भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
Annual Report
2023

भाचाअनुसं
IIRR

भाकृअनुप-भारतीय चावल अनुसंधान संस्थान
ICAR-Indian Institute of Rice Research
Rajendranagar, Hyderabad - 500 030

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Preface

It's a privilege to place before you the annual report of ICAR-Indian Institute of Rice Research for the year 2023 which saw a record rice production of 135 million tonnes of which 22.35 million tonnes was exported earning Rs.89600 crores. The Institute is justifiably considered as one of the leading research Institutions of ICAR conducting basic and strategic research on rice and also co-ordinating the largest network program in the country, perhaps in the world involving 45 funded centers, around 100 voluntary centers and 300 rice scientists.

The progress of research during the period is quite encouraging with the release of 56 varieties including 13 Hybrids for different ecologies by both central (2) and state (54) varietal release committees. Breeder seed production of 365 rice varieties and parental lines of rice hybrids was undertaken at 52 centres across the country as per DAC indent and 8056 quintals of breeder seed production was achieved. Significant breakthroughs were achieved in identifying resistant genetic stocks against blast, leaf folder, Low P tolerance, Climate resilient nutrient efficient and biofortified lines which can be exploited as donors in the research programmes. The institute brought several accolades during the reporting period for the CRISPR/Cas based multiplex genome editing of indica rice cultivars for yield improvement, whole genome sequence data for biocontrol agents, depositing beneficial microbial cultures and gene sequences to NCBI.

The Scientists and staff have been bestowed with awards and recognitions in various research and development platforms. Four scientists have been deputed abroad for advanced training, workshops and as consultants. On the research front, in addition to institute funded projects and Consortia Research Platforms (CRP), fifteen new externally sponsored projects were sanctioned to the institute with a total outlay of Rs. 480 lakhs, a commendable achievement by the scientists of the institute.

I take this opportunity to express my sincere gratitude to Dr. Himanshu Pathak, Secretary DARE and DG (ICAR); Dr. T.R. Sharma, DDG (Crop Science), Dr. D.K. Yadava, ADG (Seeds), Dr. S.K Pradhan, ADG (F&FC), Dr. R.P. Singh, ADG (CC), Dr. B. Mishra, Chairman RAC and members of RAC for providing valuable guidance and suggestions towards implementation of various research programmes. I appreciate the support and cooperation from SAUs, AICRPR centres and sister ICAR institutes for their tremendous support for consistent progress in rice improvement.

Hyderabad	Dr. R. M. Sundaram
31st December, 2023	(Director)

Executive Summary

All India Coordinated Research Project on Rice (AICRPR)

Crop Improvement

- Forty Four varietal trials and four hybrid trials were conducted in 1068 experiments (929 varietals and 139 hybrid rice) at 124 locations (43 funded, 81 voluntary centres) in 26 states and 4 union territories across seven zones of the country during 2022.
- The trials were constituted with 1238 entries (972 varieties and 82 hybrids) including 184 checks. 39 promising lines were identified including 8 hybrids.
- Sixty proposals including 42 varieties and 18 hybrids were considered by Varietal Identification Committee (VIC) and 54 entries including 39 varieties and 15 hybrids were identified.
- Fifty six varieties including 43 varieties and 13 Hybrids for different ecologies have been released and notified by both central and state varietal release committees (Central-2; state-54) during 2023.
- A total of 8055.74 quintals of Breeder seed was produced against a DAC indent of 3382.88 quintals involving 365 rice varieties from 52 centres across the country.

Crop Production

Agronomy

- A total of 250 were experiments were conducted at 48 locations consisting of evaluation of 130 promising cultivars belonging to 19 groups for their response to integrated nutrient management at 50 and 100% recommended dose of fertilizer (RDF).
- In addition, four trials on resource conservation, four trials each on rice based cropping systems and four collaborative trials with Soil science (2), Entomology (1), and Pathology (1).
- All nutrient management trials were in collaboration with Plant Breeding to develop superior and cost effective, resource efficient cultivars and technologies in rice and rice based cropping systems.
- Aerobic culture, IET 26178 was found to be promising with higher grain yield (4.16 t/ha) across the locations and found suitable across the locations.
- Trial results compiled for six locations to identify N efficient cultivars revealed that IET 29583, IET 29584, IET 29577, IET 30261, IET 28084, IET 30275 and IET 29564 are the high yielding and high nitrogen use efficient cultivars and promising over other cultures across the locations.
- The genotypes 1815 and 1823 with no or low phytotoxicity to Imazethapyr have • contributed to higher crop growth and grain yield with standard pre and post-emergence applications of Pendimethalin, Bispyribacsodium.
- In cultural management trials, mechanical transplanting of JGL 24423 variety in delayed condition resulted the highest grain yield (7.09 t/ha), however, at par with grain yield produced by same variety transplanted mechanically in normal time (6.86 t/ha).
- Weed management trials result revealed that the grain yield loss due to weeds ranged from 14.68% at Rewa to as severe as 75.24% at Jagdalpur, depending on the weed intensity and weed flora distribution during the critical period of crop growth.
- In rice based cropping systems, rice equivalent yield of the system productivity indicated superiority of the residue application at all four locations tested indicating the superiority of residue incorporation (6%-17% higher grain yield with residue incorporation).

Soil Science

- A total of seven trials were conducted in 18 locations, representing various soil and crop systems in important rice growing regions.
- Supplementary dose of FYM along with RDF resulted in maximum grain yield at all locations and nutrient omission and reduction of NPK to 50% resulted in significant yield reduction at all centres. FYM along with RDF recorded a higher positive growth rate in productivity.

- Of the many factors that contribute to the yield gap, soil quality vis-a-vis rice yield was studied across several rice ecologies of India and sharp variations in yield and soil quality indices were noted. Closing the yield gap requires a multi-faceted approach that addresses the underlying causes of low yields. Based on the results obtained, fertilizer prescriptions were made for all the farm sites to bridge the yield gap.
- Foliar application of nano Zn @ 50 ppm performed better and DRR Dhan 48 exhibited superior response across the locations except Kanpur. Significantly superior performance of Zn application (Soil/foliar/nano formulations) was observed in sodic soils across the locations.
- Application of RDF + dolomite (250 kg/ha) + Silixol spray, at vegetative, booting and grain filling stage, improved yields over only RDF by 12-35% in irrigated rice and by 14% under upland rice.
- Supplementation of nitrogen through crop residues, either alone, or in combination with green manures with or without Pusa Decomposer, gave on par yields with 100% RDF at majority of the centres.
- Two sprays of nano urea along with either 75% of Recommended Dose of Nitrogen (RDN) or 100% RDN gave better yield, N uptake and nutrient use efficiency at majority of the locations, but did not fetch more economic returns over RDN.
- Integrated Crop Management, with need-based pest management, gave significantly superior results in terms of grain yield and yield parameters and majority of the soil parameters improved with NPOF package/ ICM with organic methods of pest management.

Plant Physiology

- Physiological studies under AICRPR were conducted through six trials at nine funded centres, two ICAR institutions and four voluntary centres.
- Among the tested entries, entry 27P63 was the most promising among all the entries followed by US-312 with respect to response to silicon application.
- The genotypes DRR Dhan-44, IET 29834, IET 29859, IET 30241, IL-19075, IL-19079, IL-19083, IL-19095, IL-19103, IL-19186, IL-19344, IL-19353, Krishna Hamsa and Sahabhagidhan were identified as relatively drought tolerant genotypes suitable for rainfed cultivation based on yield Stability Index.
- Under heat stress, genotypes ET29142, IET28950, MTU-1156, IET28959 and IET28964 were identified as relatively heat tolerant.
- Pantara, IC-256508, Vandana were found to be tolerant to multiple abiotic stresses; CR4423-17 was found tolerant to anaerobic germination (AG) and osmotic stresses and AC847A and FL478 were found tolerant to salinity and AG stresses.
- AC289, AC1017A and AC1303B showed on par survival with check and were identified as highly tolerant to submergence stress; AC39460, CR4423-17, CR 3483-29-M-4-B-Sub-79 and AC931 having 60-70% survival rate are tolerant to complete submergence.
- Based on grain yield, entries IET-27530, CR Dhan 411, CR Dhan 801, IET-31288 were identified as tolerant to low light stress.

Crop Protection

Entomology

- Eight major trials involving 306 experiments were conducted at 40 locations spread over 22 states and 1 Union territory.
- Evaluation of 1581 entries against 15 major insect pests in 209 valid tests resulted in identification of 92 entries as promising against various insect pests.
- Evaluation of 176 entries against BPH and WBPH, identified 16 promising entries. RP-GP-3000-179-3-9-1, WGL 1533 and IBT-BPH M 23 performed better in the second year of retesting.
- Among 110 entries breeded specifically for gall midge resistance, IBTWGL 3, RP 6614-102-11-3-3-1-1-1(FBL 19101), *GM* 5 (IBT) IBTWGL 2, IBTWGL 21 with known gall midge resistance genes were promising under retesting.
- Evaluation of 25 entries for leaffolder resistance revealed 22 promising entries. The entry, RP5564 PTB 1-4-2 was found promising.

- Among 55 entries, 10 promising entries *viz.*, BK 49-76, RP 6505-40, RP5564 PTB 2-4-2-1-2, RP5564 PTB 1-4-2, RP5564 PTB 2-4-2-1-1, BK 64-116, RP-6112-SM-92-R-293-2-2-4-4(a), RP5564 PTB 1-1-1-2, RP2068-18-3-5, W1263 were identified for stemborer resistance with recovery resistance and tolerance mechanisms.
- Seven promising entries were identified in the multiple resistance screening trial, in which RP 6461-248-1, RP Bio 4918-230 and CRCPT 8 performed well in the second year of testing
- Seventeen gene differentials were evaluated at 12 locations against planthoppers. PTB 33 (*bph2*+*Bph3*+ *Bph32*+unknown factors) and RP 2068- 18-3-5 (*Bph33t* gene) performed well, followed by Swarnalatha with *Bph6* gene.
- The brown planthopper population at Ludhiana was more virulent than many locations studied.
- Nineteen gene differentials were evaluated at 12 locations. Aganni (*Gm8*), INRC 3021 (*Gm8*), INRC17470, INRC15888, and RP5925-24 were found promising.
- Aganni (*Gm8*) and a breeding line of Akshayadhan (with *Gm4* + *Gm8*) holds promise against gall midge
- Gall midge damage was significantly lower (1.7-3.03 % SS) in W1263 (*Gm1*), CUL M9, Suraksha (*Gm11*), Akshyadhan PYL and RP2068- 18- 3-5 (*gm3*).
- Seed treatment with thiamethoxam followed by application of fipronil 3% GR at 20-25 days after transplanting in the main field was most effective against gall midge.
- Combination of neemazal, neem oil and triflumezopyrim treatment was found to effective against brown planthopper giving a yield of 4554.2 kg/ha.
- Lower pest incidences were observed in direct-seeded rice, semi-dry rice, mechanical transplanting, and aerobic rice.
- Slow-release formulations recorded maximum catches compared to the normal formulations in the case of yellow stem borer and leaf folder across locations.
- *Lecanicillium saksenae* demonstrated superior efficacy against sucking pests, particularly the ear head bug in rice, across seven out of nine locations, while showing no adverse effects on natural enemies
- IPM implementation led to significant mean grain yield advantages ranging from 10.9% to 51.0% across different zones
- Monitoring of insect pests by light traps revealed that yellow stem borer, leaf folder, and planthopper continues to be the most important pests across the locations.

Plant Pathology

- Trials were conducted at 50 AICRPR locations on Host plant resistance, field monitoring of virulence of major rice pathogens and disease management
- Ninety-one entries were found as moderately resistant to more than two diseases at 51 locations among 1364 entries screened.
- Field monitoring of virulence of *Pyricularia grisea* revealed that genotypes at all the locations was grouped into eight major groups at 30% dissimilarity coefficient.
- Differentials possessing single bacterial blight resistance genes like *Xa1, Xa3, Xa4, xa5, Xa7, xa8, Xa10, Xa11* and *Xa14* were susceptible at most of the locations.
- The incidence of leaf blast was found to be more in the late sown crops. Incidence of bacterial blight was high in both normal and late sown crops. Incidence of sheath blight and bakanae was more in the early sown crops while, sheath rot was more in late sown crops.
- Fungicides kitazin 48% EC (1.0 ml/L) effective against the leaf blast. Isoprothiolane 40% EC (1.5 ml/L) was effective against leaf blast and neck blast, and Thifluzamide 24% SC (0.8g/L) and difenoconazole 25% EC (0.5 ml/L) (DS: 36.5%) was effective against sheath blight. Difenoconazole 25% EC (0.5 ml/L) was effective in reducing sheath rot and brown spot. Tebuconazole 25.9% EC (1.5 ml/L) showed broad-spectrum activity against sheath blight, sheath rot, brown spot, and blast.

- Across the locations, seed treatment and spraying of bio-control agent at 15-20 DAT (10 g/litre) along with one spray of propiconazole (1 g/litre) gave higher disease control and increased plant yield.
- IPM practices reduced incidence of leaf and neck blast, sheath blight and bacterial blight disease.
- A disease index of 62.6 -17.4% caused a yield reduction of 52.34- 19.66% for leaf blast; 36.51- 5.2% caused a yield reduction of 46.18- 14.8% for sheath blight and 76.45-20.69 caused a yield reduction of 23.26 – 15.94 % for BB.

Production Oriented Survey

- Survey was conducted in 98 districts from 14 rice growing states.
- The rainfall was 92, 117, 104 and 108% of long period average (LPA) during June, July, August and September respectively across the country (IMD, 2022).
- Hybrid rice varieties occupied a significant area in states like Uttar Pradesh, Haryana, Chhattisgarh, Gujarat and Bihar and its area is increasing in states like Karnataka, Himachal Pradesh, West Bengal and Maharashtra.
- Moderate to high intensity of a new virus disease called Southern rice black-streaked dwarf virus (SRBSDV) was recorded in some parts in Jammu, Punjab and Himachal Pradesh.
- Intensity of stem borer was more in Parts of Chhattisgarh, Jammu, Telangana and West Bengal. High incidence of BPH was noticed in parts of Chhattisgarh and West Bengal.

AICRPR Experimental Database –http://www.AICRPR-intranet.in

- During this year above 70% of centres uploaded data through AICRPR Intranet. Analysis modules of state and zonal reports of plant breeding and hybrid rice were refined. a query interface was added to the screening disease interface of the popular via Intranet to display the location-wise disease score for preparing the varietal identification document.

Lead Research

Crop Improvement

Plant Breeding

- Five genetic stocks namely IC0650728 (INGR23068), IC0650729 (INGR23069), IC0650730 (INGR23070), IC0650767 (INGR23071) and IC0648977 (INGR23005) governing multiple traits of biotic, abiotic stresses and yield contributing traits were registered from IIRR at NBPGR during 2023
- DRR Dhan 70 (IET 29415) for Odisha and Bihar; DRR Dhan 71 (IET 29421) for Odisha, Gujarat, and Tamil Nadu for direct seeded aerobic conditions, DRR Dhan 72 (IET 28821) for low phosphorous conditions in Karnataka and Telangana were recommended by the Varietal Identification Committee (VIC), 2023.
- Advanced promising lines for water use efficiency and high yield have been identified.
- Diverse parental lines for breeding high yielding, medium to late maturing rice varieties with tolerance to biotic stresses and grain quality were identified.
- Five major and 8 minor QTLs on chromosomes 2, 6, 7, 9 and 11 governing WBPH tolerance in a RIL population of NDR 359/MO1 were identified. The QTL qWDS2 on chromosome 2 for damage score and QTL *qWDW7*.1 for days to wilt on chromosome 7 with > 10.20% phenotypic variance contributed to WBPH tolerance.
- Four QTLs - *qPC1.1, qPC1.2, qPC5.1* and *qPC5*.2 up to 15.7% PVE for grain protein concentration in the F2 population of Samba Mahsuri/JAK 686 were identified.
- Two QTL hotspots and 7 co-localised QTLs under weedy; 2 QTL hotspots and 6 co-localised QTLs under weed-free conditions and 18 hotspots with 6 co-localised QTLs common to both conditions in a BC_1F_9 population derived from IR64*1/*Oryza glaberrima* under direct seeded conditions was identified.
- Acetohydroxyacid synthase (AHAS) mutant allele conferring herbicide resistance (i.e. Robin mutant) is being transferred from Pusa 44 NIL into elite rice varieties DRR Dhan 44, DRR Dhan 60, and MTU 1121.

- Stable and reliable heat tolerant genotypes *viz.*, Rasi, Giza 178, IR 50, Khao Daw Tai, IRGC 126084, IRGC 127227, IRGC 127663, Nerica-L44, HIRA, IRGC 128335, IRGC 72918-1, IRGC 117280, IRGC 127424 and IRGC 128373 were identified.
- GWAS based significant marker trait associations for salinity tolerance at seedling and reproductive stage for different components traits on chr. 1, 3, 5, 8,10 and 11 identified.
- Physiological basis of salinity tolerance at seedling stage and reproductive stage showed that the K^+/ Na^+ ratio was highly correlated with the salinity scores and serves as a reliable indicator of salt stress tolerance in rice.
- Two novel major marker trait associations, *qSM2*.1 and *qBS12*.1 for section modulus and bending stress were identified on chromosomes 2 and 12, respectively. *qBS12*.1 is a QTL hotspot with the synergistic association for culm strength traits and grain number.
- Promising landraces LR279, LR30, and LR299 with tentative novel genetic loci other than *Pup1* conferring tolerance to low soil phosphorus stress were identified.
- Elite genotypes with high filled grains per panicle in a range from 452 to 964 were identified and utilized to generate 42 F_1s by crossing the elite x elite parents.
- Novel QTLs for blast resistance, qBL2.2 and *qBL5*.1 were identified as candidate genomic regions for fine mapping in Swarna/*O. rufipogon* CSSLs. Novel marker trait association to QTL qFS3.1 and qFS6.1 was detected in Swarna/*O. nivara*.

Hybrid Rice

- The high yielding rice hybrid DRRH 5 with salinity tolerance was identified for release during 2023.
- Rice varieties, DRR Dhan 70, 71 (Aerobic) and DRR Dhan 72 (Low P tolerant) were identified for release.
- Six hybrids *viz.*, IIRRH 164 (IHRT-E); IIRRH-165 (IHRT-ME); IIRRH 166, IIRRH 167, IIRRH 1168 (IHRT-M) were nominated in AICRPR trials.
- Two hybrids *viz.*, IIRRH 130 (AVT 1 E to AVT 2 E) and IIRRH 164 (IHRT E to AVT 1 E) were promoted for advance evaluation based on their significant yield advantage over the checks.
- In order to develop heterotic pools, a set of 150 genotypes (129 Restorers, 15 Maintainers and 6 checks) were genotyped using SSRs and SNPs (IK Rice Custom Amplicon) and phenotyped for yield attributing traits and experimental rice hybrids evaluation is under progress.

Biotechnology

- A set of ~200 genotypes from Bengal Assam Aus Panel were characterized for their panicle traits. Genome-wide association mapping using 2 M SNP dataset has identified a set of different marker trait associations for wet and dry seasons and a set of common genomic regions for total grain filling on chromosomes 2, 5, 7 and 11 across two seasons.
- Promoter analyses of STP LOC_Os11g42430 (Os11g643800) in nine genotypes through Sanger sequencing confirmed the association of 34 bp indel with grain filling.
- Quantitative trait loci (QTL) mapping using a population of 125 doubled haploid (DH) lines developed from the elite rice hybrid, KRH2 (i.e. derived by crossing IR58025A/KMR3R) and SSRs/SNPs led to identification of 12 each of major-minor effect QTLs for yield related traits. Major effect QTLs were detected for traits namely days to fifty percent flowering, test (1,000) grain weight, plant height, panicle weight, panicle length, flag leaf width, flag leaf length, biomass and total grain yield/plant explaining the phenotypic variability in the range of 29.95%-56.75%. QTL hotspots were detected on chromosome 3 for the traits, panicle length and total grain yield/ plant and on chromosome 6 for the traits, panicle length, flag leaf length and total grain yield/plant
- Five breeding lines in the genetic background of BPT 5204/Varadhan promising for high nitrogen use efficiency were identified. IET 29581 (RP 6255-BV/RIL/BPT/Varadhan/1696) has been advanced to AVT2-LNT across all zones. Additionally, four breeding lines IET 30269, IET 31119, IET 31128 and IET 31135 were promoted to AVT1-LNT.
- The high yielding genome edited line of Samba Mahsuri (Kamala mutant; BGIR7-26-3) was

entered in AICRPR trials for multi-location testing.

- A patent was filed to protect novel allele of OsCKX2 created through CRISPR/Cas genome editing technology.
- The guide RNAs targeting *OsSWEET11* were cloned into CRISPR/Cas9 vector system. The vectors were sequenced and mobilized into *Agrobacterium tumefaciens* EHA105.
- The CRISPR/Cas12a vector for genome editing of XCP2 (Xylem Cysteine Protease 2) gene was developed and mobilized into Agrobacterium. The vector is being utilized for transformation of rice.
- *NGR5* (Nitrogen-Mediated Tiller Growth Response 5) and *GRF4* (Growth-Regulating Factor4) genes were cloned and over-expression gene constructs were developed for rice transformation.
- Recombinant inbred lines (RILs) of both Rasi/ISM (214 Nos) and Wazuophek /ISM (330 nos.) were phenotyped for morphological, morpho-physiological, and root architectural traits in low and normal phosphorus conditions during dry and wet seasons of 2023.
- The common root long non-coding RNAs (lncRNA) viz., *XLOC_049896, XLOC_051416, XLOC_054216, XLOC_075495* were upregulated in the robust root genotypes TI-128 and CR Dhan 202.
- Three Samba Mahsuri EMS mutant and mutant derivative lines (RP 5977-MS-M-112-1-9-22-4-6-3 (IET29549), RP 6112-MS-M-92-11-5-7-33-6-2 (IET30230) and RP 5977-MS-M-33-4-8-3-7-5-1 (IET30242) are in the advanced varietal trial (AVT2) under the low phosphorus trials (LPT) in All India Coordinated Research Project on Rice.

Crop Production

Agronomy

- Highest water use efficiency was obtained with drip irrigation at 1.5 Epan in raised bed system. The highest nitrogen use efficiency was obtained with LCC based N application in aerobic rice.
- Application of 859.8 mm irrigation water using drip irrigation at 1.5 Epan in raised bed system and application of 105 kg N/ha using Leaf Colour Chart at critical value-3 was found to be optimum for aerobic rice.
- In fourth year of the study on long-term effect of herbicide in transplanted irrigated rice and wet direct seeded rice (DSR), it was observed that the weed flora shifted from grasses to sedges and shift of *Ehinochloa* to *Leptochloa* was observed in DSR systems.
- Triafamone + fentrazamide 950 ml a.i./ha and Triafamone + oxadiazon 875 ml a.i./ha were found to be effective in lowering weed population, weed biomass and recorded higher weed control efficiency, higher crop growth, yield attributes and grain yield.
- Mulching with paddy straw @ 5 t/ha found to be significant and effective in controlling weed population and weed biomass with higher grain yield; whereas *Glyricidia* leaf mulch @ 5t/ha recorded higher net returns and benefit-cost ratio.
- Among different nitrogen management practices, LCC @ 160 kg N/ha resulted in numerically the highest head rice recovery (69.7%) and highest grain amylose content (24.4%) followed by STCR @ 171.5 kg N/ha (69 %).

Soil Science

- Out of 238 BAAP entries tested, top 5 entries, FR13A, M202, IR64-21, KELE BARI and KADA 176-12 at N0; FR13A, IR64-21, ARC7229, CUNAIL and BAWOI at N50 level and FR13A, ASWINA, DULA AUS, BRRI DHAN50 and CUNAIL at N100 level, recorded maximum grain yield.
- Three urease inhibitors *viz.,* Allicin, CDW, and NBPT, were superior to Neem coated Urea in grain yield by 12-19% and the differences were maximum at N75 levels.
- Methane emissions decreased by more than 39 percent in SRI and by 49 and 55 percent in AWD at 5 and 10 cm, respectively as compared to Transplanted Rice (TPR).
- Various vegetation indices namely, NDVI, GNDVI, NDRE and SAVI were extracted from temporal images of a rice field cultivated with DRR Dhan 48. Data acquired by the satellite Sentinel 2 could profitably be used and document pixel-level changes in rice fields at 10 m resolution

- A beta version of excel based carbo tracker has been developed tentatively based on metaverse data.
- Denovo sequencing of the whole genome of the *Amycolatopsis* isolate predicted the presence of a total of 7993 genes, and phylogenomic analysis identified the isolate as *Amycolatopsis keratiniphila*. Based on genes involved, *A. keratinophilic* IIRRACT9 has potential to act as a biocontrol agent and plant growth-promoting actinobacteria.
- Six out of fifty-five Phosphate Solubilizing Bacterial (PSB) cultures isolated were promising and inoculated rice seeds with these bacterial cultures significantly enhanced seed germination, germination index the root & shoot length, total fresh weight and total dry weight in *P. Flexa* IIRRPSB14, Bacillus. Sp and *Bacillus oryzecorticis* IIRRPSB7.
- Whole-genome sequencing of *Priestia flexa* IIRRPSB14 indicated phosphate-metabolizing genes along with plant growth hormone synthesis gene, nitrogen fixation, anti-microbial activity, quorum sensing, and genes for abiotic stress tolerance.
- Incubation and solution culture with ZnO nanoparticles revealed that Zn content in soil and plant is dose-dependent and showed a positive trend of up to a dose of 150 and 80 ppm, respectively. The graded level of ZnO nanoparticles positively increased the soil Zn content to the tune of 1.2 times (12 mg/kg) to 2.0 times (150 mg/kg) in the black soil.
- Application of 40 kg P in combination with phosphorus solubilizing bacteria resulted in the highest number of tillers/ m^2 (398), panicles/m^2 (369), grain yield (6127 kg/ha) and straw yield (7638 kg/ha) respectively.

Plant Physiology and Biochemistry

- Silicon has potential to control the pests and diseases such as blast, sheath blight, false smut and stem borer as well as it improves tolerance to abiotic stresses such as water stress.
- Genotypes Blackgora, E MOOM, IRGC-132252, IC-438644, IC-124667, IC-124667, IC-44975, ADAYSEL, RASI, BAKAL, VANAPRAVA, etc. are found to be highly tolerant to heat stress at reproductive stage having spikelet fertility of more than 80%.
- Gene expression analysis of contrasting GI SM mutant lines, GI noted significant positive correlation with SBE1 & SS2a and non-significant negative correlation with GBSS1. In BAAP lines, low GI was noted in 90 samples with putative associated regions in chromosomes 2, 6 and 12.

Agricultural Engineering

- A soil-puddling machine was fabricated using 1.0 hp electrical 3 phase motor and stand with a specially designed tool for puddling in a drum.

Agricultural Chemicals

- Sodium and Potassium silicate with M=1 was found most effective for 100% reduction in mycelial growth of false smut. Minimum concentration of silica for this purpose was 0.1 g/100 ml media.
- Among different essential oils, lemon grass oil was found most effective with 100% reduction in mycelial growth of false smut even with 225-ppm concentration.
- Germination of *Echinochloa* weed seed when treated with emulsified concentrate of lemon grass oil (with oil content of 200 ppm), was zero percent even after 14 days of treatment while in control treated with distilled water germination was 81%.

Crop Protection

Entomology

- About 2000 lines were screened for BPH resistance and out of which 12 were found to be highly resistant and 14 were moderately resistant. Defense responsive and metabolism associated genes were identified in resistant and susceptible mutants of Nagina22.
- The intra and interspecific interaction and vertical distribution of planthoppers was studied on 10 selected rice genotypes which had influence on nymphal survival (%), nymphal duration, growth index, winged adults (%), males (%), fecundity, and female adult longevity.
- Four genotypes, Suraksha, Aganni, KPM, and LD24 were found resistant to rice root-knot nematode *Meloidigyne graminicola*.

- Development of field sick plot facility for rice root-knot nematode was done at IIRR farm.
- Single marker analysis (SMA) of introgression lines derived from Swarna/*Oryza nivara* IRGC81848 revealed two QTLs for damage area on chromosomes 1 and 12 with phenotypic variance of 9.0 %, one QTL each for damage score and leaf width on chromosome 4.
- A Survey of stem borers revealed around 10 per cent damage with report of gold fringed borer and pink stem borer. Taxonomic analysis of YSB genitalia was studies based on moths trapped in pheromone lure traps where, results showed that all the characters except vulva width was significantly different ($p \leq 0.05$) among the nine populations.
- Herbivore induced plant volatiles emitted by rice plants upon leaf folder herbivory were more preferred over healthy plants. W1263 was more attractive to parasitoids compared TKM 6 indicating a secondary mechanism of defence.
- Olfactometer assays indicate that the volatiles produced from infested plants are perceived by adjacent plants, priming them for attack
- Maximum catches of yellow stem borer and rice leaf folder were found in slow-release (SR) formulations of pheromone blends
- GC analysis indicated that >99% was released by the 3rd week in normal formulation, while 74-81% was released by the 16th week in the slow-release formulations.
- Monitoring of insecticide resistance in brown planthopper to pymetrozine and imidacloprid revealed that Shankarpally population was relatively sensitive to pymetrozine. Honeydew and probing tests Pymetrozine-Resistant (Pym-R) insects fed more as compared to Pymetrozine and Pym-S and R strains probed significantly higher on the plant surface treated with Pymetrozine.
- Cedarwood oil and citronella oil were found effective in managing BPH.
- Combinations of insecticide dinotefuran 20 SG and eucalyptus oil resulted in higher mortality of brown plant hopper indicating possibility of a joint action.
- The population of WBPH collected from Rajendranagar, Medak, Mareturu and Nawagam were subjected to various dosages of four major insecticides and mortality was recorded.
- Mulching with paddy straw, neem leaves, glyricidia was found effective in reducing nematode abundance in rice phytobiomes
- Seed treatment with Trichoderma asperellum, Bacillus cabrialessi and Pseudomonas fluorescens were effective in managing root galls.

