-2, CRMAS 2622-43-5, CRMAS 2622-7-6, CRMAS 2622-1-2, IR 64, IRBB 60	1
NSN 1	None resistant / tolerant	-
DSN	None resistant / tolerant	-
CRRI scented rice	None resistant / tolerant	-
Hybrid rice	None resistant / tolerant	-

consisting of NSN 1 (193), NHSN (76), DSN (43), Virulence monitoring set (25), CRRI collections (1,048), CRRI breeding materials (65), DRR AVT-2 (21), scented rice (120) and hybrid rice (17) were tested for resistance to bacterial blight under artificial inoculation in the field. The promising entries are given in Table 16.

Identification of New Sources of Resistance/ tolerance to Sheath Blight

Out of 193 entries of National Screening Nursery (NSN 1), entries IET 19163, IET 19790, IET 20216, IET 20553, IET 19140, IET 20443, IET 20230, IET 20252, Pooja, Narendra 359 and Nidhi were tolerant to sheath blight disease (3 on SES).

Out of 76 entries of NHSN entries IET 20755, IET 20737, IET 20716, IET 20719, IET 20722, IET 20714, PA 6201 and IR 50 were tolerant to sheath blight (3 on SES).

Out of 43 entries of DSN entries TNRH 185, VL 30921, VL 30922, RNR 875, NGDP 1, Ajaya and IR 64 were tolerant to sheath blight disease (3 on SES).

Out of 17 entries of hybrid rice, entries CRHR 26, CRHR 29, CRHR 36, CRHR 41 and CRHR 44 were tolerant to sheath blight disease (3 on SES).

Identification of New Sources of Resistance/ tolerances to RTD

During *kharif* 2008, 460 rice genotypes consisting of AICRIP materials, CRRI cultivars and hybrids along with F_6 generation of nine crosses were screened under simulated tungro epiphytotic conditions at Cuttack. From screening of 193 entries of NSN 1 (inclusive of 38 checks) only three entries with one check had tolerant score of three on SES scale namely, IET 19790, NDR 9830145 and IR 6882-355-1-1-1-1. Entries IET 19163 and NDR 9830099 of cross combination IR 31238-474-3-PI / IR 41054-81-2—3-2 and entry 55 (IET 20561), CR 2502 of cross combination NDR9930077 / IR 2644-UBN-1-12) and entry 58 (IET 20427), NK 5048 and entry 173 Sasyasri with RTS score of 3 were highly promising, whereas, the remaining entries and checks had a score of 5, 7 or 9, hence considered susceptible to RTD at Cuttack.

From 57 entries of NHSN with 19 checks only one entry IET 20722 had tungro tolerant score of 3, whereas, the remaining had a tolerance score of 5, 7 or 9.

Under DSN, 33 entries from Coimbatore, VPKAS, Almora and ARI, Hyderabad were evaluated with 10 checks. As simulated tungro disease pressure was very high in the field only two entries TNRH 180 and TNRH 185 had a tolerance score of 5. The remaining entries and checks had a score of 7 or 9. The location specific severity index of RTD at CRRI was 7.6.

Breeding for Resistance to Major Insect Pests

Breeding for Multiple Pest Resistance with Special Emphasis on Yellow Stem Borer and Gall Midge

Generation Advancement of Existing Breeding Materials: Twentyeight crosses were advanced from F_3 to F_4. One hundred and twenty promising single plant progenies were selected from 28 crosses. The male parent of each cross is the donor for YSB tolerance. The single plants were selected on the basis of plant height, flowering duration, number of grains / panicle, panicles / plant and field tolerance / resistance to yellow stem borer attack.

Hybridization Programme for Population Approach: A population improvement work that started during *kharif* 2007 to develop a population possessing multiple resistance was continued in *kharif* 2008. Four donors of stem borer tolerance (B5332-13D-MR-1-1, Ramaboita, Ratna, R 729-45-3-2-3-1-1-1), donor for BPH (Salkathi), donor for gall midge (Abhaya) along with three high-yielding parents (CR 780-1937-2-1, Naveen and IR 64) were incorporated to genetic male sterile back ground though hybridization. During *kharif* 2008,

In the uniform blast nursery more than 1,814 germplasm were screened.

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Entries were screened for new sources of resistance or tolerance to RTD.

the F_1 populations mixed in equal proportion were transplanted for selfing purpose. The selfed seeds were collected in bulk for raising the recombination generation.

Breeding for Resistance to Major Diseases

Breeding for Multiple Disease Resistance with Emphasis on Bacterial Blight and Blast

Generation, Selection and Advancement of Breeding Material: New crosses were made involving Naveen, Geetanjali, Sarala, Durga and Varshadhan as recurrent parents and CRMAS 2231-48, CRMAS 2232-85 and IRBB 60 carrying bacterial blight resistance genes *xa 5, xa 13* and *xa 21* as donors for bacterial blight and C 101A51 (*Pi-2*), *O. minuta* der. (*Pi-9*) as donors for blast resistance.

Evaluation of Advanced Breeding Lines for Grain Yield and Bacterial Blight Resistance: Sixty advanced breeding lines selected from nine cross combinations involving donors with resistance to BLB such as IRBB 60, IRBB 8 and Ajay developed for BLB along with five checks were evaluated for grain yield and resistance to BLB in an unreplicated trial. Among the different entries tested CR 2421-28 (SES 3) gave the highest grain yield (5.7 t / ha) followed by CR 2421-16 (SES 3) and CR 2430-10 (SES 3) as against the best check Durga (SES 7) of 3.9 t / ha.

Advanced Variety Trial-NIL-Bacterial Leaf Blight (AVT 2-NIL-BLB): Twenty entries including 16 advanced breeding lines developed through marker-assisted backcross breeding (MABB) in the background of Swarna, IR 64, Lalat and Tapaswini along with five check varieties Swarna, IR 64, IRBB 60, Lalat, Tapaswini and a local check Surendra were tested. All the entries were artificially inoculated with a virulent isolate for bacterial blight resistance at the time of maximum tillering. Among the 22 entries, IET 20672 (CRMAS 2232-85) produced the highest grain yield of 4.1 t / ha as against 3.7 t / ha in the check variety Swarna

followed by other entries. This entry also scored 1 on SES scale for bacterial blight resistance.

Breeding for Resistance to Sheath Blight

The foundation population for male sterility facilitated recurrent selection approach was developed by bulking equal number of F_2 seeds from three crosses of genetic male sterile line (GMS) and sheath blight resistant donors IET 17885, IET 17886 and IET 19346. In this population 227 male sterile plants were identified, tagged and out-crossed seeds from sterile plants were harvested upon maturity to form the random mating population for the next cycle.

Four new donors Jogen (AC 40922), Mansarovar (AC 40844), Manoharsali (AC 40509) and ASD 18 (AC 40865) were resistant to sheath blight when screened in the nethouse under artificial inoculation. These resistant genotypes were crossed with GMS to develop foundation population for male sterility facilitated recurrent selection approach.

Breeding for Resistance to Rice Tungro Disease

Thirteen fixed cultures derived from crosses involving elite varieties such as Swarna, Pooja, Sarala, Tapaswini and RTD resistant donors such as IET 16952, Vikramarya, CR 682-165-1 and IET 16611 were grown in normal field condition for assessing yield performance. These cultures were also grown under simulated tungro epiphytotic condition for assessing degree of resistance. Four cultures from crosses Swarna / Vikramarya, Udaya / IET 16611, Sarala / CR 682-165-1 and Pooja / IET 16611 were highly resistant to RTD with good yield performance. The segregating generations of crosses involving elite varieties such as Swarna, Gayatri, Naveen and RTD resistant donors such as AC 290, AC 6078 and LPR 106-19 were screened for resistance to RTD during *kharif* 2008 and were advanced during *rabi* 2008-09.

Breeding for Tolerance to Major Abiotic Stresses

Breeding for Submergence Tolerance

Screening for Submergence Tolerance: Two hundred and eighteen germplasm lines were tested under direct seeding. Twenty days-old seedlings were submerged under 80 cm of water for 15 days. After 10 days of de-submergence the survival count was taken. The genotypes that were tolerant to complete submergence are given in Table 17.

Generation, Selection and Advancement of Breeding Material: Two hundred and sixtyeight single plant selections were made from 26 cross combinations developed for submergence tolerance involving donors for submergence tolerance such as IR 49830-7, IR 38784-15-19, IR 82809-237 and IR 84196-32 on the basis of tolerance to submergence and plant and panicle characters. Besides these selections, two mapping populations (IR 42 / Khoda and IR 42 / Kadara) for submergence tolerance and two mapping populations (IR

Table 17. Plant survival and elongation due to complete submergence.

Genotype	Plant height (cm)		Elongation (%)[1]	Survival (%)
	Before submergence	After submergence		
Kalaketaki	39	72	85	72
Asina	40	70	75	88
AC 38575	43	69	60	92
AC 37887	38	59	55	88
AC 39968	32	55	72	80
IR 42 (susceptible check)	32	59	91	16
FR 13A (tolerant check)	39	61	56	92
Sabita (elongating check)	43	102	137	75

[1]Elongation (%): (AS-BS) / BS*100; Survival percentage: (Number of hill before submergence / number of hills after submergence)*100.

42 / Atiranga and IR 42 / Matiaburusu) for regeneration ability were also generation advanced from F_4-F_5 through single seed decent (SSD) method.

AVT-Near Isogenic Lines (AVT1-NIL-Submergence): A set of three promising introgressed lines of *Sub1*, IET 20266 (Swarna-*Sub1*), IET 21247 (IR 64-*Sub1*) and IET 21248 (Samba Mahsuri-*Sub1*) along with the recurrent parents Swarna, Samba Mahsuri and IR 64 and two local check varieties (Pratikhya and Satabdi) were tested for grain yield and submergence tolerance under normal and stress conditions. Under submerged conditions all the introgressed lines showed significant yield advantage over the corresponding recurrent parents. Among the three introgressed lines CR 2540-1 (IET 21248) showed the highest survival of 59.7% followed by entry IET 21247 (54.5%) and IET 20266 (49.2%). All the check varieties showed less than 10% survival. Among the different entries IET 20266 had the highest grain yield of 4.3 t / ha as against the check Swarna (0.2 t / ha) There was not much difference in grain yield of the introgressed lines and respective recurrent parent under normal conditions.

From Genes to Farmers' Fields—Enhancing and Stabilizing Productivity of Rice in Submergence-prone Environments

Impact of Sub1 *on Yield and Yield Attributes:* Under favourable rainfed lowland situation introgression of *Sub1* did not show any adverse effects in relation to grain yield production under different days of sowing / planting (Table 18). The grain yield production was significantly higher at normal planting compared to delayed planting.

Under Stagnant Flooding Situation: Under stagnant flooding conditions grain yield was significantly higher in Swarna (3.2 t / ha), followed by IR 42 (2.9 t / ha) and

Rice varieties with and without *Sub1* were tested for submergence tolerance.

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Table 18. Grain yield under different days of sowing / planting of the rice cultivars with and without *Sub1* under favourable rainfed lowland conditions.

Cultivars	T[1]	T[2]	T[3]	Average
FR 13A	3.08	1.94	2.27	2.43
IR 64	3.13	2.74	2.35	2.74
IR 64-*Sub1*	3.36	2.91	2.08	2.78
Samba Mahsuri	3.12	2.79	3.09	3
Samba Mahsuri-*Sub1*	3.58	2.91	3.56	3.35
Swarna	5.08	3.26	4.25	4.25
Swarna-*Sub1*	5.16	3.65	4.4	4.4
IR 42	3.55	2.96	2.66	3.06
LSD p*<0.05	0.51	0.45	0.44	

Date of sowing: T[1] 9 Jun, T[2] 29 Jun and T[3] 18 Jul.
Date of transplanting: 9 Jul, 28 Jul, and 18 Aug.

FR 13A (2.4 t / ha) than other cultivars. Cultivars with *Sub1* yielded less under stagnant flooding conditions than the cultivars without *Sub1*, especially in Swarna-*Sub1* (2.1 t / ha).

*Evaluation of Swarna-*Sub1 *under On-farm Trials:* Twelve entries including Swarna-*Sub1* were evaluated at Nuagaon (Jajpur district) and KVK, Nimakana (Jagatsinghpur district) during *kharif* 2008 (Table 19). The same set was also evaluated at CRRI, Cuttack. At Nuagaon, the crop was under submergence for more than two weeks. Among the different entries Swarna-Sub-1 gave the highest yield of 3.8 t / ha followed by OR 2162-5 (3.5 t / ha) and CR 2340-5 (2.9 t / ha) as against the best check Banksarua (2.8 t / ha) and Swarna (2.1 t / ha). At KVK, Nimakana, the experiment did not experience any submergence. In general the yields were high. Among the different entries Swarna-*Sub1* gave the highest yield of 7.3 t / ha followed by OR 2162-5 (7 t / ha) and CR 2340-5 (6.8 t / ha) as against the best check Pratikshya (6.7 t / ha) and Swarna (6.3 t / ha). At CRRI, Cuttack Swarna-*Sub1* gave the highest yield (5.7 t / ha) followed by CR 2340-5 (5.6 t / ha) and IR 49830-9 (5.6 t / ha) as against the best check Swarna (5.6 t / ha).

Physiology of Abiotic Stress Tolerance

Mechanism of Multiple Abiotic Stress Tolerance in Rainfed Lowland Rice

Testing of Pokkali Accessions for Submergence Tolerance: Fortytwo accessions of Pokkali were tested for submergence tolerance. Accession AC 39416 exhibited more than 90% survival. The elongation due to submergence was 131%. Line, AC 39416 appeared to be tolerant to stagnant water flooding.

All India Coordinated Rice Improvement Programme (AICRIP), *Performance of NILs under Normal and Simulated Flash Flood Conditions:* Cultivars with *Sub1*showed greater survival percentage due to complete submer-

Table 19. Performance of Swarna-*Sub1* in different locations during *kharif* 2008.

Designation	Yield (t / ha)			
	Nuagaon[1]	KVK, Nimakana	CRRI, Cuttack	Mean
IR 53945-CN-35-53	2.8	6.5	5.3	4.8
IR 69973-CN-8-35-1	2.2	5.2	5	4.1
OR 2162-5	3.5	6.9	4.6	5
OR 2119-13	2.6	6.1	4.8	4.5
OR 2315-6	2.1	6.8	5.1	4.7
CR 2340-5	2.9	6.8	5.6	5.1
CR 2458-72	2.5	5.9	5.3	4.6
CR 2009-4	1.9	6.8	5.5	4.7
IR 49830-7	2.9	6	5.6	4.9
Swarna-*Sub1*	2.1	7.2	5.7	5.6
Swarna	2.1	6.3	5.6	4.7
Banksurua	2.8	6.7	1.8	3.8
Mean	2.7	6.4	5	4.7
LSD (5%)	753	1610	590	-
CV (%)	16.7	11.3	6.9	-

[1]Experiment was under submergence for more than two weeks during September.

gence treatment. The survival percentage was greater in FR 13A (93%), followed by Swarna-*Sub1* (92 %), IR 64-*Sub1* (90 %) and Samba Mahsuri-*Sub1* (86 %). The survival percentage varied from 8% to 33 % in cultivars without *Sub1*. Swarna-*Sub1* outyielded other cultivars both under normal (5.2 t / ha) and simulated flash flood (4.3 t / ha) conditions.

Identification of Germplasm/breeding Lines for Drought Tolerance at Seedling and Reproductive Stages and Mechanism of Drought Tolerance

Identification of Germplasm/breeding Lines for Drought Tolerance at Vegetative Stage: A set of 205 lines were screened for vegetative stage drought tolerance under field condition during *rabi* 2008-09. Four tolerant checks Salumpikit, Vandana, Vanaprabha and CR 143-2-2, and one susceptible check IR 20, were randomized six times each in each replication. Thirty days-old seedlings were subjected to drought stress by withdrawing irrigation water for more than 30 days till the susceptible check IR 20 showed permanent wilting and then re-watered for recovery. Soil moisture decreased from 35% to 10.2% up to 45 cm soil depth. The drought scores and recovery data were taken as per IRRI SES method, 1 to 9 scale. Out of 204 germplasm lines including five checks screened under field condition during *rabi* 2008, 126 entries were identified as drought tolerant against susceptible check IR 20.

Evaluation of Drought Tolerant Lines for Yield Potential: Fortyeight identified drought tolerant lines were evaluated for yield potential under rainfed uplands during *kharif* 2008. Out of 48 genotypes 10 entries had higher grain yield of > 3 t / ha and 11 entries > 2.5 t / ha. The highest grain yield was obtained in CRR 270-5 (3.8 t / ha) followed by RR 383-2 (3.5 t / ha).

Evaluation of Elite Lines for Drought Tolerance (AICRIP Trial): Out of 48 promising entries for rainfed uplands IET 21076, IET 21081, IET 21089, IET 21094, IET 21095, IET 21106, IET 21108, IET 21112 and IET 21117 had higher germination percentage under low osmotic potential (-6, -8, -10 bars) that indicated the inherent drought tolerance. It also suggested a possibility to use germination test under PEG induced low water potential as a screening tool. Grain yield ranged from 1.1 t / ha to 4.8 t / ha. IET 21105 had the highest grain yield (4.8 t / ha) with highest HI (0.43) and ripening percentage (78%). IET 21095 had the lowest grain yield (1.1 t / ha), and the lowest HI (0.14). Check Annada was par with IET 21105 in grain yield.

Physiological Basis of Grain Yield under Aerobic Conditions

Effect of Alternate Wetting and Drying Condition on Growth and Yield of Rice Varieties: Ten varieties including five rice hybrids PHB 71, PA 6201, PA 6444, CRHR 7, CRHR 5, two HYVs MTU 1010, Krishnahamsa, Satabdi and two check varieties Jaya and Naveen were grown in the field in two separate independent RBD sets with four replications each during *rabi* 2008-09. Alternate wetting and drying (AWD) irrigation schedule was given in seven days interval in aerobic plots and in three days interval in control plots. Though varietal difference for grain yield and yield attributes exists among the varieties under the treatments, yield loss under aerobic treatments was non-significant. PA 6444 gave the highest yield of 6.3 t / ha followed by PHB 71 (5.9 t / ha) under aerobic condition, which might be contributed by high biomass with higher ripening percentage. CRHR 7 recorded the least decline of 1.87% indicating its suitability to grow under aerobic condition. Water 35% was saved at the cost of 6.12% loss yield.

Photosynthetic Efficiency and Low Light Adaptability for Higher Grain Yield in Hybrid Rice

Photosynthetic Efficiency and Productivity of Rice Hybrids under Different Irradiance Level: In an experimental plot at CRRI, Cuttack, hybrid PHB 71 yielded 8.7 t / ha in the control (100%; 1,300–1,400 µ mol m^2 / s solar radiation), 6.7 t / ha (75%; 950–1,050 µ mol m^2 / s radiation), 5.7 t / ha (50%; 650–700 µ mol m^2 / s radiation) and 4.8 t / ha (25%; 350–400 µ mol m^2 / s radiation). Hybrid Rajalaxmi yielded 9.1 t / ha (100% radiation), 6.5 t / ha (75% radiation), 5.5 t / ha (50% radiation) and 4.5 t / ha (25% radiation). Hybrid Ajay gave 8.3 t / ha (100% radiation), 6.6 t / ha (75% radiation), 5.5 t / ha (50% radiation) and 4.8 t / ha (25% radiation).

Natural Resource Management and Input-use Efficiency for Improved Crop Production

Enhancement of Resource-use Efficiencies

Increasing Nutrient-use Efficiency in Irrigated Rice-based Cropping System

Under irrigated condition rice Swarna yielded 6.1 t / ha when the crop was treated with sub-surface placement of basal PU @ 60 kg N / ha followed by top-dressing 21 days after planting @ 30 kg N / ha and 30 kg N / ha in PI stage. The N uptake was 66.6 kg N / ha.

Evaluation and Suitable Modification of SRI Technology

The effect of plant spacing, age of seedlings, number of plants / hill and nutrient level on grain water-use efficiency (WUE) in SRI and traditional system of rice cultivation was compared through component analysis with Varshadhan as the test variety. It was found that hill spacing of 15 cm x 20 cm (33.3 hills / m^2) with single plant per hill resulted in the highest yield of 5.2 t / ha. Transplanting 16 days-old seedlings was ideal that produced a grain yield of 5.9 t / ha. When one seedling per hill was transplanted the yield was 5.2 t / ha. There was no additional advantage if the number of seedlings increased to three as the yield gain was only 6%. A dose of NPK @ 60 : 30 : 30 kg / ha produced 35% higher yield and improved WUE. The yield increased from 3.3 t / ha in the control to 5.1 t / ha. The yield reduced at the level of higher nutrient level due to lodging. Three hand weeding increased the yield and WUE by 67% compared to unweeded check.

Nutrient Management for Organic Rice

Comparison of the eight organic nutrient management treatments for the yield of scented rice variety Geetanjali showed that FYM and oil cake application in 1 : 1 ratio @ 60 kg N / ha resulted in maximum grain yield and N uptake by rice. However, the grain yield of the treatment containing FYM application alone was on par. The grain yield at maturity varied from 2.2 t / ha in control to 2.9 t / ha. This was possible due to optimum availability of N in soil resulting from the application of readily mineralizable organic source of N

The effect of plant spacing, age of seedlings, number of plants/hill and nutrient level on grain water-use efficiency in SRI and traditional system of rice cultivation was compared.

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(oil cake) and / or a slowly mineralizable source of N (FYM).

Standardization of Agro-management Practices for Organic Rice Production

When performance of two cultivars Chinikamini and Katrani was compared under four dates of planting and two crop configurations under organic management conditions grain yield was significantly higher in the range of 3.4 t / ha to 3.6 t / ha till planting up to third week of Jul. Delayed planting caused 17% and 11% yield decline for Katrani and Chinikamini, respectively. When planting was delayed, paired row planting method caused 12% less yield than the usual planting method, which resulted in 16% yield reduction. At normal crop configuration, yield of Katrani was better than Chinikamini by 8%, whereas, at paired row planting method the grain yield of two varieties were at par.

AICRIP—Agronomy Trials

Nitrogen Response: The N response of selected AVT-2 rice cultures were evaluated in several rice ecosystems in *kharif*. In AVT-2 (medium), IET 19140 and IET 18646 produced maximum yield of 4.6 t / ha and 4.3 t / ha, respectively, and responded to 12 kg N / ha.

In AVT-2 (late) group, the performance of Swarna, IET 19913 and Savitri was the best that produced highest grain yield of 5.5 t / ha, 5.5 t / ha and 5.5 t / ha, respectively. There was also response up to 120 kg N / ha.

In AVT (deepwater), the N response was up to 60 kg N / ha. IET 19646 performed the best by yielding 4.9 t / ha.

In AVT-2 (coastal saline) the N response was up to 60 kg N / ha. The best varieties were IET 18695, IET 1869, and IET 19468 yielding 3.6 t / ha, 3.4 t / ha and 3.4 t / ha, respectively.

Agrotechniques for Aromatic Rice: Results of the effect of dates of planting and nutrient management practices on aromatic rice variety Kalajeera indicated that planting on 21 Jul or 31 Jul significantly increased yield in comparison to other planting dates. The yield of these two treatments was 2.7 t / ha to 2.8 t / ha. The interaction of the nutrient management practices and dates of planting was significant. The maximum grain yield was obtained from the application of recommended fertilizer dose or from 50% recommended fertilizer dose supplemented with the rest of N by FYM or 100% nitrogen from organic sources. The benefit : cost ratio of organic rice was 2.96, which was highest of all the treatments.

Rhizosphere Effect on Soil Chemical Environment and Nutrient-use Efficiency for Sustainable Rice Production

The nature and magnitude of organic acid exudates released from the rice roots in soils of varying P status was examined (Table 20). The organic acid exudates increased from vegetative to flowering stage in all rice varieties in all the soils. IR 28 released higher quantity of root exudates during crop growth period than rice IR 36 and Dular. The P status of the soils affected the quantity of exudates at vegetative, PI and flowering stages of three rice varieties. The release of root exudates was high in P deficient Khuntuni soil at all stages of crop growth. These values reduced if the available P content of the soil increased as in Ranital and CRRI soil. The citric and acetic acid content of the root exudates were very low at all growth stages. There was higher content of tartaric and malic acid. The quantity of tartaric acid (14.8-26.4 m mol / plant / day) and malic acid (10.3-35.5 m mol / plant / day) in the root exudates at maximum vegetative stage was low in comparison to PI and flowering stages. The tartaric acid content increased for 12.6 m mol / plant / day to 35.7 m mol / plant / day at flowering stage with similar trend in malic acid content that increased to 12.2 m mol / plant / day to 89.5 m mol / plant / day. The malic acid content of the root exudate at any growth stage was higher in IR 28 than to tartaric acid, whereas reverse was true for rice variety IR 36 and Dular.

Nutrient Management Strategy for Rainfed Upland Rice

Organic Manure and Lime induced Changes in Soil Phosphorus and Upland Rice Productivity

Chemical analysis of soil revealed that the soil wa-

ter pH, normal KCl pH, available P and K were influenced by the application of organic manure. The green manure was applied in the form of sunnhemp. The soil pH, available P and K increased with the application of green manure compared to no green manure plots. But the plots treated with lime recorded more soil pH than that of organic manure plots. It indicates that sunnhemp incorporation as green manure had liming effect. With very simple methods, the delta pH of soil was also recorded and the delta pH was always negative. In the plots where rice Brown Gora was grown the delta pH was higher in green manured plots than that of limed and non-limed plots but in Vandana grown plots the trend was reverse. It showed that not only green manuring, liming or no liming influenced the soil pH but also the rice variety grown with similar treatments.

Upland Rice Productivity under different Cropping Systems with Liming and Nutrient Application

The rice crop was sown in *kharif* 2008 after the harvest of pigeonpea and rice, grown in *kharif* 2007 with the application of N 0 : P 0 : K 0, N 30 : P 30 : K 20, and N 40 : P 30 : K 20 + lime. Results showed that the rice yield of legume-based system were more by 23.5%, 35.5%, and 4% with the application of N 0 : P 0 : K 0, N 30 : P 30 : K 20 and N 40 : P 30 : K 20 + lime, respectively than that of rice-rice system. Comparison between no fertilization and fertilizer doses of NPK un-

Table 20. Organic acid contents in root exudates of rice varieties in flooded soils with different in available P status.

	Organic acid content (mol / plant / day) in root exudates					
	Tartaric acid			Malic acid		
Rice	21 DAT	PI stage	Flowering stage	21 DAT	PI stage	Flowering stage
Khuntuni soil (P-deficient)						
IR 28	26.4	31.4	35.7	35.5	44.9	89.5
IR 36	22.4	34.4	21.5	18.3	22.6	36.3
Dular	24.1	29.7	26.7	20.7	22.4	24.4
CD (5%)		1.2			0.59	
Ranital soil (P-medium)						
IR 28	20.1	25.3	28.3	24.2	33.6	63.2
IR 36	18.3	28.5	33.8	13.5	18.3	15.3
Dular	18.9	31.1	33.9	14.1	15.1	12.2
CD (5%)		0.17			0.18	
CRRI soil (P-sufficient)						
IR 28	16.8	20.6	23.2	12.4	14.3	30.6
IR 36	14.8	20.6	12.6	10.3	15.6	17.6
Dular	15.6	20.7	19.3	11.6	15.8	16.0
CD (5%)		0.43			0.44	

der different cropping system revealed that the yield of rice increased by 33.3% and 90.2% under rice-rice system and 46% and 60.3% over control plots under pulse-based system with the application of N30 : P30 : K20, and N40 : P30 : K20 + lime, respectively. It indicates that under pulse-based rice system, even in control plots, the yield was more than that of rice-rice system. This study revealed that the lime application and introduction of pulse in cropping system could be beneficial for the sustained productivity of upland.

It was also recorded that the rice crop suffered from drought when no rainfall was received from the day of flowering to maturity. Inspite of severe drought during reproductive stage (flowering to maturity), rice grain and straw yield were more in legume-based system than that of rice-rice system. Due to drought during maturity stage, the panicle length and 1,000 grain weight were reduced drastically.

Effect of Phosphorus and Green Manuring on Soil Health in Upland Ecosystem

The soil samples from the phosphorus (0 kg / ha, 20 kg / ha, 30 kg / ha, 40 kg / ha and 60 kg / ha) and green manure and without green manure applied plots were collected for the analysis of soil pH, available P and K. The green manure was applied in the form of sunnhemp 30 days after germination. The P was applied in the form of SSP. The results revealed that the soil pH, available P and K increased with the application of green manure. The increase in soil P and K was prominent at lower levels (0 kg / ha, 20 kg / ha and 30 kg / ha) of applied P. The P and K uptake by rice grain and straw was more with the application of green manure.

Development of Production Technologies for Aerobic Rice

Development of Agro-management Practices for Aerobic Rice and Water Saving

Response of promising aerobic rice genotypes to variable methods and levels of N management was studied under aerobic condition during *kharif* and *rabi*. During *rabi* 2008-09, the maximum NUE of hybrid Ajay @ 120 kg N / ha was 29 kg grain / kg N that produced the maximum yield of 5.3 t / ha. During *kharif* SPAD based N application produced comparable yield at 120 kg N / ha for inbred, whereas Ajay responded up to 140 kg N / ha using SPAD based N application. The maximum NUE was 29 kg grain / kg N for IR 74371-3-1-1.

Integrated Tillage and Crop Management for Efficient Water Productivity

Effect of deep tillage to the depth of 18-20 cm was compared with conventional tillage to the depth of 6-8 cm for WUE of variety Naveen and Anjali under three levels of irrigation management 5 cm ponding water, irrigation at safe AWD and at AWD. Results showed no significant yield difference due to variable tillage operations. Irrigation at safe AWD produced yield of 4.3 t / ha comparable with normal irrigation, while AWD caused yield decline by 21%. The WUE in safe AWD under deep tillage condition was 4 t / ha applied water that saved 53% water. The grain yield of Naveen was 18.5% higher than Anjali.

Microbial Resource Management and Diversity Analysis

Microbial Resource Mapping of Indian Rice Soils

Microbial Dynamics in Different Coastal Rice Soils: In the coastal rice soils of Namkhana, Dhunchi, Kakdweep 1, Kakdweep 2, Ramganga and Susunia in the Sundarbans, West Bengal, the populations ($x10^6$ cfu / g soil) of aerobic (24.2–159.3) and anaerobic (24.1–48) heterotrophs, aerobic (4.9–45.1) and anaerobic (23.5–41.2 spore formers, copiotrophs (6.8–9.1), oligotrophs (4.2–8.1), Gram (-)ve (11.4–13.4) bacteria, nitrifiers (0.1–187.2), denitrifiers (6.25–35.75), PO_4 solubilizers (2.3–6.1), asymbiotic N_2 fixers (2.3–44.8), sulfur oxidizers (15.5–29.5), actinomycetes (0–0.01), fungi (0–0.01) and fluorescent *Pseudomonas* spp. (0.01–0.02) were highly variable. The dynamics of the microbial guilds did not follow any common trend at different locations.

Characterization of ACC Deaminase, IAA Producing and P Solubilizing Bacteria: From the soils of Namkhana, Dhunchi, Dhunchi 1, Ramganga, Ramganga 1 and Susunia in the Sundarbans, West Bengal, and

Baliapala, Chandipur, Kashaphala, Talapada, Talasari, Humma, Chilika and Ganjam, Orissa, 331 bacteria were isolated. Out of them, 78 isolates (IAA 1–78) produced IAA and 39 isolates (ACC 1–39) produced ACC deaminase. Furthermore, four isolates (SAL 1–4) tolerated 12%, 10%, 6% and 5% NaCl respectively; two isolates (SAL 5 and SAL 6) tolerated 11% and 8% NaCl respectively; two isolates (SAL 7 and SAL 8) tolerated 9% NaCl and eight isolates (SAL 9 to 17) tolerated 7% NaCl.

Molecular Diversity of Fluorescent Pseudomonas *isolates*: Diversity of the fluorescent *Pseudomonas* spp. (Ps) of coastal rice soils of Namkhana, Dhunchi, Kakdweep 1, Kakdweep 2, Ramganga and Susunia was analyzed for 16S rRNA, ARDRA and phenazine (*phz*) genes. The amplicon sizes of the Ps genome for universal eubacterial (27f / 1492r) and Ps specific 16S rDNA (fD1 / rD2) primers were 2.88 kbp and 3 kbp, respectively. The ARDRA patterns of the *Eco*RI, *Bam*HI, *Hind*III, *Pst*I and *Alu*I restricted fD1 / rD2 primed amplicons were different among the isolates. The *Bam*HI had no recognition site on the amplified fractions. The phenazine primed (PHZ-up / PHZ-low) amplicons of the Ps were about 445 bp, whereas, the *PHZ*1 / *PHZ*2 primers produced 2-4 amplicons of 0.14-35 kbp sizes. Difference of the ARDRA pattern proved that the Ps isolates were genetically diverse. Presence of *PHZ*1 / *PHZ*2 primer recognized DNA fractions proved that the active principles of the isolates were phenazine group of compounds. The metagenome of both of the rhizospheric and non-rhizospheric soils was 21 kbp size.

PGPR Activity of the IAA and ACC Deaminase Producing Bacteria: Root growth (111–127.2%), root fresh weight (105–136.1%), shoot length (142.2–167%) and chlorophyll a (110.1–134.4%) contents of the rice plants were enhanced by 7, 6, 4 and 2 IAA producing isolates (isolates IAA 1-7, 8-14, 15-19, 20-21), respectively. Similarly, root growth (103.2–122.2%), root fresh weight (104.1–161.1%), shoot length (112.3–171.1%) and chlorophyll a (111-124%) contents of the rice plants were enhanced by 5, 4, 4 and 3 ACC deaminase producing organisms (ACC 1-5, 6-10, 11-15, 16-19), respectively. Out of 230 (Ps140-370) *Pseudomonas* isolates, 4, 14, 13 and 2 isolates tolerated 12%, 9%, 6% and 8% NaCl, respectively and 14 isolates solubilised 12–27% of the insoluble tricalcium phosphate in liquid medium.

Role of Microbes in Nutrient Acquisition and Plant Growth Promotion

Plant Growth Promotion by P Solubilizing Bacteria: From the rice soils of Erasma, Khola, Talchua, CRRI and Canning, 76 phosphate solubilizing bacteria were isolated that mineralized 1.05–61.23 µg / ml calcium phosphate. Out of them, *Bacillus megaterium* and *Enterobacter* sp. were most potent. They were tested in the net house for their growth promotion effect using 10 different rock phosphates ((North Carolina, Florida Central, Tennessee, Jhamarkotra, Morocco, Gafsa, Meghanagar grade III, Meghanagar grade I, Idaho and Missouri). The most effective isolate was identified by 16S rRNA gene analysis to be *B. megaterium* and *Enterobacter* sp.

Pesticide Biodegradation in Rice Soils

From the soils of Hazaribag (HBZ 1-2), CRRI (CRRI 1-4) and Ranital (Rani 1-3) Chlorpyriphos degrading bacteria were isolated. The Hazaribagh isolates HZB1 and HB2 detoxified 10 µg / ml Chlorpyriphos to 9 µg / ml and 9.64 µg / ml pesticides, respectively in 15 days. The T½ of detoxification of the isolates was 4 d and 3d, respectively. The Hazaribagh isolates were identified as *Inculimus* sp. and *Labrys* sp.

Microbial Function in Biogeochemical Cycling of Nutrients in Rice Soils

The total chemically extractable iron in six rice soils, rice from CRRI, Hazaribagh, Gerua, Bhubaneswar and Tamil Nadu were analyzed. The least concentration was observed with the saline soil from Canning (S-CAN), whereas, the highest quantity was in the alluvial soil of Hazaribagh (427 µmol / g) (A-HZR). The ratio of non-crystalline to crystalline form of Fe was highest in the saline soil of Canning (S-CAN), whereas the least was in the Zn-deficient soil from Ranital (Zn-d-RAN). DGGE analysis of soil microbial community in these soils showed remarkable changes with respect to the number of bands and intensities of individual profile of each soil. Cluster analysis with UPGMA method that the laterite soil of Hazaribagh (L-HZR)

had a distinct microbial community structure. The microbial community structures of A-CRRI and L-BBSR formed a single subcluster, whereas S-CAN and AS-KER formed another subcluster along with A-GER. Other soils such as A-HZR, Zn-d-RAN and L-TN clustered together, suggesting that the diversity in microbial community structures was more dependent on soil types and geographical locations.

Entomopathogenic Microbes in Rice Ecologies

Diversity Analysis of Entomopathogenic Microorganisms in Rice Ecosystems

Assay of Virulence of Bt *against Stem Borer:* In the laboratory, out of 19 indigenous Bt isolates (Bt 220-238), isolates (Bt 232, Bt 233 and Bt 238) killed 100% third instar stripped borer (*Chilo suppressalis*) larvae @ 7.86–58.6 x 10^8 bacteria / ml assayed by cut stem test. The LC_{50} of the bacteria were 4.29–5.11 x 10^5 bacteria / ml. The organisms were more effective than Biolep that killed 75% larvae with same dose.

Nature of the Fungal Entomotoxins: Fungus *B. bassiana* was effective against BPH, and *N. rileyi* and *M. anisopliae* against LF. The active principles of the fungi were the extracellular enzymes namely protease, lipase, chitinase and lecithinase. The range of chitinase activity of the three fungi was 0.46–0.52, lipase activity was 0.09–0.88 units / mg protein / h and the protease activity was 0.09–0.16 mg BSA equivalent / mg enzyme / h. No correlation could be made with enzyme activity and virulence of the pathogens.

Survival Assessment of the Fungal Entomopathogens to develop the Mass Production Strategy: Survival of the entomopathogens viz. *M. anisopliae* varied between 24 and 60 months, *B. bassiana* between 47 and 61 months, *N. Rileyi* between 3 and 12 months, *Fusarium* sp. between 3 and 29 months and *Verticillium* sp. between 10 and 19 months on nutrient agar (NA), Saboured glucose yeast extract agar (SGYA), soil extract agar (SEA), malt agar (MA), potato dextrose agar (PDA), rice grain (RG) and wheat grain (WG) media at 4°C. The PDA, SGYA, SEA and MA were equally effective for survival of the pathogens. The grain (solid) media were not suitable for storage of the fungi. The pathogens survived 3–16 months more at -20°C but all of them died within eight months at 27°C (RT). The older cultures of *M. anisopliae, B. bassiana, Fusarium* sp. and *Verticillium* sp. produced antimetabolites and *N. rileyi* autolyzed the cultures.

Growth and Sporulation of the Fungal Entomopathogens on Mass Production Media: Mycelilial growth of *M. anisopliae*, *B. bassiana*, *N. rileyi*, *Fusarium* spp. and *Verticillium* spp. varied between 0.08–0.63 mg dry weight / 50 ml PDB, SGYB, SEB and Czapex Dox broth (CDB). These produced 0.09-7.2 x 10^7 conidia / ml in these media.

Interaction of Bt *with other Entomopathogens:* About 230 *Pseudomonas* spp., thirty one isolates were halotolerant enduring 12 (4n), 9 (14n) and 6-8% (13n) NaCl. Fourteen isolates could solubilize insoluble tricalcium phosphate.

Molecular Characterization of Entomopathogenic Microbes

Cellular Organic Composition of the Pathogens: The range of the sugar, amino acid, protein, RNA, DNA and proline contents (mg / g dry weight) in the stress tolerant 12 indigenous Bt isolates (Bt 212-224) were 12.9–37.7, 0.38–99.45, 29–141.19, 37.2–260.73, 10.11–31.29 and 0.38–0.8, respectively. The organic constituents had no correlation with stress tolerance mechanism of the Bt isolates.

Proteomics of the Cellular Proteins: The cellular protein composition of Bt isolates (Bt 89 to Bt 94) were checked by SDS-PAGE. The molecular weights of the proteins varied between 0.51 kDa and 126.22 kDa. The proteogram of the crystal proteins of four out of the five isolates revealed 5 to 14 components of 3 kDa to 100.8 kDa sizes. One isolate had no known toxin protein. The δ-endotoxin of Bt 89 was Cry2 (69.1 kDa) toxic to lepidopteran / dipteran insects, Bt 90 was Cry4C toxic to dipteran insects, Bt 91 was Cry5 (78.8 kDa) toxic against lepidopteran / coleopteran insects, Bt 92 was Cry2 (69.1 kDa) effective against lepidopteran / dipteran insects, Bt 93 was Cry3 (74.2 kDa) toxic to coleopteran insects and Bt94 was Cry4C (78.8 kDa) toxic to dipteran insects.

Enhancing and Sustaining the Productivity of Rice-based Farming Systems

Development of Integrated Nutrient Management Technologies for System Productivity and Quality

Development of Agromanagement Strategies for Sustainable Crop and Soil Productivity under Favourable Lowland Ecology

The impact of different tillage management practices during *rabi vis-à-vis* contribution of corresponding legume biomass was studied on the performance of succeeding rice during *kharif* under favourable rainfed lowland conditions. A better crop stand of mungbean PDM 11 was recorded under conventional tillage that contributed a maximum fresh biomass of 3.2 t / ha followed by 2.8 t / ha in zero tillage. The seed yield of mungbean in the corresponding stands were 3.9 t / ha and 3.25 t / ha, respectively. The highest grain yield of Gayatri (3.96 t / ha) was achieved in plots treated with conventional tillage during *rabi*.

Zero, Reduced and Optimum Tillage for Improved Soil Physical Condition and Productivity of Rice-based Cropping System

Results of a field experiment conducted during *kharif* 2008, showed that wet tillage or puddling produced significantly higher grain (3.2 t / ha) and straw yield (3.4 t / ha) of rice Tapaswini over dry tillage practices. The difference in grain and straw yield between the treatments *viz.*, shallow (< 10.0 cm) and deep (> 10.0 cm) tillage with and without FYM was not significant. During *rabi*, mungbean PDM 54 was established on residual soil moisture after preparing the land with shallow dry tillage. The germination and seedling emergence was better in the plots where dry tillage was practiced during the preceding *kharif* and produced a higher grain yield (0.08 t / ha) than wet tillage (0.03 t / ha). Fewer cracks on the soil surface, greater wetness of the surface soil and friability of clods during tillage indicated structural improvement of unpuddled soil.

Optimization of Organic and Inorganic Sources of Nutrients for Enhancing Productivity and Soil Fertility

A field experiment was conducted during *kharif* 2008 to study the effects of substitution of a part of chemical N / green manure with crop residue or super imposition on crop residues with recommended dose of chemical fertilizer / green manure and compared with uniform N dose of 60 kg N / ha. Results showed that application of N gave significantly higher grain yields over the control. Substitution of chemical N (25%) with crop residue gave comparable grain yield (5.5 t / ha) than that of chemical N (5.2 t / ha) alone. Superimposition of 60 kg chemical N / ha with 2.5 t / ha crop residue increased the grain yield of rice (5.6 t / ha) over sole application of chemical N (4.9 t / ha). But superimposition of crop residue (5 t / ha) with 60 kg chemical N could give yields comparable to 60 kg N / ha when the soil organic N (0.076%) and organic carbon status (0.86%) were comparatively high.

Management of Problem Soils

Management of Coastal Saline Soils

Soil samples from six sites of Ersama block at five different depths were collected periodically and analyzed for soil pH, EC, saturation percentage and available P. Supernatant EC varied from 0.7 to 8.8 d / Sm, whereas, soil suspension EC varied from 0.7 to 7.4 d / Sm. The ratio of supernatant to suspension EC was in the narrow range of 1–1.3. The Soil EC in general decreased down the profile indicating ascent of salt towards the surface except at one site lying at an elevation lower than the surrounding rice fields. Saturation moisture percentage being largely dependent on clay content varied across the site and depth from 20.4% to 80.7%. Soil pH 1:2 were mostly acidic (3.9–6.9). One site in proximity to Hansua river showed mild alkaline reaction (7.4–7.8). Available P content at dif-

ferent depths did not show any definite trend with respect to depth and possibly it depended on the type of transported materials deposited in different layers. Out of 30 samples only one surface and two sub-surface soils were low in available P. Fortyfour surface soil samples were separately collected from five villages in the same area for assessment of available K. Out of these six (14%), five (11%) and 33 (75%) samples were low, medium and high in available K, respectively.

Management of Iron Toxicity in Rice

A field experiment was carried out during *kharif* 2008, at OUAT, Bhubaneswar in acid laterite soil (pH 5.0 and DTPA extractable Fe 400 ppm) for Fe toxicity tolerance with rice Swarna, Mahsuri and Lalat as tolerant checks and Jagannath, Jajati and Sebati as susceptible checks. Forty cultivars were tolerant to Fe toxicity. Twentyone were susceptible with a score of 7. Another 16 were moderately susceptible (score 5) and 42 were moderately tolerant (score 3). At the harvest stage, Fe content in the straw varied from 169 ppm (IR 8) to 5,545 ppm (Himalaya 1) in tolerant and susceptible cultivars, respectively, whereas, the Fe content in the grain was in the range of 42 ppm to 133 ppm. The Cu content varied from 4 ppm to 22 ppm. The susceptible varieties accumulated high quantities of Fe than others. Fe toxicity delayed maturity and resulted in chaffy grains. The proportion of non-crystalline Fe forms on the roots of six check cultivars showed marginal differences among the rice cultivars till tillering stage. Later, the tolerant cultivars had significantly higher concentrations of non-crystalline Fe till maturity. Iron was found to be distributed in the epidermis and exodermis in the roots. The tolerant cultivars had Fe from 80 units to 210 units on the epidermis. The susceptible cultivars such as Jagannath and Sebati had lesser Fe (40 units and 50 units), whereas, Jejati had comparable amounts of Fe to that of Mahsuri.