Plant Pathology

- Among the 3592 lines screened, 1118 lines were found resistant to blast from at UBN.
- Fungicide, Fenoxanil + Isoprothiolane (2ml/l) gave 70% reduction of blast disease.
- Pre-treatment of SiO_2 was effective in reducing blast (PDI of 28.3%) compared to $CuSiO_2$ (36%).
- About 46 out of 103 bacterial blight (BB) promising entries from NSN were retested and found to have resistance against multiple *Xoo* strains. Sixty-four diverse germplasm were screened and 25 were found highly resistant against multiple strains of *Xoo* from India. The lines may possess new and novel BB resistant genes.
- Antibiotic chloramphenicol (1g/3L) was effective against BLB when first sprayed 2 days before and second spray 2 days after BB inoculation.
- 384 *R. solani* and *R. oryzae sativae* / *R. oryzae* are being characterized and maintained. Of ~ 2900 entries screened 117 entries were found tolerant.
- Elevated CO_2 and temperature (700 ppm and AT + 2°C) induced higher RLH and AUDPC in tolerant genotypes (Pankaj, Tetep, Wazuhophek, and Poughak) compared to susceptible genotypes (IR50 and BPT 5204).
- As determined from studies carried out at the Institute, every one percent PDI of sheath blight on rice plant, there will be ~ 43 Kg average yield loss determined through artificial inoculation.
- Surveys in Punjab, Haryana, West Bengal, Uttarakhand and Karnataka indicated that sheath blight pathogen has developed resistance towards the azoxystrobin.

- Thirty-one (31) pure cultures of *U. virens* were obtained from the false smut infected samples collected from eight states.
- Nine hundred and five rice genotypes were screened in the artificial screening facility for false smut and 47 promising genotypes were selected based on the number of smut balls 0-2 per panicle. Six genotypes (57, 184, 196,199, 208, 214) of 112 NSN-1 lines screened, were promising with a disease score of 3 against false smut.
- Volatiles of lemon grass oil completely inhibited the mycelial growth of *U. virens* under *in vitro* conditions.
- Brown spot disease surveys of Jharkhand and Chhattisgarh, showed higher incidence in local varieties as compared to the hybrids.
- Out of 190 interspecific population derived from IR64*1/*Oryza glaberrima* was screened and four lines (GL- 46, 81, 90 and 166) were found resistant to brown spot with score of 3.
- The varieties, BPT 5204, Swarnadhan, Gangavathi Sona, RP-Bio-226 and Purple rice were found highly susceptible and CH-45, Tetep, Tadukan and Rasi were moderately resistant varieties through AUDPC against brown spot.
- Eighteen isolates of stem rot were collected from the Telangana and Andhra Pradesh and pathogenicity of all the isolates were established on the variety TN1. Isolate S0 13 from Jagtial showed 56.1% PDI. Low virulent isolate is from Morthad village of Nizamabad (3.5%PDI).
- The combination of *Bacillus* seed treatment, soil application of karanja cake and foliar spray of Tebuconazole (T7) is the best combination for the control of stem rot disease with 75.69% reduction.
- Rice Tungro Disease (RTD) survey was conducted during 2023 in Telangana state and the insect vectors and weed hosts were collected for further analysis.
- Among 149 rice genotypes screened against RTD, 5 genotypes *viz*., 4B, 5B, 6B, 24B and 25B obtained from BPT 5204 x *Oryza rufipogon*, recorded disease score of three.
- 2-Methyl Pyrazine from *Pseudomonas putida* (PIK1) showed its antagonistic ability against *S. hydrophilum* and *U. virens.*
- Survival and viability rates of the microcapsules were achieved using a combination of maltodextrin (2%), gelatin (1.5%), and $CaCl_2$ (2%) as the wall material, with spray drying conditions i.e., inlet temperature of 130 °C and flow rate of 60 mL/h for TAIK1; and 120 °C and 60 mL/h for PIK1.

Transfer of Technology and Training

- A smallholder rice production study was conducted in Gorakhpur district, Uttar Pradesh, focused on 200 small and marginal farmers, employing a Farming Systems Approach. Rapid de-peasantization was evident due to rising cultivation costs and attractive non-agricultural opportunities with assured income. About 71% of farm families revealed a lack of interest among their younger generation in agriculture. The deployment of modern technologies in rice cultivation can revise this trend to a significant extent.
- As part of SMART village project, awareness was raised among tribal farmers about varietal replacement, and in the adoption of agricultural drones. Farmers expressed willingness to pay for pest control services (Rs. 800-1000/acre), while training on the Rice IPM App enabled pest identification, and initiatives like the Pradhan Mantri Kusum Yojana and a Custom Hiring Centre in Manchal Village provided climate-resilient irrigation and economic opportunities for destitute women, respectively.
- A comprehensive profiling study was conducted for 20 selected FPOs to assess technological needs, with IIRR-FPC interventions. A dedicated training module preference was identified. A database on Farmer Producer Organizations is being maintained and updated.
- The study on energy economics in Andhra Pradesh found that the adoption of mechanized Direct Seeded Rice (DSR) reduced the total cultivation cost by 13%, with a BC ratio of 1:3; DSR exhibited higher energy use efficiency, energy productivity,

and specific energy. Overall, DSR method demonstrated higher net energy gain (1,71,657 MJ/ha) and greater energy efficiency compared to the conventional method.

- Varietal demonstrations of nine ICAR-IIRR rice varieties were conducted in three villages. Additionally, IPM strategies, including alleyways, leaf tip clipping, and alternate wetting and drying, were adopted by 78 farmers across six villages, resulting in higher yields compared to non-IPM farmers. Three *Bt* isolates and one *Alcaligenes faecalis* isolate of ICAR-IIRR showed high effectiveness against Castor semilooper *Achaea janata*.
- Data collection from carbon registries, revealed India's 3% and 6% shares in global carbon projects under Verra and Gold Standard registries, respectively, with a focus on rice-related projects like Alternate Wetting and Drying and rice husk-based co-generation, emphasizing the challenge of integrating mandatory and voluntary carbon credit markets and identifying appropriate pricing models.
- A robust genomic prediction model was developed and validated in the Rice 3K SNP-seek database; the proposed model performs better compared to classical models. Genetic gain modeling of AICRPR irrigated trials revealed a significant positive trend over the years, indicating the system has contributed positively in genetic gain.

Computer Applications

- Climatic potential yield gap was estimated using Rice DSS for popular varieties of Telangana state such as BPT 5204, Telangana Sona and MTU 1010. Maximum yield gap was observed with BPT 5204(7115 kg/ha) followed by Telangana Sona (6282 kg/ha) and MTU1010(6244 kg/ha). Further climatic potential yield gap will be estimated for other major rice growing districts.

Introduction

Introduction

Genesis

Mandate

Organizational Structure

Infrastructure

Linkages

Staff & Budget

Introduction

Genesis

The All India Coordinated Research Project on Rice (AICRPR) was established in 1965 at Hyderabad, with the responsibility to organize multi-disciplinary, multi-location testing and develop suitable varietal and production technologies. AICRPR capitalized upon the available research infrastructure in different states of India and successfully introduced a national perspective in technology development and testing. AICRPR was later elevated to the status of Directorate of Rice Research (DRR) from April 1983 with the added mandate of pursuing research on irrigated rice.

In 1965, AICRPR was started with 22 centres (19 main and 3 testing centres) with 7 zonal centres and 12 regional centres. During the fifth five-year plan (1974-79) the main and sub centres were classified as single cropped (24) and double cropped (21) centres. Except Pondicherry and Varanasi which were fully funded by the ICAR, the rest of the centres were financed in the ratio of 75:25 with State Agricultural Universities (SAUs – 25%) or 50:50 per cent basis with State Departments of Agriculture (SDAs – 50%). During VI plan period (1980-85), 8 more sub centres were sanctioned raising the total to 53. There was a total of 61 centres including 8 subject related special centres. In the VII plan period (1985-89) the number of centres was reduced to 50 (18 main and 32 sub centres. During the eighth plan (1992-97) there were 51 approved centres of which six centres were withdrawn and Karnal centre was merged with Kaul in the IX plan period (1997-2002). The total number of centres during X plan (2002-2007) increased to 46 with the approval of Kanpur and Nagina centres and to 47 during XI plan (2007-2012) with the addition of Navsari in southern Gujarat in western India. Two centres were dropped in XII plan due to poor performance. The Institute (AICRPR) has evolved into an efficient and successful program of partnership in rice research bringing together more than 300 rice researchers from 45 funded and over 100 voluntary research centres.

The Organisation

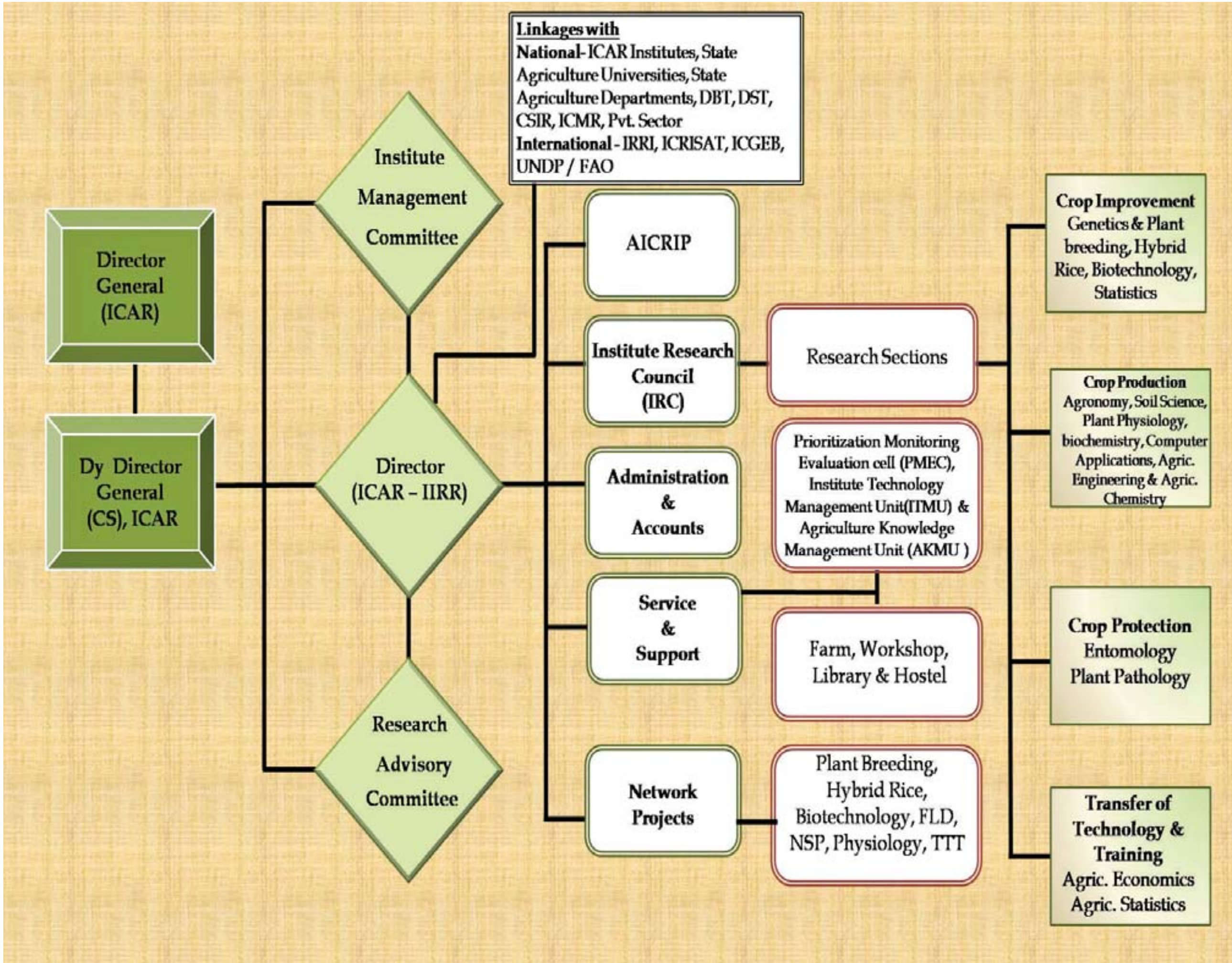
IIRR is an important constituent institute of ICAR under direct supervision of the Deputy Director General for Crop Sciences. The detailed organizational setup of the Institute is provided in the organogram. For fulfilling its mandate effectively, IIRR is organized into four sections and ten units along with centralized service wings and administration. AICRPR activities are integrated into the mandate with senior most scientists of each discipline acting as the PIs of the programme. There are 45 funded and more than 100 voluntary centres involved in rice research activities. Research and institutional activities are planned and guided by Research Advisory Committee and Institute Management Committee while the progress is critically evaluated once in five years by the Quinquennial Review Committee (QRT).

The Mandate

Basic and strategic research for enhancing rice productivity under irrigated ecosystem

Coordination of multi-location testing to develop location specific varieties and technologies for various ecosystems

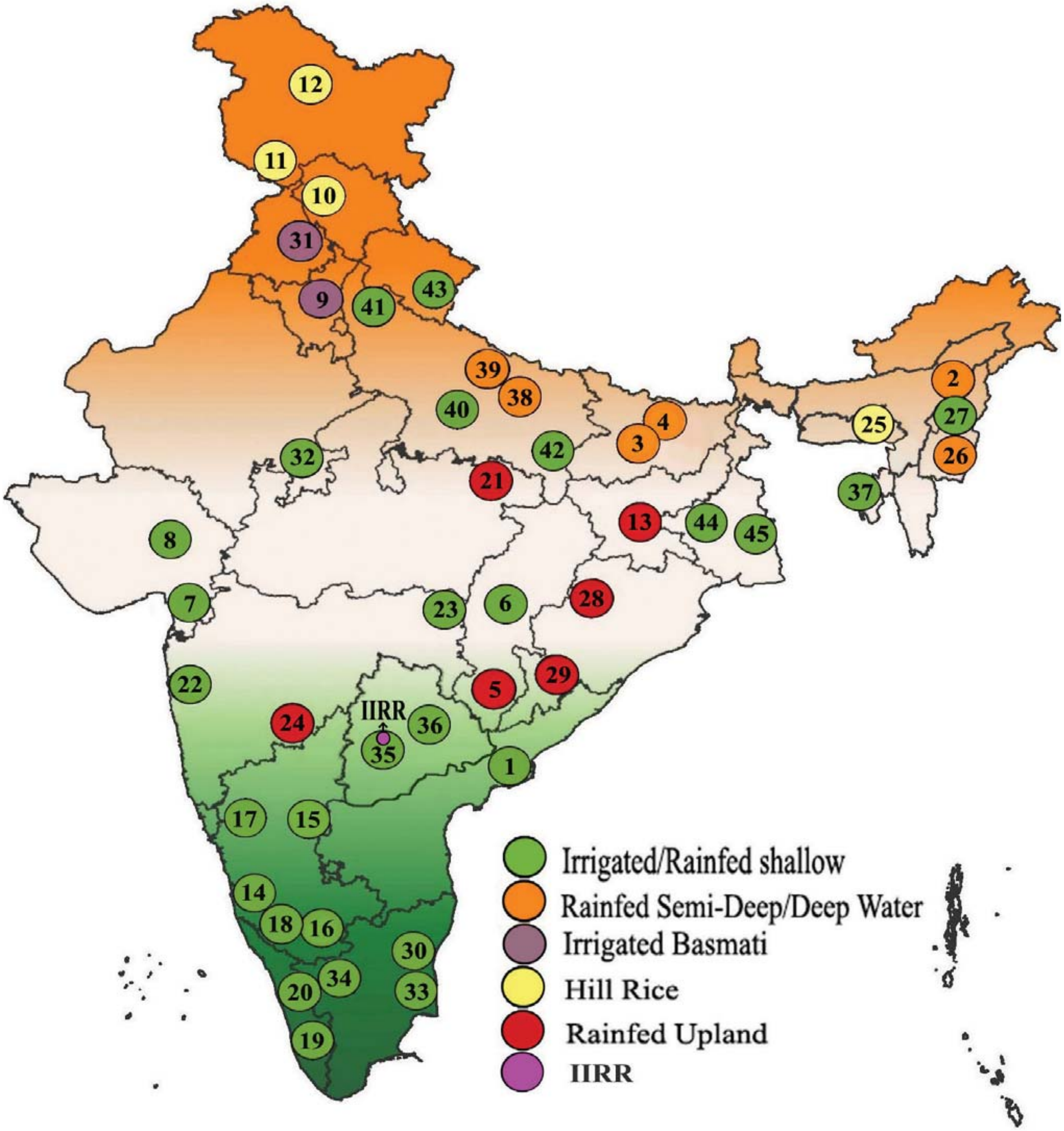
Dissemination of technologies, capacity building and establishing linkages



Organogram of the ICAR-IIRR

AICRPR - Funded Centres

S. No.	Centers	S. No.	Centers	S. No.	Centers	S. No.	Centers
1	Aduthurai	13	Jeypore	25	Mugad	37	Ranchi
2	Agarthala	14	Kanpur	26	Nagina	38	Rewa
3	Bankura	15	Karjat	27	Navasari	39	Sakoli
4	Brahmavar	16	Kaul	28	Nawagam	40	Titabar
5	Chatha	17	Khudwani	29	Pantnagar	41	Tuljapur
6	Chinsurah	18	Kohima	30	Patna	42	Upper Shillong
7	Chiplima	19	Kota	31	Pattambi	43	Varanasi
8	Coimbatore	20	Ludhiana	32	Pondicherry	44	Wangbal
9	Faizabad	21	Malan	33	Ponnampet	45	Warangal
10	Gangavati	22	Mandya	34	Pusa		
11	Ghaghraghat	23	Maruteru	35	Raipur		
12	Jagdalpur	24	Moncompu	36	Rajendranagar		



All India Coordinated Research Project on Rice (AICRPR)

Infrastructure

The Institute is equipped with state-of-the-art facilities with fully equipped laboratories for all the sections, centrally air-cooled greenhouses for screening germplasms for resistance against pests and diseases, net-houses, growth chambers, screening nursery beds, containment transgenic poly-houses and heat tunnels. Field facilities include well laid out experimental farms at Rajendranagar (20 ha) and Ramachandrapuram (40 ha) with a wild rice garden and pollination chambers along with adequate farm machinery, warehouses and limited cold storage facilities. A centrally air-conditioned auditorium with a seating capacity of 350, seminar halls, guest house, hostel facilities and a canteen, have been established for imparting training and to disseminate information using the latest multi-media and ICT tools. The Central library of the institute is fully digitized with over 4,654 books, 6,500 bound volumes and subscribes to 55 Indian and 13 foreign journals. The significant achievements of the Institute are exhibited in the form of posters, graphs and other visuals for the benefit of visitors through a state-of-the-art museum.

Linkages & Collaborations

ICAR-IIRR has a strong and wide network of linkages and collaborations with research organizations both in India and abroad. AICRPR has 45 funded centres affiliated to State Agricultural Universities and Departments of Agriculture of 27 states and 2 Union territories, besides five ICAR institutes. About 90-100 voluntary centres are also providing support in the evaluation and testing work.

Research Linkages: ICAR-IIRR has a strong collaboration with CGIAR institutes such as International Rice Research Institute (IRRI), Philippines and International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad and many National institutes like CRIDA, Hyderabad, NBAIR (Bengaluru), NBPGR, New Delhi (ICAR); PPV&FRA, New Delhi, IICT (CSIR), NIN (ICMR), Hyderabad, IICPT, Delhi University, Centre for Cellular and Molecular Biology (CCMB), Hyderabad and Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad.

Academic linkages: ICAR-IIRR has accreditation from several universities such as ANGRAU, PJTSAU, IGKV, Osmania University, University of Hyderabad, Jawaharlal Nehru Technological University, Yogi Vemana University, Kakatiya University, University of Agricultural Sciences, Bangalore, Acharya Nagarjuna University, Sanskriti University etc.

ICAR-IIRR also has a strong **Public Private Partnership** (PPP) mode of operational linkage with the private sector, especially relating to hybrid rice technology and its commercialization. This partnership started two decades back has turned out to be one of the best examples of PPP in the country.

The Staff

As on 31st March, 2023

S. No.	Category	Sanctioned	Filled	Vacant
1	Director	1	1	0
2	Scientists	66	62	4
3	Administration	36	19	17
4	Technical	42	30	12
5	Supporting Grade	47	43	04
	Total	**192**	158	34

The Budget (2022-23)

(Rupees in lakhs) As on 31st March, 2023

Item	2022-23	
	Outlay	Expenditure
IIRR, Hyderabad	5103.88	5103.88
AICRP on Rice, Hyderabad	4129.65	4129.65

Introduction

Research Achievements

Coordinated Research

Crop Improvement

New Varieties and Hybrids released

Crop Production

Agronomy

Soil Science

Plant Physiology

Crop Protection

Entomology

Pathology

All India Coordinated Rice Improvement Project (AICRIP)

Crop Improvement

Coordinated varietal testing

ICAR-Indian Institute of Rice Research (ICAR-IIRR) coordinated and conducted trials in collaboration with ICAR-NRRI and ICAR-IARI under Irrigated ecology, rainfed ecology and basmati trials respectively. A total of 54 trials (50 varietal trials and 4 hybrid rice trials) were conducted in 1182 experiments (1043 varietal and 139 hybrid rice) at 124 locations (43 funded, 81voluntary centres) in 26 states and 4 union Territories across seven zones of the country during 2022 which is the 58th year of AICRIP testing. Hybrid rice experiments were conducted by 10 private seed companies. The 54 trials were constituted with 1495 entries (1176 varietal and 82 hybrid rice) including 237 checks.

Breeder seed production of 365 rice varieties and 2 hybrids was organized at 52 locations as per the DAC indents. ICAR-IIRR also evaluated 132 entries involving 62 candidate varieties and 70 farmers varieties for DUS testing. A total of 8055.84 quintals of breeder seed was achieved against a target of 3382.88 quintals during kharif 2022. At IIRR centre, 27 varieties were included in breeder seed production with a total production of 573.35 quintals against the target of 288.87 quintals. Additionally, the strong partnership with IRRI, Philippines provides access to global elite rice germplasm with the exchange of breeding lines of early, medium and late maturity groups to accelerate genetic gain in rice for irrigated ecology through ICAR-IIRR and One-IRRI network.

In the irrigated ecology, of the 694 entries including 82 hybrids were evaluated in IVT trials in the 1st year of testing of which 218 entries were promoted to 2nd year of testing. Entries in 2nd year of testing were 180 and of them 81 entries were promoted to 3rd year of testing. In 3rd year of testing 85 entries were evaluated and of them 39 entries were found promising in various irrigated trials.

New Varieties and Hybrids released

During the year 2023, a total of 56 rice varieties were released by Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCCSN & RV) and State Varietal Release Committee (SVRC). Among these CVRC released 1 variety and 1 hybrid and the SVRC released 43 varieties and 11 hybrids. Among the 42 varieties and 18 hybrids proposals submitted to Variety Identification Committee; 34 varieties for CVRC and 5 varieties for SVRC and 15 hybrids for CVRC were identified for release in different states during 58th ARGM.

Rice Varieties Released during 2023 (CVRC and SVRC)

S. No.	Variety Name	IET No	Designation	Cross Combination	DFF	Eco-System	GT	Yield (t/ha)	Pests/ Disease reaction	Recom-mended State
A	CVRC									
1	*28P67 (Hybrid)*	24879	PR-14105	RA401F/RA406	100-105	IRM	LB	6.8	T-BS, LF	PU & HR
2	Malviya Sugandhi Dhan-156	25419	HUR 156	Taroari Basmati dwarf mutant-2/MTU 7029	104	IRM	SS	4.9	MR-BS, T-BPH, LF	UP & WB

S. No.	Variety Name	IET No	Designation	Cross Combination	DFF	Eco-System	GT	Yield (t/ha)	Pests/ Disease reaction	Recom-mended State
B	**SVRC**									
1	Swarna Shusk Dhan	27962	RCPR 56-IR93827-29-1-1-4	IR 81039-B-173-U3-3/IR 81063-B-94-U3-1	75-80	RUP	LS	2.2	MR-BL, SB, LF	UP
2	Swarna Purvi Dhan -1	24660	RCPR 19-IR 84899-B-179-13-1-1-1	IR 78877-208-B-1-1/IRRI 132	85-90	IRE	SB	4.5	MR-BL, ShBl, BS, SB	JH
3	Swarna Purvi Dhan-2	26767	RCPR 46-IR93827-29-1-1-2	IR 81039-B-173-U-3-3/ IR 81063-B-94-U-3-1	85-90	IRE	LS	4.3	MR-BLB, RTD, ShBl, SB, GM, LF	JH
4	MCM Rice 103	23407	MCM 103	BPT 5204/MTU 4870	110	IRM	MS	5.5	MT-BL, ShBl, WBPH, T-SB	AP
5	MTU Rice 1232	26422	MTU 1232	MTU 1075/ Swarna Sub 1//* Swarna Sub 1	110	IRM	MS	6.0	MR-BL, ShBl, R-BPH	AP
6	MTU Rice 1318	28527	MTU 1318	MTU 1064/ MTU 7029	120	IRL	MS	6.6	T-BPH	AP
7	Jagtiala Vari-2	27448	JGL 28545	JGL 11727/BPT 5204	105	IRM	MS	6.2	T-BLB, SB	TS
8	Jagtiala Vari-3	30064	JGL 27356	JGL 11470/Jai Sriram	105	IRM	SS	2.80	T-SB	TS
9	Rajendranagar Vari -3	28567	RNR 15459	RNR 17818/ Chittimutyalu	105-110	IRM	SB	4.2	MR-BL, SB, BPH, GM	TS
10	Rajendranagar Vari -4	27107	RNR 21278	RNR 2645/NLR 34449	85-90	IRE	MS	6.0-6.5	MR-BL	TS
11	Rajendranagar Vari - 5	29789	RNR 29325	TME 80518/ BPT 5204	90-95	IRME	LS	7.5	MR-BL, BPH, S-SB, GM, LF	TS
12	Luchai Selection 1	27015	Luchai	Selection from land race Luchai	105-110	IRM	SB	5.1	MR-BL, BLB	MP
13	Kali Kamod Selection 1	27029	Kali Kamod	Selection from land race Kali Kamod	105-110	IRM	MS	3.2	MR-BL, BLB	MP
14	Shalimar Rice -6	28199	SKUA 485	Mushk Budji/ DHMAS 70Q 164-1b//Mushk Budji///Mushk Budji	105-115	IRM	SB	4.5	R-BL	J&K

S. No.	Variety Name	IET No	Designation	Cross Combination	DFF	Eco-System	GT	Yield (t/ha)	Pests/ Disease reaction	Recom-mended State
15	PR 130	29190	RYT 3797 (PAU 6260-3-1-6)	PR 121/HKR47	105	IRM	LS	7.2	R-BLB	PU
16	PDKV Sadhana	27894	SKL 3-1-41-8-33-15	Mugad Sugandha/SKL 8-SKL 3-1-41-8-33-15	90	IRE	LS	5.0	MR-BL, SB	MH
17	Mandya Jyothi	26901	KMP-220	Jyothi/BR-2655	101	IRM	LB	5.0	MR-BL, MT-BPH	KA
18	Samruddhi	28349	MSN 99	KMR 04/ BPT 5204 (4-1-1-4)	85-90	IRE	MS	6.5		KA
19	Pant Sugandh Dhan 27	29675	UPR 3488-6-2-1	UPR 1840-31-1-1/Pusa Sugandh 2	103	IRM	LS	3.8	MT-BLB	UT
20	Swarna Sukha Dhan	24692	RCPR 16-IR84894-143-CRA-17-1	IR 77080-B-34-3/IRRI 132	80-85	IRE	MS	4.3	MR-BL, BLB, BS, SB, BPH	JH
21	***PAC 837 Plus (Hybrid)***	29720	PAC 837 Plus	-	97-103	IRM	LB	7.5	R-BL, MR-BS	AS
22	***NPH -242 (Hybrid)***	24981	NPH-242	-	99	IRME	LS	6.0	T-BL, BLB	AS
23	***VNR 2228 (Hybrid)***	24951	VNR 218	-	103	IRM	MS	5.9	MR-BL, BLB	AS
24	***PAC 8744 Plus (Hybrid)***	25785	PAC 8744 Plus (ADV 1603)	-	108	IRM	LB	7.5	T-BLB	AS
25	***PAC 8744 (Hybrid)***	20743	PAC 8744 (PAC 85052)	-	105	IRM	MS	7.0	MR-BS, SB, WBPH, LF	AS
26	***Indam 200-017 (Hybrid)***	20419	Indam 200-017	-	96	IRME	LB	5.8	MR-BL, BS, LF, R-SB	AS
27	***BIO 799 (Hybrid)***	22919	BIO 453	-	105	IRM	LB	7.0	T-BL, BLB, RTD, BPH	AS
28	***PAN 2423 (Hybrid)***	21395	PAN 2423	-	97	IRME	SB	7.8	T-BL, BLB, BS, SB, LF, MR-ShBl	AS
29	***PAN 802 (Hybrid)***	23498	PAN 802	-	99	IRME	LS	6.3	MR-BL, BLB, ShBl	AS
30	Jyotsna	25992	CR Dhan 323	Double haploid of CR Dhan 701	105-110	IRM	SB	5.5	MR-BLB, RTD, GM	OD
31	Abhaya Paushtik	28698	CR Dhan 324 (CRAC 3994-2-5)	Doubled haploid of CR Dhan 701	85-90	IRE	LS	5.5	MR-BS, GM, LF	OD
32	Panchatatva	28491	CR Dhan 326	Naveen / IRBB 66	102	IRM	MS	6.1	R-BLB	OD

S. No.	Variety Name	IET No	Designation	Cross Combination	DFF	Eco-System	GT	Yield (t/ha)	Pests/ Disease reaction	Recom-mended State
33	Madhumita	27689	CR Dhan 327	Birupa / Pusa 44	105	IRM	MS	6.7	MR-BLB, SB, BPH, R-LF	OD
34	Divya	26420	CR Dhan 328	IR 73963-86-1-5-2-2/CR 2324-1	113	IRL	LB	6.6	R-SB, LF	OD
35	***Shyamdev (Hybrid)***	28187	CR Dhan 704	***Hybrid***	95-100	IRME	SS	7.0	MR-BS, GM	OD
36	Naveen Shakti	29203	CR Dhan 805	Naveen*3 / CR 3006-8-2	98	IRME	MS	4.8	R-BPH	OD
37	Varsadhan Sub 1		CR Dhan 806		133	RSL		3.9	R-SB	OD
38	Basudev	28414	CR Dhan 911 (CRAC 3995-27-1)	Doubled haploid of BS 6444G	90	IRE	LS	4.5	MR-BS, GM, LF	OD
39	Pusa Narendra KNI	26204	Pusa 1638-07-130-2-67-1-1	P1176 / Kalanamak	115	IRM		3.6		UP
40	Pusa CRD KN2	26213	Pusa 1638-07-171-1-81-1-2	P1176 / Kalanamak	115	IRM		3.5		UP
41	ADT 58	29121	AD 12132	SAVITRI/AC 38562//VAR-SHADHAN	95	IRME	MS	6.0	MR-BL, BLB, T-SB, BPH, LF	TN
42	CO 56	25531	CB 12132	CO 50/CB 05501	100	IRM	MS	6.3	MR-BL, BLB, RTD, BS, SB, GM	TN
43	Surya Shree	27737	OUAT Kalinga Rice 8	IR 93328-46-B-7-1-3-3	90-95	IRME	LB	4.2	MR-BL, ShBl, GM	OD
44	Barunei	23666	OUAT Kalinga Rice 7	Gouri/IR 65629-22-1	105-110	IRM	LB	5.3	MR-BL, BPH	OD
45	JR 21	28388	JR 81-01	MTU 1010 / NPT13-01	98	IRME	SB	5.9	MR-GM, LF	MP
46	Kolab	25295	OUAT Kalinga Rice 1	IR 825865/ IR82861-B	100-105	IRM	LS	5.2	MR-BPH, GM	OD
47	Salandi	28444	OUAT Kalinga Rice 2	Birupa / IR 76561-AC-8-8	100-105	IRM	LB	5.9	MR-BLB, SB, LF	OD
48	Nabanna	25140	OUAT Kalinga Rice 5	Zhu11-26/ Geetanjali	85	IRE	LS	2.7		ODm
49	Bhargavi	23565	OUAT Kalinga Rice 6	Mahanadi/ RAYADA-B3	120	RSL	LB	4.4	MR-LF	OD
50	ASD 21	29799	AS 15024	ASD 16/Manjal Saradai	116	IRL	SB	6.3	MR-BL, BLB, GM, LF	TN

S. No.	Variety Name	IET No	Designation	Cross Combination	DFF	Eco-System	GT	Yield (t/ha)	Pests/ Disease reaction	Recom-mended State
51	Patkai	29034	AAU-TTB Dhan 42	Ranjit Sub 1/ Improved Samba Mahsuri// Ranjit Sub 1/// Ranjit Sub 1	120	RSL	MS	5.5		AS
52	Shatabdi	29087	AAU-TTB Dhan 43	IRGC 25239/ Ranjit	120	RSL	MS	5.5		AS
53	Prachur	29075	AAU-TTB Dhan 44	Ranjit/IRBB 59	125	RSL	MS	5.5		AS
54	***Indam 200-022 (Hybrid)***	20710								AS

Hybrid Rice

The total area planned under hybrid rice has reached 3.5 million ha during the year 2022 and more than 80% of the total hybrid rice area is in the states of Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, Madhya Pradesh, Odisha, and Haryana. So far, 137 hybrids have been released in the country for commercial cultivation. During the period under report, four hybrids (central releases-2; state releases-2) were released and notified by CSCCSN&RV for commercial cultivation in different states of the country.

Hybrids released 2022-23

S. No.	Name of the hybrid	Released for the states of
		CVRC
		Medium
1	AZ 8433 DT	Haryana, Punjab, Uttar Pradesh, Bihar, Jharkhand, Odisha, Madhya Pradesh, Chhattisgarh, Telangana, Andhra Pradesh, Tamil Nadu, and Karnataka
		Early (Aerobic ecology)
2	DRRH 4	Punjab, Odisha, Chhattisgarh, Tripura, Gujarat
		SVRC
3	PAC 837 plus	Assam
4	NPH 242	Assam

Initial Hybrid Rice Trials

During Kharif 2022, a total of 82 hybrids were evaluated in four hybrid rice trials *viz.,* IHRT-E, IHRT-ME, IHRT-M, IHRT-MS, in different locations representing North, East, Northeast, Central, West, and South zones of the country. Hybrids with significant yield advantage over the varietal check and the hybrid checks (CD @5%) are identified as promising. Details of the top three ranking hybrids in each of the trials are given below.

Promising hybrids identified in different hybrid rice trials (2022)

Name of the Hybrid	DFF	Promising in
	IHRT-E	
RRX-3276	91	Overall
LG-90204	91	Overall
KAVERI 7374	92	Overall
	IHRT-ME	
HRI-216	97	Overall
RNC-0752	98	Overall
RALLIS-21304	100	Overall
	IHRT-M	
RNE-0456	102	Overall
PHI-22109	98	Overall
ADVRH-191788	100	Overall
	IHRT-MS	
RALLIS-20609	98	Overall
CRHR-168	105	Zone III
HRI-215	100	Zone IV

Monitoring of AICRP on Rice trials during 2023

A multi-disciplinary team consisting of scientist from Crop Improvement, Crop Production and Crop Protection were constituted and monitored the conduct of AICRP on Rice across the different zones of rice ecosystems of India in collaboration with Scientists of IARI and NRRI. A total of 11 multi-disciplinary teams were organized by IIRR to monitor trials in Zone-II of North Western region, Zone-V, VI comprising Western and Central region and Zone-VII in the Southern Region of India.

Monitoring Team at UP (Zone III, Eastern region)

Monitoring team at Karjat (Zone-VI Western region)

Monitoring team at Goa (Zone-VI Western region)

Monitoring team at Goa (Zone-VI Western region)

DUS tests in Rice

The DUS testing of 132 test samples was conducted at the specialized DUS block at Ramchandrapuram Farm, ICRISAT campus during Kharif 2023. The samples included 70 in 1st year of testing (Typical/ Farmer's varieties), and 62 in 2nd year testing (Candidate hybrids, F1's from Shimoga, and Typical). These were tested in replicated trials along with checks like PA6129, US 312, Tellahamsa, BPT 5204, CO 51, Anjali, RP Bio 226, MTU 1075, MTU 1153, and CR Dhan 201. The trials were sown on 14-07-2023 (2nd year entries) and 17-07-2023 (Ist year entries) while the RCVs were sown on 04/08/2023. The plantings were completed on 24/08/23 and 26/08/23 for 2nd year and 1st year entries respectively. Five entries (2877/3171, 22R 2H, 2879/2508, 2877/2329 and 23RIRA) showed nil germination, this was communicated to PPV & FRA. The DUS tests were carried out as per statutory requirement of the PPV & FR Act, 2001 and the recorded data was submitted to the authority in time in the specified format. The monitoring of DUS trials was conducted in virtual mode on 09-12-2023 by a team comprising of Dipal Roy (Joint Registrar, PPV & FRA) and his team.

Field view of DUS tests at RC Puram Farm, Hyderabad

National seed project and Breeder Seed Production

Breeder seed production of 365 rice varieties was organized at 52 locations as per the DAC indents. Breeder seed Production of Mahsuri, BRRI Dhan 69, BRRI Dhan-75 (HUA 565), BINA DHAN-11, BINA DHAN-17, DRR DHAN 50 (IET 25671), DRR DHAN-45 (IET 23832), DRR DHAN-39, DRR DHAN-42, DRR DHAN-43, DRR DHAN-44, DRR DHAN-46, DRR DHAN -47, DRR DHAN-48, DRR DHAN-49, DRR DHAN-51, DRR DHAN -52, DRR DHAN -54, DRR DHAN-55, Improved Samba Mahsuri, JAYA, DRR Dhan-58 and DRR Dhan -62 were produced at ICAR-IIRR along with other varieties intended.

Crop Production

Agronomy

Nutrient Management Trials: A total of 132 AVT-2 entries belonging to 18 categories were evaluated at different locations under two levels of nutrient application, *i.e.*, 50 and 100 % of the recommended dose of nutrients along with standard and local cultivars to identify stable and efficient genotypes. Vivek Dhan-86 and tested cultures IET 28200, IET 28329. IET 28358. IET 28396. IET 28302 and aerobic culture, IET 26178 was found to be promising with higher grain yield were found to be promising based on grain yield efficiency index across the locations. Trial results compiled for six locations to identify N efficient cultivars revealed that IET 29583, IET 29584, IET 29577, IET 30261, IET 28084, IET 30275 and IET 29564 were high yielding with high nitrogen use efficiency cultivars. The genotypes G1 (CR 4333-181-1-2-1), G2 (CR 4333-35-2-2-1), G4 (CR 4332-184-2-2-1) and G5 (CR 4332-37-2-1-1), 1815 and 1823 with no or low phytotoxicity to weedicides tested have contributed to higher crop growth and grain yield.

Resource Conservation Technologies Trials: Transplanting method recorded the highest mean grain yield of 5.94 t/ha across all locations. In *rabi* season, alternate wetting and drying recorded the lowest cost of cultivation (Rs. 41632/- per hectare) and total water input (953 mm/ha). Similarly, mechanical transplanting method on puddled soil also recorded the lowest cost of cultivation (Rs. 34,633/- per hectare). In dry DSR, among the weed management treatments, pre + post emergent application method resulted the highest grain yield (4.25 t/ha). However, mechanical weeding was found to be promising in-terms of higher B:C ratio in most of the locations. In wet DSR, mechanical line sowing resulted in the highest grain yield (5.12 t/ha) across all locations. Similarly, among weed management practices, pre + post-emergence herbicide two times for first and second flush 20-25 days and 40-45 DAS, respectively, resulted in the highest grain yield (5.01 t/ha). Overall, the incidence of insect pests was significantly high in puddled direct-seeded rice followed by the normal transplanting method while the incidence was low in direct-seeded rice, semi-dry rice, mechanical transplanting, and aerobic rice.

Rice Based Crop Diversification System Trials: The rice equivalent yield (REY) indicated superiority of the residue application at Vadagaon, indicating the superiority of residue in rice-based system. In another trial, IIMRH cultures were significantly superior (IIMRH 1 (3.53 t/ha); IIMRH 6 (3.8 t/ha); and IIMRH 5 (2.91 t/ha) as compared to local (CSH 16 and CSH 30). Long term trial on weed dynamics study in rice based cropping systems reported from eight locations showed dominance of grasses *i.e*., *Echinochloa colonum/ crusgalli* at five locations, *Paspalum spp, Isachne spp, Oplismaanus spp* at Gangavathi, Moncompu and Pattambi, respectively. At four locations *Cyperus iria* was dominant. At 12 locations, chemical weed control was found superior over mechanical weed control and at three locations, mechanical weed control was superior.

Inter Disciplinary Trials: Overall, across all 14 locations 125% RDF of the location + FYM @ 5 t/ha resulted in the highest mean grain yield (5.89 t/ha) followed by location specific management practices (5.80 t/ha) and 125% RDF of the location (5.68 t/ha).

The results of the data collected from various districts of five states of India revealed that the yield gaps ranged from 4 to 26 per cent. The average yield gap was found to be 12 per cent and scope to enhance the yields with better management practices. In another trial of organic and natural farming practices conducted in clay loam soils of Puducherry, ADT-54 variety, best organic management practices resulted in the highest grain yield (6.52 t/ha).

Soil Science

Long term soil fertility management in rice based cropping system: The long-term soil fertility management in RBCS (rice based cropping systems) is in the 34th year of study. Combined use of RDF + FYM yielded maximum grain yield at Mandya, Maruteru and Titabar. The treatment with FYM alone was on par to RDF in *Kharif* at Maruteru and in both seasons at Titabar. Nutrient omission (NPK, Zn and S) and reduction of NPK to 50% resulted in yield reduction at all three centres and in both seasons. Over a period of 34 years, RDF recorded positive growth rate in in productivity with 63, 75 and 58 kg/ha/year at Maruteru, Titabar and Mandya, respectively.

Soil quality and productivity assessment for bridging the yield gap in farmers' fields Assessment for bridging the yield gap was conducted in farmers' fields at selected centres - Chinsurah, Titabar, Pantnagar, Kanpur, Kaul and Karaikal to record the variability in soil nutrient supply, its relationship with rice yields at current recommended fertilizer practices. Sharp variations in mean grain yields were recorded, from 2.38 to 4.73 t ha^{-1} at Chinsurah, 2.48 to 3.43 t ha^{-1} at Titabar, 4.76 to 6.59 t ha^{-1} at Kanpur, 2.4 t to 4.32 t ha^{-1} at Moncompu, 2.9 to 3.21 t ha^{-1} at Ludhiana, 3.83 to 4.36 t ha^{-1} at Karaikal, 4.83 to 5.84 t ha-1 at Pantnagar and 1.44 to 8.8 t ha^{-1} at Kaul respectively. Fertilizer prescriptions were worked out for all the farm sites. The soil quality index was much superior at Pantnagar and was at par for all other centres.

Management of sodic soils using nano Zn formulation: Two genotypes were evaluated with six different set of nutrient management practices at four locations. At Kanpur and Pusa, soil application of $ZnSO_4$ @ 50 kg/ha registered higher grain (4.36 t/ha, 3.41 t/ha) and straw (6.25 t/ha, 5.15 t/ha) yields whereas at Mandya and Faizabad foliar application of nano Zn @ 50 ppm recorded significantly higher grain (6.24 t/ha, 3.99 t/ha) and straw yields (6.86 t/ha, 5.37 t/ha). DRR Dhan 48 found superior at Mandya and Faizabad and CSR23 performed better at Kanpur. Nutrient uptake also followed similar trend as that of grain and straw yields. DRR Dhan 48 accumulated higher amount of NPK and Zn at Mandya, Pusa and Faizabad and CSR 23 recorded significantly higher nutrient uptake at Kanpur.

Management of acid soils: Application of RDF + dolomite + Silixol recorded the highest yields at all locations (except Ranchi) where RDF + Dolomite + RHA application recorded the highest grain yield. Between two varieties, Uma yielded the highest at majority of locations while Vasundhara performed better at Moncompu. Ameliorative effect of application of RDF + dolomite + RHA was observed as the pH increased to 4.39 and 6.25 was observed in acid soils of Moncompu and Titabar respectively when compared to RDF alone (4.21 and 5.22, respectively) at these locations.

Residue management in rice based cropping systems: The trial on residue management was conducted at nine centres. The results showed that the crop residues can be used to substitute half of the recommended nitrogen without yield penalty. The crop residue treatments were at par with each other in terms of nutrient uptake and also maintained higher nutrient use efficiencies over RDF. Post-harvest soil nutrient status was not influenced much by residue treatments, which were at par with each other.

Nano-fertilizers for increasing nutrient use efficiency, yield and economic returns in transplanted rice: Additional application of nano urea with 100% RDN improved the yield, yield parameters and N uptake at Jagdalpur, Faizabad, Chatha, Hyderabad, Mandya, Pantnagar, Moncompu, Sabour, Kanpur and Warangal. Whereas, 75% RDN + two sprays of nano urea registered the highest growth parameters, yield and N uptake at Karaikal, Kanpur, Coimbatore, Mandya, Bankura, Khudwani, Pattambi, and Puducherry. At Bankura, Khudwani and Karaikal, the higher NUE was observed with 75% RDN + two sprays of nano urea treatment, but 100% RDN + two sprays of nano urea treatment registered a higher NUE at rest of the locations.

Evaluation of Organic fertilizers and Natural farming practices for enhancing the productivity and soil health: Integrated Crop Management with need-based pesticides gave better performance than other treatments in terms of grain yield and yield parameters and majority of the soil parameters.

Plant Physiology and Biochemistry

Physiological studies under All India Co-ordinated Rice Improvement Program were conducted at nine funded centres (Coimbatore, Maruteru, Pantnagar, Pattambi, Rewa, Raipur, Karjat, Kaul and Titabar), two ICAR institutions (IIRR Hyderabad and NRRI Cuttack) and four voluntary centres (Chinsurah, Faizabad, Karaikal and Ranchi).

In view of the importance of silicon on improving abiotic stress tolerance, a trial was conducted with ten entries at eleven locations with four treatments and eight genotypes consisting of hybrid and high yielding varieties. The results revealed that there was no significant effect of Si application on days to 50% flowering, days to maturity, tiller number/m^2, shoot weight (g/m^2), panicle number/$m^2$and HI, whereas it significantly affected the LAI, Grain number/panicle, Total dry matter, grain yield and panicle weight. However, on the basis of grain yield, the entry 27P63 was found to be most promising among all the entries followed by US-312.

26 ILs derived from multi-parent inter-crosses in the background of Krishna Hamsa were evaluated for drought tolerance. Genotypes IET 29834, IL-19095 and IL-19100 with a reduction in grain yield of < 30% under rainfed condition can be identified as relatively drought tolerant. Based on Yield Stability Index (YSi), genotypes DRR Dhan-44, IET 29834, IET 29859, IET 30241, IL-19075, IL-19079, IL-19083, IL-19095, IL-19103, IL-19186, IL-19344, IL-19353, Krishna Hamsa and Sahabhagidhan were identified as stable genotypes under rainfed condition.

A trial was conducted at 7 AICRPR centers with 25 entries from IVT-E-TP breeding trial to phenotype rice cultivars for high temperature tolerance. The performance of the genotypes was assessed with the various heat tolerance indices. Based on the overall rank, IET29142, IET28950, MTU-1156, IET28959 and IET28964 can be identified as relatively heat tolerant genotype.

Screening of 20 rice accessions for multiple abiotic stress tolerance *viz*., anaerobic germination potential, tolerant against salinity and osmotic stresses at seedling stage on the basis of physiological traits was conducted at 7 AICRPR centres. Genotype Pantara, IC-256508 and Vandana were found to be tolerant to all the abiotic stresses; CR4423-17 was found tolerant to AG and osmotic stresses and AC847A and FL478 were found tolerant to salinity and AG stresses.

A trial for submergence tolerance was conducted at four locations with 15 genotypes. Genotype AC289, AC1017A and AC1303B have shown on par survival rate in comparison to the tolerant check FR13A and therefore were identified as highly tolerant to submergence stress, whereas AC39460, CR4423-17, CR 3483-29-M-4-B-Sub-79 and AC931 have shown 60-70% survival rate can be considered as tolerant to complete submergence.

A trial to screen 14 rice entries for low light stress was conducted at 7 locations with Swarnaprabha as the tolerant check and IR8 as the susceptible check. Low light stress resulted in significant loss in yield and its components. The entries IET-27530, CR Dhan 411, CR Dhan 801, IET-31288 recorded on par grain yield under low light stress when compared with the Swarnaprabha suggesting that these genotypes have better tolerance to lowlight.

Crop Protection

Entomology

All India Coordinated Entomology Programme was organized and conducted with seven major trials encompassing various aspects of rice Entomology involving 306 experiments that were conducted at 40 locations (ICAR-IIRR, 30 funded & 9 voluntary centres) in 22 states and one Union territory.

Host Plant Resistance Studies: Host plant resistance studies comprised of eight screening trials involving 1581 entries which included 1521 pre-breeding lines & varieties, 98 hybrids, 13 germplasm accessions and136 checks against 15 insect pests in 209 valid tests (47 greenhouse reactions +162 field reactions). The results of these reactions identified 92 entries (5.81% of the tested) as promising against various insect pests. In Planthopper screening trial (PHS) 176 entries were screened against the two planthoppers BPH and WBPH in 12 greenhouse and 8 field tests at 16 locations. 16 entries were promising in 6 to 13 tests. Two breeding lines viz., RP-GP-3000-179-3-9-1, WGL 1533 and one local collection IBT-BPH M 23 from

IBT, PJTSAU performed better in the second year of retesting. In Gall midge screening trial (GMS) 110 entries bred specifically for gall midge resistance were evaluated in 8 field tests and one greenhouse reaction against 9 populations of gall midge which helped in identification of 12 entries as most promising with nil damage in 5-6 tests of the 9 valid tests. Of these, IBTWGL 3, RP 6614-102-11-3-3-1-1-1(FBL 19101), *GM* 5 (IBT) IBTWGL 2, IBTWGL 21 with known gall midge resistance genes in different varietal backgrounds were observed to be promising under retesting. Field evaluation of 25 entries replicated thrice at 18 locations in Leaf Folder Screening Trial (LFST) during Kharif 2022 revealed that 22 entries were promising in 2-6 tests out of 14 valid field tests. In the first year of testing, RP5564 PTB 1-4-2 was found promising in 6 of the 14 valid tests while four entries, viz., BPT 3182, RP5564 PTB 1-4-1-2, RP5564 PTB 2-4-1-5, and RP5564 PTB 1-4-1-1 were promising in 5 out of 14 valid field tests. BPT 3068, RP5564 PTB 1-4-1 and BPT 3085 were found promising in 4 valid field tests out of 14 while seven entries were promising in 3 valid field tests and the rest of the entries in 2 out of 14 valid field tests. Stem borer screening trial (SBST) comprised of 55 entries which were evaluated in 16 valid field tests, 10 promising entries were identified for stemborer resistance with recovery resistance and tolerance mechanisms. Seven promising entries were identified in the multiple resistance screening trial of which RP 6461-248-1, RP Bio 4918-230 and CRCPT 8 performed well in the second year. 17 gene differentials were evaluated at 12 locations again planthoppers. PTB 33 (*bph2*+*Bph3*+ *Bph32*+unknown factors) and RP 2068-18-3-5 (*Bph33t* gene) performed well, followed by Swarnalatha with *Bph6* gene.

Insect Biotype Studies: The brown planthopper population at Ludhiana was more virulent than many locations studied. 19 gene differentials were evaluated at 12 locations. Aganni (*Gm*8), INRC 3021 (*Gm*8), INRC17470, INRC15888, and RP5925-24 were found promising. Aganni (*Gm*8) and Akshayadhan (with *Gm*4 + *Gm*8) holds promise against gall midge.

Chemical Control Studies: Evaluation of granular insecticides for gall midge management (EIGM): All treatments resulted in higher yield compared to untreated control (3214.5 kg/ha). Application of fipronil granules in nursery followed by chlorantraniliprole granules in main field resulted in the highest yield (4496.4 kg/ha), with a 39.9% advantage over the untreated control. In the Insecticide Botanicals Evaluation Trial (IBET), among various treatments, all insecticides treatment recorded highest mean yield of 4991.0 kg/ha followed by treatment consisting of neemazal, neem oil and triflumezopyrim giving yield of 4554.2 kg/ha.

Optimum Pest Control Trial: Nine resistant rice cultures and TN1 were evaluated across 9 locations, showing significantly lower silver shoot damage (1.7-3.03%SS) in W1263 (*Gm*1), CUL M9, Suraksha (*Gm*11), Akshyadhan PYL, RP2068-18-3-5 (*gm*3) compared to other varieties (7.7-11.6% SS). Dead heart damage was significantly lower in insecticide treatments at 4 locations, while CUL M9, RP2068, RP5587-273-1-B-B-B, and Suraksha recorded lower dead heart damage across locations, albeit not statistically significant.

Ecological Studies: Puddled direct-seeded rice exhibited significantly high incidences of various insect pests, including gall midge, whorl maggot, caseworm, and BPH, followed by the normal transplanting method, whereas lower pest incidences were observed in direct-seeded rice, semi-dry rice, mechanical transplanting, and aerobic rice. Slow-release formulations of pheromone blends resulted in higher catches of yellow stem borer and rice leaf folder compared to normal formulations across all locations, with Ludhiana exhibiting the highest catches for both pests.

Biocontrol and Biodiversity Studies: *Lecanicillium saksenae* demonstrated superior efficacy against sucking pests, particularly the ear head bug in rice, across seven out of nine locations, while showing no adverse effects on natural enemies.

Assessment of Insect Populations Using Light Trap: Yellow stem borer, leaf folder, and plant hoppers remain predominant pests in terms of both quantity and distribution across various locations based on light trap data. Gall midge persists as an endemic pest, while case worm and gundhi bug exhibit a worrying increase in spread and intensity, raising future concerns. Seasonal data from light traps highlights October and November as peak months for key pest activity during the kharif season, necessitating timely management strategies for effective control in rice cultivation.

Integrated Pest Management Studies: IPM implemented plots resulted in mean grain yield advantage of 51.0, 25.0, 21.4, 10.9, 45.0 and 11.0%

in Zone-I, III, IV, V, VI and VII, respectively over the farmer practices. The mean weed population reduction ranged from 22.5 to 66.7%. The dry weed from 13 locations was reduced significantly by 15.7 to 69.7%. Adoption of IPM practices effectively reduced the disease progression.

Plant Pathology

Host Plant Resistance: Five national screening nurseries comprising of 1364 entries of advanced breeding lines and new rice hybrids were evaluated at 49 centres for their reactions to major rice diseases. Among the entries tested across the locations, total of 91 entries found moderately resistant to minimum of two and maximum of four diseases.

Nursery	No. of entries	IET No/ Designation	Resistant or tolerant than three diseases
NSN-1	13	29411; 30020	LB, SHR and RTD
		30233	LB, NB and BS
NSN-2	14	30722	NB, BS and SHR
NSN-H	14	30531	RTD, LB and SHB
		30507	NB, LB and BS
NHSN	20	30578	LB, NB, and SHR
		30603	SHB, SHR and RTD
DSN	30	19273	SHB, SHR and RTD
		CB MSP9 006	LB, BS and SHR
		KNM 12346	NB, SHB and BS
		UB 1066	LB, SHB and SHR
		VP-R36-SHB	NB, SHB and SHR.

Field monitoring of virulences of *Pyricularia oryzae:* The experiment was conducted at 24 locations during the crop season to monitor the blast reaction on different genotypes. The nursery included 39 cultivars consisting of near isogenic lines, international differentials, donors and commercial cultivars. Disease pressure was high at Cuttack (LSI 6.5) and Gudalur (LSI 6.3). RP Bio Patho-4 showed susceptible reaction at 10 locations. The susceptible checks like HR-12 and Co-39 showed susceptible reaction at most of the locations. The resistant check Rasi was highly susceptible at Cuttack, Ghaghraghat, Navasari, Karjat, Almora and Jagdalpur. Similarly, IR 64 showed susceptible reaction at Cuttack, Ghaghraghat and New Delhi. The reaction pattern of genotypes at all the locations was grouped into eight major groups at 30% dissimilarity coefficient. The reaction pattern at Cuttack, Gudalur, Lonavala, Ghaghraghat, Navasari and Karjat are distinct form the other isolates. The isolate from Jagityal and Khudhwani are grouped in the same cluster while the other 16 isolates formed a major cluster.

Field monitoring virulences of *Xanthomonas oryzae* pv. *Oryzae*: Trial on monitoring virulence of bacterial blight (BB) pathogen, *Xanthomonas oryzae pv. oryzae* (*Xoo*) was conducted at 25 locations. The differentials used in this trial consisted of eleven near isogenic lines (IRBB lines) possessing different single BB resistant genes in the genetic background of rice cultivar IR 24 along with susceptible check, TN1 and resistant check Improved Samba Mahsuri. Most of the differentials possessing single bacterial blight resistance genes like *Xa1, Xa3, Xa4, xa5, Xa7, xa8, Xa10, Xa11* and *Xa14* were susceptible at most of the locations. BB resistance gene *xa13* was susceptible in 8 locations while *Xa21* was susceptible in 11 locations. Based on their virulence, the isolates were grouped into high, moderate and low virulence groups. The isolate from Maruteru formed a distinct cluster. Other highly virulent category isolates *viz*., IIRR, Chinsurah, Chiplima, Raipur and Pattambi grouped closer. Low virulent isolate of Karjat, Moncompu, Rajendranagar and Warangal grouped together. Most of the isolates from moderately virulent category grouped together.

Disease observation nursery was conducted at 10 locations with different sowing dates with an aim to estimate the effect of varied sowing/planting dates on the occurrence and severity of the disease in the respective endemic regions. The incidence of leaf blast was found to be less this year. The centre Maruteru reported the highest incidence of BLB in the normal and late sown crops (67.35% and 52.07% DS respectively) when compared to the early sown crops (24.71% DS). In general, the incidence of sheath blight was found to be more in the early sown crops when compared to the normal and late sown crops. Maruteru centre had the highest percent disease severity of sheath blight (67.41% DS at 110DAT) in the early sown crop among all the other centres and all the sowing periods. Kaul centre reported the incidence of *Bakane*, in the early sown crop and Nawagam center observed severe sheath rot incidence in late sown crops.

Disease management with fungicides against location specific diseases: Different fungicidal molecules were evaluated to identify effective molecules against major rice diseases at different locations. Commercial products Kitazin 48% EC (1.0 ml/L) and Tebuconazole 25.9% EC (1.5 ml/L) were found effective in minimizing the leaf blast at

51.4% and 43%, respectively. Isoprothiolane 40% EC (1.5 ml/L) was also found effective in minimising the neck blast at 51% and increased the yield 31%. Difenoconazole 25% EC (0.5 ml/L) (DS:33.8%) and Tebuconazole 25.9% EC (1.5 ml/L) (36.9%) were found effective in reducing sheath blight at 53% and 49%. Tebuconazole 25.9% EC (1.5 ml/L) and Difenoconazole 25% EC (0.5 ml/L) were found effective in reducing the sheath rot severity at 45% and 41%, and reducing the sheath rot incidence at 42% and 42%. Difenoconazole 25% EC (0.5 ml/L) was identified as the best molecule to reduce brown spot (60%) and showed broad spectrum activity against sheath blight and sheath rot. Tebuconazole 25.9% EC (1.5 ml/L) showed broad spectrum activity against sheath blight, sheath rot, brown spot and blast.

Bio-control formulations against fungal diseases: Among the different formulations tested *viz.,* the liquid formulation was found to be better than the solid formulation. Similarly, the combination of bioagent formulation and fungicides were providing higher percent disease control and increased plant yield than when compared to the fungicide treatment alone. Among the different treatments overall for the management of the sheath blight disease, Moncompu reported the highest percentage control over the disease (DC) *viz.,* 91.05% followed by IIRR (90.73) when applied with the liquid formulation of the bioagent as seed treatment followed by seedling dip @ 5g/l followed by Hexaconazole @ 2ml/l at tillering stage (T6). In the study of IDM against false smut disease using the bioagent *T. asperellum* Strain TAIK1, Karaikal centre reported the highest percent decrease in disease severity over control (91.80%) when the plant was treated with bioagent as seed treatment followed by seedling dip @ 5g/l with liquid formulation (T4) followed by the treatment bio agent as seed treatment followed by seedling dip @ 5g/l with solid formulation (T3).