Management of Zinc Deficiency in Rice

A field experiment was conducted during *kharif* 2008, at Regional Research Station of OUAT at Ranital, Bhadrak district of Orissa in soil moderately deficient in available (DTPA) Zn containing 0.63 mg / kg. The effect of 1% ZnO root dipping for 12 hours and 1% Zn sulphate as foliar spray were tested with 35 varieties in a split plot design. Results revealed that seedling root dip with 1% ZnO suspension gave 14% higher grain yield over the control. The total uptake of Zn increased from 217.4 g / ha in the control to 465.2 g / ha in seedling root dip. The grain yield ranged from 1.5 t / ha (GR 9) in the control to 3.8 t / ha (Bhuban) for seedling root dip.

In another experiment, the effect of Librel (12% Zn in Zn EDTA) was studied with IR 36, Ratna, IR 64 and Tapaswini as test varieties. Ratna had the highest yield of 2.7 t / ha. Tapaswini gave the lowest yield of 1.6 t / ha. There was significant difference in case of Zn uptake. Soil application of librel @ 1 kg / ha showed 15% higher yield over the control. It was 11% in case of foliar spray.

Development of Cropping Systems for Different Rice Ecologies

Development of Suitable Multiple Cropping Systems under Rice Ecologies with Intercropping, Sequence Cropping and Relay Cropping

A field experiment was conducted to study the nutrient dynamics during both *kharif* and *rabi* in rainfed lowlands. Gayatri yielded 4 t / ha during *kharif*. Mungbean PDM 11, established in residual soil moisture, produced higher biomass of 3.3 t / ha in the plots that received 100% NPK in preceding Gayatri with seed yield of 0.4 t / ha. Over the years, yield difference between 100% and 75% NPK reduced by 5%.

Studies on Crop-weather Relationships under Important Rice-based Cropping Systems

Studies were conducted at CRRI, Cuttack to identify the optimum sowing time of groundnut (TAG 24) in rice-based cropping sequence during *rabi* with an analysis of thermal environment on the crop performance. The crop was sown at 10 days interval starting from 4 Dec 2008 to 2 Feb 2009. It was found that the flower initiation started after accumulating 379-428 GDD during Dec. But the total accumulation of GDD was less (353-401 GDD) during Jan for floral expres-

Table 21. Results of crop in rice-based cropping system in rainfed lowlands of Assam.

Crops	Yield (t/ha)	Gross returns (Rs/ha)	Total expenditure (Rs/ha)	Net returns (Rs/ha)
Spinach	2.3	13,800	10,618	3,182
Amaranthus	2.4	14,460	10,618	3,842
Coriander	0.8	17,000	10,918	6,082
Potato	4.7	33,040	30,882	2,158
Utera lathyrus	0.7	14,960	5,120	9,840
Utera pea	1.8	17,600	8,600	9,000
Utera linseed	0.4	12,000	4,180	7,820
Toria	0.5	15,040	12,500	2,540
Radish	5.7	19,950	15,242	4,708
Frenchbean	0.2	20,000	18,982	1,018
C.D. (P=0.05)	0.16	-	-	1,487

sion. The same trend was recorded with Heliothermal unit and photothermal unit at different sowing dates.

The highest seed yield of 2 t/ha was recorded in the early sown 4 Dec crop and gradual reduced up to 24 Dec. It again showed an increasing trend during the first fortnight of Jan. Afterwards, there was a sharp decrease in seed yield. Heat use efficiency (HUE) in terms of economic yield was highest (1.57) in early sowing date of 4 Dec. The least HUE (0.99 and 0.88) was noted at delayed sowing on Jan 23 and Feb 02, respectively.

Development of Agrotechniques for Direct-sown Summer Rice

Field experiments were conducted to standardize the sowing method and direct weed control practices for wet direct-sown summer rice. Results showed that the highest grain yield of 6.1 t/ha was obtained with rice Naveen when transplanted with a spacing of 15 cm x 15 cm with 2-3 seedlings/hill. However, comparable yields of 5.9 t/ha was also obtained when the crop was established by spot seeding dibbling 3-4 pregerminated seeds/hill with seed rate of 70 kg/ha with a spacing of 15 cm x 15 cm under saturated puddled condition. About 8% and 19% reduction in yield was recorded over transplanting when the crop was established by sowing with drum seeder at 15 cm apart rows and broadcast seeding (70 kg seed/ha), respectively. However, the highest net returns (Rs 25,230/ha) was obtained when the crop was established by spot seeding at 15 x 15 cm spacing, whereas, the highest benefit : cost ratio (2.9) was found in case of sowing by drum seeder at 15 cm apart rows.

Improvement of Rice-based Cropping System in Floodprone Areas through Introduction of Short Duration crops

Several crops were tested under rice-based cropping sequence in rainfed lowlands of Assam for yield potential and profitability. Among the vegetable crops, radish produced the highest yield (5.7 t/ha) followed by potato (4.7 t/ha). Table 21 gives details of the crops.

Crop Management for Flood-prone Areas Through Multiple Cropping and Crop Weather Relationship

Several crops were tested to study performance under late sown conditions in mid-Dec in rice-based cropping sequence. Results are given in Table 22.

Table 22. Performance of crops under late sown conditions in rice-based cropping sequence.

Crops	Yield (t/ha)	Gross returns (Rs/ha)	Gross expenditure (Rs/ha)	Net returns (Rs/ha)
Potato	5.8	40,390	31,557	8,833
Radish	6.9	23,065	15,242	7,823
French bean	2.3	23,300	19,672	3,628
Pea	2	20,400	15,200	5,200
Cabbage	5.7	22,840	19,500	3,340
Broccoli	3.7	55,800	24,400	31,400
Cowpea	3.3	16,500	12,350	4,150
Sunflower	1.8	29,440	17,310	12,130
CD (p=0.05)	0.25	-	-	1,583

*Price: Potato Rs 700/q; radish Rs 350/q; greenpea/french bean pods Rs 1,000/q; cabbage Rs 400/q; broccoli Rs 1,500/q; cowpea Rs 500/q; sunflower seed Rs 1,600/q.

Mechanization for Rice Production and Post-harvest Systems

Design and Development of Power operated Grain Cleaner-cum-grader

The winnower cum grader (8 q / h) was refined after repeated trials for longer duration. The major addition in the unit was inclusion of a roller feeder in the hopper for uniform feeding of the threshed crop on to the vibratory feeder. Modification was also made in the power transmission system through belt pulley and gear pinion arrangement to run the roller feeder at 100 rpm. The connecting mechanism from the eccentric drive to the grader component was further strengthened to avoid breakdown due to overloading of the materials by chance. With the above modifications, the machine performed well with an output of 7-8 q / h of clean paddy with 99% cleaning efficiency and 84-86% screen effectiveness.

Development, Evaluation and Improvement of Power Weeder for Rice and Rice-based Cropping System

After suitable modification and refinement, the CRRI power weeder was evaluated during *kharif* with rice Anjali and pigeonpea. The performance of the machine was better with a row spacing of 20 cm. The machine was designed to take out weeds from two inter-spacing rows at a time and to minimize damage to the plants. The first weeding was done 22 DAS and 74% weeds were removed in rice and 85% in pigeonpea. The second weeding in rice was done 15 days after first weeding, which uprooted 84% of the weeds. Besides removing weeds, the weeder loosened the soil that helped in aeration and moisture retention. The field capacity of the weeder was 0.065 ha / h. The remaining weeds in the field were taken out by fingerweeder. The cost of weeding by the machine was Rs 1,280 / ha including weeding by fingerweeder as against Rs 4,560 / ha of manual weeding. It saved labour requirement by 15 days / ha.

Design, Fabrication and Testing of Self-propelled Paddy Hill Seeder

Self-propelled paddy hill seeder was tested for sowing rice Naveen during *rabi* 2008–09. The field capacity was 0.05 ha / h, which yielded 4.6 t / ha. The cost of sowing with the machine was Rs 1,058 / ha. Line sowing with hill seeder saved about 30% energy in weeding than the broadcasting system.

Design and Development of Power Tiller Operated Multi-crop Seed Drill

The CRRI five-row power tiller operated multi-crop seed drill mounted on the backside of a 12 hp Kamco power tiller was tested for sowing rice Naveen during *kharif* and mungbean during *rabi* 2008-09. The field capacity was 0.1 ha / h and skidding 29.3% in low speed. The yield of rice was 3.1 t / ha and mungbean 0.8 t / ha. The cost of sowing with power tiller seed drill was Rs 1,058 / ha.

Performance Evaluation and Development of Bullock and Power Tiller Operated Weeder for Dry Seeded Rice

The CRRI seven-row bullock drawn weeder was tested during *kharif* 2008–09 with rice Anjali. The field capacity for one pass of operation was 0.071 ha / h. A minimum of two passes of weeder were required in the early stage of the crop. The plant damage was 13.4% and weed destruction 55% for two-pass. The cost of operation was Rs 1,105 / ha for the two-pass operation.

The CRRI eight-row power tiller operated weeder, was mounted on the back side of 12 hp Kamco power tiller for testing with rice Anjali. Its field capacity in low speed was 0.14 ha / h for one-pass operation. Its depth of operation was 8–10 cm. The weed destruction was 30.4% and plant damage was 10.23%. The cost of operation was Rs 837 / ha.

The CRRI is evolving strategies to tackle resurgence of pests and diseases. Seen in the photo is a farmwoman in Khalikote in Orissa with an infected rice that was given to the CRRI for study. (Photo: Ravi Viswanathan)

Strategic Research on Pathogens/ Pest Population Dynamics, Crop Losses, Forecasting

Studies on Pest/Natural Enemy Population Dynamics

Studies on Off-season Biology of Major Pests of Rice

Rice Yellow Stem Borer, Scirpophaga incertulas *Walk:* Ratoons of the *kharif* crop grown during *rabi* (second crop) showed 5% DH as compared to 10% in the first crop. The WEH were 3% as against 5%. Thus, a decreasing trend of infestation of YSB in the ratoon crop was observed. The third crop grown from the second crop showed further decrease of 3% DH and 2.5 % WEH, respectively.

Off-season Biology of Rice Ear Head Bug, Leptocorisa acuta *Thunberg (Alydidae):* The bug was searched during off season (after harvest of the crop in *kharif* 2008) in B-Block of CRRI, Cuttack especially on rice weeds *viz.*, *Cyperus rotundus*, *Digitaria ciliaris*, *Echinocloa crus-galli* and *Paspalum dilatalum*. All these weeds harboured the adult bugs.

Studies on Pest Outbreaks and Resurgence in Rice Ecosystem

There was a severe outbreak of rice swarming caterpillar, *Spodoptera mauritia* in Blocks Uffula, Hilling, Bagbbar, Jatesingha, Sublaya, Sangrampur, Pitarmahal, Mursimdi, Khandahata, Kenjhiripali, Lutarpark, Bahalpadar and Durjantalia of Sonepur district of western Orissa in Jul 2008, where 6-8 larvae / hill were recorded in the initial stage that declined after two weeks.

Outbreaks of hispa were reported at Bainsia, Ballav and Ambabati gram panchayat of Gondia Block of Dhenkanal district during first week of Sep 2008. An area of 1,300 ha was affected under varieties Annapurna, Pooja, Swarna and Lalat.

Rice swarming caterpillar, *Spodoptera mauritia* caused severe damage to rice in western Orissa in Jul 2008.

P.C. Rath

Global Warming and Dynamics of Major Rice Pathogens

Pathogenic dynamics in Relation to Global Warming and Synthetic Pesticide Molecules and Monitoring of Resistance

Application of Streptocyclin + Copper oxychloride reduced the incidence of bacterial blight on the varieties Tapaswini, Annapurna and Swarna by 67.4%, 66.5% and 66.9% in *rabi* and 65.3%, 63.2%, and 62.8%, respectively in *kharif*. Application of Sheathmar-3 controlled the incidence of sheath blight on the varieties Tapaswini, Annapurna and Swarna by 65.2%, 65.3% and 67.8% in *rabi* and 58.84%, 52.53%, and 56.64%, respectively, in *kharif* 2008.

In *rabi* 2008, application of Sivic on the artificially inoculated varieties HR 12 and Lalat reduced the blast incidence by 69.4% and 66.6% and increased the yield by 57.87% and 52.84%, respectively. The application of Bavistin on the artificially inoculated varieties HR 12 and Lalat reduced the blast incidence by 68.6% and 64.6% and increased the yield by 51.85% and 47.15%, respectively. The disease incidence was less and yield was more in *rabi* than in *kharif*. The chemicals were more effective in controlling the disease incidence in *rabi* compared to *kharif*. The maximum average temperature recorded was 33.2°C in r*abi* and 31.2°C in *kharif*.

Quantitative and Qualitative Diseases Severity Assessment

Estimating Crop Losses caused by Major Rice Diseases (Blast, Sheath blight, False Smut, BLB and RTD)

Incidence of sheath blight was highest (34.3%) in variety Tapaswini under unprotected and high levels of NPK @ 120 : 60 : 60 kg / ha. There was overall 40% more disease incidence irrespective of fertilizer level. Timely plant protection could reduce the disease by 65.4% in Tapaswini and by 31% in the less infected variety Naveen. There was 34% yield loss in unprotected over protected plots over all. The highest (28.4%) sterility was recorded in Tapaswini with high NPK in unprotected plot followed by the same variety (19.3%) with low NPK under unprotected conditions. The longest panicle (28.3 cm) was observed in Naveen with high NPK under protection.

Analysis of Population Dynamics

Collection, Isolation and Virulence Monitoring of *Xanthomonas compestries* pv-*oryzae*

Twentyone resistant lines received from IRRI were screened for resistance to bacterial blight with local isolates of Hazaribagh. Seven lines exhibited resistant reaction.

The following entries of NSN 1, NHSN and DSN were screened and found resistant to bacterial blight: NSN 1: CR 780-1937-1-1, CR 661-236-1-2, CR 780-1937-1-3 and CR 2285-6-6-3-1, NHSN: TNRH 174, TNRH 185, HRT MS-5, IHRT MS-l, IHRT MS-3 and IHRT-MS-4, DSN: VL 30686.

Division of Crop Protection

Developing IPM Technologies for Different Rice Ecologies

Studies on Components of IPM

Chemical Control Measures Against Field Pests

Field and Net-house Evaluation of Pesticides: Granular insecticides Carbofuran 3G @ 1,000 g ai / ha, Chorantraniliprole 0.4G @ 50 g ai / ha, Fipronil 0.3G @ 75 g ai / ha and Cartap 4G 1,000 g ai / ha were evaluated against stemborer and gall midge during *kharif* 2008. Both DH and SS were negligible @ 30 DAT, with 0% to 0.5% of DH and 0.6% to 1.2% of SS. There was a slight increase in damage @ 50 DAT. The incidence of DH was 3% and SS was 8.8% in the untreated control compared to 0.8% DH and 4.4% SS under Carbofuran. Chorantraniliprole showed 1.5% DH and 5.1% SS. There were 9.6% WEH in the untreated control compared to 6.8 % under Carbofuran and 6.3% WEH under Cartap treated plots.

Exploitation of Botanicals against Insect Pests of Rice

In net-house experiments, several proportions of combinations of seed powder of Neem, Karanja and Kochila were tested against gall midge for efficacy as standing water application. Four combinations were found promising recording only 4.7% to 7.8% SS formation than the individual treatment.

Botanicals, Grain Protectants and Pheromones against Rice Storage Insects

Oil from mint (*Mentha piperata*) was tested against lesser grain borer, *Rhyzopertha dominica*, one of the major pests of stored milled rice (Ratna) under artificial infestation for nine months using doses of 0.5% v / w, 1.0% v / w and 2.0% v / w. Mint oil neither caused significant grain protection nor checked the infestation of the beetle pest.

AICRIP Trials

Species Compositions: Based on the male moth collections in the field conditions using pheromone traps, the species composition of stem borers available in this locality was established. total of 581 moths were collected from fields using sweep nets. YSB was the only species available in this area.

Multiple Resistance Screening Trial (MRST) and Planthopper Screening (PHS): Of the 35 entries for MRST and 55 for PHS screened in greenhouse, only 4 entries, RP 4680-1-1-17, RP 4680-1-2-23, KAU 9412-13, CR AC 34997 showed resistance to BPH with score 1.

Optimum Pest Control Trial during rabi *2008-09:* In optimum pest control trial seven varieties were tested with check varieties Jaya and Krishnahamsa under need-based protection and no protection situation against insect pest of rice in RBD with four replications during *rabi* 2008-09. Insecticide Carbofuran @ 1 kg ai / ha was applied @ 30 DAT and observations DH, WEH, WBPH and BPH were taken along with yield data. The result revealed that IET 10890 performed better (6.4 t / ha) followed by IET 11689 (5 t / ha). None of the varieties was resistant against stem borer.

Testing the Efficacy of New Molecules of Chemicals and other Products against the RTD and its Vectors

Six combinations of different insecticides with a standard check (Monocrotophos) were tested to manage tungro disease through the management of its vector *Nephotettix viresens* during *kharif* 2008. Natural infection of tungro observed under simulated tungro garden averaged 43% infection (Table 23) and disease score of 6.9 in 0-9 scale.

Development, Evaluation and Validation of IPM Modules for Different Rice Ecologies

Developing IPM Package for Irrigated Rice

During *rabi* 2008, 30-days-old seedlings of variety Naveen were transplanted in RBD for three treatments comprising of IPM, insecticide and untreated control (each treatment in eight replications). The YSB moths started appearing during the third week of Jan and

Table 23. Control of rice tungro disease in *kharif* 2008 at CRRI.

Insecticides	Dosage / ha (g / ai)	Infected hils / plot		Yield (t / ha)
		30 DAT	50 DAT	
Thiamethoxam (Actara) 25WG + Deltamethrin (Decis) 100EC	12.5 + 50	35.3 (36.4)	30.5 (33.3)	2.5
Thiamethoxam (Actara) 25WG + Lambda Cyhalothrin (Kungfu) 2.5EC	12.5 + 6.25	33.5 (35.4)	29.5 (32.9)	2.8
Clothianidin (Dantop) 50WDG + Deltamethrin (Decis) 100EC	7.5 + 50	25.5 (30.2)	25.0 (29.9)	2.7
Clothianidin (Dantop) 50 WDG + Lambda Cyhalothrin (Kungfu) 2.5EC	7.5 + 6.25	23.5 (29)	20.5 (26.9)	2.8
Buprofezin (Applaud) 25WP + Deltamethrin (Decis) 100EC	31.25 + 50	26 (30.4)	26.3 (30.6)	2.7
Buprofezin (Applaud) 25WP + Lambda Cyhalothrin (Kungfu) 2.5EC	31.25 + 6.25	21.5 (27.5)	21.5 (27.5)	2.8
Monocrotophos (Monocrown) 36SL	504	29.5 (32.7)	27.3 (31.3)	2.6
Check		44.3 (41.7)	40.5 (39.5)	2.4
CD		6.6	6.1	ns
CV (%)		13.6	13.1	11

prevailed up to the second week of Mar. In IPM treatment, neem seed powder was applied @ 20 kg / ha at 10 DAT, 30 DAT and PI stage. Simultaneously, Carbofuran was applied @ 1 kg ai / ha at the same time in insecticide treatment. The DH was low in IPM treatment at 30 DAT and 50 DAT, which was 0.4% and 14.8% as against 13.9% and 28.8% in the untreated control. The grain yield was significantly higher in neem treatment (5.8 t / ha) than in untreated control plots (4.8 t / ha) and was on par with treatment with Carbofuran (6 t / ha).

During *kharif* 2008, a bio-mixture comprising of neem, karanja and kochila seed powders was applied as neem-based IPM treatment to the test variety Pooja in a field experiment. It reduced the GM and YSB infestation considerably, which was on par with insecticide treatment of Chlorpyriphos. The grain yield of 5.5 t / ha was also significantly higher than the untreated control plots (4.7 t / ha).

Biointensive, IPM in Rainfed Lowland Ecosystem

Components of bio-intensive pest management employed in 1 ha in CRRI farm were: Variety less susceptible to stemborer such as Sarala; Timely transplanting (first week of Jul); Pitcher traps for crabs (6 pitchers / ha); Sex pheromone traps for monitoring (3 traps / ha) followed by mass trapping (20 traps / ha) YSB population; Snail traps (8 traps / ha) for gundhibug; Spray of neem oil (5 ml / litre of water) for leaf folder, caseworm and hispa.

Plants were observed to be infested by crabs (*Oziotelphusa senex senex* and *Sartoriana spinigera*) during Jul.

Sex pheromone traps were fixed for mass trapping of YSB moths. The peak of moth catches were observed during the third week of Sep and continued throughout the season. Thus, the damage due to stem borer was minimized. The grain yield recorded from biointensive management plot was 4.6 t / ha as compared

to 4 t / ha obtained from insecticide treated plots. Thus bio-intensive management is feasible in lowland ecosystem.

IPM module for Rainfed Lowland Unfavorable (Shallow and Medium Deep Rice Ecology)

Demonstration of an IPM Module: Based on the reports of the last three years, rice Varshadhan was selected as a suitable variety for the IPM module for rainfed lowland unfavorable (shallow and medium deep rice ecology) at CRRI farm. Nursery treatment with Carbofuran (Furadon 3G) @ 1 kg ai / ha seven days before uprooting followed by one round of need-based spray depending on pest prevalence @ 0.5 kg ai / ha yielded 5.5 t / ha. Pheromone traps were used for monitoring YSB. Trichocards were used @ 50,000 / ha, three times at 10 days interval. The IPM module was found effective.

Socio-Economic Research for Sustainable Development

Assessment of Appropriateness of Improved Rice Cultivation Technologies for Different Ecosystems

Appropriateness of recommended rice cultivation technologies suitable for uplands was judged by applying four criteria simplicity-complexity, profitability, compatibility and need. For each selected practice, farmer's response was assessed. Scores were assigned accordingly and subsequently mean appropriate score (MAScore) was computed. Based on the MAScore four categories of appropriateness were made: not appropriate (MAScore up to 2.05); somewhat appropriate (MAScore 2.06-2.25); appropriate (MAScore 2.26-2.45); and highly appropriate (MAScore more than 2.45). The degree of appropriateness varied proportionally with the category of farmers on not appropriate to highly appropriate continuum. As far as overall recommended rice cultivation technologies were concerned, these were somewhat appropriate to small farmers and appropriate to medium and large farmers.

Findings revealed that out of 14 selected recommended rice cultivation technologies, small farmers perceived half of the technologies as not appropriate (MAScore up to 2.05), whereas, small and medium farmers perceived only two technologies sowing should be completed during second fortnight of June and deep summer ploughing as highly appropriate (MAScore more than 2.45). As far as large farmers were concerned most of the technologies were perceived as

Table 24. Relationship between socio-personal, psychological and economic variables with the knowledge level of farmers.

	Beneficiaries		Non-beneficiaries	
Independent variables	r	t	r	t
Age	0.342	2.52[1]	0.079	0.55[2]
Education	0.421	6.19[1]	0.093	0.12[2]
Family Type	0.082	0.57[2]	0.089	0.34[2]
Social Participation	0.27	3.73[1]	0.061	0.42[2]
Risk bearing preference	0.123	0.86[2]	0.101	0.63[2]
Economic motivation	0.187	1.41[2]	0.157	1.1[2]
Land holding	0.162	1.14[2]	0.118	0.82[2]
House type	0.19	1.34[2]	0.075	0.52[2]
Farm Power	0.29	2.11[1]	-0.109	-0.76[2]
Material possession	0.055	0.38[2]	-0.23	-1.39[2]
Family income	0.307	2.24[1]	-0.21	-1.65[2]

[1]Significant at 0.01 level of probability.[2]Not significant.

appropriate (MAScore 2.26-2.45) or highly appropriate (MAScore more than 2.45). High cost of cultivation (85.62%), non-availability of quality seeds at the time of sowing (93.75%), delayed monsoon at the time of sowing (96.87%) and lack of technological interventions (88.75%) were the major financial, infrastructural, agro-climatic and technological constraints experienced by the farmers in adopting recommended rice cultivation technologies for uplands.

Development of Model Village for Effective Dissemination of Rice Production Technologies

Benchmark survey of the village Purbakachha of Cuttack district was conducted. Under cultivable land the majority area was lowland (310 ha). The rice varieties that grown were Pooja, MTU 1001, Naveen, Durga, Padmini, Sarala, Moti, Swarna, Kanchan, Jagabandhu, Mahanadi, Prachi, CR 1018, Jagannath and Ketekijoha. The major constraints in the surveyed villages observed were water stagnation for long time, late supply of irrigation water, unavailability of good quality seed, high price of fertilizer and availability of pesticides at the time of requirement.

Assessment of Effectiveness of KVK Programme on Sustainable Development of Farmers

Two KVK, Santhapur adopted villages Kacheripara and Kantia and two non-KVK adopted villages Palapatna and Tarasa in Kendrapara district were selected. Twentyfive farmers were randomly selected from each village constituting a fixed sample size of 100. The results (Table 24) revealed that 74% of the beneficiaries and 56% of the non-beneficiaries had medium knowledge level. The adoption level was more in beneficiaries (72%) than the non-beneficiaries (42%).

Different rice lines are under evaluation in the experimental fields at the CRRI in Cuttack. (Photo: Ravi Viswanathan)

Krishi Vigyan Kendras

Santhapur

Training

A total of 35 training programmes were conducted on Harmful Disease, Pest in Pulse crops and their Nature of Damage; Biological Control of Harmful Pests and Diseases in Important Crops; Income Generation Activities for Empowerment of Rural Women; Importance of Balanced Diet in Day-to-day Life, Entrepreneurial Development of Farmers / Rural Youths; Value Addition; Importance of Up-gradation Programme of Sheep and Goat for Improvement of Local Genetic Stock; Improved Goatry Management during Rainy Season, Preventive Measures of Infectious Diseases of Animal, Entrepreneurship and Economic Development of Farmwomen, Care and Management of Dairy Animal; Integrated Weed Management in Rice; Integrated Disease Management in Rice; Nutritional Garden and Importance of Farm Implement; Apiary–an Income Generation Vocation for Rural Youth; Seed Treatment and Nursery Raising.

A total of six in-service training programmes were conducted on "Integrated Disease Management in Rice," "Capacity Building of Para Veterinarians on different A.H. Activities" and "Group Dynamics and Farmers Organization."

A total of six sponsored training programmes were conducted on "Preparedness, Control and Contaminates of Avian Influenza (Bird Flu)" organized by Sub-Divisional Veterinary Officer, Cuttack.

Frontline Demonstrations

Demonstrations of groundnut AK 12-24 in 5 ha area in *kharif* and groundnut TMV 2 in 5 ha area in *rabi* were conducted in different adopted villages of Guali and Arada benefiting 30 farmers. In *kharif* 2008 the average yield of groundnut AK 12-24 was 2.2 t / ha as against 1.8 t / ha in the local (Angul). In *rabi* TMV 2 yielded 2.3 t / ha as against 2.1 t / ha in the local.

Pigeonpea UPAS 120 in *kharif* and urdbean PU 30 in *rabi* were demonstrated in 5 ha each in adopted villages Rajakana, Uchhapada, Poparada and Jhadeswarpur. The average yield of UPAS 120 was 2.1 t / ha as against 1.3 t / ha in the local check. Urdbean PU 30 gave 0.8 t / ha and the local 0.5 t / ha.

FLD on HYVs and scented rice were conducted in different KVK adopted villages of Usuma, Alara, Jhadeswarpur, Guali, Kamanga, Satyabhamapur, Buhalo, Budukunia and Madhayakachha in different blocks of Cuttack district covering an area of 13.67 ha during *kharif* 2008.

Backyard Poultry: Demonstrations of 500 coloured bird variety Vanaraja were demonstrated to 72 farmer / farmwomen in different KVK adopted villages of Uchapada, Rajakana, Poparada, Khetrapala, Damaka, Kadei and Nisthinta in Tangi-Choudwar Block, Arada of Cuttack Sadar Block and Budukunia and Jhadeswarpur of Mahanga block. The male birds at the age of four months attained a body weight of 3.2 kg.

Oyster Mushroom: Demonstrations on oyster (Dhingri) mushroom were conducted for 60 farmwomen in Jhadeswarpur of Mahanga block of Cuttack district. The dhingri mushroom yielded 1.75 kg / bed.

The KVK, Santhapur conducts FLD in adopted villages.

KVK, Santhapur

KVK, Santhapur

Animal health camps were organized by the KVK, Santhapur.

Demonstrations on paddy straw mushroom were conducted for 25 farmwomen in Bainchua and Mania of Tangi block of Cuttack district. The paddy straw mushroom yielded 2 kg / bed.

Other Activities

Animal Health Camp: Eight animal health camps were organized in collaboration with the Sub-Divisional Veterinary Officer, Cuttack. A total of 1,650 animals were treated against diseases such as anoestrus, metritis and stringhalt.

Animal Deworming Camp: Deworming camps of small ruminants were organized in village Uchhapada and Bainchua of Tangi Choudwar block in collaboration with Sub-Divisional Veterinary Officer, Cuttack. A total of 322 animals were dewormed with Albomar medicines and injected with Belamyl and Livosin against parasitic diseases.

Jainagar, Koderma

Training

The KVK organized 39 training programmes out of which seven were on-campus and 32 were off-campus.

A training programme sponsored by BAU, Ranchi on "Soil Testing for Nutrient Management" was organized during Mar 2009.

On-farm Trials

Management of Insects and Diseases: Management of Gundhibug (*Leptocorisa varicornis*) in rainfed rice with Malathion dust @ 25 kg / ha gave higher yield of 4.2 t / ha than farmers' practice of dusting of methyl parathion dust @ 25 kg / ha that gave 3.7 t / ha.

High incidence of Yellow Vein Mosaic Virus resulting in low yield of okra was treated with foliar spray of methyl demeton / Malathion @ 1.5 ml / l water based on monitoring of pest (whiteflies) gave higher yield of 9.9 t / ha and pest incidence of 15% than the farmers' practice of foliar application of Cypermethrin @ 1 ml / l and Mancozeb @ 1.0 ml / l water resulting in 8.6 t / ha and pest incidence of 21%.

Pod borer *Helicoverpa armigera* was managed in chickpea by replacing the existing varieties with improved varieties and use of Endosulfan @ 2.5 ml / l water, which gave higher yield of 1.6 t / ha with a pest incidence of 13.4% than farmers' practice of *Desi Chana* with no control measures that gave 1.2 t / ha with a pest incidence of 24.8%.

Seed treatment of pea with Bavistin (Carbendazim) @ 2 g / kg controlled fusarium wilt seed and gave higher yield of 6.5 t / ha with an incidence of 13.6% than farmers' practice of 4-5 sprays of Mancozeb @ 500 g / ha that gave 5.5 t / ha with incidence of 18.3%.

Identification of suitable establishment methods for wheat cultivation in rainfed ecosystem by replacement

On- and off-campus training programmes were conducted by the KVK, Koderma.

KVK, Koderma

KVK, Koderma

of existing wheat varieties with improved ones and planting of wheat with zero tillage machine gave higher yield of 4.1 t / ha than farmers' practice of broadcasting the seed and mixing with country plow that gave 3.1 t / ha.

Application of NPK @ 100 : 60 : 60 kg / ha increased the tuber size and yield of potato. Potato yielded 19 t / ha than the farmers' practice of NPK @ 60 : 30 : 0 kg / ha that yielded 8.8 t / ha.

Mushroom grown in paddy straw in Chandwara Block gave an average yield of 1,880 g / packet / four cuttings, wheat straw of 1,745 g / packet, and mixture of paddy and a wheat straw 1,585 g / packet. Sterilized conditions gave better results.

Poor health status and lower production of dairy cattle was treated with deworming (three times) + 1 h water soaked chopped straw + grazing + balanced concentrate @ 1 kg / 2 l of milk + 1 kg concentrate for maintenance. An average milk yield of 2.9 l and lactation period of 260 days than the farmers' practice of unchopped dry paddy straw + grazing + some quantities of concentrate that gave 1 l of milk and 200 days of lactation period.

Non-occurrence of oestrus / heat even after three to four years of age was treated with Antihelmintic medication + mineral supplement (seven days after deworming up to 35 days) and phosphorus 10 ml (0 and 15 days) gave better results of 90% than the farmers' practice of 0.5 kg wheat bran resulting in 20%.

Extension Activities

The KVK organized various extension activities for the benefit of farmers. The list of these extension activities is given in Table 25.

Table 25. Extension activities organized by the KVK, Koderma.

Activities	Number	Beneficiaries
Field day	3	684
Kishan gosthi	1	75
Farmers seminar	1	404
TV talks	15	-
Extension Literature	3	-
Farmers visit to KVK	841	841
Animal Health Camp	3	410

A view of the experimental fields at CRRI, Cuttack. (Photo: Ravi Viswanathan)

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Seen in the photograph is a farmer in Khurda district of Orissa bunching rice variety Pooja for transplanting. (Photo: Ravi Viswanathan)

RAC, IMC, SRC, SAC Meetings

Research Advisory Committee

The XIV Meeting of RAC was held at the Central Rice Research Institute during 17-18 Sep 2008.The following Members were present:

Dr R.K. Singh ..... Chairman
Prof B. Vidyachandra ..... Member
Prof Swapan Datta ..... Member
Dr A.P.K. Reddy ..... Member
Dr S.K. Sharma ..... Member
Dr M.P. Pandey ..... Member
Dr T.K. Adhya ..... Member-Secretary

Dr B.C. Viraktamath, Project Director, Directorate of Rice Research, Hyderabad attended the meeting as a special invitee of the Chairman, RAC.

Dr S.N. Shukla, ADG (FFC), ICAR, Shri Srikant Jena and Dr S.S. Rahangdle, Farmers' Representatives, could not participate in this meeting due to preoccupation.

The Chairman, along with all the RAC members, conducted a pre-meeting briefing with Dr M.P. Pandey, Director, CRRI.

Dr T.K. Adhya, welcomed the members of RAC followed by the address of the Chairman, and other Members. Dr R.K. Singh, Chairman listed five major constraints for rice cultivation: Shortage of labour for field operations as well as shortage of water; Increasing cost of fertilizers and the decline in partial factor productivity; Lack of appropriate cropping system for restoration of soil fertility; Marginal seed replacement rates of approximately 15-20%; and Small nature of land holdings. He stressed upon the need to reorient the programme on rice research to address these issues.

Dr M.P. Pandey, presented the highlights of research achievements and other activities pertaining to the period since the last meeting. Dr D.P. Sinhababu, Member-Secretary, Staff Research Council reported the salient features of the programme of work as approved by the SRC for the year 2008-09, and activity milestones for the XI Plan period (2007-12) as well as the externally-aided projects (EAPs).

Institute Management Committee

The 20th meeting of the IMC was held on 13Jan 2009 at Cuttack. The following members attended the meeting:

Dr T.K. Adhya, Director,
CRRI, Cuttack ..... Chairman

Dr R.K. Singh (fourth from right), Chair, RAC outlines the major constraints for rice cultivation at the RAC meeting.

B. Behera

Dr S.N. Shukla, ADG (F&FC), ICAR, New Delhi ..... Member

Dr Dibakar Naik, Dean of Research, OUAT, Bhubaneswar ..... Member

Dr B. Giri, Joint Director of Agriculture, Government of Orissa, Bhubaneswar ... Member

Dr K.S. Rao, Principal Scientist and Head, Division of Crop Production, CRRI, Cuttack ..... Member

Dr G.J.N. Rao, Principal Scientist and Head, Division of Crop Improvement, CRRI, Cuttack ..... Member

Shri A.K. Lal, Finance and Accounts Officer, CIFA, Bhubaneswar ..... Member

Shri S.K. Sinha, SAO, CRRI, Cuttack ..... Member-Secretary

The following Members could not attend the meeting: Director of Agriculture, Government of West Bengal, Kolkata; Dr S.S. Rahangdale, Maharashtra; Shri Digambar Mohapatra, Cuttack; Dr B.V. Viraktamath, Principal Scientist and Head, Plant Breeding, Directorate of Rice Research, Hyderabad and Dr S.K. Naskar, Principal Scientist and Head, CTCRI Regional Centre, Bhubaneswar.

The Chairman briefed the Members about the research progress for the period from Apr to Dec 2008. The committee reviewed the research and technical programme and finalized the action plan.

Institute Joint Staff Council

The IJSC meeting was held at KVK, Koderma on 6 Jan 2009. The following members were present.

Dr Anand Prakash, Head, Division of Crop Protection and Principal Scientist ..... Chairman

Dr S.N. Tewari, Principal Scientist ..... Member

Dr A.K. Mishra, Principal Scientist ..... Member

Shri P.C. Naik, I/c FAO ..... Member

Shri S.K. Mathur, AAO ... Secretary (Office Side)

Shri D.K. Parida ..... Member

Shri S. Nayak ..... Member

Shri S.C. Pradhan ..... Member, CJSC

Shri A. Panda ..... Secretary (Staff Side)

Shri S.K. Ojha ..... Member

Shri B.K. Behera ..... Member

Shri B.B. Das ..... Member

Dr T.K. Adhya, Director, CRRI and Shri S.K. Sinha, Senior Administrative Officer could not attend the meeting. In addition to the above, Dr. R.K. Singh, Principal Scientist and O.I.C., KVK, Koderma and Dr V.D.

The 20th meeting of the IMC that was held on 13 Jan 2009 reviewed the progress in research and finalized an action plan.

B. Behera

Shukla, Principal Scientist and Incharge, O.I.C., Hazaribag also attended the meeting and took active part in the deliberations.

Staff Research Council

The 22nd meeting was held from 28 to 30 Apr 2008 and from 5 to 6 May 2008 under the Chairmanship of Director Dr M.P. Pandey. Results of *kharif* 2007 were presented, and the work programme for 2008–09 was finalized.

The 23rd meeting washeld from 24–25 Nov and on 4 Dec 2008 under the Chairmanship of Dr T.K. Adhya, Director, CRRI. The Work Plan for *rabi* 2008–09 and *kharif* 2009–10 was finalized. A field visit was held during 3–6 Nov 2008.

Scientific Advisory Committee of Krishi Vigyan Kendras

KVK, Santhapur

The 10th Scientific Advisory Committee Meeting of the KVK, Santhapur was held on 23 Mar 2009 at Santhapur.

The following were present:

Dr T.K. Adhya, Director, CRRI, Cuttack ..... Chairman

Dr S.S. Nanda, Dean, Extension Education and State Coordinator of KVK ..... Member

Shri R.C. Swain, DDA, Cuttack ..... Member

Dr Laxman Behera, CDVO, Cuttack ..... Member

Shri K. Jena, Horticulturist, O/O DDH, Cuttack ..... Member

ShriR.C. Senapati, Assistant Engineer, O/S SCO ..... Member

ShriH. Mallick, A.E. Mahanadi South Division Irrigation ..... Member

Dr B.K. Panda, I/c CARI, BBSR ..... Member

Shri Sampad Mohapatra, DD Representative ..... Member

Shri Bhakta Praharaj, Farmer Representative, Jhadeswarpur ..... Member

KVK, Santhapur

Dr T.K. Adhya (centre) deliberates on the action plan at the SAC meeting of the KVK, Santhapur.

Shri Ashok Samal, Farmer Representative, Satyabhamapur ..... Member

Smt Pramila Ojha, Lady Farmer Representative, Mania ..... Member

Dr S.M. Prasad, Sr. Scientist and OIC,, KVK, Cuttack ..... Member-Secretary

Dr S.S. Nanda, Dean, Extension Education, OUAT, Bhubaneswar was the invited guest.

Dr S.M. Prasad, Senior Scientist and Officer-in-Charge presented the progress report for the period Apr 2008 to Mar 2009 and the Action Plan for Apr 2009 to Mar 2010.

KVK, Jainagar, Koderma

The SAC that was held at KVK, Jainagar, Koderma, Jharkhand on 26 Mar 2009 was attended by:

Sister Josline, Directress, Holly Cross KVK, Hazaribag ..... Chairman

Dr R.K. Singh, Officer-in-charge, KVK Jainagar, Koderma

Dr P.K. Sinha, Principal Scientist and Officer-in-Charge, CRRI-RRS, Hazaribag, Dr J.P. Singh, Senior Scientist, IINRG, Ranchi, Dr Srinivas Giri, Deputy Director, Goriakarma Farm, BAU Ranchi, Dr S.B. Singh, SMS (Plant Breeding), BAU Ranchi, Shri K.N. Singh, Agriculture Inspector, Koderma, Shri Sonu Singh, Deputy Manager, Paradeep Phosphate Ltd., Shri S.N. Chaudhary, Sister Ssjita, Holly Cross, KVK Hazaribag, Representatives from press/media, farmers group, women self help groups and progressive farmers also attended the meeting.

Dr Mahesh Pathak presented the Annual Progress Report from Apr 2008 to Mar 2009 and the Action Plan for Apr 2009 to Mar 2010.

Participation in Symposia/Conferences/Workshops/ Training in India and Abroad

Dr S.G. Sharma attended the first meeting of the ICAR Committee for PG course curricula modification in basic sciences of the SAUs and ICAR Institutes at the GBPant University of Agriculture and Technology, Pantnagar on 4 Apr 2008. He also attended the second and final meeting held at IARI, New Delhi during 20-21 May 2008 to finalize the recommendations.

Dr K.S. Rao attended the State Level ICAR-SAU Coordination Committee Meeting at the Water Technology Centre for Eastern Region, Bhubaneswar on 10 Apr 2008.

Dr B.C. Patra attended the symposium on "Wetland and Mangrove Biodiversity in Orissa Coast" at the Regional Plant Resources Centre, Bhubaneswar on 5 Apr 2008 and gave a talk on "Wild Rice Genetic Resources in Wetlands and Mangroves of Orissa."

Dr B. Ramakrishnan coordinated the International Workshop on "Environmental Impact Assessment of Pollution from Agriculture," supported by the United States Educational Foundation in India (USEFI), the Fulbright Commission in India, New Delhi in collaboration with the Central Rice Research Institute, Cuttack, at CRRI, Cuttack on 8-11 Apr 2008, and delivered a theme lecture on "Environmental Impact Assessment of Pollution from Agriculture".

Drs M.P. Pandey, G.J.N. Rao, R.N. Rao, P. Sen, O.N. Singh, S. Singh, S.K. Mohanty, A. Prakash, Jagadiswari Rao, S. Sasmal, V. Nandagopal, Sanjukta Das, Padmini Swain, R.K. Sarkar, R.C. Dani, V.D. Shukla, R.K. Singh,

Courtesy: IRRI

Top: The photo shows the delegates during the deliberations at the CURE Annual meeting.
Below: The delegates get together for a group photo.

M. Variar, C.V. Singh, N.P. Mandal, N.K. Sarma, S.K. Rautaray and N. Bhakta attended the 43rd Rice Research Group Meeting at IGAU, Raipur, during 11-14 Apr 2008.

Drs M.P. Pandey and S.R. Dhua attended the Seed Committee Meeting under the National Food Security Mission (NFSM) at Krishi Bhawan, New Delhi on 15 Apr 2008.

Dr B. Ramakrishnan attended the National Seminar on Biodiversity: Threats and Conservation organized at the Department of Botany, T.M. Bhagalpur University, Bihar, and delivered a lecture on "Biogeochemical Cycling in Rice Paddy Fields: Agriculture, Biodiversity, Pollution and Environmental Issues," on 16 Apr 2008.

Drs P.K. Sinha, V.D. Shukla, M. Variar, R.K. Singh and N.P. Mandal attended the Annual Planning Meeting of CURE at IGAU, Raipur during 15–16 Apr 2008, in which the Workplan for the Indian Plateau Uplands and Drought-prone Shallow Lowlands were finalized.

Dr B.C. Patra acted as Co-Chairperson in the technical session-III of the National Symposium on "Biodiversity Management and Sustainable Use" of Resources at the G.M. College (Autonomous), Sambalpur during 19-20 Apr 2008, and presented a paper on "Biodiversity of Rice Genetic Resources Management and Sustainable Use."

Drs K.S. Rao, Padmini Swain, P. Samal and R.N. Dash attended the Annual Review and Planning Workshop of the ADB supported project: "Development and Dissemination of Water Saving Rice Technologies in South Asia" from 19-21 Apr 2008 at CRRI, Cuttack.

Shri Manoj Nayak attended the Launching Workshop of NAIP project on "Consortium for e-Resources in Agriculture (CeRA)" at IARI, New Delhi during 30 Apr to 1 May 2008.

Dr G.J.N. Rao attended the ICAR Network meeting on "Gene Pyramiding for Resistance to Multiple Biotic Stress in Crops" and "Molecular Breeding" at NBPGR, New Delhi on 8 May 2008.

Dr K.S. Rao attended the Officers Conference and monthly S.M.S. workshop of Cuttack Agricultural Range conducted in the office chamber of DDA, Cuttack on 14 May 2008, and delivered a lecture on "SRI Method of Rice Cultivation."

Drs R.K. Singh and A.K. Dubey attended the "Symposium on Rice-wheat System under Zero Tillage" in Bihar, from 21-22 May 2008.

Shri S.M. Chatterjee participated in the training programme on "Technical and Administrative Support for Consortia-based Research in Agriculture," at NAARM, Hyderabad from 21 to 27 May 2008.