Integrated pest management (special – IPM) trial was conducted at four different zones. Disease severity of various diseases, recorded at weekly intervals was converted in to AUDPC values and compared. AUDPC of leaf blast and neck blast diseases indicated that the disease progress was significantly lower in the experimental plots where IPM practices were followed when compared to the farmer's practices. IPM practices against leaf blast were effective at Mandya, Masodha, Chiplima, Kaul and Jagdalpur compared to farmer's practices. In neck blast, IPM practices were effective at Masodha and Jagdalpur. At Jagdalpur, Pantnagar and Kaul IPM practices performed well compared to farmer practices against Sheath blight., IPM was effective against bacterial blight at Masodha and Jagdalpur. In case of brown spot, grain discoloration, sheath rot and false smut diseases, IPM practices performed well at each one location.

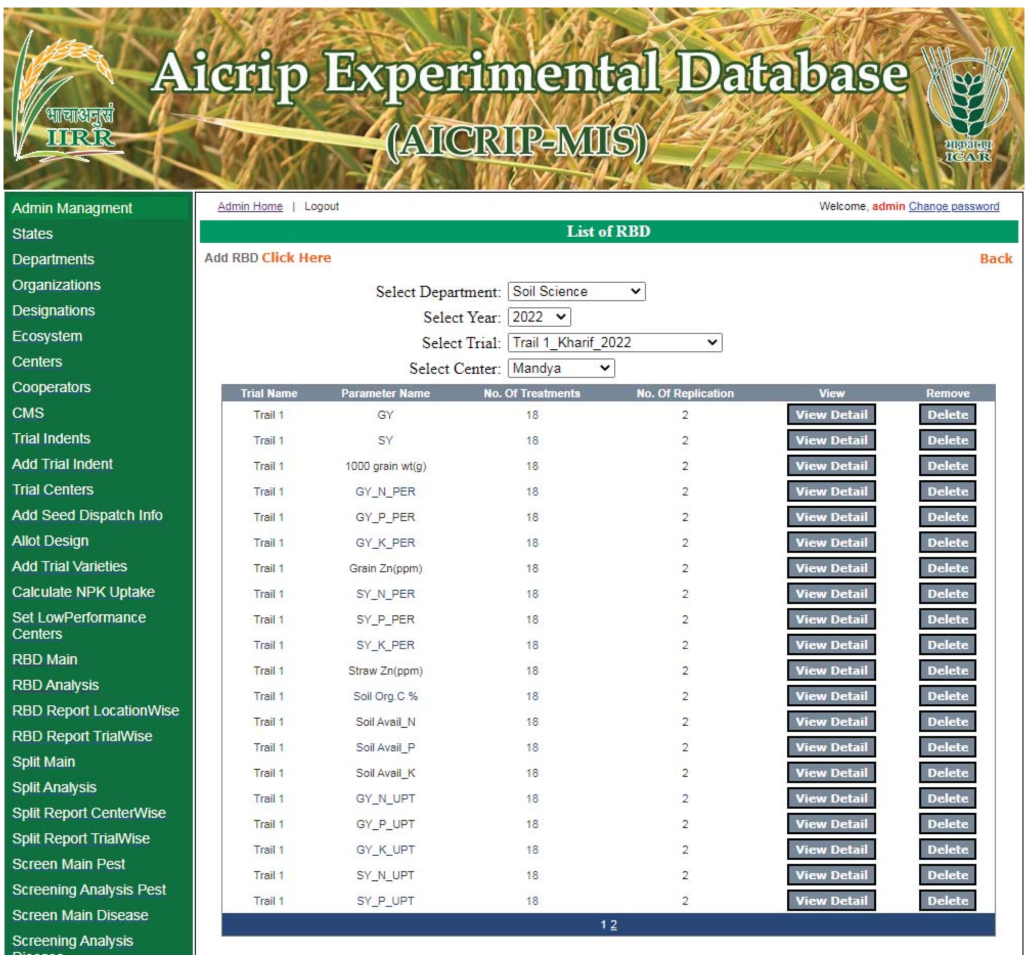
Special trial on yield loss assessment due to major rice diseases: Trial on yield losses due to major rice diseases such as leaf blast, sheath blight and bacterial blight was conducted. Leaf blast percent disease index of 52.34%, 38.36%, 19.66% and 17.4% caused a yield reduction of 52.34, 38.36 and 19.66%. Sheath blight percent disease index of 68.53%, 46.93%, 36.51% and 5.2% caused a yield reduction of 46.18%, 31.57%, 14.80% from 100% inoculated (T1); 50% inoculated (T2) and 33% inoculated treatments respectively. Similarly, the BB percent disease index of 76.45, 56.64 and 20.69% caused a yield reduction of 23.26%, 16.36% and 15.94% from 100% inoculated (T1); 50% inoculated (T2) and 33% inoculated treatments, respectively. Results from the present study revealed that leaf blast, sheath blight and bacterial blight severity significantly reduced the rice grain yield.

Production oriented survey: Production oriented survey was conducted in 16 states by 18 AICRIP centres. A total of 110 Scientific staffs from the different cooperating centres and several officials from state department of agriculture surveyed 833 villages in 121 districts in 16 states. The Southwest monsoon seasonal rainfall during June to September for the country as a whole had been above normal (105 -110% of Long Period Average (LPA)). Quantitatively, all India monsoon seasonal rainfall during 1 June to 30 September 2022 had been 92.5 cm against the Long Period Average of 87.0 cm based on data of 1971-2020 (106% of its LPA). The rainfall over the country as a whole was 92%, 117%, 104% and 108% of LPA during June, July, August and September respectively (IMD, 2022). In addition to several monsoon depressions in Bay of Bengal, there were three major cyclones (Asani, Sitrang and Mandous during 2022. Hybrid rice varieties occupied a significant area in states like Uttar Pradesh, Haryana, Chhattisgarh, Gujarat and Bihar and its area is increasing in states like Karnataka, Himachal Pradesh, West Bengal and Maharashtra.

Among the diseases, leaf and neck blast, brown spot, sheath blight, false smut, grain discoloration and bacterial blight were widespread. High intensity of neck blast was noticed in some parts of Kerala and Telangana. High intensity of false smut was recorded in parts of Chhattisgarh and Jammu while bacterial blight was severe in parts of coastal Andhra Pradesh, Chhattisgarh, Kerala and Konkan region of Maharashtra. Moderate to high intensity of a new virus disease called Southern rice black-streaked dwarf virus (SRBSDV) was recorded in some parts in Jammu, Punjab and Himachal Pradesh. Among the insect pests, stem borer, leaf folder and BPH were very wide spread. Intensity of stem borer was more in Parts of Chhattisgarh, Jammu, Telangana and West Bengal. High incidence of BPH was noticed in parts of Chhattisgarh and West Bengal.

AICRIP Experimental Database –http://www.aicrip-intranet.in

During this year above 70% of centers uploaded data through AICRIP Intranet. Many modules of Intranet such as set low performance centers, state - zonal performance modules were updated as per the proceedings of 57 ARGM. Hybrid Rice, Soil Science and Agronomy Trials of 2022 were successfully analysed with RBD and Split Analysis modules and state, zonal reports along with location wise treatment means with CD, CV, ranks over checks were generated using RBD and Split report modules of AICRIP Intranet.



Research Achievements

Lead Research

GEQ - Genetic enhancement of quality for domestic & export purpose

GEY - Genetic enhancement of yield and stress tolerance

ABR - Application of biotechnology tools for rice improvement

RUE - Enhancing resource and input use efficiency

SSP - Sustaining rice system productivity

CCR - Assessing and managing crop response to climate change

HRI - Host-plant resistance against insect pests and its management

IPM - Integrated pest management

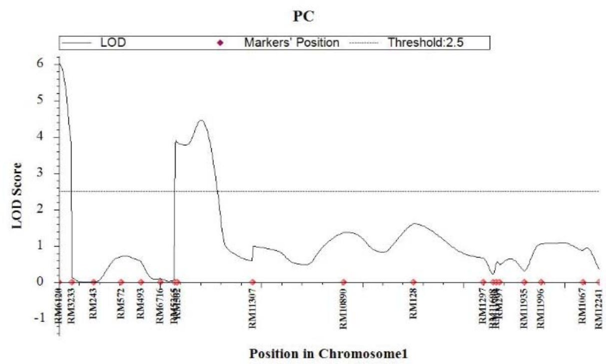
HRP - Host-plant resistance against pathogens and its management

TTI - Training, transfer of technology and impact analysis

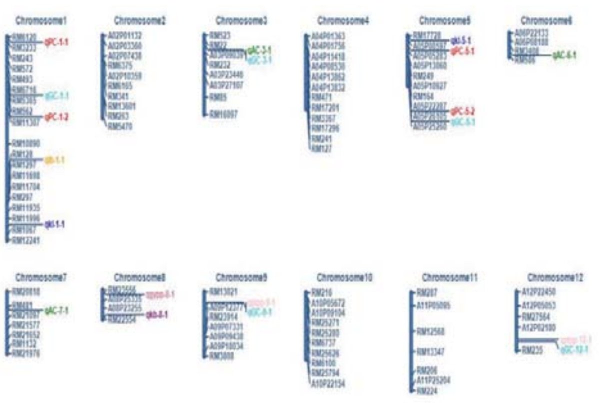
GEQ: Genetic Enhancement of Quality for Domestic and Export Purpose

GEQ/CI/BR/9: Development of Rice Cultivars with High Grain Protein Content (GPC) and Quality Traits

Diverse parental lines differing for grain protein content (GPC) *viz.*, Samba Mahsuri (protein content of 8%) and JAK 686 (protein content of ~12.5%) identified to develop mapping population and genetic studies. Polymorphic study involving 1280 markers spanning the 12 chrs. revealed 103 polymorphic markers between Samba Mahsuri and JAK 686. The F_1s between Samba Mahsuri/JAK 686 confirmed using these polymorphic SSR markers and were backcrossed to Samba Mahsuri to generate BC_1F_1s. An F_2 mapping population (250) was phenotyped for GPC which ranged from 7.2 to 14.67% with a mean of 10.08%. Five transgressive segregants with high GPC values recorded between 13.4% to 14.7 % identified. Heterozygous F_1s were selfed to generate F_2 mapping population (250) as well as backcrossed with Samba Mahsuri to generate BC_1F_1s. The GPC ranged between 7.2 to 14.67% with a mean of 10.08% in the F_2 population. In F_2 population, five plants, 140 (14.7%), 12 (14.4%), 7 (14.3%), 147 (13.6%) and 41 (13.4%) recorded high GPC values. A linkage map of 2478.95 cM with 103 polymorphic markers covering 12 chrs. was generated. Four QTLs (*qPC1.1, qPC1.2, qPC5.1* and *qPC5.2*) were detected for GPC in the F_2 population using Inclusive Composite Interval Mapping (ICIM) with 5.4%, 15.7%, 4.6% and 3.1% PVE with a LOD value of 6.0, 4.5, 2.8 and 2.9 respectively. Single marker analysis revealed the association of RM562 to be associated with GPC. Three QTLs for amylose content (*qAC3.1, qAC6.1,* and *qAC7.1*), five QTLs for gel consistency (*qGC1.1, qGC3.1, qGC5.1, qGC9.1* and *qGC12.1*), two QTLs for kernel length (*qkl1.1,* and *qkl5.1*) and one QTL for grain yield per plant (*qGYPP8.1*) were also detected. Twenty-eight, epistatic QTLs for GPC were detected using IM-EPI, the LOD score ranged from 5.0 to 7.6. Three of the interactions occurred between a significant main effect QTL in the marker interval of RM 562-RM11307 and other non-significant loci. Generation Mean Analysis revealed the prevalence of additive gene effect for GPC. Apart from this, generation advancement of the following crosses was carried out: JAK-16 X Undi; ISM X Undi; ISM X JAK-16; ISM X IRRI 162; JAK-25 X Undi; ISM X JAK-25; DRR Dhan 53 x IRRI-162. Several new crosses involving high GPC lines (JAK 16, and JAK 686), Remenika and Bhadra were carried out.



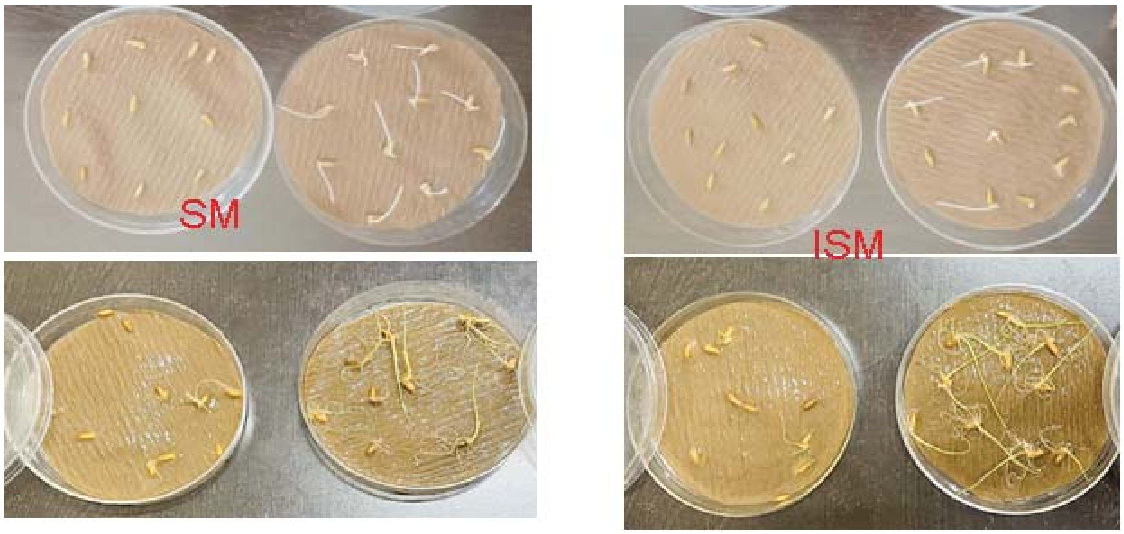
Details of the major QTL (qPC 1.2) for grain protein content on Chr. 1



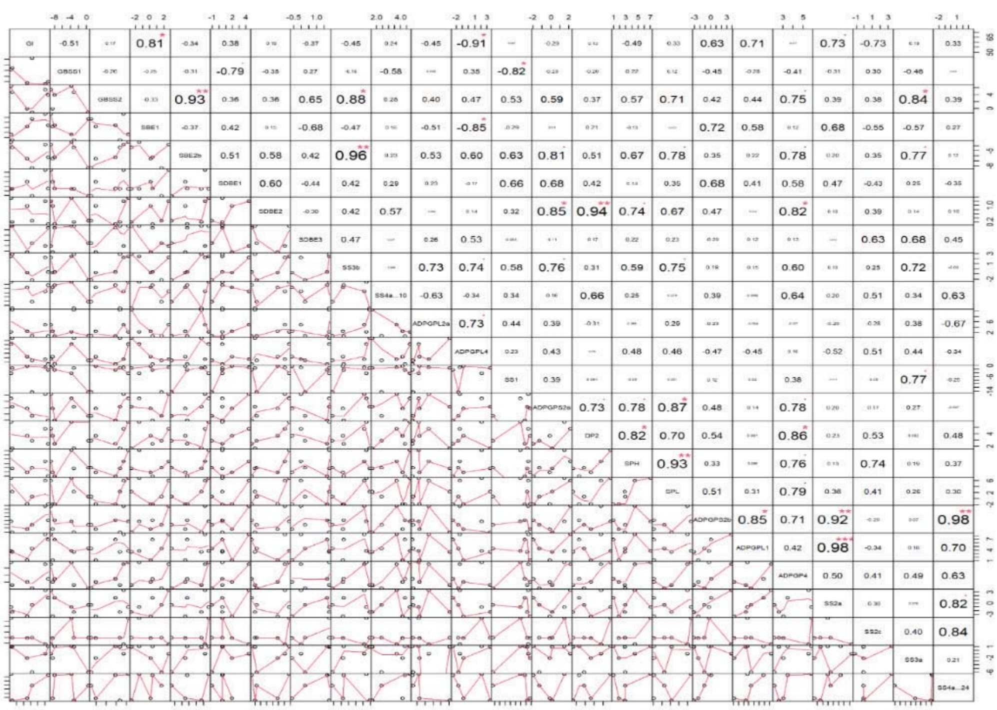
A genetic linkage map of the 12 chrs. of rice constructed based on the F2:3 population of a cross between BPT 5204 and JAK 686-1. The map was constructed using 103 SSR markers. A major peak, associated with high grain protein content was discovered on Chr. 1.

GEQ/CP/PP/1/ Selective biochemical and molecular analysis of natural and accelerated ageing in rice

In accelerated ageing (AA) experiment, germination was almost negligible in saturated KCl solution at 100 days of incubation in desiccator. However, only marginal variation in protein content was observed unlike natural ageing. In gene expression analysis of contrasting GI SM mutant lines, GI noted significant positive correlation with SBE1 & SS2a and non-significant negative correlation with GBSS1. In BAAP lines, low GI was noted in 90 samples with probable associated regions in chromosomes 2, 6 and 12. RS ranged from 0.24% to 1.3% with one associated region each in chromosomes 1 and 7. Myristic, palmitic, stearic, oleic and linoleic acids are the major fatty acids. Of the two essential fatty acids (linoleic and linolenic), linoleic acid is present in higher amount and ranged from 140 to 230 ug/100mg polished rice powders. Among 63 coloured rice samples, bran content ranged from 3.234 g (RMS 56) to 11.695 (RMS 213) g in 100g of paddy. Bran oil content ranged from 0.035g (RMS 129) to 1.68g (RMS 213). The UNSFA to SFA ratio ranged from 0.6 to 3.1. Linoleic acid content ranged from 0.12 g to 1.18 g/ g bran. Linolenic acid content ranged from 0.8 mg (RMS-244 & RMS-338) to 3.2 mg (RMS-187) /g bran.



Variation in germination in two rice lines under accelerated ageing treatment



Multiple correlation between GI and expression of starch synthesizing enzymes

GEY - Genetic enhancement of yield and stress tolerance

GEY/CI/ BR/26: Breeding for high yielding water use efficient short duration rice hybrids & varieties.

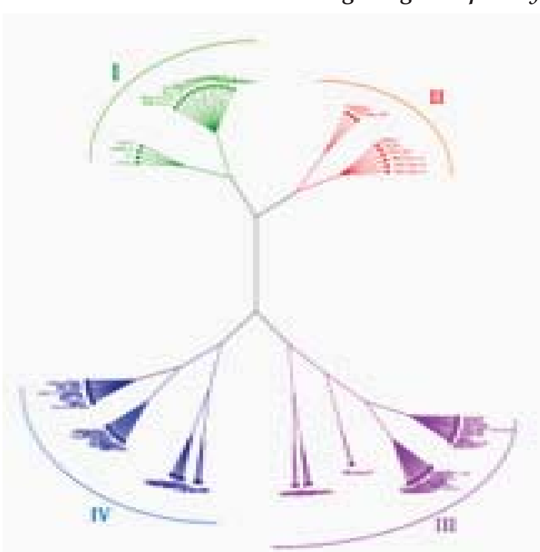
Crosses between 10 selected parents (MTU 1010, Prasanna (early), Rasi, Pooja, DRR Dhan 44, 42 (Drt), 50 (Drt+sub), DRR 45, 48 (Zn), MTU 1081 (high yield, low shattering), BPT 5204, WGL 14 (GT), ISM (BB), Tetep (BL), Akshayadhan, Swarna, 4 lines with strong culm) in half diallel. 24 F_1s were assessed for yield and other characters. The F_4 lines were assessed for high yield and short duration along with other morphological characters. A total of 94 entries were evaluated in station trial to identify promising entries for multilocation testing in AICRPR trials based on their morphological and grain characteristics and yield parameters. Experiment with 270 advanced breeding lines under Accelerated Genetic Gain in Rice-Irrigated Ecology was conducted and 25 selections made to assess them critically for water use efficiency and high yield. Another set of 40 selected advanced breeding lines also assessed in replicated yield trial and elite lines were identified.

Field view of high yielding, water use efficient, short duration rice genotypes at ICRISAT farm

GEY/CI/BR/31: Breeding for high yielding, medium to late maturing rice varieties with tolerance to biotic stresses and good grain quality

A total of 55 genotypes were evaluated, and 18 elite genotypes were identified *viz*., Akshaydhan, MTU 1121, JGL 21078, JGL 11470, DRR Dhan 54, MTU 1224, Binadhan 11, DRR Dhan 47, Jaya, IR 64, JGL 18047, MTU 1010, MTU 1155, Salivahana, Improved Samba Mahsuri, Binadhan 17, DRR Dhan 50 and DRR Dhan 60 for yield and yield components. Among them DRR Dhan 47, IR 64, Jaya, JGL 18047 and JGL 21078 were identified for yield and yield components, and MTU 1010, MAS 26, JGL 21078, JGL 25958 and IR 64 identified for quality will be utilized for elite x elite hybridization. Estimates of PCV were slightly higher than the corresponding GCV for days to 50% flowering, days to maturity, plant height, yield components, physiological and quality traits. Grain yield and biomass exhibited significant positive correlation with number of productive tillers, grain weight/ plant, biomass and harvest index; whereas significant negative correlation with canopy temperature 1 (CT1), and canopy temperature 2 (CT2). Significant positive correlation was observed between 1000 grain weight with panicle length and negative with grains/panicle. Grain weight/plant showed significant positive correlation with plant height, FLL, FLW, panicle length, grains/panicle, biomass and grain yield. Grain yield has significant positive correlation with quality traits: hulling, milling and HRR and negative correlation with volume expansion ratio and water uptake. Biomass/plot exhibited the highest positive direct effect on grain yield/plot followed by panicle length, no. of productive tillers, no. of grains/panicle, days to 50% flowering, harvest index and canopy temperature after booting. Elongation ratio exhibited the highest positive direct effect on grain yield/ plot among quality traits followed by kernel width, hulling and gel consistency. These characteristics can be prioritized in the selection procedure in order to uncover better lines with genetic potential for increased yield. Diversity analysis using 4 functional gene markers linked to yield *viz*., GN-1a-indel-3, SPL-14-12, TGW6-1d and SPIKE-01, which showed only 4 major clusters. Whereas, based on morphological traits, 8 clusters were formed exhibiting good diversity among the cultivars. MTU 1010, MTU 1262, ISM, MTU 1121 and DRR Dhan 49 showed low GI among the cultivars; CR Dhan 311, DRR Dhan 47, Akshaydhan, DRR Dhan 44, DRR Dhan 45, DRR Dhan 46, DRR Dhan 51, DRR Dhan 54, DRR Dhan 55, DRR Dhan 60 and DRR Dhan 62 showed blast resistance; and MTU 1121, JGL 11470, DRR Dhan 42, KMP 149, Binadhan 17 and Swarnadhan showed low phosphorus tolerance. These genotypes will be given priority in crossing programme. Twenty-five crosses were promoted to F_2 generation and 15 crosses were attempted between elite x elite genotypes. 50 F_3 plants from 8 crosses were subjected for selection and 60 elite plants were selected for further promotion.

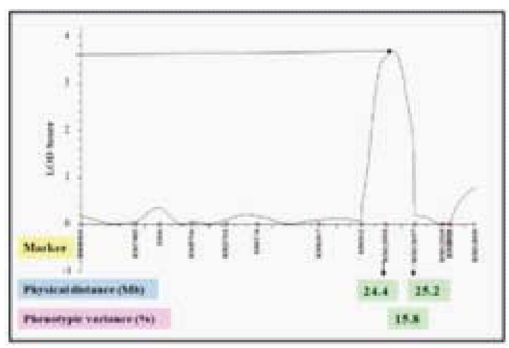
Screening of medium to late maturing rice varieties with tolerance to biotic stresses and good grain quality



Cluster Diagram based on yield related genes

GEY/CI/ BR/16: Traditional and molecular approaches for breeding improved rice varieties with resistance to planthoppers

Genetic basis of white backed plant hopper (WBPH) resistance has been studied in 150 RILs ($F_{9.10}$) derived from the cross NDR 359/MO1 along with parents for six phenotypic tests involving three basic mechanisms of resistance *viz.*, namely damage score, nymphal preference at 24, 48 and 72 hours after infestation (antixenosis), days to wilt at 30 days after sowing (tolerance) and feeding rate at 30 days after sowing (Antibiosis). QTL analysis utilizing phenotypic screening data and SSR marker data identified 13 QTLs of 5 major effect and 8 minor effect QTLs on chrs. 2, 6, 7, 9 and 11, governing resistance. The major QTLs accounted for >10% phenotypic variance, *qWDS2* on chr. 2 for damage score, was located on the 0.8 Mb genomic region flanked by RM13593 and RM13637 with a LOD score of 3.54 and 15.8% phenotypic variance showing positive additive effect of 0.70. The resistance alleles at this region are contributed by MO1, resistant parent. Another major QTL for days to wilt (*qWDW7.1*) located within the marker interval of RM125 - RM6835 occupied a physical region of 7.2 Mb on chr. 7 with a LOD score of 7.20, explained 10.20% phenotypic variance and a positive additive effect of 5.24. *In-silico* candidate gene analysis revealed 6 putative candidate genes within the major QTL *qWDS2* locus namely *LOC_Os02g40030, LOC_Os02g41480, LOC_Os02g40500, Os02g40710, LOC_Os02g41510* and *Os02g41770* involved in plant's defence regulation against insects and diseases that can be utilized in further breeding procedures in improving the germplasm.



Composite interval mapping showing damage score QTL (qWDS2) for white backed planthopper resistance on chr. 2.

GEY/CI/ BR/29: Genetic improvement of direct seeded rice traits of rice varieties

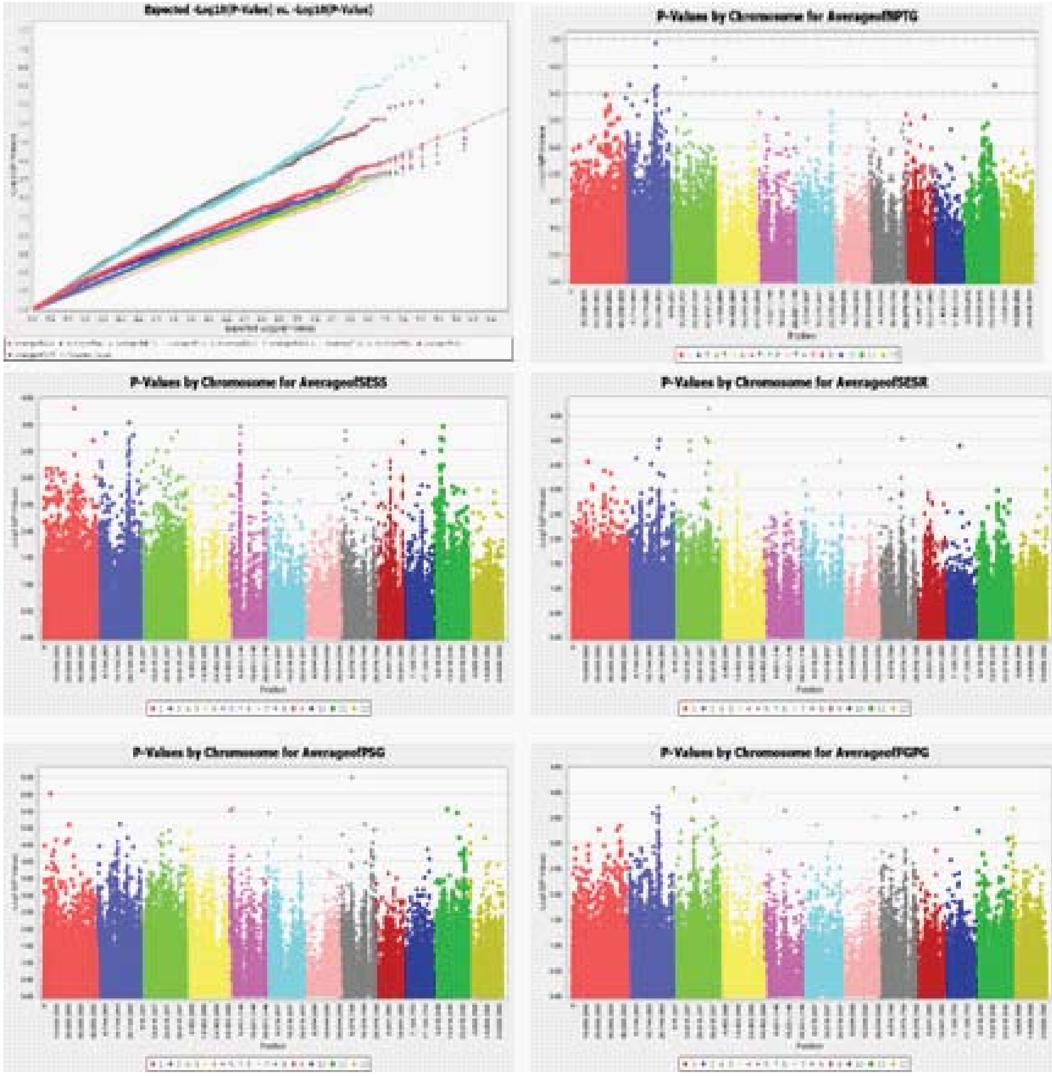
A total of 190 lines of BC_1F_9 population derived from IR64*1/*Oryza glaberrima* were phenotyped under weedy and weed free direct seeded rice in an augmented design with four checks for weed suppressive ability (WSA), weed tolerance (WT) and weed competitive traits (WC). Majority of seedling vigour (SV) traits exhibited moderate to high positive association with each other and with yield traits except days to 50% flowering. WSA is negatively associated with single plant yield (SPY) and WT and positive correlation with test weight (TW). QTL mapping using high-density linkage map was constructed (2089 polymorphic SNP markers from GBS and 1K-RiCA genotyping) and phenotyping data over three seasons detected 353 QTLs at LOD >2.5 with phenotypic variance >5%. Majority of QTLs were for seedling vigour (248) and yield traits (91), while seven QTLs for WSA and WT each detected. Identified 2 QTL hotspots and 7 co-localised QTLs under weedy; 2 QTL hotspots and 6 co-localised QTLs under weed-free conditions; 18 hotspots with 6 co-localised QTLs common to both conditions. Six QTLs consistently affecting same trait in two of the three subsequent seasons were identified. *In-silico* analysis of two major QTLs for WSA, one QTL with highest PVE for WT along with 4 genomic regions governing multiple traits found genes involved in physiological functions related to SV, plant growth, yield, abiotic and biotic stress responses and WS. 40 BILs with weed suppressive (WS) and weed tolerant (WT), best four lines (KA 34, KA 63, KA 194-2, and KA 198) among 10 lines with WS, WT with high ESV identified as donors for WS and WT ability.