Dr S.R. Dhua attended the "Second DUS Test Launching Function and DUS Test Guidelines for Species Meeting" at NASC Complex, New Delhi on 27 May 2008.

Drs K.S. Rao, S. Saha, P. Samal and Lipi Das attended the "In-country Trainers Training on Participatory Varietal Selection (PVS)" under IRRI-Bill and Melinda Gates Foundation Project on "Stress-tolerant Rice for Poor Farmers in Africa and South Asia" at CRRI, Cuttack during 26-29 May 2008.

Dr K.S. Rao attended the State-level Pre-seasonal Orientation Training of Extension Officers for *kharif* 2008 at IMAGE, Bhubaneswar on 30 May 2008, and gave a presentation on "SRI Method of Rice Cultivation."

Drs P. Mishra, R.K. Sarkar and Meera K. Kar attended the ICAR Training-cum-workshop on IP and Technology Management at NAARM, Hyderabad from 29 to 31 May 2008.

Dr S.R. Dhua attended the XXIII Group meeting of the NSP (Crops) held at IIVR, Varanasi from 30 May to 1 Jun 2008.

Dr K.S. Rao attended the XII Working Group Meeting of the All-India Coordinated Research Project for Dryland Agriculture at OUAT, Bhubaneswar during 2-4 Jun 2008.

Dr B.C. Patra attended the workshop on "Man-elephant Interface" at Regional Museum of Natural History, Bhubaneswar on 4 Jun 2008 on the eve of World Environment Day, and spoke on "Development of Long-awned Rice Varieties and Paddy Storage Structure in Elephant Depredation Areas."

Drs M.P. Pandey and T.K. Adhya attended the 15th Annual General Body Meeting of NAAS at New Delhi on 5 Jun 2008.

Dr N. Bhakta acted as a resource person at the "Farmers' Field Day" on "Early Ahu Rice Variety Luit" organized by KVK, Nalbari, Assam on 5 Jun 2008.

Drs M.P. Pandey, D.P. Singh, P.K. Sinha and M. Variar attended the 7th Annual Meeting of the CURE at the IRRI, Philippines during 10-12 Jun 2008.

Dr K.S. Rao attended the "MDP Workshop on Policy and Prioritization and Evaluation (PME) Support to National Agricultural Innovation Project (NAIP)" organized at NAARM, Hyderabad during 17-21 Jun 2008.

Drs M. Variar and R.K. Singh attended the workshop on "Procedures of World Bank" at BCKV, Kalyani during 26-27 Jun 2008.

Dr S.R. Dhua attended a meeting for planning for breeder seed during 2009-10 and 2010-11 for Orissa at the Directorate of Agriculture, Bhubaneswar on 8 Jul 2008.

Dr S.K. Rautaray was a Resource Person for training on "Techniques of Raising Sali Rice Nursery," by the KVK, Nalbari at Balijar Village on 16 Jul 2008.

Dr P.K. Sinha attended as a Member the Scientific Advisory Committee Meeting of the Holly Cross Krishi Vigyan Kendra, Hazaribag on 18 Jul 2008.

Drs K.S. Rao, S. Saha, P. Samal, N.C. Rath and Lipi Das attended the Workshop on "Forecasting Future Technological Needs for Rice in India" under NAIP Project V-PAGe: sub Programme II- Technology Forecasting organized by CRRI, Cuttack in collaboration with IASRI, New Delhi at CRRI, Cuttack during 28-29 Jul 2008.

Dr B. Ramakrishnan attended the Programme Advisory Committee on "Water Technology Initiatives of DST" and presented the project proposal on 30 Jul 2008.

Dr S.K. Pradhan attended the "Advanced Rice Breeding Course: Laying Foundation for the Second Green Revolution" at IRRI, Philippines from 30 Jul to 14 Aug 2008.

Dr M.P. Pandey attended the First Regional Conference on "Sustainable Development: Local Solutions for Global Problems" at Penang, Malaysia during 19-21 Aug 2008.

Dr P.K. Sinha attended the meeting of the National Food Security Mission Working Committee on 22 Aug 2008 at Ranchi.

Drs P.K. Sinha, V.D. Shukla, M. Variar, D. Maiti and N.P. Mandal attended the Workshop on "Outcome and Impacts Assessment of Working Group 1 & 5," of CURE from 25–30 Aug 2008 at Bangalore.

Drs P.K. Sinha, V.D. Shukla, D. Maiti, M. Variar, and N.P. Mandal attended the "Data Analysis and Compilation Workshop" for CURE WG1 and WG5 from 25-30 Aug 2008 at Bangalore, India.

Dr R.K. Sarkar attended the training on "Generation Challenge Programme Travel Grant Award 2008" at IRRI, Philippines from 20 Aug to 29 Sep 2008.

Drs N.K. Sarma and N. Bhakta attended the Workshop-cum-Orientation Programme on "Seeds and Planting Materials Production" at AAU, Jorhat during 30–31 Aug 2008.

Dr G.J.N. Rao attended as an expert a meeting of the External Evaluation Panel on "Evaluation of Agency Programmes on Intensification of Crop Production Systems" at Vienna, Austria during 8–12 Sep 2008.

Dr M.P. Pandey attended the Fifth International Hybrid Rice Symposium at Changsh, PR China from 11 Sep to 15 Sep 2008.

Dr M.P. Pandey attended the XV Zonal Workshop of KVKs in Zone-VII at JNKVV, Chhattarpur during 19–20 Sep 2008.

Dr J.N. Reddy participated as a Member in the multi-disciplinary monitoring team to monitor the relative performance of 'Sub1' introgressed lines under Advanced Variety Trial (AVT) 1-NIL-Submergence at Cuttack, Chinsurah, Titabar, Pusa, Patna, Masodha and Ghagraghat during 13-22 Sep 2008.

Shri R.C. Dani attended the National Seminar on "Pheromone Technologies: Development and Com-

mercialization for Strengthening Eco-friendly Agriculture in India" at Chennai during 25–26 Sep 2008.

Dr M.P. Pandey attended the Regional Committee Meeting held at OUAT, Bhubaneswar during 26–27 Sep 2008.

Shri J. Meher attended a training course on "Breeding for Biotic and Abiotic Stresses" at the Centre of Advanced Studies in Genetic and Plant Breeding, PAU, Ludhiana from 3 to 23 Oct 2008.

Dr A.K. Shukla was invited to deliver lectures on "Concept, Issues and Strategies for Precision N-Management using LCC in Rice-Wheat System and Leaf colour chart: A tool for Precision Nitrogen Management in Rice-Wheat System" in the winter school of precision farming held at PDCSR, Modipuram, Meerut on 6 Oct 2008.

Dr K.S. Rao attended the meeting organized by OUAT, Bhubaneswar to discuss and finalize the strategies for managing the flood affected areas in Orissa on 13 Oct 2008.

Dr B.C. Patra attended the ICAR Training-cum-Workshop on "IP and Technology Management on the theme: Copyright Protection" at the National Institute for Research on Jute and Allied Fibre Technology (NIRJAFT), Kolkata during 16-18 Oct 2008.

Dr P. Samal attended the workshop on "Socio-economic Research Planning and Training Workshop on Household Surveys" of the IRRI collaborative project on "Stress-tolerant Rice for Poor Farmers in Africa and South Asia' at CRRI, Cuttack from 16-18 Oct 2008.

Dr Ramesh Chandra and Shri Manoj Nayak attended the Library Connect Seminar, organized by ELSEVIER at Bhubaneswar on 17 Oct 2008.

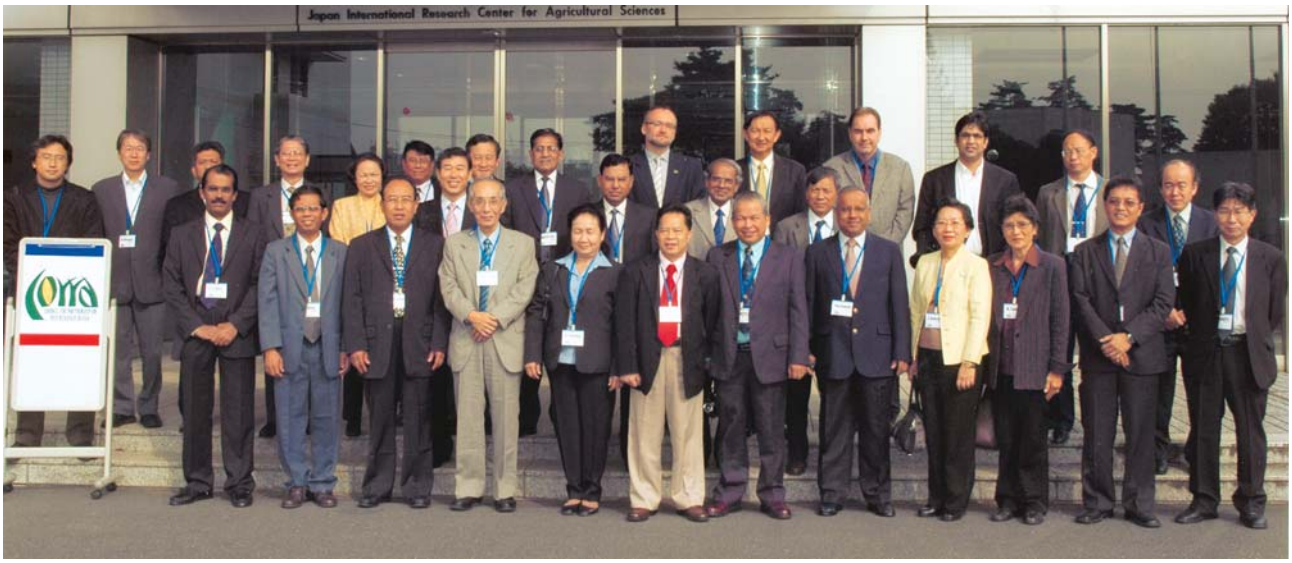
Dr A.K. Shukla was invited to deliver lectures on "Precision N-management in Rice-Wheat System" in the National Symposium on "Recent Trends in Agriculture in Changing Climatic Conditions" organized by the Society for Recent Development in Agriculture, SVBP University of Agriculture and Technology, Meerut from 19-20 Oct 2008.

Drs K.S. Rao and P. Samal attended the NIAS-DST training programme on "Impact of Globalization" at the National Institute of Development Studies, IISc Campus, Bangalore from 20-24 Oct 2008.

Dr T.K. Adhya, Director, CRRI attended the 12th CORRA Annual Meeting at the International Research Centre for Agricultural Sciences (JIRCAS), Tsukuba, Japan from 23 to 24 Oct 2008.

Dr S.K Rautaray attended the "International Convention on Water Resources Development and

Dr T.K. Adhya, Director, CRRI, (front row first from left) attended the 12th CORRA Annual Meeting at JIRCAS, Japan.



Courtesy: JIRCAS

Man-agement" at BITS, Pilani, from 23-26 Oct 2008. He presented a paper "Integrated Rice-fish Farming Sys-tem under Rainfed Lowland Situation in Assam."

Drs J.N. Reddy and R.K. Sarkar participated in the field tour to the sites of BMZ funded project on submergence "From Genes to Farmers' Fields: Enhancing and Stabilizing Productivity of Rice in Submergence-prone Environments" in India and Bangladesh including the review workshop during 1-8 Nov 2008.

Dr R. Raja attended the training programme "Enhancing Skills in Information Communication Technology-based Decision Support System for Market and Agri-business Orientation of Research and Sustaining Rural Livelihoods" at MANAGE, Hyderabad during 3-12 Nov 2008.

Dr K.S. Rao went as external examiner to the Banaras Hindu University, Varanasi, for evaluating the doctoral dissertation of Shri S. Dwivedi, Research Scholar, Department of Agronomy on 8 Nov 2008.

Dr B. Ramakrishnan was invited to attend the Brainstorming Session on "Agricultural Sustainability through Microbial Biotechnology: Novel and Innovative Concepts," on 11 Nov 2008 by the National Academy of Agricultural Sciences, New Delhi.

Dr Padmini Swain attended the Golden Jubilee Conference on "Challenges and Emerging Strategies for Improving Plant Productivity" at IARI, New Delhi, during 12-15 Nov 2008.

Shri Manoj Nayak attended the Workshop-cum-Training programme of SAU / DAU / ICAR Librarian's on "Digitalization of Indian Agricultural Doctoral Dissertations" at C.C.S Haryana Agricultural University, Hisar during 14-15 Nov 2008.

Drs T.K. Adhya and T.K Dangar attended the 49th Annual Conference of AMI International Symposium on "Microbial' Biotechnology: Diversity, Genomics and Metagenomics" at Delhi University, North Cam-pus, New Delhi from 18-20 Nov 2008.

Dr T.K. Adhya attended the 51st Meeting of the Central Sub-committee on Crop Standards, Notifica-tion and Release of Varieties for Agricultural Crops at IARI, New Delhi on 26 Nov 2008.

Shri R.C. Dani attended the launch workshop of NAIP, Component-4 on "Development of Decision Support System for Insect Pests of Major Rice and Cotton-based Cropping System" at CRIDA, Hyderabad on 28 and 29 Nov 2008.

Dr S. Lenka attended the short course on "Participatory Action Plan Development" at OUAT, Bhubaneswar from 24 Nov to 3 Dec 2008.

Drs Sanjoy Saha and K.R. Mahata participated in the End-of-Project Meeting and Synthesis Workshop of "Challenge Programme for Water and Food (PN 7)" at IRRI, Philippines during 2-4 Dec 2008.

Dr Annie Poonam attended the Dialogue Workshop on "Strengthening the Learning alliance: Scaling-up Options for SRI in Orissa" at the Xavier Institute of Management, Bhubaneswar, Orissa during 8-9 Dec 2008.

Dr Mayabini Jena attended the Group Monitoring Workshop (GMW) of Science and Society Division, DST, New Delhi, at Home Science College and Research Institute, Madurai (Tamil Nadu) from 8 to 10 Dec 2008 under the DST project "Bio-intensive management of Rice Pests with Emphasis on Botanicals."

Drs S.K Rautaray and Arun Pandit attended the Global Potato Conference at NASC Complex, New Delhi from 9-12 Dec 2008. Dr S.K. Rautaray presented a paper on "Mulching with Dried Water Hyacinth or Paddy Straw under Rainfed Rice-potato Cropping System in Assam" and "Integrated Use of Organic Materials, Mineral Fertilizer and Fly Ash is Beneficial for Rice-potato Cropping System under Acid Later-itic Soil Conditions." Dr Arun Pandit spoke on "Growth of Potato Production in India: A Nonpara-metric Analysis of Time Series Data."

Shri Manoj Nayak and Shri Arun Panda attended the National Conference on "Digitize and Digital Preservation" organized by the Defense Scientific Information and Documentation Centre (DESIDOC), DRDO at the National Science Academy (INSA), New Delhi during 11-12 Dec 2008.

Dr B. Ramakrishnan attended the meeting of the Task Force Committee on Environmental Biotechnol-

ogy of DBT and presented the project proposal on 12 Dec 2008.

Dr T.K. Adhya attended the QRT Review Meeting of DRR at CRIJAF, Kolkata during 16-17 Dec 2008.

Dr Jyoti Nayak attended the Winter School on "Participatory Research for Main Streaming in Gender concern in Agriculture" at NRCWA Bhubaneswar from 4-24 Dec 2008.

Dr Annie Poonam attended the Workshop on "SRI-Village-RKVY 2008-09 for Central Zone" at IMAGE, Bhubaneswar, Orissa on 17 Dec 2008. She also delivered a talk on "Nursery Raising and Planting Techniques for SRI."

Dr J.R. Mishra attended the orientation training programme for extension scientist at OUAT, Bhubaneswar from 17-20 Dec 2008.

Drs N.C. Rath, G.A.K. Kumar and Lipi Das attended the National Seminar on "Innovative Extension Strategies for Agricultural Development and Rural Prosperity" organized by ISEE, New Delhi at RAU, Pusa, Samastipur, Bihar during 18-20 Dec 2008.

Dr T.K. Adhya attended the 52nd meeting of the Central Sub-Committee on Crop Standards, Notifica-tion and Release of Varieties for Agricultural Crops at Krishi Bhavan, New Delhi on 29 Dec 2008.

Dr Lipi Das attended the Inception Workshop of the ICAR- Network Project on "Gender issues in Rice-based production System and Refinement of Selected Technologies in Women Perspective" at NRCWA, Bhubaneswar during 29-30 Dec 2008.

Dr S.R. Dhua attended the Mega Seed Project Review Meeting at NASC Complex, New Delhi from 5 to 6 Jan 2009.

Shri S.K. Sinha, imparted training on "Public Procurement: Objectives and Legal Framework" as per World Bank guidelines to Consortia partners of the NAIP at CIFE, Mumbai from 5 to 6 Jan 2009, at NIANP, Bengaluru from 15 to 16 Jan 2009, NAARM, Hyderabad from 29 to 30 Jan 2009, NDRI, Karnal from 3 to 4 Feb 2009 and IISR, Lucknow from 9 to 10 Feb 2009.

Dr Lipi Das attended an ICAR sponsored Winter School on "Advanced Tools and Techniques for Project Formulation, Implementation and Evaluation" at OUAT, Bhubaneswar during 5-25 Jan 2009.

Drs R. Raja and B.B. Panda attended the Winter School on "Management Options for Waterlogged / excess Water Situation" at WTCER, Bhubaneswar during 7 to 27 Jan 2009.

Dr S.R. Dhua attended a meeting on DUS Testing organized by PVPFR authorities at Gujarat Agricultural University, Dantiwada, Gujarat on 8 Jan 2009.

Dr G.A.K. Kumar attended the Stakeholders Workshop on "Development and Maintenance of Rice Knowledge" at the Directorate of Rice Research (DRR), Hyderabad on 9 Jan 2009.

Dr T.K. Adhya attended the INSA Platinum Jubilee meeting at New Delhi from 10 to 11 Jan 2009.

Dr T.K. Adhya attended the ICAR Directors' Conference at New Delhi from 15 to 17 Jan 2009.

Dr B. Ramakrishnan was invited to deliver a lecture on "Genetic Fingerprinting of Microbial Communities by T-RFLP," in the training programme on "Novel and Innovative Biochemical and Molecular Tools for Characterization of Agriculturally Important Microorganisms," organized by the NBAIM, Mau on 19 Jan 2009.

Dr T.K. Adhya attended the ICAR-IRRI Work Plan (2009-2012) meeting at ICAR, New Delhi on 20 Jan 2009.

Dr S.K. Rautaray attended the monitoring and evaluation meeting of NAIP subprojects "Livelihood Promotion through Integrated Farming System in Assam" under component-III on 22 Jan 2009.

Dr K.S. Rao visited Bolangir, Kalahandi and Malkangiri districts of Orissa during 21-24 Jan 2009 as a Member of the National Level Monitoring Team of all NFSM activities (NLMT) constituted for Bihar, Jharkhand and Orissa.

Drs T.K. Adhya and R.N. Rao attended the NFSM meeting on Hybrid Rice at Krishi Bhawan, New Delhi on 28 Jan 2009.

Dr T.K. Adhya attended the Rice-Wheat Consortium Meeting at New Delhi from 2 to 3 Feb 2009.

Drs M. Variar, D. Maiti and Md. Arif attended the training workshop on "DNA-markers, MAS and Allele Mining for Consortium Partner (NAIP; Compo-nent 4; Rice Blast)" at NRCPB, New Delhi from 29 Jan to 11 Feb 2009.

Dr N.P. Mandal was deputed to IRRI, Philippines as a Visiting Research Fellow (VRF) to compile and analyze the data generated over the last three years and to prepare the final report of the ICAR-IRRI collaborative project "Developing and Disseminating Resilient and Productive Rice Varieties for Drought-Prone Environments in India" from 25 Jan to 28 Feb 2009.

Drs Mayabini Jena, D. Maiti, M.K. Barnwal, S.K. Rana, R.K. Singh, M. Variar and Amal Ghosh attended the 4th World Congress on Conservation Agriculture at New Delhi from 4 to 7 Feb 2009.

Dr S.R. Dhua attended the seminar on "Maintenance of Pure Stock of Genotypes and Reference Varieties" and the Plant Genome Saviour Community Recognition function organized by PPVFR authorities at NASC, New Delhi on 12 Feb 2009.

Dr K.S. Rao delivered a lecture as resource person on "Nutrient Management in Rainfed Rice-based Cropping Systems" on 12 Feb 2009 for the trainees of the Short course on "Site-specific Integrated Nutrient Management in Rice and Rice-based Cropping Systems" at DRR, Hyderabad during 4-13 Feb 2009.

Dr P.K. Mallick attended the National Symposium on "Livestock Biodiversity Conservation and Utiliza-tion: Lessons from Past and Future Perspectives" at the National Bureau of Animal Genetic Resources, Kamal from 12 to 13 Feb 2009.

Dr P. Samal attended the 41st Annual Conference of the Orissa Economics Association at Utkal University, Bhubaneswar on 14-15 Feb 2009.

Dr S.R. Dhua attended a sensitization workshop and acted as a resource person on PPV and FRA at OUAT, Bhubaneswar on 18 Feb 2009.

Drs R.N. Dash, O.N. Singh and Amal Ghosh were deputed to IRRI, Philippines to attend the Training-cum-Meeting of the ADB funded project "Development and Dissemination of Water Saving Rice Technologies in South Asia" from 16 to 20 Feb 2009.

Dr T.K. Adhya attended the Annual Review and

The progress in the ADB-IRRI-ICAR funded project on "Development and Dissemination of Water Saving Rice Technologies in South Asia," was reviewed at the Annual Review and Planning Meeting.

Courtesy: IRRI

Planning Meeting of the ADB Funded Project at IRRI, Philippines from 19-20 Feb 2009.

Dr G.J.N. Rao attended the Institute Management Committee Meeting of the DRR, Hyderabad as a Member at DRR, Hyderabad on 21 Feb 2009.

Drs T.K. Adhya and K.S. Rao attended the Research Advisory Committee Meeting of the DRR, Hyderabad at DRR, Hyderabad from 23 to 24 Feb 2009.

Drs T.K. Adhya and S.R Dhua attended the Annual Breeder Seed Review Meeting with the DDG (CS), ICAR at NBPGR, New Delhi on 24 Feb 2009.

Dr S.M. Prasad attended the National Seminar of Agricultural Extension at NASC Complex, New Delhi from 26 to 27 Feb 2009.

Dr P.K. Sahu attended the Summer School on "Recent Trends in Seed Production of Freshwater Fin Fishes and Shellfishes" from 18 Feb to 10 Mar 2009.

Dr B. Ramakrishnan attended the "Conference for Fulbrighters in South Asia-Role of Fulbright Program in Promoting Educational Collaborations," or-ganized by the United States-India Educational Foundation (USEFI), New Delhi in Kolkata from 2 to 4 Mar 2009.