Efforts were made to transfer AHAS mutant allele conferring herbicide resistance into elite rice varieties - DRR Dhan 44, DRR Dhan 60, and MTU 1121 using MABB. Pusa 44 NIL possessing AHAS mutant gene conferring resistance to Imidazolinine herbicide (Imazethapyr) is the donor parent. Phenotypic validation of parents for herbicide tolerance done by spraying a non-selective broad-spectrum herbicide, Imazethapyr, available commercially as Pursuit @2.5 ml/l on all plants at 30 days after sowing (DAS). Putative resistant plants identified based on retention of greenness of leaves and absence of drying symptoms. All the recurrent parents (RP) - DRR Dhan 44, MTU 1121 and DRR Dhan 60 dried, whereas Pusa 44(NIL) survived. SSR marker RM6844 linked to AHAS mutant gene located on chr. 2 was used for molecular validation of parents. Crosses were executed between parents *viz*., DRR Dhan 44* Pusa 44 NIL, DRR Dhan 60* Pusa 44 NIL, MTU 1121* Pusa 44 NIL. Subsequent backcrosses up to BC_3F_1 by crossing respective RP with true F_1s, BC_1F_1s, and BC_2F_1s in DRR Dhan 44, DRR Dhan 60. In case of MTU 1121, BC_2F_1s were developed. RM6844 marker and random SSR markers was used for hybridity confirmation and for foreground selection of herbicide tolerance in BC_1F_1s, and BC_2F_1s. In addition to RM6844, gene specific markers BLB resistance [(*xa5*(fm); xa 5 (FM); *xa* 13, *Xa* 21*(pTA248)*], Blast (*Pi54)*, drought (RM 520, RM204) and low "p" tolerance (K-46-1, K-46-2) were used to identify positive plants with desirable traits across RP's background. 14 BC_1F_1s, 3 BC_2F_1 with desirable traits in DDR Dhan 44 genetic background identified. Background recovery of DRR Dhan 44 and DRR Dhan 60 in BC_1F_1s is done through 1k RiCA analysis and BC_2F_1s background recovery of DRR Dhan 44 and DRR Dhan 60 and BC_1F_1s background recovery of MTU 1121 is being undertaken.

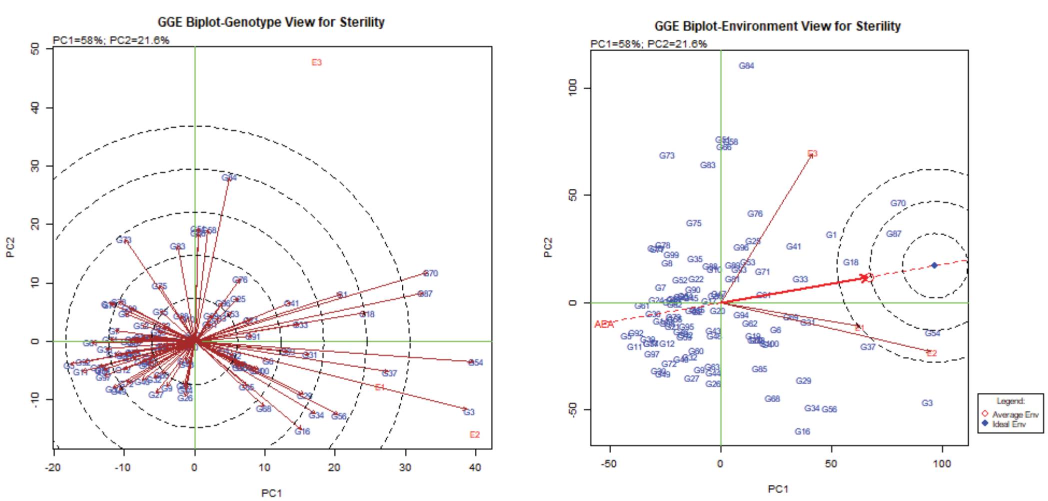
GEY/CI/ BR/27: Novel Genetic approaches for development of Climate Smart Rice Varieties

Multilocation phenotyping of 580 lines constituting 3k subset and elite lines at five saline hot spots India resulted in identification of tolerant genotypes for reproductive stage salinity tolerance. The saline stress level varied from 6 dSm^{-1}(Navsari) to 14 dSm^{-1} (Machilipatnam) across locations. At high stress level of 14 dSm^{-1} few tolerant genotypes IRGC 128372, IRGC 125873, IRGC 128085, IRGC 125944, IRGC 125876, IRGC 125882, Sadri, survived were identified. Among these IRGC 128085 & IRGC 125876 were found to be promising. The genotypes IRGC 125914, IRGC 125832, IRGC 122150, IRGC 125666 exhibited tolerance at both seedling and reproductive stage.

Genome wide association analysis conducted among 273 genotypes with 77248 SNP marker GAPIT package of R (https://www.rproject.org) using multiple linear regression and cantered IBS kinship model identified the genomic regions associated with salinity tolerance for component traits including SES scores, spikelet sterility, panicle traits and yield components. Significant marker trait associations (MTA) were identified at a threshold of LOD ≥ 3 for seedling stage on chr. 1 (7.02%PV), chr.2 (6.83% PV) and chr.5 (6.74% PV) and for reproductive stage salinity tolerance on chr. 3 (6.86% PV) 8 (7.06% PV) and 10 (9.03%PV); for unfilled grain per panicle on chr. 2 (15.22%PV), chr.1 (11.98% PV), chr.6 (13.22% PV and chr.2 (5.08%PV) spikelet sterility on chr. 8 (15.31% PV), chr.1 (10.82% PV), chr.5 (9.69%PV) and chr.11(9.76% PV) were identified. 114 heat tolerant lines, with spikelet fertility varying between 60 to



Marker trait associations of component traits governing salinity tolerance



GGE Biplot analysis depicting the stable and heat tolerant genotypes

Research Achievements

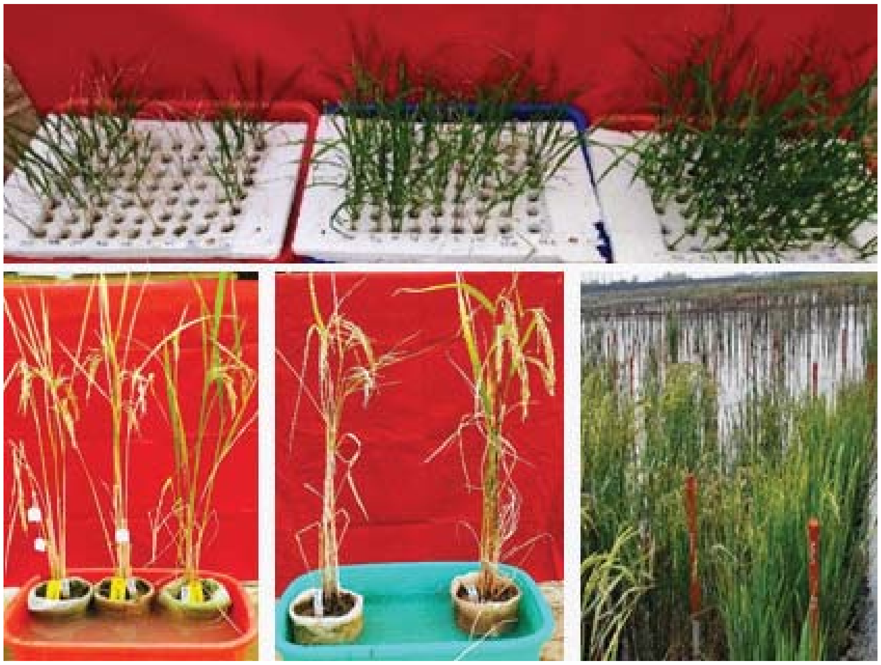
>95% identified from 500 diverse germplasm screened over three years were validated in different staggered experiments under high temperature stress (35°C to 42.5°C) and identified the stable heat tolerant donors. AMMI and GGE analysis revealed stable and reliable heat tolerant genotypes namely Rasi, Giza 178, IR 50, Khao Daw Tai, IRGC 126084, IRGC 127227, IRGC 127663, Nerica-L44, HIRA, IRGC 128335, IRGC 72918-1, IRGC 117280, IRGC 127424 and IRGC 128373 with spikelet sterility ranged from 5 to 10%.

Physiological basis of salinity tolerance studied in 91 rice genotypes at seedling stage showed an apparent decrease in growth characteristics such as shoot length, shoot weight, root weight and seedling vigour index and increase in proline, superoxide dismutase (SOD), Catalase (CAT) activity under salinity stress. The K^+/Na^+ ratios were highly correlated with the salinity scores thus the K^+/Na^+ ratio serves as a reliable indicator of salt stress tolerance in rice. Principal component analysis (PCA) based on physiological characters could clearly distinguished rice cultivars into salt tolerance genotypes.

Twenty-seedling stage tolerant among the 91 rice genotypes were studied for reproductive stage salt tolerance along with physiological and yield components. Physiological characters photosynthetic rate (µ. mole CO_2 $m^{-2}s^{-1}$), stomatal conductance (mole H_2O $m^{-2}s^{-1}$), transpiration rate (mmole H_2O m^{-2} s^{-1}) and biochemical characters- chlorophyll content (mg g^{-1}), carotenoid (mg g^{-1}), superoxide dismutase (mg^{-1} min), catalase (µg H_2O_2 $mg^{-1}min^{-1}$), proline (mg g^{-1}), K^+ /Na^+ ratio found positively correlated with salt tolerance. None of the genotypes exhibited increase in all the physiological and biochemical traits and thus differential expression of specific traits contributed to salinity tolerance. Molecular characterization with 40 reported markers for salinity tolerance revealed genomic regions associated with salinity tolerance.

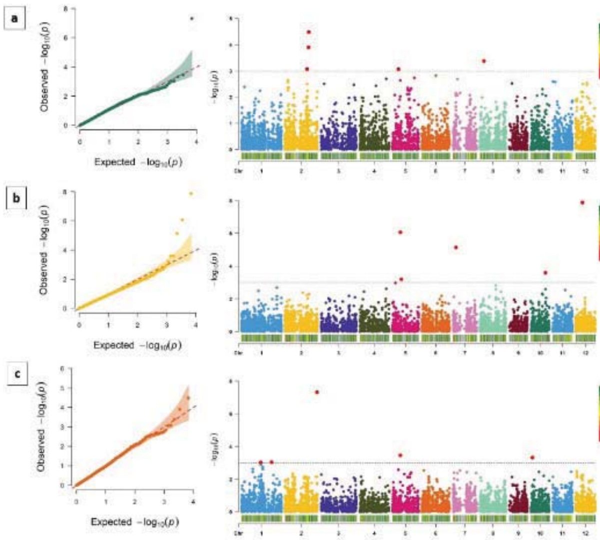
GEY/CI/ BR/25: Broadening the genetic base of indica rice and modify plant type by introgressing traits from Tropical japonica

Genotyping by sequencing (GBS)-based genome-wide association study (GWAS) was employed among 181 genotypes for dissecting the genetic control of culm strength traits. The traits identified as key influencers of lodging resistance were a) section modulus (SM) as a function of culm morphology traits; b) bending stress (BS) as a measure of pushing resistance and tiller number; and c) breaking resistance as a measure of internode breaking weight (IBW). Two novel major effect MTAs, *qSM2.1* and for SM and BS were identified on chrs. 2 and 12 with a phenotypic variability (PV) of 21.87% and 10.14%, respectively. *qBS12.1* is a QTL hotspot with the synergistic association for culm strength traits (SM, BS, and IBW) and grain number



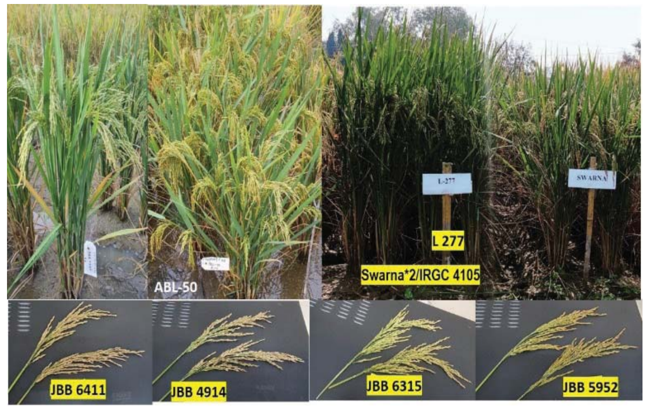
Screening for seedling and reproductive stage tolerance under controlled and field conditions

with a dual purpose of enhancing culm strength (CS) and grain yield (GY). This is the first report from India on GWAS for culm strength traits and synergistic genetic associations between CS and GY traits in rice. A novel protocol for assessment of culm breaking resistance as a measure of IBW has been developed.



Q–Q and Manhattan plots for genomic regions associated with (a) Section modulus (SM), (b) Bending stress (BS) and (c) Breaking resistance as a measure of internode breaking weight (IBW)

IBW showed highly significant, strong and positive correlation with four major cell wall structural components *viz*., cellulose, hemi-cellulose, lignin and silica contents. QTL-Seq was employed combining whole genome re-sequencing (WGRS) and bulked segregant analysis (BSA) in a mapping population from the cross of Samba Mahsuri (*indica*) and Cuba 65::IRGC 10658 (Tropical *japonica* accession). Three genomic regions, 37.98 to 39.07 Mb, 18.05 to 19.6 Mb and 26.33 to 27.82 Mb on chrs. 1, 7 and 11 respectively were identified at a statistical confidence of P<0.01 from 'Cuba 65' as associated with CS. The regions on chrs. 1 and 11 align with previously reported QTLs for CS and genes discovered in these regions were related to both CS and GY. Lima, an *indica* germplasm accession was identified as having strongest culm with highest values for CS traits (SM-29.89mm^3; BS-56.34N/m^2 and IBW-1200g) as against ILs with *SCM2* (SM-14.79mm^3; BS-40.20N/m^2 and IBW-797g). Gundil Kuning, a tropical *japonica* accession was identified as the donor for high grain number (360) based on the consistency in the trait values over the years. Six advanced elite breeding lines, JBB 1120 (JBB 6411), JBB 4914, JBB 6315, JBB 4547, JBB 4511 and JBB 5952 were identified as high yielding strong culm and high grain number lines with more than 6 t/ha. Further, ABL-50, a breeding line (*indica*/Tropical *japonica*) with MS grain type, fully exerted panicle, high grain number (632) and more productive tillers (19) recorded grain yield of 8043 kg/ha.



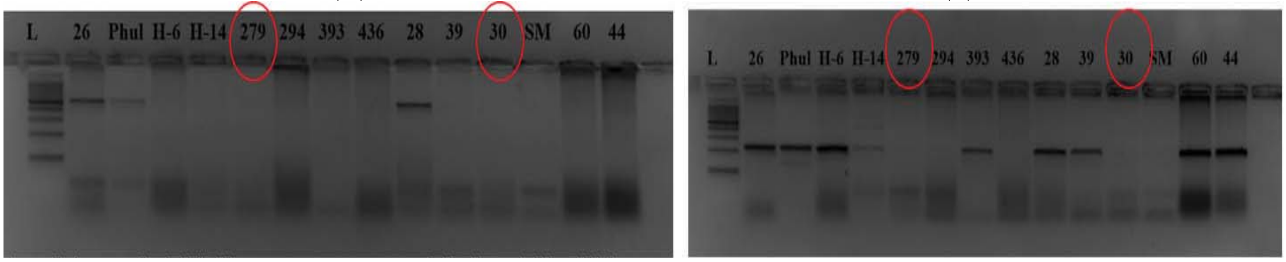
Breeding lines derived from the crosses of indica/Tropical japonica with high grain number (300-630) and strong culm

GEY/CI/ BR/: Genomic assisted breeding for development of low phosphorous and nitrogen stress tolerant rice varieties

A total of 350 germplasm lines were screened in the low soil P in an Augmented Block Design for the identification of lines tolerant to low soil phosphorus. The soil P levels were monitored during transplanting, maximum tillering and grain maturity stages. The association panel was genotyped with 1K Rica and mapping of novel QTLs/genes is under progress.

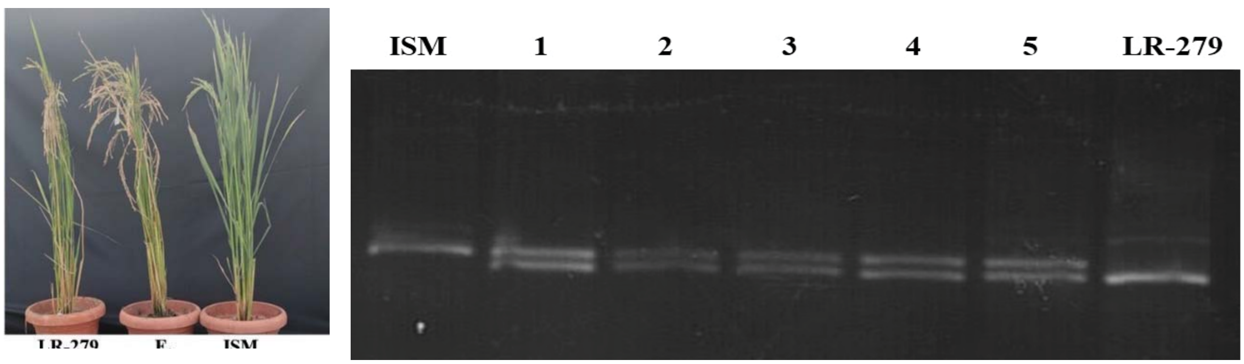
Identification of novel genes/ QTLs for low P tolerance - To identify genetic loci other than *Pup 1* QTL contributing to the low soil phosphors tolerance in rice, 500 landraces were screened in the low soil phosphorus screening facility available at ICAR-IIRR, Hyderabad and promising landraces (LR279, LR30, and LR299) showing excellent tolerance to low soil phosphorus stress were identified. The identified landraces were characterized for the presence of *OsPSTOL1* gene using functional molecular markers (K46-1 and K46-2). LR279 and LR30 did not exhibit presence of *OsPSTOL1* gene indicating the presence of novel gene/QTL for low P. Crossing was carried out between these landraces (LR279, LR30, and LR299) and Improved Samba Mahsuri (ISM).

(A) (B)



Amplification of **OsPSTOL1** *gene in landraces using(A) K46-1;(B) K46-2 markers.*

(A) (B)



Amplification of **OsPSTOL1** *gene in landraces using(A) K46-1;(B) K46-2 markers*

(A) Morphological and (B) Molecular confirmation of F1 hybrids. 1, 2, 3, 4, and 5 are F_1 hybrids using RM493 marker

An F4 mapping population of ISM / LR279 was developed and was phenotyped for yield and component traits.

GEY/CI/ BR/ Target 1000: Towards Revolutionizing Rice Yields through Increasing Number of Grains per Panicle

A total of 120 elite genotypes selected from elite x elite breeding population were characterized for panicle architecture and grain development traits such as number of grains per panicle, test weight, panicle exsertion, number of filled grains per panicle, number of unfilled grains per panicle, number of productive tillers per plant, panicle length, plant height, days to 50% flowering, culm strength, number of primary branches per panicle, number of secondary branches per panicle, length and width of the primary flag leaf, flag leaf (attitude of blade), grain type and yield per plant. The number of filled grains per panicle in the elite genotypes varied from 452 to 964 and unfilled grains per panicle ranged from 37 to 335. A total of 42 fresh crosses were made using elite genotypes. A total of 19 F_1's, 103 F_2, 69 F_3, 59 F_4, and 51 F_5 populations were also evaluated. A total of 1200 germplasm consisting of lines collected from different states of India, IRRI Philippines, green super rice lines, INGER lines were evaluated and maintained and a total of 572 donor lines identified in AICRIP screening were also maintained.

GEY/CI/BR/30: Breeding high yielding stress tolerant rice varieties using interspecific wild introgression lines derived from *Oryza nivara* and *Oryza rufipogon*

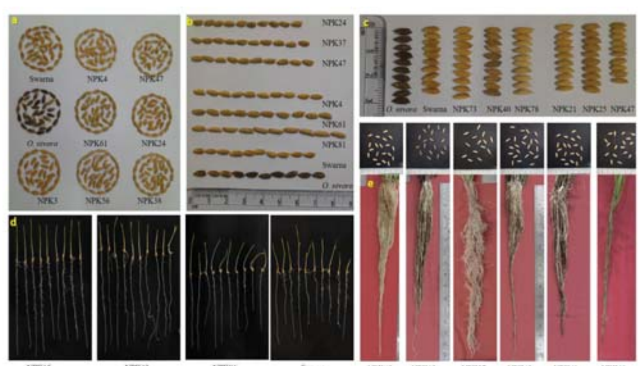
Chromosome segment substitution lines from interspecific crosses; advanced back cross introgression lines derived from MTU1010/ *O. rufipogon* IC309814, Swarna/ *O. rufipogon* IC309814, Swarna/ *O. nivara* IC336681 and KMR3 / *O. rufipogon* WR120 were characterised for various yield and stress related traits. Developed 43 crosses for generation of mapping populations and selected improved lines from wild, landraces and elite cultivars having high yield and seedling vigour during 2023. QTL mapping for seedling vigour and grain size-related traits detected 18 QTLs, of which three major QTL (*qAS7.1*, *qPL7.1* and *qL7.1*) for grain size-related traits on chr. 7, explained 21.44%, 19.11% and 22.60% of phenotypic

Field and panicle view of elite rice genotypes grown at Hyderabad

variation, respectively. Similarly, for seedling vigour traits, seven major QTL, *viz*., *qSDW3.1*, *qTDW3.1*, *qSVI2-3.1*, *qSL3.1*, *qTL3.1*, *qSVI1-6.1*, and *qRDW8.1* detected, explained 18.3–26.38% of phenotypic variation. 136 BC4F10 BILs from BPT5204 x *Oryza rufipogon* WR119 were evaluated for 3 years for nine yield related traits. Grain Fe and Zn were estimated using ED-XRF. In all, 11 major QTLs with phenotypic variance from 10 to 16.8% were identified for Fe, Zn, and 5 yield related traits. *O. rufipogon* alleles were trait-enhancing in 18% of all QTLs and an allele at *qFe2.1* increased iron concentration. Major effect QTLs *qFe1.1* for grain Fe and *qZn5.1*, *qZn8.1*, and *qZn10.1* for grain Zn explained 11 to 16% PVE, *qZn8.1* and *qZn10.1* were co-located with QTLs for grain yield related traits. Seven chromosomal regions showed QTLs for more than two traits. QTLs were associated with several high priority candidate genes for grain Fe, Zn and yield.

Twenty-four advanced introgression lines of *Oryza nivara* characterized for agro-morphological traits and yield under normal and low phosphorous conditions. Genotype C2-128, and C2-36 under normal, C1-116 under low phosphorous while C2-143 under normal and low P conditions were found to be superior for grain yield per plant. Grain yield per plant had a high positive significant correlation with plant height, and biomass, in both the normal irrigated and low phosphorus conditions. Stability analysis of wild introgression lines (ILs) for yield and adaptability identified G14 (C1-15) and G65 (C1-101) as stable genotype for single plant yield and for yield and adaptability respectively for three seasons.

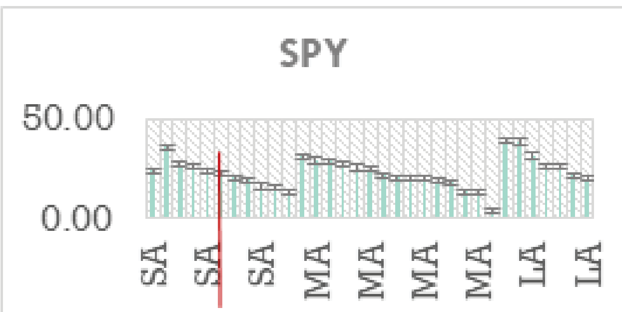
Seven QTLs LOD > 2.5 were detected for yield and yield traits on chrs. 2, 5, 6 and 1. QTL analysis based on multi-environment data detected 52 QTLs on three environments with two QTLs *qPTN2.1* on chr. 2 and one QTL *qBM11.1* on chr. 11 were consistent in two environments within the same marker intervals. Wild introgression lines of Swarna characterized for blast resistance showed twelve race specific quantitative trait loci (QTL) for partial blast resistance. Ten among 12 QTLs showed resistance to one isolate each. Two novel QTLs *qBL2.2* and *qBL5.1* between RM106-RM5460 and RM5140-RM289 with PVE% of 12.28 and 12.48 respectively identified. A total of 9 QTLs for false smut resistance was detected on chrs. 1, 2, 3, 5, 6 and 7 which explained between 5.2 to 11.2% of the phenotypic variance by composite interval mapping. The flanking markers SNP283 and SNP591 of QTL *qFS3.1* and *qFS6.1* showed high PVE% of 17.31 and 21.11 respectively by single marker analysis.



Morphological variation for grain size, seedling vigour and root traits in the introgression lines

GEY/CI/ BR/10: Breaking the yield plateau in native aromatic short and medium grain rice through classical and molecular breeding

A total of 13 advanced and stable breeding were selected out of 41 based on their superior performance *viz*. aroma, plant height, culm strength, semi dwarf nature, duration, grain shape, yield and yield related traits. The selected thirteen stable lines were multiplied for bulk production of seed material and evaluated and square meter yield data collected as well evaluated for blast screening and aroma analysis. The breeding lines were also evaluated for blast following screening method of infector row technique with HP 12 as susceptible check and the lines which showed moderate resistance.



Yield performance of advanced breeding lines with varied ranges of aroma and Screening of advanced breeding lines for Blast disease

54 F_1 cross combinations fourteen genotypes were selected, the F_2 seeds were phenotypically evaluated in *Kharif* season. 14 F_2 populations were maintained and overall 52 single plants were selected during *Kharif*, 2023.

Hybrid Rice

GEY/CI/HY/13: Development and evaluation of three-line hybrids with better grain quality and resistance to major pests and diseases

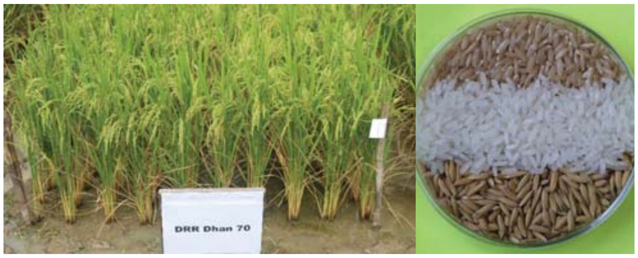
Six hybrids *viz*., IIRRH 164 (IHRT-E); IIRRH-165 (IHRT-ME); IIRRH 166, IIRRH 167, IIRRH 1168 (IHRT-M) were nominated in to AICRIP trials during *Kharif* 2022. Two hybrids *viz*., IIRRH 130 (AVT 1 E to AVT 2 E) and IIRRH 164 (IHRT E to AVT 1 E) were promoted in AICRPR trials for advance evaluation based on their significant yield advantage over the checks. IR 68897A-30 kg, IR 68897B-50 kg, DR 714-1-2R –70 kg, APMS 6A-40 kg, APMS-6B-60 kg and RPHR-1005-30 kg were produced through the barrier isolation method, 20 new rice hybrids were produced and the seed will be used for preliminary evaluation in station trials.

GEY/CI/HY/15: Genetic enhancement of parental lines suitable for aerobic and tolerance to salinity conditions through conventional and molecular approaches

DRRH-5 (IET 27847) world's first coastal salinity tolerant rice hybrid released for coastal ecologies of West Bengal, Gujarat, Goa and Andhra Pradesh. It is moderately resistance to leaf blast and neck blast, sheath rot and plant hoppers. It possesses medium slender (MS), HRR: 62%, Gel Consistency: 49.67 mm, Amylose Content: 26.6%.

Field view DRRH-5 (IET 27847)

DRR Dhan 70 (IET 29415) is a mid-early maturing variety suitable for dry direct seeded aerobic. It is suitable for aerobic ecosystems of Odisha, Bihar, Chhattisgarh and Gujarat. It is moderately resistance to leaf blast, brown spot, sheath rot, Tungro, plant hoppers, stem borer, gall midge and leaf folder. It has long bold (LB), HRR of 64.8%, gel consistency of 38 mm, amylose Content: 21.26%.



Field view DRRH-5 (IET 27847)

DRR Dhan 71 (IET 29421), a mid-early maturing variety suitable for dry direct seeded aerobic cultivation. It is suitable for aerobic ecosystems of Odisha, Gujarat and Tamil Nadu. It is moderately resistance to leaf blast, brown spot, sheath rot, Tungro, sheath blight, plant hoppers, stem borer, gall midge and leaf folder. It has medium slender (MS), HRR of 64.6%, gel consistency of 24 mm, amylose Content: 23.75%.

Field view DRRH-5 (IET 27847)

Conversion of improved APMS6B possessing Bacterial leaf blight resistance (*Xa21*, *Xa38*) and *Pup1* into new CMS line are in BC_1F_1 stage. Based on station trial evaluation, the new hybrid combinations namely PSV 6363, PSV 3401, PSV 5733, PSV 4581 and PSV 8172 have been included in station trials for evaluation for their performance with respect to yield contributing traits. New hybrids included in seed production trials namely APMS6A/PSV7272, APMS 6A/NPVR 11, APMS6A/PSV394-1, APMS6A/PSV 4564, APMS6A/ PSV3366 for nominations for AICRPR on aerobic and salinity trials respectively. MABB derived restorer lines namely RP 6340-NPVR-32 & RP 63340-NPVR 1 possessing drought tolerant QTLs *(qDTY12.1, qDTY2.3, qDTY1.1* and *qDTY6.1*), RP 6341-VTCP 56, RP 6341-VTCP45 possessing Saltol, RP 6342-MB44 and RP 6342-TCP2 possessing SUB1 and RP 6343-BP10-5 with *Xa21*, *Xa38* + *Pup1* in the background of APMS6B has been found promising introgressed lines will be nominated to AICRPR trials and promising parental lines with high level of tolerance will be registered as novel genetic stock with tolerance to different abiotic stresses.