Dr S.R. Dhua attended a meeting of rice breeders for discussions on various aspects of the registration of Extant Notified Varieties at DRR, Hyderabad on 4 Mar 2009.

Drs Urmila Dhua, T.K. Dangar and B. Rama-krishnan attended the Brain-storming Session on "Plant-Microbe Interactions," sponsored by the DST, Government of India, organized at the MACS-Agharkar Research Institute, Pune from 6 to 7 Mar 2009.

Dr Mayabini Jena attended the training cum workshop on "Statistical Tools for Data Analysis" at CRIDA, Hyderabad during 2-7 Mar 2009.

Dr K.S. Rao participated in the workshop on "Coping with Complexity-Mapping Sustainable Agriculture in Orissa" using the RTD Framework on 6 Mar 2009 at XIMB, Bhubaneswar, Orissa.

Dr S.K. Rautaray acted as a resource person in the training programme for farmers on "Production Technology for *Ahu* and *Boro* Rice" organized by the KVK, Nalbari at Barkhetri village on 13 Mar 2009.

Drs P.K. Sinha, N.K. Sharma, R.K. Singh and Shivan Thakur attended the work-shop on "Integrated Farming System Models for Eastern Region of India" at the Indian Institute of Natural Resins and Gums, Ranchi on 13 Mar 2009.

Dr A.K. Shukla as a representative of the east zone attended the Council Meeting of the Indian Society of Soil Science on 14 Mar 2009 at IARI, New Delhi.

Drs T.K. Adhya, D.P. Singh, K.R. Mahata, Sanjoy Saha, R.K. Sarkar, Bijoy Bhattacharjee, J.N. Reddy, Padmini Swain, P. Samal, P.K. Sinha, N.P. Mandal, V.D. Shukla, M. Variar, Shri S.S.C. Patnaik and Shri B.C. Marandi attended the Annual Review and Planning workshop on "Stress Tolerant Rice for Poor Farmers in Africa and South Asia" at New Delhi from 16 to 18 Mar 2009.

Dr J.N. Reddy attended the Review and Planning Meeting of the "Eastern India Rainfed Lowland Shuttle Breeding Network (EIRLSBN)" held at NASC Complex, New Delhi on 17 Mar 2009.

Dr J.N. Reddy attended the Second Annual Review and Planning Meeting of the ICAR-IRRI collaborative project "Enhancing and Stabilizing the Productivity of Salt-affected Areas by Incorporating Genes for Tolerance of Abiotic Stresses in Rice" held at NASC Complex, New Delhi on 18 Mar 2009.

Dr K.S. Rao as a member of National Level Monitoring Team-II (NLMT-II) for Bihar, Orissa and Jharkhand visited Bhagalpur, Banka, Khagaria and Patna districts of Bihar during 17-21 Mar 2009 and interacted with different stake holders.

Dr D.P. Sinhababu delivered the Plenary Lecture on "Finfish and Shellfish Production in Rice Ecologies" in the National Seminar on Aquaculture Researches in India-Status and Strategies for Future Development at the Utkal University, Bhubaneswar during 26-27 Mar 2009.

Workshops, Symposia, Seminars, Farmers' Day Organized

B. Behera

Shri Biswabhusan Harichandan (left) lights the lamp at the 62nd Foundation Day celebrations of the CRRI.

CRRI 62nd Foundation Day

Shri Biswabhusan Harichandan, Hon'ble Minister of Rural Development, Industries and Law, Government of Orissa was the Chief Guest at the 62nd Foundation Day celebrations of the CRRI in Cuttack on 23 Apr 2008. Shri P.R. Biswal, Hon'ble MLA, Cuttack Sadar and Dr N. Sarangi, Director, CIFA, Bhubaneswar also attended the celebration.

USEFI Workshop Identifies Agri-Environmental Issues

"Environmental Impact Assessment of Pollution from Agriculture," was the USEFI (United States Educational Foundation in India) Workshop held in collaboration with the CRRI in Cuttack from 8–11 Apr 2008. There were five technical sessions with 18 presentations. These presentations were made by stakeholders in research institutes, universities, NGOs, and by both Indian and U.S. Fulbrighters. The Workshop identified key agri-environmental issues and indicators for the integration of environmental concerns into the agricultural practices.

Annual Review and Planning Meeting Evaluates Progress

The 2nd Annual Review and Planning Meeting of the ADB-supported Project "Development and Dissemination of Water-saving Rice Technologies in South Asia," was held at the CRRI, Cuttack from 19 to 21 Apr 2008. The project has components in Bangladesh, Pakistan, Nepal and India. Dr O.N. Singh at the CRRI is the Coordinator for the activities in India and Dr A. Kumar is the Programme Leader of the Project, and is based at the IRRI, the Philippines. A total of 42 scientists from six countries deliberated over the progress in research. Mr J. Zhang, Project Economist, Asian Development Bank also participated.

Kharif Interface Meeting

To formulate strategies for increasing rice production in *kharif* in Orissa, an interface meeting with the Government of Orissa and the CRRI was held on 18 Jun 2008 under the Chairmanship of Dr M.P. Pandey, Director, CRRI. Dr B. Giri, Joint Director of Agriculture (SP&C) presented the status report on rice production scenario in Orissa. A strategy was formulated for cultivation in *kharif*.

CURE Meeting Reviews Work Plan

Drs M.P. Pandey, D.P. Singh, P.K. Sinha and M. Variar attended the 7th Annual Meeting of the Consortium for Unfavourable Rice Environments (CURE) at the IRRI, Philippines during 10–12 Jun 2008. The meeting was organized to evaluate the progress of CURE partnership and activities for improved livelihoods in unfavourable rice environments, to draft the work plan of each CURE working group for 2008–09, to align the

CURE organization along with IRRI's structure of research in unfavourable environments in the medium-term plan (MTP), to identify opportunities for funding and strategic alliances, and to promote linkages between CURE and other networks. It was attended by participants from seven countries, besides CURE Steering Committee members and many IRRI scientists. The progress of work during 2007 was reviewed and work plan for 2008-09 was discussed and approved by the CURE Steering Committee.

Training-cum-planning Workshop Organized

A training-cum planning Workshop on "Stress Tolerant Rice for Poor Farmers of Africa and South Asia" funded by the Bill & Melinda Gates Foundation was organized by the IRRI, Philippines at CRRI, Cuttack during 26 to 28 May 2008. Sixteen participants from India participated and Dr Thelma Paris, Social Scientist, IRRI, Philippines co-ordinated. The main theme of the programme was Participatory Rural Appraisal (PRA), standard methods for varietal evaluation, base line data collection on socio-economic aspect and data management for participatory varietal selection (PVS).

NAIP Activities

A National Agriculture Innovation Project (NAIP) V-PAGe (Visioning, Policy Analysis and Gender): Subprogramme II-Technology Forecasting Workshop on "Forecasting Future Technological Needs for Rice in India" was held at the CRRI, Cuttack from 28 to 29 Jul 2008. The technical sessions provided an overview of the workshop, as well as the R & D strategies in India in relation to the needs of next five years. The Workshop was attended by Drs M.P. Pandey, Director, CRRI, B.C. Viraktamath, Project Director, Directorate of Rice Research (DRR), Hyderabad, Krishna Srinath, Director, National Research Centre for Women in Agriculture (NRCWA), Bhubaneswar, S.C. Mani, Joint Director (Research), GBPUAT, Pantnagar, S.D. Sharma, Director, Indian Agricultural Statistics Research Institute (IASRI), New Delhi, Ranjana Agrawal, Head, Forecasting Techniques, IASRI, New Delhi, R. Kalpana Sastry, Principal Scientist, National Academy of Agricultural Research Management (NAARM), Hyderabad, Anil Rai, Senior Scientist, V. Ramasubramanian, Shri Amrendra Kumar and Shri Satya Pal from the IASRI, New Delhi, and scientists from the CRRI.

A launching workshop of NAIP Component-4,

Sixteen participants from India participated in the training-cum planning Workshop on "Stress Tolerant Rice for Poor Farmers of Africa and South Asia."

B. Behera

"Soil Organic Carbon Dynamics vis-à-vis Anticipatory Climatic Changes and Crop Adaptation Strategies" and "Towards Development of a Single Cell C4 Photosynthesis System in Rice" was held at the CRRI, Cuttack on 26 Dec 2008. Dr A.K. Singh, DDG (NRM), ICAR was the Chief Guest. Dr A. Bandyopadhyay, National Coordinator, Component-4, NAIP gave an overview of NAIP. Dr P. Bhattacharyya and Prof. B.C. Tripathy, CPIs of the Projects spoke on the objectives of the projects. The workshop was attended by Drs Aswani Kumar, Director, WTCER, Bhubaneswar, K.S. Rao, Head, Crop Production, CRRI, Cuttack, Prasanna Mohanty, Adjunct Professor, Jawaharlal Nehru University, New Delhi, D.C. Uprety, ICAR Emeritus Scientist, S.N. Singh, Deputy Director and Head, Division of Environmental Sciences, National Botanical Research Institute (NBRI), Lucknow, V.R. Rao, J.K. Sainis, BARC and Prof M. Udayakumar, UAS, GKVK, Bangalore.

Twentyfive trainees from the PDCSR, Modipuram, IGAU, Raipur, TNAU, Coimbatore, IISS, Bhopal and APRRI, RARS, Maruteru were trained in a 10-day's training workshop under NAIP Component-4 (2031): Sub-programme on "Soil Organic Carbon Dynamics *vis-à-vis* Anticipatory Climatic Changes and Crop Adaptation Strategies" at CRRI, Cuttack from 16 to 25 Feb 2009. The technical sessions comprised of 14 lectures and eight hands on practicals dealing with soil organic carbon decomposition, its kinetics, GH gas emission, microbial and insect diversities, metagenomics, rice-based cropping system, and rice varieties in relation to anticipatory climatic changes.

62nd Independence Day Celebrated

The CRRI, Cuttack celebrated the 62nd Independence Day in Cuttack. Dr M.P. Pandey, unfurled the Indian National Flag. In his address he spoke on the significant achievements of the CRRI and the challenges for the future.

Republic Day Celebrated

Dr T.K. Adhya unfurled the Indian National Flag at Cuttack during the celebrations of the 60th Republic Day. In his address to the staff he spoke on the achievements of the CRRI and asked them to address the challenges faced by the farmers.

STRASA Planning and Training Workshop Held

"Socio-economic Research Planning and Training on Survey Design and Data Collection" was the Workshop held at CRRI, Cuttack from 16–18 Oct 2008 to facilitate socio-economic research activities under objective 7 (Impact Assessment and Targeting) of the project, "Stress Tolerant Rice for Poor Farmers in Africa and South Asia (STRASA)" funded through the

Seen in the photograph are participants at the workshop on "Socio-economic Research Planning and Training on Survey Design and Data Collection."

B. Behera

Courtesy: BMGF

After the inaugural session, the delegates at the Annual Review and Planning Workshop of STRASA get together for a group photograph.

Bill and Melinda Gates Foundation (BMGF). Dr T.K. Adhya, Director, CRRI inaugurated the workshop. Dr S.R. Dhua welcomed the participants. Dr Sushil Pandey, Senior Scientist and Programme Leader, Rice Policy and Impact, briefed the participants about the overall objectives of the workshop. Dr Samrendu Mohanty, Head, Social Science Division, IRRI, provided a brief overview of the IRRI social sciences research activities and future strategies. Fifteen social scientists representing various NARS partner institutions from Bangladesh, Nepal and India participated.

STRASA Planning Workshop Held

The Annual Review and Planning Workshop on "Stress Tolerant Rice for Poor Farmers in Africa and South Asia" was held at New Delhi from 16 to 18 Mar 2009. The Workshop reviewed the progress in STRASA and also the components of Drought Breeding Network, Eastern India Rainfed Lowland Shuttle Breeding Network, Upland Shuttle Breeding Network and Salinity Breeding Network that are funded by the Bill and Melinda Gates Foundation (BMGF). Dr S.P. Tiwari, Deputy Director-General (CS), ICAR, New Delhi chaired the opening session. Dr David Mackill, IRRI, the Philippines explained the objectives and expected outputs of the Workshop. Dr David Bergvinson, Program Officer, Science and Technology Global Development, BMGF spoke on the activities for the promotion of agriculture under the BMGF. Dr U.S. Singh is the Project Coordinator for South Asia, STRASA. Drs T.K. Adhya, D.P. Singh, K.R. Mahata, Sanjoy Saha, R.K. Sarkar, Bijoya Bhattacharjee, J.N. Reddy, Padmini Swain, P. Samal, Shri S.S.C. Patnaik and Shri B.C. Marandi from CRRI, Cuttack, and Drs P.K. Sinha, V.D. Shukla, M. Variar and N.P. Mandal from the CRRI Regional Research Station, Hazaribag attended the Workshop.

STRASA Team Visits Site at Ersama

The CRRI, Cuttack, initiated a farmers' participatory on-farm research in Ersama block of Jagatsinghpur district, Orissa in 2004 under two ICAR-IRRI collaborative projects funded by the ADB and the Challenge

The STRASA team evaluated the farmers' participatory on-farm research in Ersama block.

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B. Behera

Left: A view of the delegates at the meeting to review the progress of the project at village Nuagaon.
Right: A lady farmer (left) seeks clarifications from the delegates during the review meeting.

Program on Water and Food. The objectives of these projects were to enhance the productivity of rice and rice-based cropping systems in salt-affected coastal areas for ensuring food security and improving livelihoods of poor farming communities. The "STRASA" project with funding from the BMGF started in Jan 2008.

Dr David Bergvinson, BMGF, Dr David Mackill, Project Leader, STRASA and Dr U.S. Singh, Project Coordinator for South Asia, STRASA along with Dr T.K. Adhya visited the project site for coastal salinity in Ersama block on 20 Mar 2009 to review the progress. At the farmers' meeting in Nagari village the farmers' acknowledged that the use of improved varieties and management practices had helped them in increasing rice productivity, and improving their food security, livelihood and socio-economic status.

ICAR-IRRI-BMZ Project Evaluated

Progress in the ICAR-IRRI project "From Genes to Farmers' Fields: Enhancing and Stabilizing Productivity of Rice in Submergence-prone Environments," funded for the past five years by Germany's Federal Ministry for Economic Cooperation and Development (BMZ) was evaluated by a site visit in village Nuagaon of Jajpur district of Orissa followed by a one day wrap-up workshop at CRRI in Cuttack during 6–8 Nov 2008. Delegates were Drs David Mackill, Umesh Singh, Sigrid Heuer, Georgina Vergara, Darlene Sanchez, Endang Septiningsih, Gene Hettel, Adam Barclay and Namrata Singh from IRRI, Philippines, Drs Pamela Ronald, Patricia Ronald and Julia Bailey-Serres from the USA, Drs Md. Abdul Mannan Akhank, K.M. Iftekharuddaula, Md. Abdulla-Al-Mahbub and Mst. Kamrun Naher from Bangladesh, and Drs P.C. Ram, V.N. Singh and P.N. Singh from the NDUAT, Drs J.N. Reddy, R.K. Sarkar and S.S.C. Patnaik from CRRI, Cuttack and Drs N. Shobha Rani and C.N. Neeraja from DRR, Hyderabad. The team evaluated the performance of Swarna-*Sub1* in the farmers' field in Nuagaon that was followed by an interaction with the farmers. The results were discussed in the wrap-up workshop that was followed by presentations on the recent developments on research on *Sub1*.

EIRLSBN Selection Activity

Dr D.J. Mackill, Programme Leader, IRRI, Philippines with Drs T. Ahmed, RARS, Assam, P.K. Goswamy, AAU, Assam, N.K. Singh and V.N. Sahai, RAU, Samastipur, S.R. Das, OUAT, Bhubaneswar and J.N. Reddy, CRRI, Cuttack participated in the selection activity that consisted of selecting single plants from the segregating populations at CRRI in Cuttack during 18–19 Nov 2008. The CRRI is the coordinating centre for the Eastern India Rainfed Lowland Shuttle Breeding Network (EIRLSBN) activity.

SRI Training Programme Organized

A training programme sponsored by the Uttar Pradesh Council of Agricultural Research, Lucknow on "System of Rice Intensification," was held at the CRRI in Cuttack from 18 to 24 Oct 2008 in which eight progressive farmers of Uttar Pradesh participated.

Hindi Fortnight Organized

Competitions in Hindi Essay Writing, Précis Writing, Computer Typing, Technical Words Writing, Reading and Noting and Drafting were conducted for the staff of the CRRI whose mother tongue was other than Hindi and their family members as part of the Hindi Fortnight 2008 from 15 to 28 Sep 2008. In the closing ceremony on 21 Oct 2008, Shri A.K. Upadhyay, IPS, DIG (Police), Cuttack was the Chief Guest. A Hindi Kavi Sammelan was also organized. Smt Rehana Khanum, Women Polytechnic College, Bhubaneswar, Shri B.K. Mishra, Senior Hindi Pradhyapak, Hindi Teaching Scheme, Government of India, Cuttack, Smt Pushpa Singh and Dr T.P. Tripathi from Cuttack participated.

Vigilance Awareness Week Observed

The CRRI, Cuttack observed the Vigilance Awareness Week during 3–7 Nov 2008. Dr T.K. Adhya, Director, CRRI, administered the pledge to the staff followed by reading of message from the Central Vigilance Commission, Government of India by Shri S.K. Sinha, SAO and Vigilance Officer, CRRI. An essay competition on "Utility of the Right to Information Act in Effective Governance" was held among the staff. At the closing ceremony on 10 Nov 2008, Shri M. Akhaya, IPS, IG of Police (Vigilance), Cuttack, Orissa, spoke on corruption, and rules and regulations enforced by the Vigilance Department for keeping the organization free from corruption. He distributed prizes to the winners of the essay competition.


B. Behera

Shri A.K. Upadhyay, IPS, addressed the staff during the Hindi fortnight.


B. Behera

Gopinath Sahu Memorial Lecture Delivered

"Genetic Enhancement of Short-grain Aromatic Rices for Higher Productivity," was the topic of the 17th Gopinath Sahu Memorial lecture delivered by Dr S.R. Das, Professor, Department of Plant Breeding and Genetics, OUAT. The lecture was organized by Dr Gopinath Sahu Memorial Trust at CRRI, Cuttack on 6 Nov 2008. Prof B. Jena, President, Dr Gopinath Sahu Memorial Trust spoke on the activities of the Trust and on the Annual Lecture.

NAAS Eastern Chapter Organizes Seminars

The Eastern Chapter of the National Academy of Agricultural Sciences (NAAS) organized two seminar lectures at CRRI in Cuttack. The first one "Molecular Breeding of Rice and Plant Biotechnology" was given by Prof H. Uchimiya of the Institute of Molecular and

Cellular Biosciences, University of Tokyo on 22 Nov 2008. The second one was delivered by Dr Reiner Wassmann, Coordinator, Rice and Climate Change Consortium project, IRRI, Philippines on "Rice and Global Climate Change Impact Assessment, Adaptation and Mitigation Options," on 12 Dec 2008.

The Eastern Chapter also held its meeting at CRRI in Cuttack on 12 Dec 2008 under the Chairmanship of Prof. K. Pradhan, Fellow and Ex-Secretary, NAAS, of the Academy and former Vice-Chancellor, OUAT, Bhubaneswar and Rajasthan Agricultural University, Bikaner.

AMAAS Meeting Reviews Progress

Dr D.K. Arora, Director, National Bureau of Agriculturally Important Microorganisms (NBAIM), ICAR, Mau and National Coordinator of AMAAS spoke on its activities during the Review Meeting held at CRRI in Cuttack on 28 Jan 2009. Dr T.K. Adhya, Director, CRRI spoke on the progress in research at the CRRI. A total of 17 delegates deliberated on the progress of work at different centres and finalized the work plan. The AMAAS (Application of Microorganisms in Agriculture and Allied Sectors) is an all-India project started in 2006.

B. Behera

Interaction Programme on SRI

"SRI Method of Rice Cultivation" was the title of the farmer-scientist interaction programme sponsored by ATMA, Cuttack at CRRI, Cuttack on 16 Jan 2009. Fifty farmers from different districts participated.

CAC Meets at Hazaribag

The 2nd Meeting of the Consortium Advisory Committee (CAC) of the project "Allele Mining for Rice Blast Resistance Genes for the Development of Race Non-Specific Disease Resistance" was held at CRRI-RRS, Hazaribag on 28 Feb 2009 under the Chairmanship of Prof. B.L. Jalali, Former Director of Research,

Seen in the photograph are delegates at the Review Meeting of AMAAS.

B. Behera

B. Behera

Participatory Varietal Trials were evaluated in village Samian.

HAU, Hisar. Dr R. Sridhar and Dr P.K. Sinha were the Members of the committee. The meeting was attended by Dr T.R. Sharma, PI of the Project at the lead institution (NRCPB) and partners from the IARI, New Delhi (Drs A.K. Singh, Plant Breeder and CCPI, U.D. Singh, PS and COPI); UAS, Mugad (Dr S.K. Prashanthi, CCPI, and N.C. Hanaramaratti COPI); HPKV, Palampur (Dr P. Plaha, CCPI); and CRURRS, Hazaribag (Drs M. Variar, CCPI and D. Maiti, COPI).

PVT Evaluated in Village Samian

Participatory Varietal Trials (Mother and Baby) in village Samian, Badchara block, Jajpur district, Orissa were evaluated on 23 Mar 2009 by Drs T.K. Adhya, Director, CRRI, Cuttack, A. Kumar, IRRI, the Philippines, O.N. Singh, P. Samal, A. Ghosh and Padmini Swain from the CRRI, Cuttack, and Ayan Hazara, IRRI under the ADB-IRRI-ICAR funded project on "Development and Dissemination of Water-saving Rice Technology in South Asia and Drought-breeding Network." The experiments comprise of drought-tolerant rice lines with farmers' adopted varieties (Khandagiri and Lalat) grown under limited water conditions. The progress was discussed at a farmer meeting.

IRRI-ICAR Project Reviewed

Progress in the ADB-IRRI-ICAR funded project on "Development and Dissemination of Water-saving Rice Technology in South Asia," was discussed in the 3rd Annual Review and Planning Meeting at the IRRI, the Philippines. It comprised of a "Hands-on Training on Data Analysis" to delegates from the Bangladesh Rice Research Institute, Ghazipur, Bangladesh Rural Development Agency, Bogra, Rice Research Station, Kala Shah Kaku and Rice Research Institute, Dokri from Pakistan, Nepal Regional Agriculture Research Stations at Tarahara and Hardinath, and the CRRI, Cuttack from 16 to 18 Feb 2009 followed by the Re-

view from 19 to 20 Feb 2009. Drs O.N. Singh, R.N. Dash and A. Ghosh from the CRRI participated in the Hands-on Training. They were joined by Dr T.K. Adhya, Director, CRRI. Dr A. Kumar, IRRI is the Coordinator. After a review of the progress of work in 2008, a Work Plan for 2009 was finalized.