GEY/CI/ HY/17: Development and evaluation of biotic stress-resistant restorers and their hybrids for yield and grain quality traits by conventional and molecular approaches in rice

The improved restorer lines with multiple stress (BLB, blast, sheath blight, BPH, GM & drought, salinity, low P) resistance/tolerance were genotyped with the help of 10 SNP panel for the genes *viz*., *Pi-ta, Xa-21, DTY 3.1, Rf4, Saltol, DTY-2-2, DTY3-2, NAS3_2, Pi54* and *IR 36ms* (male sterility). The results were utilized in selecting restorer lines for developing experimental rice hybrids for heterosis and grain quality analysis. Seven hundred and sixty improved restorer lines were genotyped with 1K RiCA mid-density SNP genotyping panel consists of roughly 800 genome-wide markers, 22 quality-control markers and up to 200 trait markers distinguishing 87 high-value genes and QTLs. Around 250 potential restorer lines were utilized in three-line hybrid breeding and evaluated for heterosis and combining ability in augmented block design. Heterosis prediction of remaining genotyped lines are under progress.

The improved restorer lines with blast resistance genes *viz*., *Pi9*, *Pi54* and *Pi54*+*Pi9* are under second year of evaluation in the AICRIP disease screening nursery. The lines RP 6617-58, RP 6617-59, RP 6619-17 and RP 6618- 50 showed high level of resistance against leaf and neck blast disease in the multi-location evaluation. By utilizing IR 36 GMS restorer population as a base population through recurrent selection breeding strategy coupled with marker assisted selection, we could develop multiple stress resistance restores with biotic (BLB, Blast, BPH, Sheath blight, Gall midge resistance) and abiotic stress tolerance (Drought, Salinity, Low P soil conditions). These multiple stress tolerant restorer lines are routinely deployed in three-line hybrid rice breeding for developing highly heterotic multiple stress tolerance rice hybrids. A new restorer population for grain quality traits (medium to short slender grain type with high iron, zinc and protein) utilizing improved multiple stress tolerance IR 36 restorer population as base population is under progress using recurrent selection approach.

DRR Dhan 72, IET 28821(RP 5964-82), a high-yielding rice variety in zero to low soil phosphorous (P) conditions possessing long bold-grains with medium maturity duration was identified to be released for the states of the states of Karnataka and Telangana during 58th ARGM,2023.

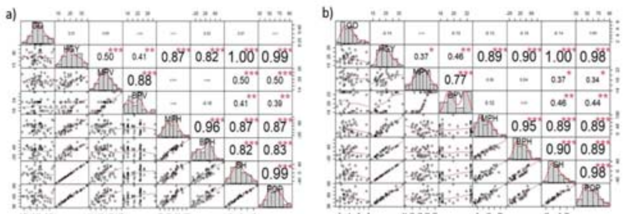
Field view of DRR Dhan 72

GEY/CI/HY/16: Genetic improvement of maintainer for biotic stress and yield enhancing genes

Six hundred and fifty test crosses were attempted by growing 800 entries in the source nursery. Two hundred and seventy-five crosses were successfully evaluated in the test cross nursery. A total of 33 maintainers were identified *viz.*, TCN 4381, 4394, 4399, 4401, 4413, 4415, 4420, 4422, 4430, 4436, 4438, 4439, 4440, 4442, 4443, 4446, 4451, 4452, 4454, 4455, 4458, 4463, 4523, 4524, 4540, 4548, 4566, 4567, 4568, 4570, 4601, 4603 and 4627. The promising maintainers were back crossed with corresponding CMS lines (IR 58025B, IR 79156B and APMS-6B) to develop CMS lines, which are in different back cross generations and promising maintainers include BP-5-22-1, BP-7-5-6, BP-7-8-1, BP-12-P2, BP-14-4-2, BP-24-15-3, BP-24-15-4, BP-24-17-2, BP-24-17-2, BP-24-19-1, BP-37-3-3, BP-37-4-3, BP-37-4-3, 14RR1-13-P2, 14RR1-12-P2, 14RR1-12-P2, 14RR1-1-P1, 14RR1-1-P1, HYP 4, HYP 2, HYP 12, HYP 7, HYP 7, HYP 3, HYP 5, HYP 7, HYP 9, HYP 9, TCP 4505, TCP 4475, TCP 4480, TCP 4473, HYP 10, HYP 13, HYP 13, 14RR1-5-P1, 14RR1-8-P2, 14RR1-8-P2, 14RR1-18-P1 and 14RR1-20-P1. For improvement of maintainers, selection was imposed on BC_3F_3 population for yield enhancing genes and 60 plants were selected. Cross was attempted with TE 36 (mutant line) for improvement of elongation of upper internode traits in the IR 58025B, APMS 6B and IR 68897B maintainers.

GEY/CI/HY/14: Establishment and validation of heterotic gene pools in hybrid rice

To develop heterotic groups, a set of 150 genotypes (129 Restorers, 15 Maintainers & 6 checks) was genotyped using SSRs and SNPs (1K Rice Custom Amplicon @ Intertek) and phenotyped for yield attributing traits. These 129 restorers were received from six different hybrid rice centers (PAU, Ludhiana; RARS, Karjat; IARI, New Delhi; JNKVV, Jabalpur; ZARS, Mandya and ICAR-IIRR, Hyderabad) under CRPHT project for heterotic grouping. The diversity analysis based on phenotypic data grouped the parental lines into 13 distinct clusters. The molecular characterization based on polymorphic SSR and SNP markers grouped the parental lines into 13 clusters. To validate the groups formed based on morphological and molecular genetic distance for heterosis and combining ability, representative lines were selected from each R and B line clusters and test crossed in L X T mating fashion. These hybrids were evaluated along with parents and checks (*Rabi* 2022-23). The correlation analysis between genetic distance and heterosis revealed that non-significant positive correlation was found between molecular genetic distance and better parent heterosis (r = 0.03) and standard heterosis (r = 0.01), non-significant negative correlation was found between molecular genetic distance and mid-parent heterosis (r = -0.02). Whereas negative correlation was found between morphological genetic distance and mid parent heterosis (r = -0.13), better parent heterosis (r = -0.1) and standard heterosis (r = -0.14). The molecular marker based parental group combinations showed superior standard heterosis over the best check US312 as compared to morphological trait based parental group combinations.



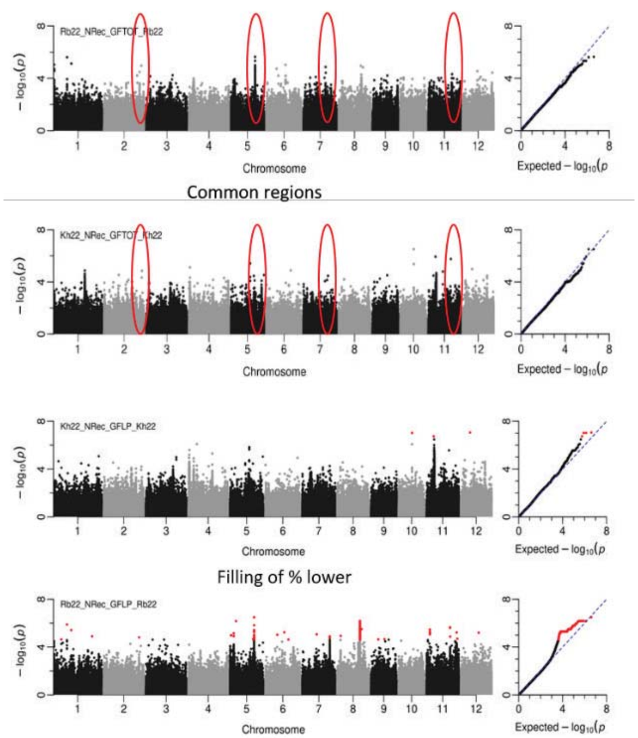
a) Correlation between molecular genetic distance (SSRs and SNPs) and heterosis

b) Correlation between morphological genetic distance and heterosis

ABR - Application of biotechnology tools for rice improvement

ABR/CI/BT/6: Identification of genes for grain filling in rice (Oryza sativa L.)

From a set of ~200 rice accessions from the Bengal Assam Aus Panel (BAAP) evaluated at two environments (*Rabi* 2022 and *Kharif* 2022) for their panicle architecture, 27 promising genotypes during *Rabi* 2022 and 74 promising genotypes during *Kharif* 2022 with ≥ 50 grains on lower secondary of the panicle were identified. Genome-wide association mapping using 2 M SNP dataset has identified marker trait associations for different panicle traits for two seasons (as shown for GFLP - grain filling of % on lower secondary). A set of common genomic regions were also found to associated with total grain filling (GFTOT) across two seasons on chrs. 2, 5, 7 and 11.



Manhattan plots for the GWAS of GFTOT and GFLP in the BAAP panel. The x-axis displays the SNP location along the 12 rice chrs. y-axis displays -Log10 (P)

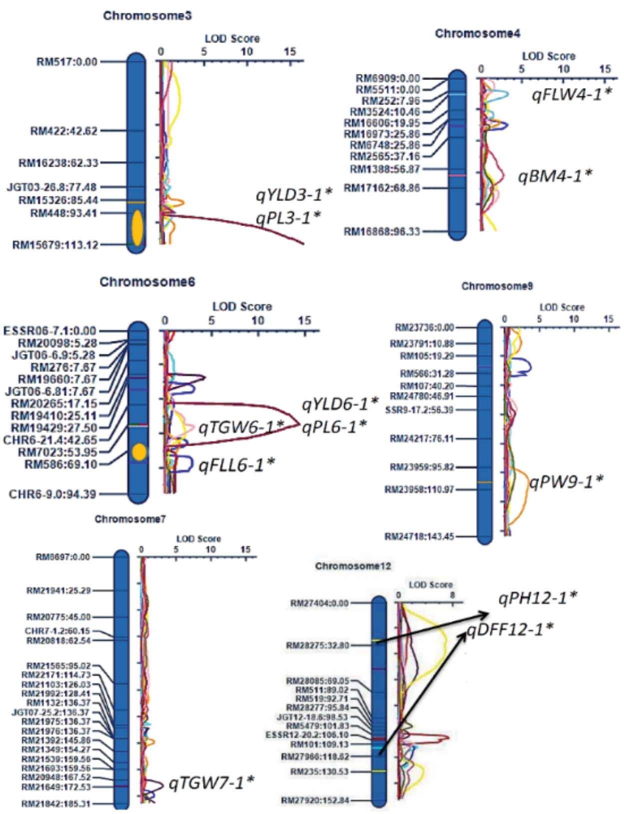
Based on candidate gene mapping, an indel of 34 bp was identified in the sugar transporter gene *LOC_Os11g42430* (6.5 kb) (which was found to be associated with filling of grains on primary and secondary branches of lower portion of the panicle) and its association with grain filling was confirmed through mapping and Sanger sequencing in nine genotypes.

ABR/CI/BT/17: Application of genomic, transcriptomic and proteomic tools for understanding and improvement of yield heterosis in rice hybrids

A set of ~ 188 parental lines (156 R lines and 15 B lines) have been collected and analyzed with a set of markers specific for the yield enhancing genes, *Gn1a, SCM2* and *OsSPL14* etc. A few parental lines were observed to possess some of the yield enhancing genes. The maintainer lines which possess the favourable allele for *Gn1a* are IR60888B, DRR-3B, CRMS32B and Pusa 6B, while IR58025B possesses the favourable allele for *OsSPL14.* Interestingly, three maintainer lines, DRR-10B, CRMS32B and Pusa6B possessed the favourable allele for *SCM2.*

Quantitative trait loci (QTL) mapping using a population of 125 doubled haploid (DH) lines developed from the elite rice hybrid, KRH2 (i.e. derived by crossing IR58025A/KMR3R) and SSRs/SNPs led to identification of 12 each of major-minor effect QTLs for yield related traits. Major effect QTLs were detected for traits namely days to fifty percent flowering, test (1,000) grain weight, plant height, panicle weight, panicle length, flag leaf width, flag leaf length, biomass and total grain yield/plant explaining the phenotypic variability in the range of 29.95%-56.75%. QTL hotspots were detected on chr. 3 for the traits, panicle length and total grain yield/plant and on chr. 6 for the traits, panicle length, flag leaf length and total grain yield/plant. Though many of these QTLs were noted to co-localize with the QTL regions reported in earlier studies, five novel

An indel of 34 bp in sugar transporter gene **LOC_Os11g42430** and major effect QTLs for panicle length, biomass, flag leaf width, panicle weight, plant height and three novel minor effect QTLs for panicle weight and fertile grains per panicle, were identified in this study. Through this study, both major-minor effect novel QTLs for crucial yield related traits, *viz*., fertile grains per panicle, panicle length, panicle weight were identified. Further, the QTL hotspots identified on two different chrs. for flag leaf length, panicle length and total grain yield/plant shall not only help in understanding the underlying genetic mechanisms of yield regulation but also would provide an insight into the genetic synchrony among the various yield related traits in contributing for yield heterosis. The identified QTL hotspots after their validation can be deployed in breeding programs targeted towards improvement of yield heterosis.



Major effect QTLs denoted by asterisk (*) in 125 Doubled Haploid (DH) lines QTL hotspot indicated by yellow bead

Two QTLs namely *qYLD3-1, qPL3-1* were detected in common for two traits namely total grain yield per plant and panicle length, respectively, were identified among the RILs based on SSR marker analysis. A set of 24 selected RILs (which constituted by 12 high yielding and 12 low yielding RILs) were subjected for genotyping using SNP markers. Based on mapping with SSR markers the *qYLD3-1*, originally, was identified to span a physical distance of 20.74 Mb, but through SNP marker-based mapping, the interval was narrowed down to ~ 730 kb. Negative additive effect was observed for this QTL through mapping with both SSR and SNP markers. High cumulative phenotypic variation (RSq value) of 81.65% was observed, when the QTL was mapped with SNP markers, whereas with SSR markers, the RSq value was 32.92%. The size of *qPL3-1*, which was, originally of 20.74 Mb when mapped with SSR markers was narrowed down to ~ 830 Kb, when mapped with SNP markers. As observed with total grain per plant QTL, negative additive effect was observed for *qPL3-1* with very high cumulative phenotypic variation of 96.74% in the mapping exercise with SNP markers, while it was only 31.57% when mapped with SSR markers. These observations indicate that molecular mapping using high throughput SNP markers can be more precise than SSR markers.

ABR/CI/BT/18: Genomics and genome editing approaches for abiotic stress tolerance (low P and heat), biotic stress tolerance (sheath blight and bacterial blight), and yield improvement of rice

The Samba Mahsuri alleles of *XCP2*, *Sweet11*, *Sweet14*, *OsTB1* and *Dep1* genes were used to design the guideRNAs using CRISPR-P (http://crispr.hzau.edu.cn/CRISPR2/) web-based tools. The guideRNAs were synthesized using commercial facility and cloned into unit vectors followed by Gibson assembly to develop multiplex genome editing CRISPR/Cas12a vector systems. In parallel, the guideRNAs targeting *Sweet11* were cloned into CRISPR/Cas9 vector system. The vectors were sequenced and mobilized into *Agrobacterium tumefaciens EHA105*.

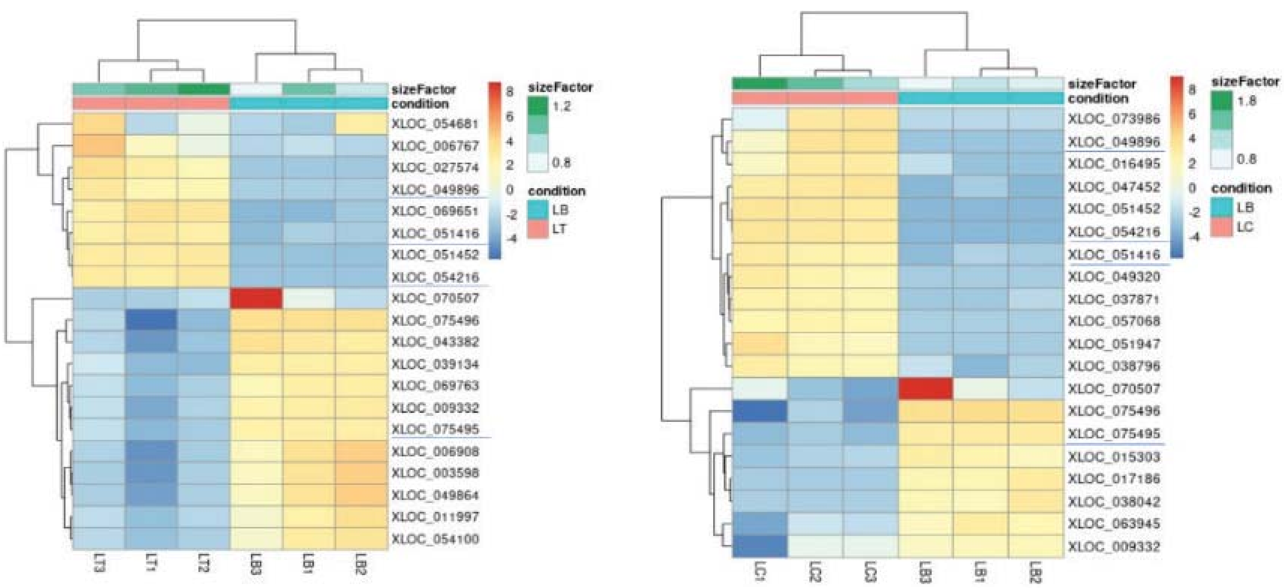
Nagina22 and its EMS mutant (NH4824) were used for whole-genome transcriptome analysis to identify the differentially expressed genes under low P conditions at reproductive stage. Three biological replicates of floral tissue were sequenced from both the genotypes collected from low P field at ICAR-IIRR. After filtered reads were mapped to rice genome, the differentially expressed genes were analyzed. NH4824 showed 513 up and 575 down-regulated genes with high significance (p value <0.05).

ABR/CI/BT/19: Elucidation of long non-coding RNAs and association of molecular markers for important root traits under aerobic condition

The root long non-coding RNAs were sequenced (lncRNA) from the line having robust root system *viz*. TI-128 (LT), aerobic adapted cultivar CR Dhan 202 (LC), flooding adapted mega variety BPT-5204 (LB) at the panicle initiation stage. Differential expression of lncRNAs in roots of LB, LC, LT emanated a total of 89 and 129 up regulated lncRNAs in LC_LB vs LT_LB and LT_LC vs LT_LB respectively. A total of 107 and 94 downregulated lncRNAs were shared between LC_LB vs LT_ LB and LT_LB vs LT_LC respectively. The common root lncRNAs *viz*. *XLOC_049896, XLOC_051416, XLOC_054216, XLOC_075495* were upregulated in the robust root genotypes TI-128 and CR Dhan 202. Among the target genes for the lncRNAs, *BRASSINOSTEROID INSENSITIVE 1*-associated receptor kinase 1, *BTBN23* - Bric-a-Brac, Tramtrack, Broad Complex BTB domain with non-phototropic hypocotyl 3 NPH3 and coiled-coil domains, *OsPOP11* - Putative Prolyl Oligopeptidase homologue, *OsWAK55* - *OsWAK* receptor-like protein kinase, *ZOS9-05* - *C2H2* zinc finger protein, *AAA-type ATPase* family protein, putative, were significantly up regulated in the robust RSA lines.

ABR/CI/BT/20: Genetic improvement of rice for brown planthopper (BPH) tolerance through novel biotechnological approaches

Several rice lines, which included the EMS mutagenized lines of BPT-5204 (PRV1-11) and nine breeding lines in Improved Samba Mahsuri (ISM) background, *viz*., (ISM-5 (BB, BPH, PUP1); ISM-6 (BB, BPH, PUP1); ISM-8 (BB, BLAST, BPH); ISM-15 (BB, Gall midge, BPH) ISM-17 (BB, BPH); ISM-18 (BB, BPH); ISM-20 (BB, BLAST, BPH, PUP1); ISM-22 (BB, BLAST, BPH, PUP1); ISM-25 (BB, BLAST, BPH, PUP1) were evaluated for tolerance to brown planthopper (BPH) and white-backed planthopper (WBPH) at the Marteru, a hot spot for both the pests in *kharif* 2023. A line, PDV-41 exhibited a resistance score of 3 out of 10 against both BPH and WBPH in field conditions. To introgress a BPH resistance gene *Bph33*(t) into the elite rice varieties "Improved MTU1010" and "WGL 1487", crosses were made in *Kharif* 2023.



Heat maps showing relative expression of lncRNAs in LT, LC, LB

RUE- Enhancing resource and input use efficiency

RUE/CP/AG/11: Strategic research on enhancing water use efficiency and productivity in irrigated rice system

Precision water and nitrogen management in aerobic rice (*rabi*) under drip system was studies. Significantly highest growth and yield of aerobic rice was recorded under surface irrigation (up to saturation) with LCC based nitrogen application over drip irrigation with recommended practice of N application. Highest water use efficiency was obtained with drip irrigation at 1.5 Epan in raised bed system. While highest nitrogen use efficiency, was obtained with LCC based N application in aerobic rice. Application of 859.8 mm irrigation water using Drip irrigation at 1.5 Epan in Raised bed system and application of 105 kg N ha-1 using LCC at critical value-3 was found to be optimum for aerobic rice under drip irrigation. Surface irrigation (up to saturation) with LCC based nitrogen application was found to be economical with highest net returns and B:C ratio in aerobic rice. Use of IOT based water management which quantifies the real time water status and irrigation in different methods of crop establishment was tested. Alternate wetting and drying (AWD) saved 15 per cent of total water requirement during crop growth period. Among the systems of cultivation, mechanised SRI method required the lowest amount of water (12.2% and 14.3% less of mean applied water than drum seeding and normal transplanting, respectively). IOT based water management was also adopted in different crop establishment methods for its suitability and compared with AWD pipes for adopting Alternate wetting and drying. DSR adoption at large scale (6000 ha) was taken up with seed – to - seed mechanization with reduction of the cost of cultivation to the tune of Rs 10,000/ per acre. These experiments were validated in collaborative study carried out with a NGO, based on Bapatla, Andhra Pradesh, named PRAANADHARA.

RUE/CP/AG/18: Development of Climate smart and economic weed management technologies for changing rice establishment systems

Long term efficacy and sustainability issues are also the driving forces behind the reconsideration of herbicide dependent weed management. With these aspects in view, the trial was conducted in kharif 2023 in replicated randomized block design with weedy check, weed free, hand weeding twice, mechanical weeding at 20 and 40 Days After Transplanting (DAT/DAS) using weeder, sequential application of pre-emergence herbicide pretilachlor and post-emergence bispyribac-sodium, sequential application of pre-emergence herbicide pyrazosulfuron-ethyl and post emergence bispyribac-sodium and sequential application of pre-emergence herbicide pretilachlor and mechanical weeder at 45 DAT/DAS. The weed flora recorded in the trial included *Echinochloa crusgalli*, *Leptochloa chinensis*, *Cyperus difformis, Cyperus rotundus, Eclipta alba*. *Ammania baccifera, Marsilea quadrifolia etc.* The group wise and total weed population, weed biomass at three crop growth stages was increasing from active vegetative stage to heading stage. Weed population showed group wise dominance of Grasses-Sedges-Broad Leaf Weeds at 30 DAT/DAS., Sedges-Grasses-Broad Leaf Weeds (BLW) at 45 DAT/DAS., and BLW-Grasses-Sedges at 60 DAT/DAS. Among the treatments, weed population and weed dry biomass at 30 DAT/DAS was significantly low with sequential application of herbicides. At 45 DAT/DAS, Mechanical weeder was comparable with sequential herbicide application and at 60 DAT/DAS, Mechanical weeding twice using weeder and pre-emergence herbicide application follwed by mechanical weeding were equally effective as chemical weed control treatments. In fourth year of the study, the group wise shift from grasses to sedges was recorded (numerical but not statistically significant) and shift of *Ehinochloa* to *Leptochloa* was observed in wet and dry DSR systems.

A broad-spectrum new combination herbicide, Triafamone+fentrazamide 950ml a.i./ha., was effective and comparable to standard chemical in lowering weed population, weed biomass and recorded higher weed control efficiency resulted in higher crop growth, yield attributes and grain yield. The single post-emergence new combination herbicide -Triafamone + Oxadiazon in wet direct seeded rice, Triafamone+oxadiazon 875ml a.i./ha, was effective and comparable to standard chemical in lowering weed population, weed biomass and recorded higher weed control efficiency resulted in higher crop growth, yield attributes and grain yield.

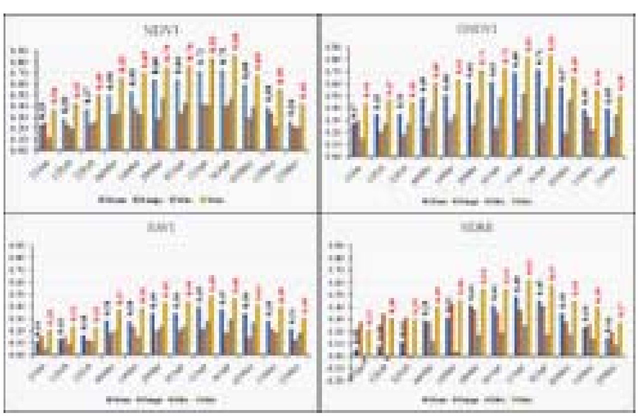


In aerobic rice system, mulching with paddy straw @ 5 t/ha is significant and effective with lower weed population and weed biomass and higher grain yield, whereas *Glyricidia* leaf mulch @5t/ha at sowing time recorded higher net returns and benefit-cost ratio. Wherever field bunds and farm fence had trees, application of green leaf mulch is economical, practical and environmentally sound weed control option.

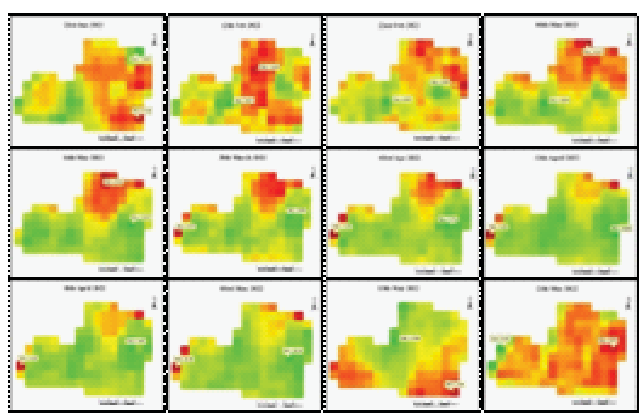
On-farm monitoring in SPSR Nellore district of Andhra Pradesh, Dhamteri and Ghariaband districts of Chattisgarh indicated the dominance of *Echinochloa colona*, *Leptochloa chinensis*, among grasses and *Cyperus difformis* among sedges, even after post-emergence herbicide application in semidry rice mono cropping areas. Essential oils such as citronella, lemongrass, peppermint and palmarosa were found to inhibit germination of *Echinochloa crusgalli* seed in laboratory.

RUE/CP/SS/16: Study of rice vegetation in terms of crop stress to model the yield using NDVI

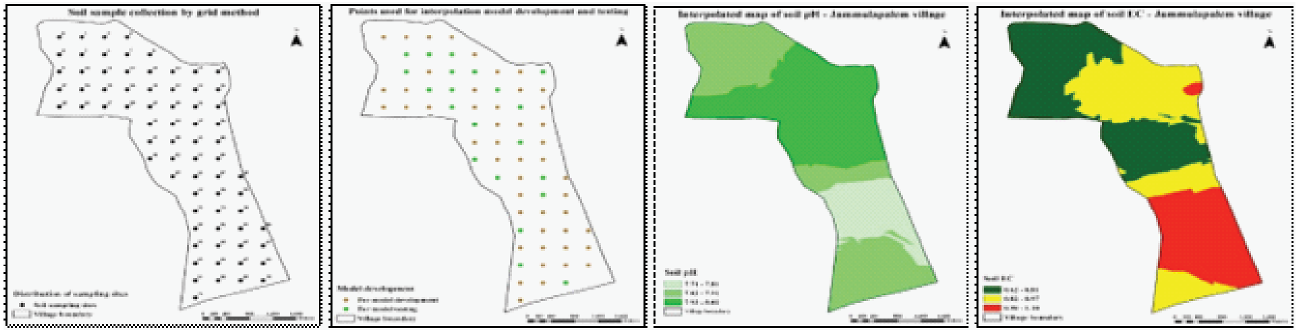
During further analysis and interpretation, it was understood that all the vegetation indices (VIs) are not useful at all stages of crop growth paving the way to the development of different VIs to help understand the vegetation dynamics. Vegetation indices including NDVI, GNDVI, NDRE, and SAVI from temporal images about a field cultivated with DRR Dhan 48 during *Rabi* 2022 were extracted. Pixel-level information could be extracted at near real-time depending on the availability of cloud-free data of Sentinel 2 satellite. In continuation to the effort of highlighting soil-based crop management over crop-based soil management, a detailed soil survey was organized in Jammulapalem village in Andhra Pradesh and digital soil maps for monitoring the vegetation using satellite data was developed. Twelve rice fields were identified and selected based on pH and EC for monitoring temporally using Sentinel 2 data during the *Kharif* season in 2023. A ground truth survey was conducted in October 2023 in fields cultivated with Kalanamak to help with possible mapping after understanding the spectral response in different bands of Sentinel 2. Kalanamak vegetation could be discriminated from routinely grown rice. Initial plotting of NDVI of one field (containing 236 pixels) indicated the changes in NDVI from time to time.