Exhibitions

The CRRI participated in:

The "State Level Krushak Divas 2008" held at Nagiaposhi of Dhenkanal District on 8 May 2008. This was organized by the Directorate of Agriculture and Food Production, Government of Orissa. Shri P. Jana and Shri P.K. Mohanty represented the CRRI.

The "6th Folk Fair 2008" held at Puri from 10 to 14 May 2008. Shri P. Jana and Shri P.K. Mohanty represented the CRRI.

The Regional Agricultural Fair 2008 from 1 to 3 Dec 2008 at Gangtok, Sikkim. The Fair was inaugurated by Shri D.N. Takarpa, Hon'ble Speaker, Sikkim Legislative Assembly. The CRRI exhibited various technologies and was represented by Shri P. Jana and Shri P. K. Mohanty.

The Pusa Krishi Vigyan Mela from 23 to 26 Feb 2009 at IARI, New Delhi. The exhibition was inaugurated by Shri Sharad Pawar, Hon'ble Union Minister of Agriculture. Shri P. Jana and Shri P.K. Mohanty explained the exhibits.

The State Agriculture Exhibition "Krishi Mahotsav 2008–09" from 19–21 Feb 2009 at Bhubaneswar. The exhibition was inaugurated by Shri S.N. Nayak, Hon'ble Minister of Agriculture, Government of Orissa. The CRRI exhibits were explained by Shri S.M. Chatterjee, Shri B.D. Ojha and Shri A.K. Parida.

The CRRI-RRS, Hazaribag participated in the farmers' fair organized by the BAU, Ranchi from 26 to 28 Feb 2009, and displayed technologies on rice and package of practices suitable for Jharkhand.

Institute Seminar

The following talks were delivered at CRRI, Cuttack:

Shri J. Meher on "Effect of High Temperature Stress on Tropical Rice and its likely Impact on Rice Production and Options available for its Adaptation" on 14 May 2008.

Dr D. Swain on "Studies on Phylogenetic Relations in the Genus *Oryza*" at CRRI, Cuttack on 29 May 2008.

Dr A.K. Shukla on "Leaf Colour Chart (LCC): A Tool for Precision N-management in Rice-wheat System," on 14 Nov 2008.

Dr Bhattacharyya on "Soil Organic Carbon Dynamics in Relation to Anticipatory Climate Change" on 21 Nov 2008.

Dr R.K. Sarkar on "GCP Travel Grant Award-2008 Work done at IRRI," on 28 Nov 2008.

Prof H. Uchimiya on "Molecular Breeding of Rice and Plant Biotechnology" on 22 Nov 2008.

Dr Reiner Wassmann on "Rice and Global Climate change Impact Assessment, Adaptation and Mitigation Options" on 10 Dec 2008.

Dr G.A.K. Kumar on "Meta Analysis—A Method for Generalization of Studies," on 12 Dec 2008.

Dr A. Prakash on "Climate Change and Insect Abundance," on 19 Dec 2008.

Prof H. Uchimiya spoke on "Molecular Breeding of Rice and Plant Biotechnology" on 22 Nov 2008.

B. Behera

Dr Mayabini Jena on "Bio-intensive Management of Rice Pests with Emphasis on Botanicals" on 2 Jan 2009.

Dr O.N. Singh on "Aerobic Rice for Sustainable Improvement" on 9 Jan 2009.

Dr S. Sasmal on "Controlled Release of Pesticide" on 17 Jan 2009.

Dr D.P. Sinhababu on "Rice-fish Farming—Looking Back and Forward" on 23 Jan 2009.

Dr Alok Ranjan Ray, Professor, Centre for Biomedical Engineering, Indian Institute of Technology, New Delhi, and the All India Institute of Medical Sciences, on "Issues in Developing Biodegradable Polymers" on 30 Jan 2009.

Dr K.S. Behera on "Faunal Diversity in Rice Fields" on 31 Jan 2009.

Dr M.J. Baig on "Chloroplast Photorespiration bypass Effects on Increase in Photosynthesis and Productivity of Rice" on 31 Jan 2009.

Dr R. Raja on "Technological Options for Restoring Agricultural Production in Tsunami-affected Agricultural Land" on 6 Feb 2009.

Dr P. Kaushal on "Apomixis: Experiences and Plans" on 6 Feb 2009.

Dr Sanjoy Saha on "Allelopathy Traits for Weed Management in Rice" on 13 Feb 2009.

Dr M.J. Baig on "Single Cell C_4 Photosynthesis System—Potential to Introduction in Rice" on 20 Feb 2009.

Shri R.C. Dani on "Use of Pheromones in Rice Insect Pest Management" on 27 Feb 2009.

Dr Sanjoy Saha on "Agro-techniques for Sustaining Productivity of Wet-direct Sown Summer Rice in Flood-prone Lowlands" on 27 Feb 2009.

Dr P.C. Rath on "IPM in SRI" on 6 Mar 2009.

Dr S.K. Apte, Associate Director, Bio-medical Group (B) and Head, Molecular Biology Division, Bhabha Atomic Research Centre (BARC), Mumbai, on "Genetic Manipulation of Nitrogen-fixing Cyanobacteria for Basic Research and Environmental Applications" on 9 Mar 2009.

Dr S.R. Dhua on "Plant Variety Registration" on 21 Mar 2009.

Shri Suvendu Das, on "Elevated Atmospheric Carbondioxide Alters Microbial Population Structure in Tropical Rice Soils" on 27 Mar 2009.

Dr B.C. Patra on "Genetic Resources in Rice" on 27 Mar 2009.

Radio and TV Talk

Dr Prasanta Kumar Mallick gave a radio talk on "Ghara Aganare Kukuda Chasa" on 2 May 2008.

Dr Jyoti Nayak gave a radio talk on "Kharif Nature Chatu Chasa" on 13 May 2008.

Shri R.C. Dani participated in a programme over Doordarshan on "Insect Pest Management in Rice" on 21 and 23 Jul 2008, and also participated in a phone-in programme on the same subject on 25 Jul 2008.

Dr Mayabini Jena gave a radio talk over the AIR on "Management of Insect Pests of Rice by Plant Products" on 11 Aug 2008.

Shri R.C. Dani gave a radio talk over the All India Radio (AIR) on "Insect Pest Problem in Rice and their Management" on 15 Aug 2008.

Dr Srikanta Lenka gave a radio talk over the AIR on "Safe Use of Plant Protection Chemicals in different Crops" on 12 Sep 2008.

Dr Mayabini Jena participated in a telecast over the Doordarshan and spoke on "Botanical Products in the Insect Pest Management of Rice" on 22 and 25 Sep 2008 and also participated in a phone-in programme on 25 Sep 2008.

Dr Jyoti Nayak gave a radio talk on 22 Sep 2008 on "Development of Nutritional Garden".

Dr Jyoti Nayak gave a radio talk over the AIR on "Kitchen Garden" on 25 Sep 2008.

Shri A. Patnaik participated as an expert on the topic "Basna Dhana Pain Bises Yatna" (Special Care for Aromatic Rice Cultivation) in the "Pallishree" agricultural extension programme of Doordarshan, Bhubaneswar on 3 Nov 2008.

Dr P.K. Mallick gave a radio talk over the AIR on "Mukta Aganare Kukuda Chasa" (Backyard Poultry Rearing) on 15 Dec 2008.

Distinguished Visitors

PROFESSOR Jane E. Schukoske, Executive Director, USEFI, New Delhi visited CRRI, Cuttack from 8-11 Apr 2008.

Dr D.P. Ray, Vice-Chancellor, OUAT, Bhubaneswar visited CRRI, Cuttack from 19 to 21 Apr 2008.

Shri Biswabhusan Harichandan, Hon'ble Minister of Rural Development, Industries and Law, Government of Orissa was the Chief Guest at the 62nd Foundation Day celebrations of the CRRI in Cuttack on 23 Apr 2008. Shri P.R. Biswal, Hon'ble MLA, Cuttack Sadar and Dr N. Sarangi, Director, CIFA, Bhubaneswar also attended the celebration.

Shri B.P. Mehta, Hon'ble Member of Parliament, Hazaribag, visited the CRRI-RRS, Hazaribag on 14 Jun 2008.

Dr P.L. Gautam, Deputy Director-General (Crop Sciences) visited CRRI, Cuttack on 9 Aug 2008.

Dr A. Govindan, Senior Agricultural Specialist, American Embassy, New Delhi visited CRRI, Cuttack on 27 Aug 2008.

B. Behera

Dr Mangala Rai, Secretary, DARE and Director-General, ICAR visited CRRI in Cuttack on 28 Sep 2008. He was accompanied by Shri A.K. Upadhyay, Additional Secretary, DARE, and Secretary, ICAR, Dr P.L. Gautam, DDG (CS), Dr S.P. Tiwari, DDG (Education), Dr S. Ayyappan, DDG (Fisheries) and Dr Nawab Ali, DDG (Agricultural Engineering).

Shri A.K. Upadhyay, IPS, DIG (Police), Cuttack visited CRRI, Cuttack on 21 Oct 2008.

Dr Mangala Rai takes a look at the experimental fields during his visit to the CRRI in Cuttack (top and below).

B. Behera

Dr Mangala Rai inaugurated the Oryza museum at the CRRI in Cuttack.

Dr Mangala Rai examines the exhibits at CRRI-RRS, Hazaribag.

Shri M. Akhaya, IPS, IG of Police (Vigilance), Cuttack, Orissa visited CRRI, Cuttack 10 Nov 2008,

An IRRI External Programme and Management Review (EPMR) Team comprising of Drs G.O. Edmeades, Chair, R.B. Tripp and U.S. Singh visited CRRI from 28 to 30 Nov 2008.

Dr A.K. Singh, DDG (NRM), ICAR, New Delhi visited CRRI, Cuttack on 26 Dec 2008.

Dr P.L. Gautam evaluates a rice transgenic line at the transgenic greenhouse in CRRI, Cuttack.

Dr Mangala Rai, Secretary, DARE and Director-General, ICAR, visited CRRI-RRS, Hazaribag on 9 Feb 2009. He was accompanied by Dr N.N. Singh, Vice-Chancellor, Birsa Agricultural University (BAU), Ranchi and Dr B.N. Singh, Director (Research), BAU. Dr T.K. Adhya, Director, CRRI and Dr P.K. Sinha, OIC, were also present.

Dr T.K. Adhya (left) explains field experiments to Dr A.K. Singh during his visit to CRRI, Cuttack.

Professor Jane E. Schukoske (second from right), Executive Director, USEFI, New Delhi visited CRRI, Cuttack.

Award/Recognitions

Courtesy: ICAR, New Delhi

ICAR Interdisciplinary Team Award

The ICAR Award for outstanding interdisciplinary team research in agriculture and allied sciences for the biennium 2005–06 was given by Shri Sharad Pawar, Hon'ble Union Minister of Agriculture on 16 Jul 2008 to Dr J.K. Jena and his team comprising of Drs P.C. Das, S.N. Mohanty, K.N. Mohanta, P.K. Sahu and Niranjan Sarangi for generating technologies of seed production and grow-out farming of medium carps. Dr P.K. Sahu works at CRRI in Cuttack, and Drs J.K. Jena, P.C. Das, S.N. Mohanty, K.N. Mohanta and Niranjan Sarangi at the CIFA, Bhubaneswar.

B. Behera

CRRI in Sports

The CRRI Kabaddi team won the 56th Senior Kabaddi Championship-2008, defeating the Orissa Police Kabaddi team on 24 Aug 2008 at Bhubaneswar.

The CRRI lifted the ICAR Overall Team Championship Trophy jointly with NDRI, Karnal in the ICAR Inter Zonal Sports Meet 2008 at Hyderabad from 17–20 Nov 2008.

The CRRI lifted the ICAR Overall Institute Championship Trophy at the ICAR Zonal Sports Tournament for Eastern Zone held at ICAR Research Complex for Eastern Region, Patna from 29 Jan to 2 Feb 2009.

Personnel

Staff strength as on 31 March 2009

	Posts at CRRI, Cuttack			Posts at KVK, Santhapur			Posts at KVK, Koderma		
Category	Sanctioned	Filled	Vacant	Sanctioned	Filled	Vacant	Sanctioned	Filled	Vacant
Scientist	115	82	33	4	1	3	1	-	1
Technical	184	149	35	10	6	4	11	9	2
Administrative	104	88	16	2	2	-	2	1	1
Supporting	171	106	65	2	2	-	2	2	-
Canteen	5	5	-	-	-	-	-	-	-
Sub-total	579	430	149	18	11	7	16	12	4
RMP	1	1	-	-	-	-	-	-	-
Total	580	431	149	18	11	7	16	12	4

M.P. Pandey ..... Director (till 30 Sep 2008)

T.K. Adhya ..... Director (from 1 Oct 2008)

Crop Improvement

G.J.N. Rao ..... Principal Scientist and Head

Plant Breeding

S.R. Dhua ..... Principal Scientist

O.N. Singh ..... Principal Scientist

K. Pande ..... Principal Scientist (on deputation)

J.N. Reddy ..... Principal Scientist

Ashok Pattnaik ..... Principal Scientist

Sanjaya Singh ..... Senior Scientist (till 6 Jun 2008)

Meera Ku. Kar ..... Senior Scientist

S.K. Pradhan ..... Senior Scientist

Lotan Kr. Bose ..... Senior Scientist

K. Chattopadhyay ..... Senior Scientist

J. Meher ..... Scientist (Sr. Scale)

Ramesh Chandra ..... Jr. Technical Astt.

A.V.G. Sharma ..... Sr. Mechanic

Genetics and Cytogenetics

R.N. Rao ..... Principal Scientist

P. Sen ..... Principal Scientist (till 31 Aug 2008

R.K. Sahu ..... Scientist (S.G.)

S.S.C. Pattnaik ..... Scientist (S.G.)

Economic Botany

B.C. Patra ..... Principal Scientist

D. Swain ..... Senior Scientist

H.N. Subudhi ..... Senior Scientist

B.C. Marndi ..... Scientist (Sr. Scale)

Biotechnology

Pankaj Kaushal ..... Principal Scientist

..... (from 24 Dec 2008)

Lambodar Behera ..... Senior Scientist

Bijoya Bhattacharjee ..... Senior Scientist

..... (from 1 Sep 2008)

B.S. Subramanian ..... Scientist

Crop Production

K.S. Rao ..... Principal Scientist and Head

Agronomy

Amal Ghosh ..... Senior Scientist
Sanjoy Saha ..... Senior Scientist
Annie Poonam ..... Scientist (Sr. Scale)
R. Raja ..... Senior Scientist (from 22 Aug 2008)
B.B. Panda ..... Senior Scientist (from 1 Sep 2008)

Fish and Fisheries

D.P. Sinhababu ..... Principal Scientist
P.K. Nayak ..... Principal Scientist

Soil Science and Microbiology

A.K. Mishra ..... Principal Scientist
R.N. Dash ..... Principal Scientist
S.P. Chakravorty ..... Principal Scientist
T.K. Adhya ..... Principal Scientist (till 30 Sep 2008)
A.K. Shukla ..... Principal Scientist
..... (from 10 Nov 2008)
K.R. Mahata ..... Principal Scientist
T.K. Dangar ..... Principal Scientist
S.K. Pradhan ..... Senior Scientist (till 30 Nov 2008)
B. Ramakrishnan ..... Senior Scientist
P. Bhattacharyya ..... Senior Scientist
R.R. Dash ..... Field Assistant
Kusha Panda ..... Sr. Scientific Asstt.

Agricultural Engineering

P.C. Mohapatra ..... Principal Scientist
B.C. Parida ..... Principal Scientist
S.P. Patel ..... Principal Scientist
P.N. Mishra ..... Principal Scientist
A.K. Choudhury ..... Principal Scientist
M. Din ..... Principal Scientist (from 17 Oct 2008)

Crop Protection

Anand Prakash ..... Principal Scientist and
..... Head (from 22 Dec 2008)

Plant Pathology

S.K. Mohanty ..... Principal Scientist
..... (till 30 Nov 2008)
Urmila Dhua ..... Principal Scientist
S.N. Tewari ..... Principal Scientist
G. Bhaktavastalam ..... Senior Scientist
K.M. Das ..... Senior Scientist
S.K. Singh ..... Scientist (Sr. Scale)

Entomology

Jagadiswari Rao ..... Principal Scientist
Gauri Padhi ..... Principal Scientist
R.C. Dani ..... Principal Scientist
S. Sasmal ..... Principal Scientist
K.S. Behera ..... Principal Scientist
Mayabini Jena ..... Principal Scientist
P.C. Rath ..... Senior Scientist
V. Nandagopal ..... Senior Scientist

Nematology

S.C. Sahu ..... Principal Scientist
C.D. Mishra ..... Senior Scientist

Biochemistry, Physiology and Environmental Sciences

S.G. Sharma ..... Principal Scientist and
..... Head (from 15 Jan 2009)

Biochemistry

Avijit Das ..... Senior Scientist

Plant Physiology

D.P. Singh ..... Principal Scientist
R.K. Sarkar ..... Principal Scientist
Padmini Swain ..... Principal Scientist
Sanjukta Das ..... Principal Scientist
M.J. Baig ..... Senior Scientist

Biophysics

Pramila Krishnan ..... Senior Scientist

Social Science and Extension, Communication and Training

Agricultural Statistics

A.V. Suriya Rao ..... Principal Scientist
..... (till 31 Jan 2009)

Agricultural Economics

Parshuram Samal ..... Principal Scientist
Arun Pandit ..... Senior Scientist (from 29 Sep 2008)

Extension, Communication and Training

N.C. Rath ..... Senior Scientist
G.A.K. Kumar ..... Senior Scientist
Lipi Das ..... Scientist (Sr. Scale)
Ravi Viswanathan..Editor-cum-Information Officer
P. Jana ..... Rice Production Trg. Astt.
P.K. Mohanty ..... Artist
Prakash Kar ..... Sr. Photographer

Automobile Unit

K.K. Swain ..... Mechanical Engineer

Farm Unit

D.S. Meena .... Training Asstt. and I/c Farm Supdt.

Dispensary

P. Mohapatra ..... Medical Officer

CRRI-RRS, Hazaribag

P.K. Sinha ..... Principal Scientist and OIC
R.K. Singh ..... Principal Scientist
V.D. Shukla ..... Principal Scientist
M. Variar ..... Principal Scientist
D. Maiti ..... Principal Scientist
C.V. Singh ..... Senior Scientist
N.P. Mandal ..... Senior Scientist
Bhaskar Das ... Scientist (Sr. Scale) (till 31 Jan 2009)
S. Tuti ..... Farm Supdt. (till 30 Nov 2008)
J. Terom ..... Senior Farm Assistant

CRRI-RRS, Gerua, Assam

N.K. Sarma ..... Principal Scientist and
..... OIC (till 21 Sep 2009)
S.K. Routray ..... Senior Scientist
N.C. Pande ..... Scientist (Sr. Scale)
Narayan Bhakta ..... Scientist (Sr. Scale)

KVK, Santhapur

S.M. Prasad ..... Senior Scientist and
..... OIC (from 6 Nov 2008)
J.R. Mishra ..... Sr. Trg. Asstt.
Jyoti Nayak ..... Sr. Trg. Asstt.
S. Lenka ..... Sr. Trg. Asstt.
P.K. Mallick ..... Sr. Trg. Asstt.

KVK, Jainagar, Koderma

A. Dandapat ..... Sr. Trg. Asstt.
Chanchila Kumari ..... Sr. Trg. Asstt.
Akhilesh Kr. Dubey ..... Sr. Trg. Asstt.
..... (till 8 Sep 2008)
Sudhanshu Sekhar ..... Sr. Trg. Asstt.
Mahesh Pathak ..... Sr. Trg. Asstt.

Administration and Finance

S.K. Sinha ..... Senior Administrative Officer
B.K. Sinha ..... Administrative Officer
.....(till 28 Sep 2008)
Prashanta Sharma ... Finance and Accounts Officer
..... (till 16 Apr 2008)

Projects and Financial Resources

Work Plan for 2008–2009

Programme 1. Genetic Resources and Seed Technology: Leader: S.R. Dhua / B.C. Patra

Principal Investigators (PI)

A. Prakash, B.C. Marndi, B.C. Patra, C.V. Singh, H.N. Subudhi, L Behera, N. Bhakta, N.P. Mandal, Pramila Krishnan, P. Mishra, R.K. Sahu, S.R Dhua and Urmila Dhua

Co-PIs

B.C. Patra, B.C. Marndi , H.N. Subudhi, A. Patnaik, Jagadiswari Rao, L Behera, Pramila Krishnan, S.R.Dhua, N.K. Sarma, S.K. Rautaray, P.K. Sinha, R.K. Sahu, J.N. Reddy, S.S.C Patnaik, A. Prakash, S. Saha, Urmila Dhua, R.K. Singh, R. Kumar (ICAR, NEH) and R.K. Sarkar

Programme 2: Genetic Enhancement of Yield: Leader: G.J.N. Rao / R.N. Rao

Principal Investigators

P. K. Sinha, A. Patnaik , B.C. Marndi, D. Swain, D. Swain. G.J.N. Rao, H.N. Subudhi, J. Meher, J.N. Reddy, K Pande, K.M. Das, K.S. Behera, L Behera, M. Variar, M.J .Baig, Meera Kumari Kar, N. Bhakta, N.K. Sarma, N.P. Manda, O.N. Singh, Pramila Krishnan, P. Sen, Padmini Swain, R.N. Rao, S.C. Sahu, S.K. Pradhan, S.S.C. Patnaik, Sanjukta. Das, T.K. Danger, Urmila Dhua and V.D. Shukla

Co-PIs

N. P. Mandal, M. Variar and V.D. Shukla, Padmini Swain, M.J. Baig, K. Pande, S.K. Pradhan, A. Ghosh, R.N. Dash, L. Behera, S.K. Mohanty, A. Prakesh, C.V. Singh, P.K. Singh, R.K. Singh, S.S.C. Patnaik, Meera Kumari Kar, G.J.N. Rao, N.K. Sarma, N. Bhakta, O.N. Singh, Pramila Krishnan, D. Panda, A.K. Mishra, R.K. Sarkar, K.M. Das, Urmila Dhua, S. Sasmal, J.N. Reddy, P. Sen, D.P. Singh, K.R. Mahata, B.C. Marndi, Gauri Padhi, S.K. Rautaray, R.N. Rao, G.Bhaktavatsala, P.N. Mishra, R.K. Sahu, A. Patnaik, A. Das, J. Meher, S.C. Sahu, S.G. Sharma, Mayabini Jena, P.K. Sinha, N.P. Mandal, G.N. Mishra, D. Swain, S. Saha, R.N. Dash and K. Pande

Programme 3: Improvement of Grain and Nutritional Quality: Leader: A Patnaik / S.G. Sharma

Principal Investigators

A. Patnaik, S.G. Sharma, Sanjukta Das, A. Das and B. Das

Co-PIs

A. Das, Sanjukta Das, B.C. Marndi, P. Mishra, G.J.N. Rao, K.S. Behera, S.N. Tiwari, L. Behera, S.G. Sharma, A.K. Mishra, H.N. Subudhi, J.N. Reddy, N.P. Mandal, S.C. Sahu, Pramila Krishnan and S.P. Chakravorty

Programme 4: Breeding for Resistance/tolerance to Biotic, Abiotic and Environmental Stresses:

Leader: J.N. Reddy / R.K. Sahu

Principal Investigators

Gauri Padhi, S.K. Mohanty, K.M. Das, G. Bhaktavatsalam, S.K. Singh, A. Prakash, R.K. Sahu, S.K. Pradhan, J.N. Reddy, Meera Kumari Kar, O.N. Singh, B.C. Marndi, J. Meher, R.K. Sarkar, D.P. Singh, Padmini Swain, M.J. Baig and Pramila Krishnan

Co-PIs

V. Nandagopal (SSB), Mayabini Jena(BPH), K.S. Behera (LF), P.C. Rath (WBPH), S.K. Pradhan (YSB), R.K. Sahu (BPH), Urmila Dhua, J.N. Reddy, Meera Kumari Kar, S.K. Mohanty, Jagadiswari Rao, L. Behera, A. Prakash, S.C. Sahu, G.J.N. Rao, K.M. Das, G. Bhaktavatsalam, Padmini Swain, R.K. Sarkar, P. Sen, D.P. Singh, Pramila Krishnan, K.R. Mahata, B.C. Marndi, M.J. Baig, O.N Singh, N.P Mandal, S. Saha, R.N. Rao, B. Ramakrishnan, K.S. Rao and J. Mehar

Programme 5: Natural Resource Management and Input-use Efficiency for Improved Crop Production: Leader: T.K. Adhya / A. Ghosh

Principal Investigators

A. Ghosh, R.N. Dash, P.C. Mohapatra, Annie Poonam, P.C. Mohapatra, G.N. Mishra, S.K. Rautray, S.P. Chakravorti, K.S. Rao, P. Bhattacharya, C.V. Singh, R.K. Singh, T.K. Adhya, B. Ramakrishnan, T.K. Dangar and D. Maiti

Co-PIs

K.S. Rao, P.C. Mohapatra, O.N. Singh, Pramila Krishnan, P. Bhattacharya, S. Saha, S.K. Pradhan, A. Ghosh, B. Ramkrishnan, M.J. Baig, V.D. Shukla, R.K. Singh, B. Das, N. Bhakta, N.K. Sharma, K.S. Behera, Sanjukla Das, S.P. Chakravorti, S.N. Tewari, Mayabini Jena, Annie Poonam, R.N. Rao, T.K. Adhya, R.N. Das, R.K. Singh, G.N. Mishra, C.V. Singh, AICRP Centres, P. Samal, L. Das, K.R. Mahata, Padmini Swain, T.K. Dangar, A.K. Misra, P.C. Mohapatra, B.C. Patra, A.V. Suriya Rao, C.V. Singh and M. Variar

Programme 6: Enhancing and Sustaining the Productivity of Rice-based Farming Systems:

Leader: K.S. Rao / A.K. Misra

Principal Investigators

A. Ghosh, S.K. Pradhan, S.P. Chakravorti, A.K. Misra, K.R. Mahata, S. Saha, S.K. Rautaray, Annie Poonam, G.N. Mishra, C.V. Singh, K.S. Rao, P.K. Nayak, D.P. Sinhababu and P.K. Nayak

Co-PIs

K.S. Rao, S.K. Pradhan, K.R. Mahata, B.C. Parida, B. Ramrkrishnan, P. Bhattacharya, A.V. Suriya Rao, A.K. Misra, D.P. Singh, S. Saha, Pramila Krishnan, J. Meher, S.K. Mohanty, S. Sasmal, Annie Poonam, K.S. Behera, N. Bhakta, N.K. Sharma, R.N. Dash, Mayabini Jena, B.C. Patra, S.G. Sharma, D.P. Sinhababu, B.C. Marndi, C.V. Singh, G.N. Mishra, R.K. Singh, P.K. Nayak, P. Samal, V. Pandey, M. Nedunchenzhiyan, T.K. Adhya, T.K. Dangar and M. Das (collaborative project with WTCER, Bhubaneswar)

Programme 7: Mechanization for Rice Production and Post-harvest Systems. Leader: P.C. Mohapatra / P. Mishra

Principal Investigators

S.P. Patel, A.K. Choudhury, B.C. Parida and P. Mishra

Co-PIs

P.C. Mohapatra, K.S. Rao, S. Saha and A.K. Choudhury

Programme: 8. Strategic Research on Pathogens/pest Population Dynamics, Crop Losses, Forecasting:

Leader: S.K. Mohanty / Urmila Dhua

Principal Investigators

S. Sasmal, P.C. Rath, Gauri Padhi, V. Nandagopal, G. Bhaktavatsalam, K.M. Das, S.K. Mohanty, A.V. Suriya Rao, Sanjukta Das, Urmila Dhua, S.K. Singh, D. Maiti, S.N. Tewari, M. Variar and V.D. Shukla

Co-PIs
Jagadiswari Rao, Mayabini Jena, K.S. Behera, S. Sasmal, S. Saha, A. Prakash, S.N. Tewari, S.K. Mohanty, Urmila Dhua, K.M. Das, S.K. Singh, G. Bhaktavatsalam, A.V. Suriya Rao, S.C. Sahu, V. D. Shukla, Avijit Das, D. Maiti

Programme 9: Developing IPM Technologies for Different Rice Ecologies: Leader: Anand Prakash / S. Sasmal
Principal Investigators
R.C. Dani, Mayabini Jena, K.S. Behera, V. Nanadagopal, Jagadiswari Rao, C.D. Misra, S. Sasmal, S.N. Tewari, G. Bhaktavatsalam, K.M. Das, S.K. Singh, V.D. Shukla and P.C. Rath
Co-PIs
Mayabini Jena, P.C. Rath, R.C. Dani, S. Sasmal, T.K. Danger, C.D. Mishra, S. Saha, Jagadiswari Rao, A. Prakash, V. Nandagopal, S.C. Sahu, Gauri Padhi, Padmini Swain, S.K. Mohanty, S.N. Tiwari, V.D. Shukla, G.N. Mishra, P. Samal, S. Saha, G.A.K. Kumar, K.S. Behera, Urmila Dhua, N. Bhakta, S.K Routray, K.M. Das, Annie Poonam and R.N.Rao

Programme 10: Socio-Economic Research for Sustainable Development:
Leader: N.C. Rath / A.V.S. Rao
Principal Investigators
A.V.S. Rao, N.C. Rath, P. Samal, G.A.K. Kumar, Lipi Das and V.D. Shukla
Co-PIs
L ipi Das, F.C. Das, D.P. Sinhababu, R.C. Dani, S. Saha, K.M. Das, S.S.C. Pattnaik, P. Samal, K.S. Rao, O.N. Singh, R.N. Samantray, P.C. Rath, S.K. Pradhan, G.A.K. Kumar, S.R. Dhua, N.C. Rath and C.V. Singh

Ongoing Externally Aided Projects (EAPs)

Number	Title of the Project	Principal Investigator	Source of Funding
EAP 27	Revolving fund scheme for seed production of upland rice varieties at CRURRS, Hazaribagh	P.K. Sinha	AP Cess
EAP 30	Frontline demonstration of improved implements on pulse crops	S.P. Patel	AICP
EAP 36	National Seed Project (Crops)	S.R. Dhua	NSP
EAP 49	Revolving fund scheme for breeder seed production	S.R. Dhua	NSP
EAP 80	Upland shuttle breeding network program at Hazaribag (coordinating unit)	P.K. Sinha	ICAR-IRRI
EAP 81	Consortium for unfavourable rice environment (CURE)—Working Group 5	P.K. Sinha	ICAR-IRRI
EAP 84	Identification and functioning of genes related to yield and biotic stresses (BPH)	S.C. Sahu	DBT (MST)

Number	Title of the Project	Principal Investigator	Source of Funding
EAP 93	Network project on Gene Pyramiding for resistance to Multiple Biotic Stress in crops	G.J.N. Rao	ICAR Network
EAP 95	From genes to farmers fields- enhancing and stabilizing productivity of rice in Submergence prone environments	J.N. Reddy	IRRI-ICAR
EAP 96	Biochemical Kinetics and genetic improvement of microbial metabolism of the fungicide vinclosolin.	A. Banerjee (T.K. Adhya)	DST
EAP 97	Microbial Function and Diversity in Biogeochemical Cycling of Iron	B. Rama-krishnan	MST, GOI
EAP 98	FLD of self propelled rice transplanter, Tractor operated rotary (lug wheel) puddler and animal drawn lug wheel puddler	S.P. Patel	DAC
EAP 99	Transgenic in crops	G.J.N. Rao	ICAR Network
EAP 100	Seed Production in Agricultural Crops and Fisheries —Mega Seed Project	S.R. Dhua	ICAR
EAP 101	Evaluation of Azimsulfuron alone and Azimsulfuron + Metsulfuron methyl for Broad-spectrum Weed Control in Rice under Rainfed Shallow Lowland and Irrigated Ecology	Sanjoy Saha	E.I. DuPont India, Gurgaon
EAP 104	Microbial diversity and identification	T.K. Adhya (T.K. Dangar)	ICAR Network
EAP 105	Nutrient management	T.K. Adhya (V.R.Rao)	ICAR Network
EAP 106	Microbial bioremediation	T.K. Adhya	ICAR Network
EAP 107	High temperature stress effects and associated biophysical changes in rice *Oryza sativa* L.	Pramila Krishnan	DST
EAP 108	Developing and disseminating resilient and productive rice varieties for drought prone areas on India—Hazaribag	P.K. Sinha	IRRI (RF & GCP), ICAR
EAP 109	Isoenzyme profiles of antioxidants and marker assisted selection of submergence tolerance gene in rice	R.K. Sarkar	DBT/ PDF
EAP 112	Development and dissemination of water saving rice technologies in South Asia	O.N. Singh	ADB (DARE/ICAR)
EAP 113	Bio-intensive management of rice pests with emphasis on botanicals	Mayabini Jena	DST
EAP 114	Iron metabolism in rice (*Oryza sativa* L) plant with emphasis on its translocation and assimilation	Avijit Das	DST
EAP 115	Multilocation evaluation of germplasm (Blast , Hazaribag)	M. Variar	ICAR

Number	Title of the Project	Principal Investigator	Source of Funding
EAP 117	Evaluation of the impact of demonstration of different implements and its effect on Farm Mechanization in the state of Orissa.	B.C. Parida	State Government Orissa
EAP 118	Detecting and fine-mapping QTLs with major effects on rice yield under drought stress for deployment via marker-aided breeding	Padmini Swain	IRRI (GCP)–ICAR
EAP 119	Soil organic carbon dynamics vis'-a'-vis' anticipatory climatic changes and crop adaptation strategies	T.K. Adhya	ICAR (NAIP)
EAP 120	Towards development of a single cell C4 photosynthetic system in rice	M.J. Baig	ICAR (NAIP)
EAP 121	Developing Sustainable Farming System Models for Prioritized Micro Watershed in Rainfed Areas in Jharkhand	R.K. Singh	ICAR (NAIP)
EAP 122	Allele Mining and Expression Profiling of Resistance-and Avirulence-genes in Rice Blast Pathosystem for Development of Race Non-Specific Disease Resistance	M. Variar	ICAR (NAIP)
EAP 123	Enhancing and stabilizing productivity of salt affected areas through incorporation of genes for tolerance of abiotic stresses in rice	D.P. Singh	IRRI (BMZ)–ICAR
EAP 124	Microbiological and chemical characterization of water before and after treatment with rice husk ash (RHA) filters of different quality	B. Rama -krishnan	DST, GOI
EAP 125	Stress tolerant rice for poor farmers of Africa and South Asia— Drought prone rain-fed rice areas of South Asia – Hazaribag Centre	P.K. Sinha	ICAR-IRRI (BMGF)
EAP 126	Stress tolerant rice for poor farmers of Africa and South Asia— Drought prone areas- CRRI Centre	O.N. Singh	ICAR-IRRI (BMGF)
EAP 127	Stress tolerant rice for poor farmers of Africa and South Asia— Submergence and Flood prone areas	J.N. Reddy	ICAR-IRRI (BMGF)
EAP 128	Stress tolerant rice for poor farmers of Africa and South Asia— Saline prone areas	D.P. Singh	ICAR-IRRI (BMGF)
EAP 129	Stress tolerant rice for poor farmers of Africa and South Asia— Socio-economic survey and impact assessment	P. Samal	ICAR-IRRI (BMGF)
EAP 131	Research into development of decision support system for major insects pests or rice and cotton	R.C. Dani/ Mayabini Jena	NAIP
EAP 132	Gender issues of rice based production system and refinement of selected technologies in women perspective	Lipi Das	ICAR Net work
EAP 141	DUS Testing	S.R. Dhua	PPV&FRA

Financial Statement for 2008-09 (Indian Rupees in lakhs)

(As on 31 Mar 2009)

	Plan		Non-Plan	
Head of Account	Allocation	Expenditure	Allocation	Expenditure
Estt. Charges (including wages)			1,788.72	1,769.74
TA (including HRD)	27.00	20.93	7.00	6.89
OTA	0.00	0.00	0.40	0.40
Other Charges (including I.T.)	573.00	578.95	227.00	226.92
Works (Major / R&M)	0.00	0.00	98.00	97.97
Total	600.00	599.88	2,121.12	2,101.92

Weather

At CRRI, Cuttack

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h / day)
	Max	Min	RH I	RH II		
Apr 2008	34.9	24.7	90	51	14	7.7
May 2008	36.3	25.7	85	57	72.5	7.9
Jun 2008	32.3	25.2	89	71	471.3	3.7
Jul 2008	31.9	25.3	91	75	236.3	2.7
Aug 2008	31.1	25.4	93	79	473	4.3
Sep 2008	31.1	24.9	91	73	339	5.2
Oct 2008	31.7	23.7	91	62	23.6	7.3
Nov 2008	29.6	19.3	91	53	Nil	7
Dec 2008	28.7	17.3	95	49	Nil	5.3
Jan 2009	28.9	17.3	97	50	Nil	6.3
Feb 2009	32.5	20.1	97	45	Nil	7.3
Mar 2009	34.2	21.8	94	43	Nil	6.5

At CRRI-RRS, Hazaribag

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h / day)
	Max	Min	RH I	RH II		
Apr 2008	33.6	18.3	55.6	43.6	8.7	3.4
May 2008	36.7	21.0	63.6	53.0	41.5	8.6
Jun 2008	29.8	21.7	84.7	80.2	423.1	5.1
Jul 2008	29.9	22.4	88.3	84.4	457.2	2.5
Aug 2008	29.7	22.4	85.1	74.9	352.6	4.9
Sep 2008	29.4	21.5	80.1	67.7	161.2	6.7
Oct 2008	29.2	17.3	73	53.8	0.8	8
Nov 2008	27.7	11.7	69.7	55.3	2	8.5
Dec 2008	25	8	83.5	56.2	0	7.7
Jan 2009	25.2	9.7	83.4	51.1	3.4	8.3
Feb 2009	28.5	10.7	57.4	29.4	0	9.5
Mar 2009	32.8	13.9	39.9	23.9	2.8	8.9

At CRRI-RRS, Gerua

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h / day)
	Max	Min	RH I	RH II		
Apr 2008	30	17.5	86	74	176.4	6.5
May 2008	32.5	20.6	83	66	127	7.2
Jun 2008	33.1	22.3	88	77	329.9	3.9
Jul 2008	33.2	23.4	86	72	154.6	5.1
Aug 2008	32.9	22.5	90	77	208.4	3.6
Sep 2008	33.2	21.8	92	76	172	6.5
Oct 2008	31.7	18.7	89	69	43.1	6.5
Nov 2008	28.4	11.6	93	73	0	7.9
Dec 2008	26.0	10.9	95	73	2	5.8
Jan 2009	25.0	8.8	96	88	0	5.9
Feb 2009	28.4	11.1	88	56	0	7.1
Mar 2009	30.7	12.7	79	53	69.8	5

Acronymns

AAU : Assam Agricultural University

ADB : Asian Development Bank

ADG : Assistant Director-General

AE : Agroniomic Efficiency

AICRIP : All India Coordinated Rice Improvement Project

AIR : All India Radio

AMAAS : Application of Microroganisms in Agriculture and Allied Sectors

ARC : Assam Rice Collection

ASGON : Aromatic Short Grain Observation Nursery

ASRB : Agricultural Scientists Recruitment Board, New Delhi

AVT : Advanced Varietal Trial

AYT : Advanced Yield Trial

AZRA : Applied Zoologists Research Association, Cuttack

BARC : Bhabha Atomic Research Centre

BAU : Birsa Agricultural University, Ranchi

BB / BLB : Bacterial Leaf Blight

BITS : Birla Institute of Technology and Science

BMGF : Belinda and Bill Gates Foundation

BMZ : Germany's Federal Ministry for Economic Cooperation and Development

BPH : Brown Planthopper

Bt : *Bacillus thuringiensis*

CARI : Central Avian Research Institute

CIAE : Central Institute of Agricultural Engineering, Bhopal

CIFA : Central Institute of Freshwater Aquaculture, Bhubaneswar

CIFE : Central Institute of Fisheries Education, ICAR, Mumbai

CJSC : Central Joint Staff Council

CMS : Cytoplasmic Male Sterile / Sterility

CRIDA : Central Research Institute of Dryland Agriculture, ICAR, Hyderabad

CRRI : Central Rice Research Institute, ICAR, Cuttack

CRURRS : Central Rainfed Upland Rice Research Station, Hazaribag

CTCRI : Central Tuber Crops Research Institute, ICAR

CURE : Consortium for Unfavourable Rice Environment

DAS : Days After Sowing

DAT : Days After Transplanting

DBT : Department of Biotechnology, New Delhi

DFF : Days to 50% Flowering

DH : Dead Hearts

DNA : Deoxyribonucleic Acid

DRR : Directorate of Rice Research, Hyderabad

DSN : Dry Season Nursery

DST : Department of Science and Technology, New Delhi

EAP : Externally Aided Projects

EC/ECe : Electrical Conductivity

FLD : Frontline Demonstration

FYM : Farmyard Manure

g : Gram

GBPUAT : Govind Ballabh Pant University of Agriculture and Technology, Pantnagar

GLH : Green Leafhopper

GM : Gall Midge

h : Hour

ha : Hectare

HI : Harvest Index

HRR : Head Rice Recovery

HUE : Heat Use Efficiency

HYV : High-yielding Variety

IARI : Indian Agricultural Research Institute, New Delhi

IASRI : Indian Agricultural Statistics Research Institute, New Delhi

ICAR : Indian Council of Agricultural Research

IET : Initial Evaluation Trial

IGKVV : Indira Gandhi Krishi Vishwavidyalaya, Raipur

IISR : Indian Institute of Sugarcane Research, ICAR, Lucknow

IIVR : Indian Institute of Vegetable Research, ICAR, Varanasi

IJSC : Institute Joint Staff Council

IMC : Institute Management Committee

IPM : Integrated Pest Management

IPS : Indian Police Service

IRRI : International Rice Research Institute, Philippines

ITK : Indigenous Technical Knowledge

IVT : Initial Varietal Trial

kg : Kilogram

KVK : Krishi Vigyan Kendra

l : Litre

LB : Long-bold

LCC : Leaf Colour Chart

LF : Leaf Folder

LS : Long-slender

MABB : Marker-assisted Backcross Breeding

MAS : Marker-assisted Selection

MAScore : Mean Appropriate Score

MB : Medium Bold

MLT : Multilocation Trial

MRST : Multiple Resistance Screening Trial

MS : Medium-slender

NAARM : National Academy of Agricultural Research Management, Hyderabad

NAIP : National Agricultural Innovation Project

NARS : National Agricultural Research System

NASC : National Agricultural Science Complex, New Delhi

NBAIM : National Bureau of Agriculturally Important Microorganisms, ICAR, Mau

NBPGR : National Bureau of Plant Genetic Resources, ICAR, New Delhi

NBUSG : Nimin Blended Urea Super Granules

NDRI : National Diary Research Institute, ICAR, Karnal

NDUAT : Narendra Dev University of Agriculture and Technology, Faizabad

NFSM : National Food Security Mission

NIL : Near-isogenic Lines

NPK : Nitrogen, Phosphorus, Potassium

NPT : New Plant Type

NRCPB : National Research Centre for Plant Biotechnology, ICAR, New Delhi

NSN : National Screening Nursery

NSP : National Seed Project

OFT : On-farm Trials

OUAT : Orissa University of Agriculture and Technology, Bhubaneswar

OYT : Observational Yield Trial

PDCSR : Project Directorate on Cropping Systems Research, ICAR, Modipuram

PE : Panicle Emergence

PHS : Plant Hopper Screening

PI : Panicle Initiation

PU : Prilled Urea

PVS : Participatory Varietal Selection

q : Quintal

QTL : Quantitative Trait Loci

RAC : Research Advisory Committee

RAPD : Random Amplification of Polymorphic DNA

RBD : Randomized Block Design

RFLP : Restriction Fragment Length Polymorphism

RH : Relative Humidity

RIL : Recombinant Inbred Line

RTV / RTD : Rice Tungro Virus / Disease

SAC : Scientific Advisory Committee

SATVT : Saline Alkaline Tolerant Varietal Trial

SAU : State Agricultural University

SB : Short-bold

SES : Standard Evaluation System

SRC : Scientific Research Council

SRI : System of Rice Intensification

SS : Silver Shoots

STRASA : Stress Tolerant Rice for Poor Farmers in Africa and South Asia

t : Tonne

UBN : Uniform Blast Nursery

USEFI : United States Educational Foundation in India

WBPH : White-backed Plant Hopper

WCE : Weed Control Efficiency

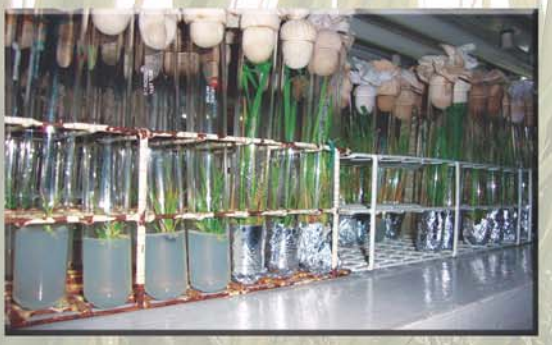
WEH : White Ear Heads

WTCER : Water Technology Centre for Eastern Region, Bhubaneswar

WUE : Water-use Efficiency

YSB : Yellow Stem Borer

YVMV : Yellow Vain Mosaic Virus

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