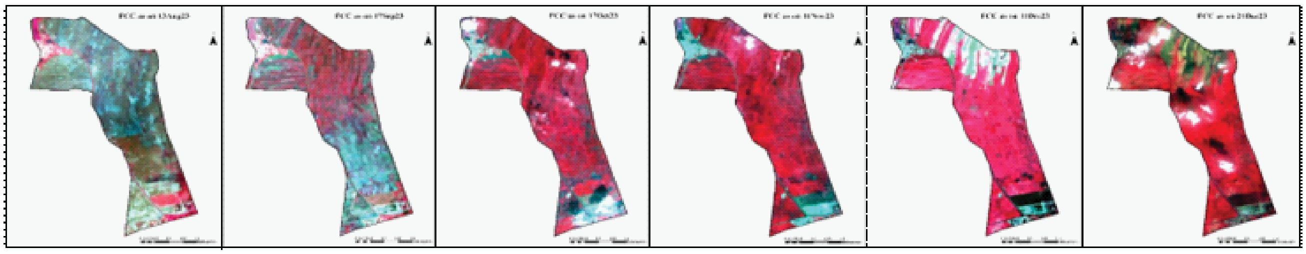
Temporal changes in different indices



Temporal changes in NDVI and analysis at pixel (n = 121 pixels)

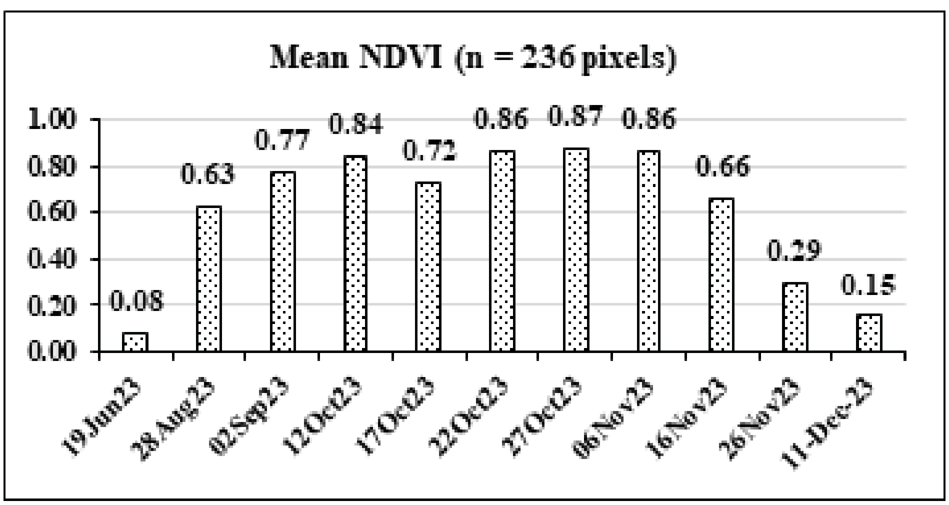


Development of digital soil theme maps at village level



Temporal FCCs of rice fields in Jammulapalem during Kharif 2023

The contrast between vegetation of Kalanamak and regular rice



Plot of mean NDVI extracted from temporal images of Kalanamak rice field

SSP/CP/SS/18: Studies on Soil Organic Carbon Status. Mapping and stocks in Rice Soils of India

Nearly 1400 samples were collected from the field adjacent to the Rythu Vedika Tukkuguda, Maheshwaram Mandal. The major area of the soil tested in the Maheshwaram, Kadthal, Kandukur, and Amangal regions of the Rangareddy District is sandy, followed by Loamy and Clay. The major soil color of the soil tested in the Maheshwaram, Kadthal, Kandukur, and Amangal regions of Rangareddy District is red, followed by brown. Soil nutrient maps depicting the soil nutrient status for the following parameters mentioned below in Table 1 (Nutrient Range). A base map depicting the layers of Mandal boundaries, roads, railway line and water bodies was developed. The nutrient maps developed for the Maheshwaram, Kadthal, Kandukur, and Amangal Mandal in the Rangareddy district of Telangana are also made available on the cloud. Most of the soils tested were in the medium range. A minimum of 6 soil pH was recorded and a maximum of 9.72 also was recorded. Most of the samples were in the low range. A minimum of 0.21 percent soil organic carbon was recorded with a maximum of 2.33 percent also recorded from the areas following heavy forestation.

RUE/CP/SS/22: Study on releasing pattern, kinetics and impact of nanoparticles in soils

Fitting of expression *i.e.* Langmuir and Freundlich were developed from the kinetic study and results revealed that binding energy in the Langmuir expression derived at 0.0045 $\mu g\ g^{-1}$; whereas, the extent of Zn adsorption (a) and degree of linearity between the solution phase and adsorption (n) stands as -2.45 ($\mu g\ g^{-1}$) and 1.05 ($g\ mL^{-1}$), respectively. It is clear from this kinetic study that the higher the concentration, the higher adsorption was observed with the ZnO nanoparticles. In case of an Incubation study in black soil under a saturation moisture regime, the application of ZnO nanoparticles significantly reduces the pH with the optimum dose *i.e.* 60 ppm due to metal dissolution-induced pH reduction. The highest Zn content was recorded with 150 mg ZnO treated soil followed by 120, 90 and 60 mg ZnO; incubation time and period did not alter the Zn content in black soil. The graded level of ZnO nanoparticles positively increased the Zn content to the tune of 1.2 times (12 mg/kg) to 2.0 times (150 mg/kg). In solution culture, the highest Zn content was observed at 80 ppm (62.9 mg/kg) (135 % improvement over control) followed by 100 and 60 ppm (59.5 and 59.4 mg/kg, respectively). It is clear from the study that ZnO nanoparticles capable of supplying Zn to rice plants.

RUE/CP/SS/21: Exploiting legacy phosphorus and enhancing phosphorus use efficiency in irrigated rice

Field experiments were conducted during Kharif 2022 and Rabi 22-23 to study the effect of graded levels of phosphorus (No application of P, 20 kg P 40 kg P, and 60 kg P) with humic acid and phosphorus solubilizing bacteria combination and coated phosphorus on performance of the rice variety, Improved Samba Mahsuri, in a randomized complete block design. Results revealed that the application of 40 kg P in combination with phosphorus solubilizing bacteria resulted in the highest number of tillers/ m 2 (398), panicles/m 2 (369), grain yield (6127 kg/ha) and straw yield (7368 kg/ha). The yield improvement with the various management practices was to the tune of 3 -15% compared to respective fertilizer doses. Application of 20 kg phosphorus supplemented either with PSB or humic acid or coating with silica recorded on par yields with higher Phosphorus doses. Application of coated phosphorus fertilizers registered higher agronomic and recovery efficiency than their respective uncoated phosphorus treatments. A similar trend was noticed during *rabi*, with application of 40 kg P in combination with phosphorus solubilizing bacteria resulting in the highest number of tillers/ m^2 (433), panicles/m^2 (397), grain yield (6183 kg/ha) and straw yield (8227 kg/ha). Coated phosphorus fertilizers registered higher agronomic efficiency to the tune of 4 to 37% than their respective uncoated phosphorus treatments. Higher agronomic efficiency was recorded with 20 kg coated P followed by 40 kg coated P.

SSP – Sustaining rice system productivity

SSP/CP/AG/15: Sustainable intensification of conservation agriculture practices in rice-maize system to enhance system productivity in Southern India

The best nitrogen management technologies for higher yield and nitrogen use efficiency was evaluated to calculate energy use efficiency and economics. The experiment was laid out in a randomized block design with three replications and plots comprised of nine different nitrogen management practices *viz*., Control (no nitrogen), 100% RDN* @120 kg/ha (neem coated urea), Soil Test Crop Response (Target Yield 6.5 t/ha), nano urea, leaf colour chart (LCC) based nitrogen management, Cedar wood oil coated urea @ 90 kg N/ha, Silicon coated urea @ 90 kg N/ha, Nutrient Expert (Decision Support Tool), 100% RDN @120 kg/ha (Prilled Urea). The Recommended dose of N-P_2O_5-K_2O was 120-60-40 kg per hectare. The highest grain yield (5707 kg/ha) and straw yield (7102 kg/ha) were obtained with application of N @ 160 kg/ha based on LCC, however, on par with STCR based N application @ 171.5 kg N/ha. 100% RDN @120 kg N/ha neem coated urea resulted higher grain yield and straw yield than that of silicon coated urea @ 90 kg N ha $^{-1}$ and cedar wood oil coated urea @ 90 kg N/ha. The lowest grain and straw yield and kg/ha were recorded in the control plots. Harvest index was found to be similar among the different N management practices.

SSP/CP/SS/11: Assessment of Genotypic variability and improving nitrogen use efficiency (NUE) in irrigated rice

To evaluate nitrogen use efficiency of existing popular rice varieties and to identify efficient rice genotypes for their responsiveness and utilization of soil and applied N, field experiments were repeated under N-0, N-50, and N-100 kg/ha as main treatments and 238 BAAP genotypes along with control genotype MTU1010 were evaluated as sub treatments in a split plot design with 2 replications. In another experiment, three urease inhibitors (UIs-Allicin, CDW, and NBPT) were evaluated (var. DRR Dhan 64) in comparison with NCU at graded levels of N (0, 50, 75, and 100 kg N/ha) during *kharif* and *rabi* for the first year to know their response at different N levels. In the third experiment to improve N use efficiency, two urease inhibitors (allicin and NBPT) were tested under field experiment with DRR Dhan 42 variety at 20% reduced doses in comparison to 100% NCU. In addition, nine varieties were selected based on their NUE (both high and low NUE), and the germination test was repeated for confirmation studies in small pots. The seedlings were grown for three weeks and observations on root and shoot length, root and shoot fresh and dry weights were recorded. Seedling vigor indices 1 and 2 were calculated from the data on total length and total dry weight. Out of 238 BAAP entries tested, top 5 entries, FR13A, M202, IR64-21, KELE BARI and KADA 176-12 at N0; FR13A, IR64-21, ARC7229, CUNAIL and BAWOI at N50 and FR13A, ASWINA, DULA AUS, BRRI DHAN50 and CUNAIL at N100, recorded maximum grain yield.

At graded levels of N, grain yield was maximum at N100 (6.58 t/ha) but it was on par to N75 (6.47 t/ha). All three UIs were superior to NCU in grain yield by 12-19% and the differences were maximum at N75. At least 25% of the N dose can be saved when UIs were used as coating on urea. 6 varieties with high NUE and 3 varieties with low NUE were consistent confirming the results from germination data. BV1704, Nidhi, Tellahamsa, PSV 344, PSV 181 and PUP 221 were identified as high NUE varieties and Mandya vijaya, BPT 5204 and Mahsuri were identified as low NUE varieties.

Evaluation of nitrogen use efficiency of existing popular rice varieties

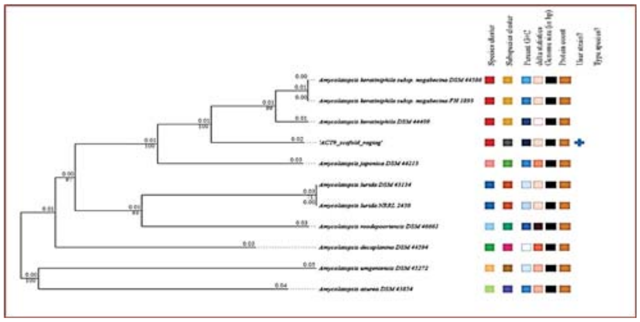
Germination studies for selected NUE varieties

Nitrogen-use efficiency of existing popular rice varieties was evaluated in field to identify efficient rice genotypes for their responsiveness and utilisation of soil and applied N. Main treatments included N-0, N-50 and N-100 kg/ha and 190 BAAP genotypes along with control genotype MTU1010 were evaluated as sub treatments in a split plot design with 2 replications. In another experiment to improve N use efficiency, different urease inhibitors and coated urea were evaluated at 20% reduced doses in comparison to 100% NCU. Twenty varieties selected based on their NUE (both high and low NUE) were subjected to germination studies. Out of 190 BAAP entries tested, top 5 entries at N-50 level based on grain yield were: 39-BAAP-81 (CHHOLA BORO (2) G1); 126- BAAP-199 (DULA AUS IRGC 49180-1); 180- BAAP-266 (DHALI BORO 105-2 IRGC 29314-1); 133- BAAP-210 (JATI AUS IRGC 34940-1) and 8-BAAP-13 (SADUCHO). Application of different sources of N along with coated materials indicated significant improvement in grain yield with urease inhibitors. NBPT 1000 ppm better performed with a yield of 4.58 t ha^{-1} (13% higher than 100% NCU) followed by Allicin 2000 ppm (4.43 t ha^{-1} with 9% yield increase over NCU). 6 High NUE out of 21 varieties (BV1704, Nidhi, Tellahamsa, PSV 344, PSV 181 and PUP 221) were selected, based on total length, total dry weight, SVI-1 and SVI-2. Mandya Vijaya, BPT 5204 and Mahsuri were the low NUE varieties. Low SVI of other cultivars is mainly due to lower germination %, root and shoot parameters. High NUE is thus associated with high root and shoot parameters and high seedling vigour.

Field evaluation of Nitrogen with different coated materials

SSP/CP/SS/19: Prospecting endophytic actinobacteria of rice for sustainable rice production

Whole genome sequencing of the filamentous *Amycolatopsis* sp IIRRACT9, which was found to possess both plant growth promoting and bioactive secondary metabolite production potential, was performed through Illumina NovaSeq 6000, and ~ 6.7 Gb of high-quality data were generated. Whole genome–based taxonomic analysis using the Type (Strain) Genome Server (TYGS), delineated the isolate as *Amycolatopsis keratiniphila.* A total of 7,993 genes were predicted in the genome using Prokka, of which 3449 genes were annotated, and 4544 genes were hypothetical genes. Annotation of the predicted amino acid sequences from *Amycolatopsis* genes using the dbCAN database revealed 234 CAZymes, indicating the ability of the isolate to degrade various substrates like cellulose, chitin, xylan and other glucans. Genes for secondary metabolites like siderophores, non-ribosomal peptides, and lanthipeptides were predicted in the whole genome using antiSMASH software. In addition, the potential of the actinobacteria to produce i) terpene volatiles (2-methylisoborneol), ii) ε-poly-L-lysine, a naturally occurring poly (amino acid) with antimicrobial activity, and ii) ectoine which is a heterocyclic amino acid derivative which is compatible solute and cell protectant, were identified.



Phylogenomic identification of Amycolatopsis isolate

SSP/CP/SS/20: Development and Evaluation of N-fixing and P-solubilizing Microbial Consortia for Sustainable Rice Production

In the study on development and evaluation of N-fixing and P-solubilizing Microbial Consortia for Sustainable Rice Production, the soil samples were collected from farmer's field and IIRR research farm from different rice establishment methods to isolate potential phosphorus solubilising microbes. Fifty-seven potential phosphorus-solubilising microbes (PSB) were isolated. Twelve PSB were deposited to NCBI GenBank and were evaluated for seed germination and germination index with ISM cultivar, the inoculated rice seeds with bacterial cultures significantly enhanced seed germination and germination index compared to uninoculated control. The germination percentage was in the range of 92 to 100 % and germination index was in the range of 13.9 to 17 in inoculated rice seeds as compared to the control. Based on higher germination percentage six potential PSB cultures *Citrobacter amalonaticus* IIRRPSB1, *Bacillus sp.* IIRRPSB6, *Bacillus pumilus* IIRRPSB10, *Bacillus sp.* IIRRPSB13, *C. amalonaticus* IIRRPSB4 and *C. amalonaticus* IIRRPSB4 were selected for plant interaction study. The root & shoot length, total fresh weight and total dry weight were higher in *Priestia flexa* IIRRPSB14, *Bacillus* sp. IIRR PSB5 and *Bacillus oryzecorticis* IIRRPSB7 as compared to uninoculated control. Whole-genome sequencing of *P. flexa* IIRRPSB14 was performed to identify the phosphate-metabolism and plant growth-promoting genes that helps in the plant bacteria interaction. The *P. flexa* IIRRPSB14 genome possesses phosphate-metabolizing genes and plant growth promotion traits including plant hormone (indole-3-acetic acid) synthesis gene, genes involved nitrogen fixation, anti-microbial activity, quorum sensing, genes involved in abiotic stress tolerance and underlying mechanisms that control the bacterial ability to provide fitness advantages to the plant.

CCR- assessing and managing crop response to climate change

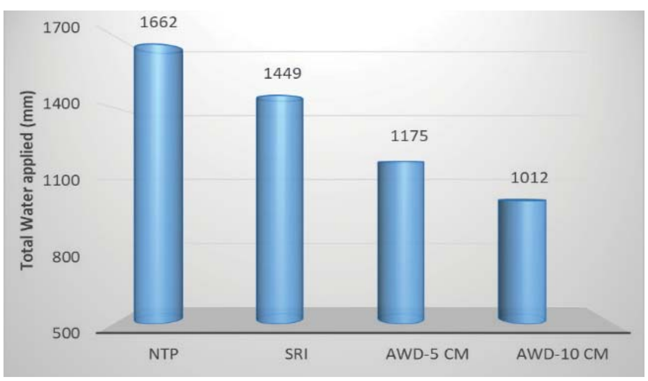
CCR/CP/SS/17: Studies on emission of greenhouse gases (GHGs) from rice soils and their mitigation

Greenhouse gas (Methane and nitrous oxide) emissions during the crop growth period were significantly impacted by the different rice establishment techniques. The seasonal integrated flux (SIF) for methane was the highest in the normal/conventional transplanted (TPR) method (28 kg ha^{-1}) followed by SRI (17 kg ha^{-1}) and AWD methods resulting in lower flux values of 15 and 13 kg ha^{-1} with irrigation at 5 cm and 10 cm depletion of ponded water, respectively. Methane emissions decreased by more than 39 percent in SRI and by 49 and 55 percent in AWD at 5 and 10 cm, respectively as compared to TPR. The higher methane emissions under the conventional TPR method were due to the depletion of oxygen under submerged conditions leading to a conducive anaerobic or reduced atmosphere throughout the crop growth season. The seasonal integrated fluxes of N_2O-N were least in TPR (0.792 kg ha^{-1}) as compared to SRI (0.994 kg ha^{-1}) and AWD methods (1097 and 1243 kg ha^{-1}).

Carbon Equivalent Emissions (CEE) significantly varied with different establishment techniques. The CEE was the highest under TPR (257 kg C ha^{-1}) and lowest under AWD methods at 5 and 10 cm (188 & 187 kg C ha^{-1}). The highest CEE in TPR was due to higher methane emissions during the entire crop growth period. The Carbon Efficiency Ratio (CER) was the lowest in TPR (10) and highest in SRI (14).

The Global Warming Potential (GWP) varied significantly with the crop establishment methods. SRI and AWD methods lowered the GWP due to lower methane emissions as compared to the conventional TPR method. The highest GWP was recorded by TPR with 943 kg CO_2 eq. ha^{-1} which reduced to 729 kg CO_2 eq. ha^{-1} in SRI and further to 691 and 685 kg CO_2 eq. ha^{-1} in AWD at 5 and 10 cm depletion respectively. SRI lowered the GWP by 23 percent while AWD methods by 28% over TPR. The grain yield varied significantly with the different planting/water management methods. The highest grain yield was recorded in SRI (5600 kg ha^{-1}). TPR recorded a grain yield of 5212 kg ha^{-1}, which was lower by 8 percent as compared to SRI. There was a grain yield penalty of 6 and 18 percent in AWD at 5 and 10 cm respectively over TPR.

The irrigation water applied was maximum (1662 mm ha^{-1}) in TPR-Flooded followed by 15 percent saving (1449 mm ha^{-1}) in SRI. The water usage was further reduced by 46 percent in AWD at 10 cm depletion. The water productivity ranged from the lowest of 3.14 kg ha mm^{-1} in TPR to 3.86, and 4.17 kg ha mm^{-1} in SRI and AWD respectively.



Water applied in different systems

Water Productivity

CCR/CP/ PP/12: Role of Silicon in inducing biotic and abiotic stress tolerance in rice

In biotic stress studies, it was revealed that Silicon has potential to control the pests and diseases such as Blast, Sheath blight, False smut and Stem borer. It was also found that when Silicon was applied in above formulations there was a positive response for abiotic stress tolerance, particularly water stress and lodging resistance. Silicon application has a positive role on the physiology of growth, development and yield. It was observed that on Silicon application leaf area, leaf biomass and yield were enhanced by 4–7% based on soil type, location and genotype.

Research Achievements

Evaluation of silica material against Sheath blight (Rhizoctonia solani)

T1 Silicate solution-KS50 *T2 Silicic acid* *T3 control*

Evaluation of Potassium silicate and Silicic acid against pathogen False smut (Utilaginoidea virens at 30th day of treatment)

1. Potassium Silicate solution *2. Silicic acid* *3 control*

CCR/CP/PP/13: Deciphering physiological basis of heat stress tolerance in rice

About 450 rice germplasm were sown in augmented block design with two treatments for phenotyping of rice germplasm for physiological traits related to heat stress tolerance. One set of germplasm was characterized under normal conditions without heat stress as control and another set was transplanted under heat stress in Heat Tunnel. Based on physiological traits related to heat stress tolerance such as spikelet fertility among 450 genotypes about few genotypes were identified as highly tolerant to heat stress at reproductive stage having spikelet fertility more than 80% are namely Blackgora, E MOOM, IRGC 132252, IC 44975, ADAYSEL, RASI, BAKAL, VANAPRAVA, IRGC 127466, and IRGC 128373. Further, few others were identified as tolerant having spikelet fertility ranging from 61% to 80% are namely IC 282803, Kalinga-1, IC 426049, BAM 4477, BIJULI BATI, DERAWA, HIRA and IRGC 117271 etc.

HRI - Host-plant resistance against insect pests and its management

HRI/CPT/ENT/11: Assessment of host plant resistance to rice planthoppers - brown planthopper *Nilaparvata lugens* and white-backed Planthopper *Sogatella furcifera* and their management

Out of 2000 entries consisting of advanced breeding lines, germplasm accessions screened for brown planthopper resistance using standard seed box screening technique (SSST), twelve entries were highly resistant *viz*., MO 22 (Shreyas) (0.5), ISM-3 (0.9), IET 30261, IET 29964, IET 29743, IET 29749, IET 30233, IET 30815, IET 31120, IET 31119, IET 30582 and RPBio-4918. Seventy entries were resistant with a damage score of 1.1 to 3.0 and one hundred and fifty entries were moderately resistant with a damage score of 3.1 to 5.0. Out of 2000 entries consisting of advanced breeding lines, germplasm accessions screened for white-backed planthopper resistance, fourteen entries were moderately resistant *viz*., IET 29353, 30164, 29940, 30700, IET 31032, 29816, 31016, 31014, 30926, 31106, IET 30603, RP Bio 5477-NH363, RP Bio 5477-NH663 and RP Bio 5477-NH733.

Expression of ten selected defense responsive and metabolism-associated genes was compared in the identified resistant and susceptible mutants of Nagina 22 before and after infestation by planthoppers. When there was a biotic stress (insect infestation), the expression of defense genes was up regulated while that of metabolism-related genes was down regulated.

The intra and interspecific interaction and vertical distribution of planthoppers was studied on 10 selected rice genotypes. Nymphal survival was lowest, the nymphal duration was long and the growth index value was lowest, sex ratio was in favour of males, winged adults were more and fecundity was less in the resistant entries. In intraspecific interactions, in BPH, there was higher nymphal survival (%), nymphal duration, growth index, winged adults (%), males (%), fecundity, and female adult longevity compared to WBPH. However, in WBPH intraspecific interactions females (%), and male adult longevity were higher than in BPH intraspecific interactions on selected rice genotypes. In interspecific interactions, nymphal survival, fecundity, wingless adults were more in BPH than that in WBPH. Females were more in WBPH than those in BPH. BPH nymphs, adults occupied lower plant position, WBPH nymphs were more in middle plant part and WBPH adults were more in upper plant part

HRI/CPT/ENT/31: Understanding the interaction of internal feeders –stem borers and gall midge with rice for their management

In a survey of stem borers incidence in rice based cropping system of Andhra Pradesh, the tiller damage ranged from 10.9% - 14.7% DH/WE warranting insecticide sprays. It was observed that though yellow stem borer (YSB) was the dominant species in all the rice-growing areas, in few pockets of West Godavari, pink stem borer and dark headed striped borer were observed. In certain pockets of Srikakulam and Vizianagaram districts, gold-fringed borer and pink stem borer were observed. Except for YSB the other three borers were gregarious in nature. The damage by pink stem borer manifests as either dead heart or white ear. However, at times, there is extensive tunnelling within the tiller without any external symptoms except for presence of frass from the bored holes.

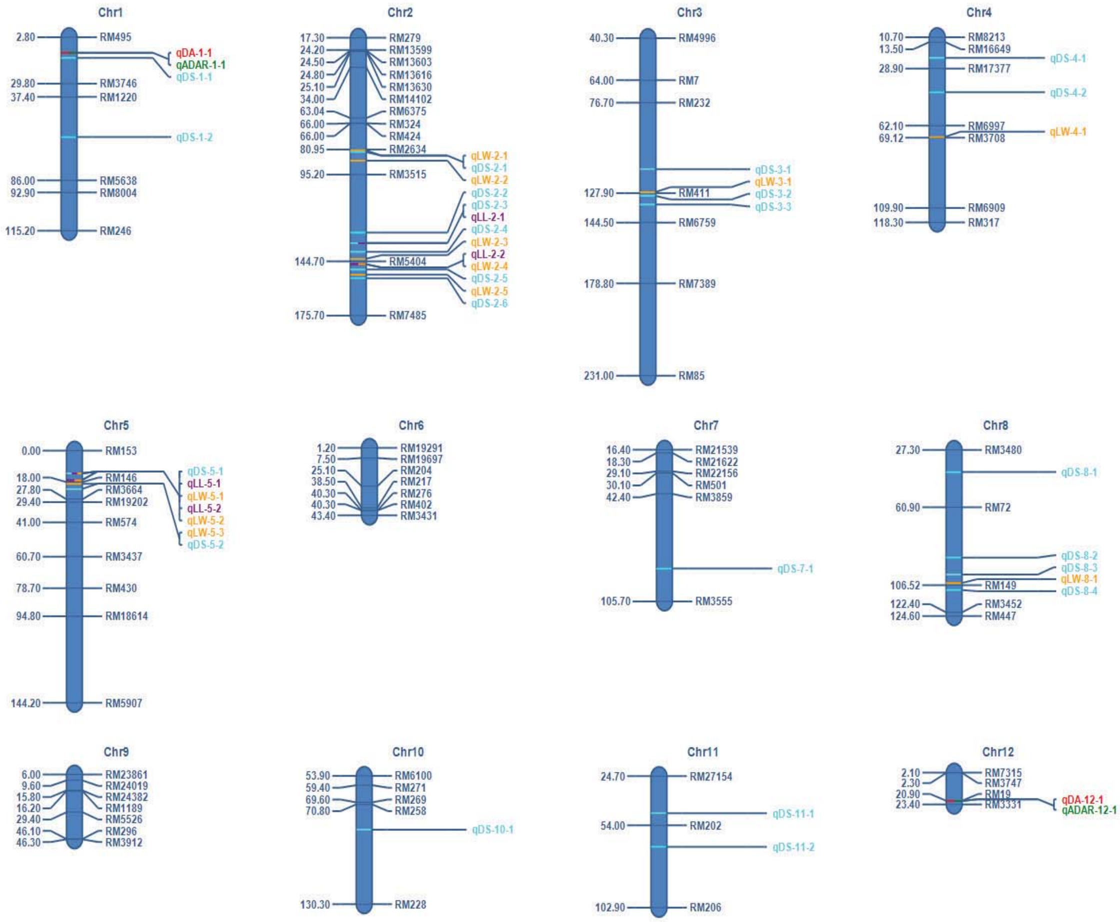
Greenhouse studies on pink stem borer, *Sesamia inferens* revealed that the insect could survive and complete its development on the rice varieties. When reared on TN1 stems 30% of the larvae metamorphosed to adults and 27% on BPT 5204. Morphometric characterization of male genitalia is an important aspect for studying intraspecific variation in Lepidoptera. The size variation in the male genitalia of rice yellow stem borer (YSB) *Scirpophaga incertulas* (Walker) collected from nine locations through sex pheromone traps was examined. Measurements of male genitalia like uncus length (UL), uncus width (UW), valva length (VL), valva width (VW), saccus length (SL), saccus width (SW), aedeagus length (AD) were considered. Significant size variation was observed among the populations, and the measurements SL, SW, VL, VW, UL, UW and AD contributed to about 16% to location variability. The results showed that all the characters except valva width was significantly different ($p \leq 0.05$) among the nine populations.

Damage by the pink stem borer evident through the bored hole in the tiller as frass

Pupa of Pink stem borer within the tiller

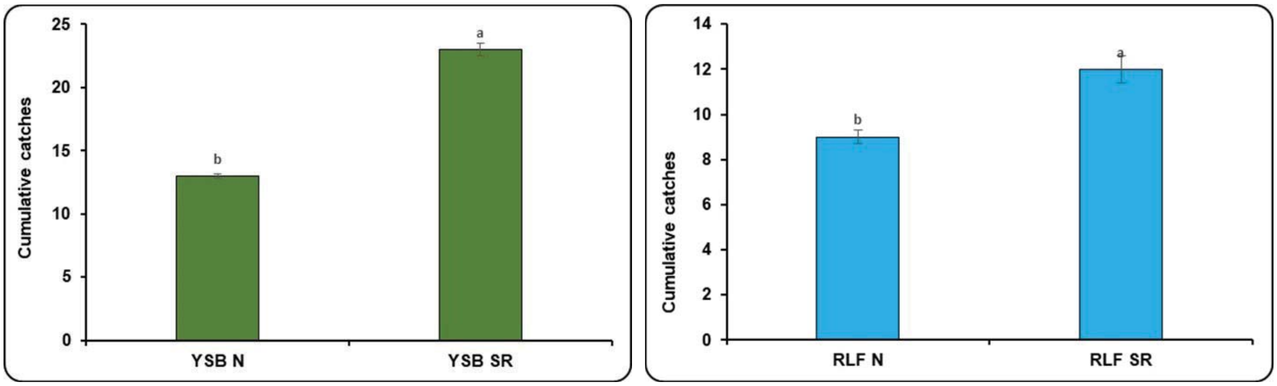
HRI/CPT/ENT/27: Host Plant resistance to rice Leaf folder and semio-chemical approaches for the management of insect pests of rice

A C2 population (162 RILs) of two stable moderately resistant backcross alien introgression lines 166s and 14s derived from Swarna / *Oryza nivara* IRGC81848 (NPS lines) were screened using rapid field screening method. QTL mapping was done using 79 SSR markers. Single marker analysis (SMA) revealed two QTLs for damage area on chromosomes 1 and 12 with phenotypic variance of 9.0%, one QTL each for damage score and leaf width on chromosome 4. Inclusive Composite Interval Mapping (ICIM) also identified divulged two QTLs for damage area on chromosome 1 and 12 with phenotypic variance of 14.1 and 3.8%, 23 QTLs for damage score on chromosomes 1,2,3,4,5,7,8, 10 and 11, four QTLs for leaf length on chromosomes 2 and 5, 11 QTLs for leaf width on chromosomes 2,3,4,5 and 8.



Linkage map of C2 population of two stable moderately resistant backcross alien introgression lines 166s and 14s

Bio-efficacy studies on pheromone blends of rice pests in the field revealed that maximum catches of yellow stem borer and rice leaf folder were found in slow-release (SR) formulations compared to normal (N) blends. GC analysis of pheromone compounds released indicated that >99% was released by the 3rd week in the case of normal formulation while 74-81% was released by the 16th week in the case of slow-release formulations.



Comparative leaf folder and stem borer moth catches in slow release and normal pheromone blends

IPM : Integrated Pest Management

IPM/ CPT/ ENT/29: Studies on Plant Nematode Interactions in Diverse Rice Phytobiomes

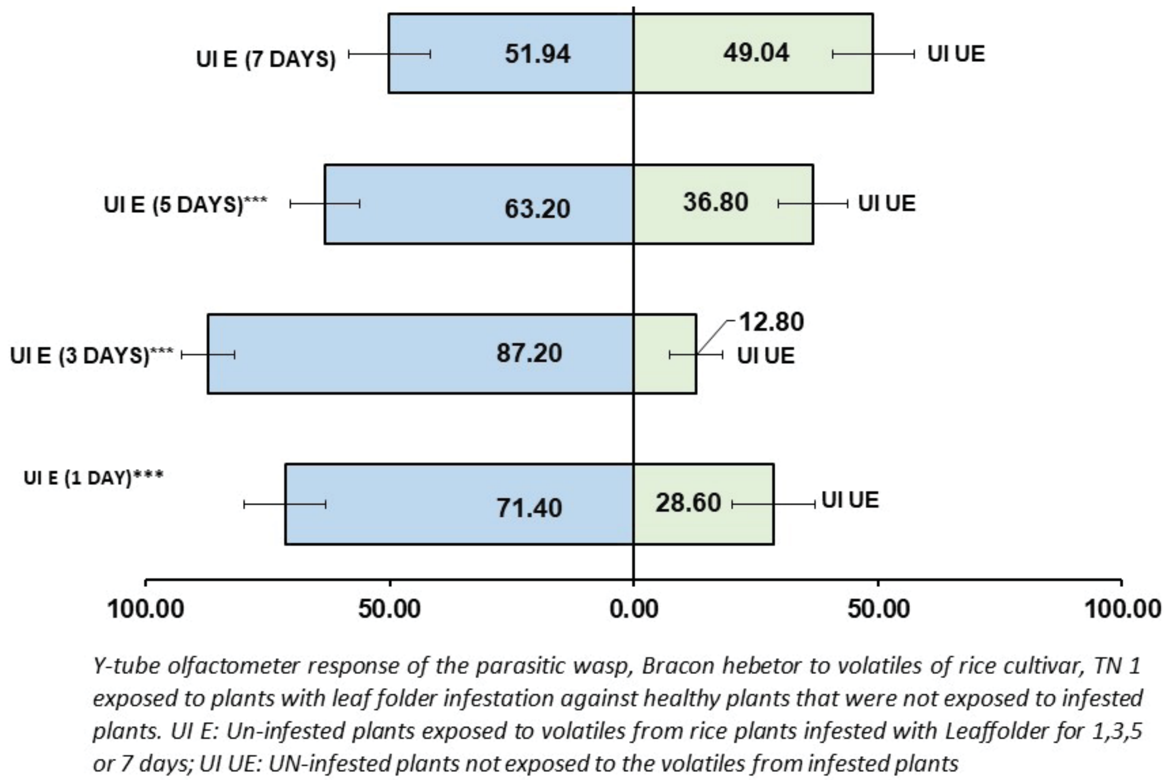
Screening of 40 rice genotypes for resistance to rice root-knot nematode *Meloidogyne graminicola* revealed that four genotypes ((Suraksha, Aganni, KPM, and LD24) were resistant to the nematode when rated on both Relative Root Gall Index (RRGI) and Relative Reproduction Index (RRPI).

A field sick plot facility for rice root-knot nematode *Meloidogyne graminicola* is being developed at IIRR farm. The plot was transplanted with seedlings of highly susceptible rice cv. TN1 to build up nematode population in soil. The nematode population development is monitored periodically. Field experiments on weed management in aerobic rice revealed that application of biological mulches *viz.*, paddy straw, neem leaves, and glyricidia leaves was found effective in reducing plant parasitic nematode population and weeds in aerobic rice.

Seed treatment with bioagents *viz., Trichoderma asperellum* (isolate IIRR TAIK1), *Bacillus cabrialessi* (isolate IIRR BIK1) and *Pseudomonas fluorescens* (Commercial formulation) resulted in significant reduction of root galls caused by the rice root-knot nematode *M. graminicola* in pot culture studies. Pure cultures of entomopathogenic nematode isolates and cultures of their insect hosts (*Galleria mellonella* and *Corcyra cephalonica*) are being maintained in the laboratory and cultures of plant parasitic nematode *M. graminicola* are being maintained in the glasshouse.

IPM/CPT/ENT/30: Enhancing biological control of rice pests through Chemical ecology

Chemical Ecology of herbivore induced plant volatiles emitted by rice plants upon leaf folder herbivory were studied vis-a vis parasitism by *Trichogramma chilonis*, its egg parasitoid. *T. chilonis* significantly preferred infested plants over healthy plants of the same variety. Three varieties with varying resistance to leaf folder *viz.*, TN 1, W1263 and TKM 6 were evaluated for dual choice preferences of the infested cultivars. Significant variation was observed in the rate of attraction of parasitoids. The percentage of parasitoids that chose different infested cultivars ranged from 27.10 per cent to 72.90 per cent. The infested plants of W1263 attracted the highest percentage of parasitoids (91.20) over healthy plants. Variation in volatile emission exists with the genotype of a plant species as observed in this study, which in turn affects the behaviour of natural enemies. TKM 6 a known resistant source for leaf folder was least attractive to parasitoids. Adult leaf folder moths showed a clear preference for TN 1 followed by W1263 and TKM 6, was again, least preferred. Similarly, third instar leaf folder larvae also displayed a preference for TN 1, choosing it within 30 minutes while TKM 6 was least preferred by the larvae, with only 0.10 larvae being attracted after 24 hours. Healthy plants of the cultivar *TN 1 were exposed to leaf folder infested plants and subjected to olfactometer assays with the larval parasitoid Bracon hebetor, at 1, 3, 5 or 7 days after infestation.* Rice plants that were exposed to infested plants after 3 days attracted a higher number of parasitoids (17.44) followed by the plants that were exposed to infested plants after 1 day (14.28). These results indicate that the volatiles produced from infested plants are perceived by adjacent plants, priming them for attack and the production of volatiles from such exposed plants. In addition, the volatiles produced by infested plants also act as attractants to the natural enemies. Eight land races along with one popular variety BPT5204 grown organically in a farmer's field at Wanaparthy was also evaluated for pest incidence versus natural enemy presence. The highest damage by stem borer of 12.33 % white ears (WE) was noticed in Narayana Kamini followed by Jeeraga Samba (8.2% WE) as compared to popular cultivar BPT 5204 which recorded yellow stemborer damage of 25.22% WE.



Y-tube olfactometer response of the parasitic wasp, Bracon hebetor to volatiles of rice cultivar, TN 1 exposed to plants with leaf folder infestation against healthy plants that were not exposed to infested plants

IPM/CPT/ENT/28: Bio efficacy and toxicological studies of insecticides against major insect pests of rice

In a field experiment viratko 0.6 GR @6 kg/ha applied at 21 days after transplanting and cartap hydrochloride 50WP @20kg/ha at 45 days after transplanting was most effective in preventing white ears for stem borer infestation.

Monitoring of insecticide resistance in brown planthopper to against pymetrozine was conducted during the period 2022-23. Populations were collected from Toopran, Nalgonda, Warangal, Shankarpally, Maruteru and Raichur. Rice seedling dip method was adopted for bioassay. Results revealed that Shankarpally population was relatively sensitive to pymetrozine with LC_{50} value of 28.64 ppm. Whereas, Warangal-21 field population showed 15-fold resistance with LC_{50} of 431.5 ppm. In the laboratory, pymetrozine resistant populations were developed by exposing to sub-lethal doses. At F6, it showed 34.45-fold resistance as compared to susceptible population with LC_{50} of 987 ppm.

Insecticide resistance in brown planthopper to imidacloprid was monitored during the period. Populations from Toopran, Warangal, Raichur, Maruteru, Nellore and Shankerpally were tested. Bioassay was conducted by rice seedling dip method. Results revealed that Raichur population was relatively sensitive to imidacloprid with LC_{50} value of 149.9 ppm. Maruteru population was most resistant (LC_{50}-2125 ppm). Piperonyl butoxide (PBO) showed 2.7-fold synergism ratio in pymetrozine resistant populations suggesting the role of mixed function oxidases in the detoxification of pymetrozine in resistant populations.

The feeding behaviour of pymetrozine resistant and susceptible brown planthopper strains was investigated in this study by standard honeydew test and probing test. Pymetrozine-Resistant (Pym-R) insects fed more as compared to Pymetrozine-Susceptible (Pym-S) insects under both the untreated and treated conditions as reflected in honeydew test. Whereas, probing test revealed that both the Pym-S and R strains probed significantly higher on the plant surface treated with Pymetrozine as compared to the untreated as reflected by the no of feeding probes.

In a glasshouse, experiment cedar wood oil and citronella oil were found effective against brown plant hopper. A laboratory test was conducted to study the joint efficacy of insecticide dinotefuran 20 SG and eucalyptus oil against brown plant hopper, *Nilaparvata lugens* revealed that all combinations resulted in higher mortality as compared to insecticide or eucalypus oil alone indicating possibility of a joint action.

IPM/CPT/ENT/32: Studies on the genetics of inheritance of insecticide resistance and fitness cost in white backed Plant hopper *Sogatella furcifera* (Horvath) in India

The definition of resistance itself stress on the inherent ability of the pest to detoxify the certain dosage of insecticide. Insecticide resistance in BPH and WBPH indicates that farmers mainly rely on chemical pesticides for BPH and WBPH management and the over application and indiscriminate use of insecticides is common. The population of WBPH was collected from Rajendranagar, Medak, Maruteru and Nawagam were subjected to various dosages of four major insecticides like, *Imadacloprid* (Neonicotinoid), *Triflumezopyrim* (Novel messianic class), *Buprofezin* (IGR) and *Pymetrozine* (Pyridineazomethines) insecticides. Mortality of the test insect was recorded under laboratory condition.

IPM/CPT/ENT/33: Investigations on genetics and mechanisms of resistance to rice root-knot nematode *Meloidogyne graminicola*

A new research project entitled 'Investigations on genetics and mechanisms of resistance to rice root-knot nematode *Meloidogyne graminicola*. The main object of this project is to investigate the mechanisms of resistance in *M. graminicola*-resistant rice lines and the mechanisms of induced resistance (IR) activated by IR stimulators and to study the genetics of resistance and development of mapping populations with identified resistant rice.

Rice lines/cultivars previously reported resistant to *M. graminicola* were screened to confirm their resistance to *M. graminicola*. Among them, LD24 and Aganni, were found resistant to *M. graminicola*. Total galls, nematodes and egg-laying females were significantly lower in these lines compared to susceptible check TN1. Further work on investigating the mechanisms of nematode resistance in these lines is under progress.

HRP - Host-plant resistance against pathogens and its management

HRP/CPT/PATH/15: Assessment of host plant resistance for rice blast disease and its management

A total of 3592 rice entries *viz*., advanced breeding lines, near isogenic lines (NILs), RILs and germplasm etc., were evaluated in the Uniform Blast Nursery (UBN) until the susceptible line reached to 9 on SES scale. Out of that, 1118 lines were found resistant. The virulence of the blast pathogen was monitored across the locations in the country and observed that there is no major shift of the virulence of the pathogen.

Disease reaction in the resistant and susceptible entries – Kharif 2023

Seven different fungicides *viz*., mancozeb 50% + thiophanate methyl 25% WG, kasugamycin 5% + copper oxychloride 45% WP, azoxysrobin 5.1% + tebuconazole 9.1% + prochloraz 18.2% EC, fenoxanil 5% + isoprothiolane 30% EC, azoxystrobin 14% + epoxiconazole 9% SC, picoxystrobin 7.05% + propiconazole 11.7% SC, and tebuconazole 50% + trifloxystrobin 25% w/w WG were tested against blast disease under field through artificial inoculation on susceptible variety HR12. Two sprays of fungicides with 15 days interval. Observations taken at 15 days interval from first and second spray as per SES 0-9 scale (IRRI, 2013). All the fungicides significantly superior over the control (72.2%) in reducing leaf blast.

Among the fungicides, Fenoxanil + Isoprothiolane (2ml/l) showed less disease (21.73%) and found 70% reduction over control, increased the yield followed by azoxysrobin + tebuconazole + prochloraz 18.2% (3.5 ml l^{-}) found effective in minimizing the disease.

Bio-efficacy of CuSiO2 and SiO2 against rice blast was study under UBN during 2023. Experiment consisted of four treatments *viz*., (T1) $CuSiO_2$ spray- pathogen inoculation, (T2) SiO_2 spray- pathogen inoculation, (T3) pathogen inoculation- $CuSiO_2$ spray and (T4) pathogen inoculation- SiO_2 spray. We ensured the congenial weather conditions for the blast development at UBN. Scoring done after 10 -15 days of post infection depending on the severity of the infection on the control plots using SES scale (IRRI, 2013). Both the chemicals performed better under pre-application condition as compared to post application. In pretreatment, SiO_2 was found effective and showed PDI of 28.3% compared to $CuSiO_2$ (36%).

HRP/CPT/PATH/13: Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice

Seventeen promising genotypes from Plant Pathology National Screening Nursery 2020 were re-evaluated with 6 different *Xanthomonas oryzae* pv. *oryzae* (IX-020 from Telangana, IX-015 from Tamil Nadu, IX-027 from West Bengal, IX-116 from Maharashtra, IX-071 and IX-132 from Uttar Pradesh) isolates under glasshouse conditions. Out of 17 entries tested 9 entries *viz*., IET# 28391, 28706, 29201, 28014 (R), 29353, 29567, 28503, 29492 and 29403 showed broad spectrum resistance against all the six strains of *Xoo*. The parentage of these lines indicate that they do not possess any known genes.

Thirty-eight selected lines from Plant Pathology Screening Nursery 2021 (9 entries from National

Screening Nursery 1, 25 entries from National Screening Nursery 2 and 4 entries from National Screening Nursery for Hills) were re-evaluated with 6 different X*anthomonas oryzae* pv. *oryzae* isolates (IX-020 from Telangana, IX-015 from Tamil Nadu, IX-027 from West Bengal, IX-116 from Maharashtra, IX-071 and IX-132 from Uttar Pradesh) under glasshouse conditions. Out of 38 entries tested, 19 (IET # 29238, 29492, 28065(R), 29970, 29990, 30227, 30002, 30025, 29781, 29803, 29823, 29849, 29861, 29884, 27152, 28273, 29934, 29937 and 30087) entries showed high level of broad-spectrum resistance against 5-6 isolates. The parentage of these lines indicate that these genotypes may not possess any known genes.

Forty-eight promising entries from Plant Pathology National Screening Nursery 2022 were re-evaluated under glasshouse condition with 3 different *Xoo* strains (IX-020 from Telangana, IX-015 from Tamil Nadu and IX-027 from West Bengal) to reconfirm their resistance to bacterial blight of rice. Eighteen genotypes showed high level of resistance to 2 or more *Xoo* strains.

Thirty-nine selected 3k lines and 25 selected germplasm accessions were re-tested for their broad-spectrum resistance against 8 *Xoo* strains (IX-020 from Telangana, IX-015 from Tamil Nadu, IX-027 from West Bengal, IX-200 from Uttarakhand, IX-050 from Andhra Pradesh, IX-071 and IX-132 from Uttar Pradesh and IX-125 from Odisha). Fifteen 3k lines and 10 germplasm lines showed broad spectrum resistance to 4 or more *Xoo* strains. Many of these lines did not possess any known major BB resistance genes like (*Xa4*, *xa5*, *xa13*, *Xa21*, *Xa33* and *Xa38*) when tested with gene-specific markers. Thirteen BAAP lines (Bengal and Assam Aus Panel) out of 233 screened which showed moderate to good level of BB resistance under field condition against strain IX-020, were retested with 3 different. However, these gentoypes did not show broad spectrum resistance to other strains of *Xoo*.

Out of several common antibiotics tested in vitro against *Xanthomonas oryzae* pv. *oryzae*, chloramphenicol significantly reduced BB disease intensity. We retested the efficacy of chloramphenicol along with copper sulphate and one commercial product for their ability to suppress BB disease severity under glasshouse condition. One spraying of chloramphenicol 2 days before inoculation and second spraying 2 days after BB inoculation was most effective in reducing the BB disease severity under glasshouse condition.

Efficacy of chloramphenicol in reducing bacterial blight disease severity under glasshouse condition

Tre.	Chemical	Dose	Spray schedule	Mean score ± SE
T1	Chloramphenicol	1 g/3 litre	One spray 2 days before BB inoculation and second spray 2 days after BB inoculation	1 ± 0
T2	Chloramphenicol	1 g/3 litre	One spray 2 days after BB inoculation	3.6 ± 0.42
T3	Chloramphenicol + CuSO4	1 g/4 litre + 2 g/litre	One spray 2 days before BB inoculation and second spray 2 days after BB inoculation	3 ± 0.73
T4	Spot clear (immunomodulatory) (commercial product)	0.5 g/litre	One spray 2 days before BB inoculation and second spray 2 days after BB inoculation	8 ± 0.45
T5	Spot clear + CuSO4	0.5 g/litre + 2 g/litre	One spray 2 days before BB inoculation and second spray 2 days after BB inoculation	8 ± 0.45
T6	Inoculated control		Inoculated control	9 ± 0

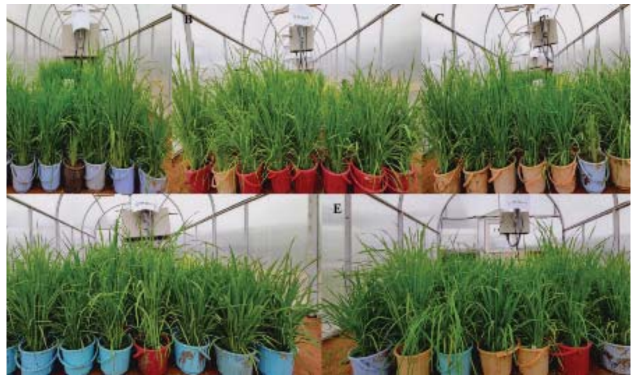
HRP/CPT/PATH/22: Population dynamics of rice sheath blight pathogen and sustainable disease management

140 samples were collected from a diagnostic survey conducted in Andhra Pradesh, Chhattisgarh, Karnataka, Tamil Nadu and Kerala of which 110 were isolated and 60 were characterized through ITS sequencing and submitted to NCBI *Gen bank*. About 376 isolates of *R. solani* were collected and 40 isolates of *R. oryzae sativae / R. oryzae* were characterized and preserved for long term.

About ~2900 entries were screened artificially under field conditions through typha bit method of inoculation. Disease severity was observed using SES scale. Around 117 tolerant lines were identified.

Impact of climate variables like elevated CO_2 (eCO_2) and temperature (eTemp) on sheath blight was studied under Carbon dioxide and Temperature Gradient Tunnel (CTGT) with five controlled environmental conditions (E1-E5) with 8 different rice genotypes having varied level of susceptibility to sheath blight by inoculating *R. solani*. Among the environments, E4 (700 ppm and AT+2°C) induced higher relative lesion height (RLH) and area under disease progress curve (AUDPC) in tolerant genotypes (Pankaj, Tetep, Wazuhophek, and Poughak) compared to susceptible genotypes (IR50 and BPT 5204). AUDPC exhibited variation ranging from 602 (Phoghak) to 1689 (TN-1) under ambient conditions, while it ranged from 1689 (Phoghak) to 1792 (IR64) at E4. It is clear from the study that severity of the disease exhibited a positive correlation with the rise in CO_2 levels, particularly when coupled with a temperature increase of up to 2°C.

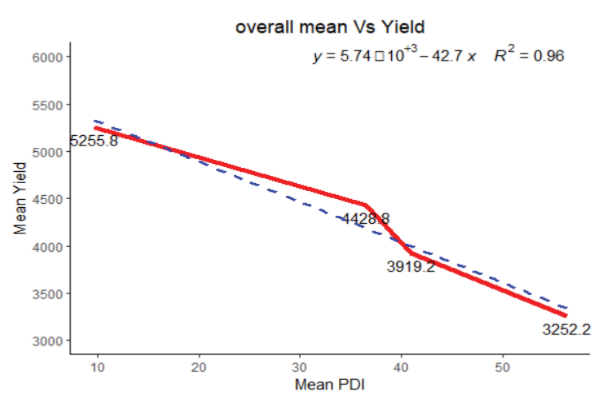
Carbon dioxide and temperature gradient tunnel (CTGT), ICRISAT



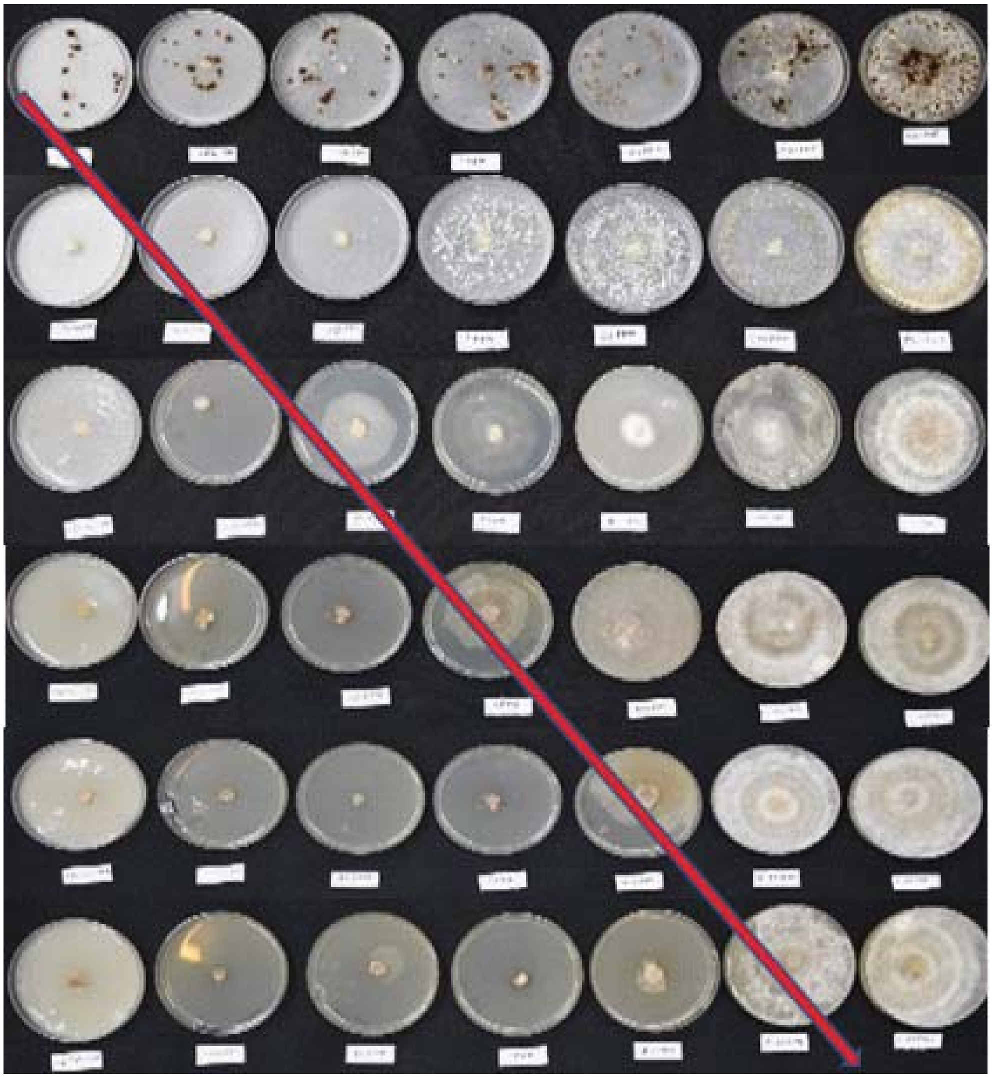
CTGT; A: Ambient, B: 550 ppm CO_2 LT, C: 550 ppm CO_2 HT, D: 700 ppm CO_2 LT, E: 700 ppm CO_2 HT.

In field, experiment during K-2022 showed percent yield reduction over control (PDR) was 56.57% in 100% diseased block (T1), 22.42% in 50% diseased block (T2), 9.97% in 30% diseased block (T3) and 0% in naturally diseased block (T4). Sheath blight disease severity and yield loss in rice shows strong negative correlation of 2:1 ratio. Based on the three-year yield loss data from Gangavathi, Ludhiana, Moncompu, Marateru and IIRR found that every one percent PDI on rice plant there will be ~ 43 Kg average yield loss due to sheath blight through artificial inoculation.

Huge variations were observed among 120 isolates through 12 cultural and morphological parameters. Among the 120 isolates, 35 isolates were identified as micro sclerotial in nature possessing the characteristic feature of *R. oryzae-sativae* or *R. oryzae*. Maximum number of (23/30) micro-sclerotial isolates was observed in West Bengal. Bioassay study was conducted for all the isolates with six different concentrations (0.01, 0.1, 1, 10, 100, 1000 ppm) of azoxystrobin by using poison food technique.



Sheath blight yield loss



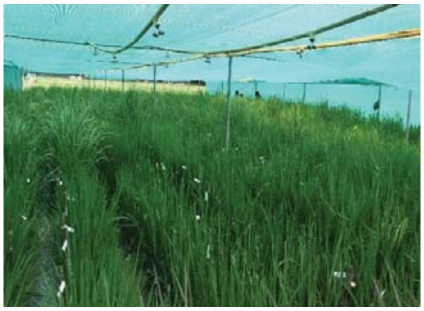
Azoxystrobin bioassay

Azoxystrobin bioassay of sheath blight pathogen from different states

State	Samples isolated	No of isolates showing resistance to different concentrations of azoxystrobin (ppm)					
		1000	100	10	1	0.1	0.01
Haryana	28	18	24	24	27	28	28
Punjab	33	11	28	29	31	33	33
Uttarakhand	15	7	15	15	15	15	15
West Bengal	30	19	26	28	30	30	30
Karnataka	11	7	9	11	11	11	11

HRP/CPT/PATH/23: Assessment of Host plant resistance, virulence, and management of false smut disease

False smut-infected grain samples were collected from the states of Chhattisgarh, Goa, Maharashtra, Karnataka, Kerala, Gujarat and Tamil Nadu during Kharif 2023. Thirty-one pure cultures of *U. virens* were obtained from the collected samples. Around 250 isolates of *U. virens* cultures are being maintained at IIRR.



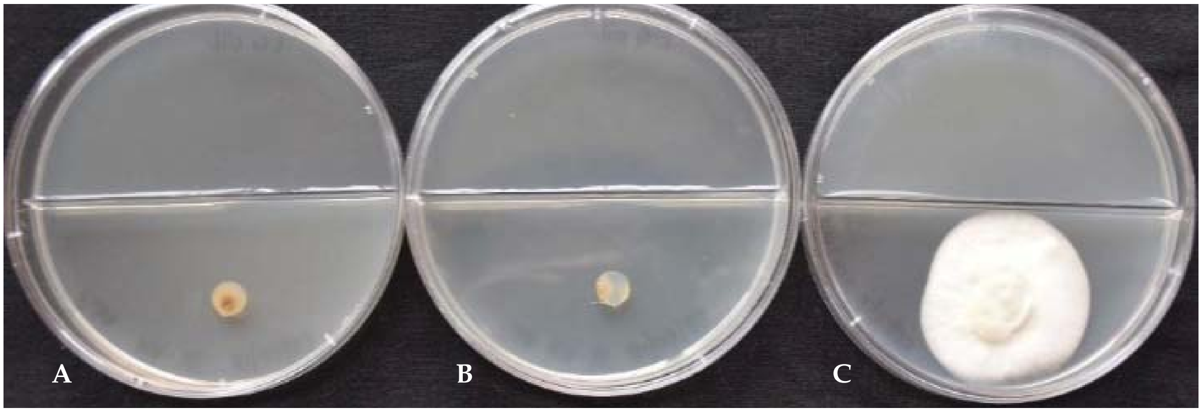
Establishment of genotypes in the artificial screening facility created at Rajendranagar Farm, IIRR.

Genotype NSN-71 showed susceptible disease reaction against false smut disease under artificial Screening

High number of smut balls (40) were recorded in CO-51 under artificial Screening

In Rabi 2022-23, a hundred and thirty-seven genotypes (137) were selected for the artificial screening. During, *Kharif* 2023, around 905 genotypes including National Screening Nursery lines, Landraces, Wild rice introgression lines, germplasm lines, and selected lines of *Kharif* 2022 were screened artificially in the false smut screening facility established at Rajendranagar Farm, IIRR. For each genotype, 5 to 10 panicles were inoculated at the booting stage. Under *in vitro* conditions, *U. virens* conidial suspension was prepared and injected into individual panicles using the injection method of inoculation. Inoculation of the genotypes was done from the 4th week of August 2023 to the 1st week of October 2023. Among the screened genotypes, 446 genotypes recorded smut balls ranged from 4 to 64 per panicle and categorized as susceptible. A total of forty-seven promising genotypes were selected based the number of smut balls ranging from zero to two (0 to 2) per panicle for further confirmation. Among the NSN-1 lines (112) were screened, 6 genotypes (entry numbers, 57, 184, 196,199, 208, 214) were selected as promising with a disease score of 3, which will be confirmed during Rabi 2023-24.

Based on the *in vitro* studies, five selected essential oils *viz*., lemon grass oil, Peppermint oil, Palm rose oil, Citronella oil and Cedarwood oil were evaluated (@ 0.05%) for their volatile effect on the *U. virens* mycelial growth. Among them, lemon grass oil completely inhibited the mycelial growth under *in vitro* conditions.



A, B – Mycelial growth is completely inhibited by the volatiles produced by Lemon grass oil; C- Control

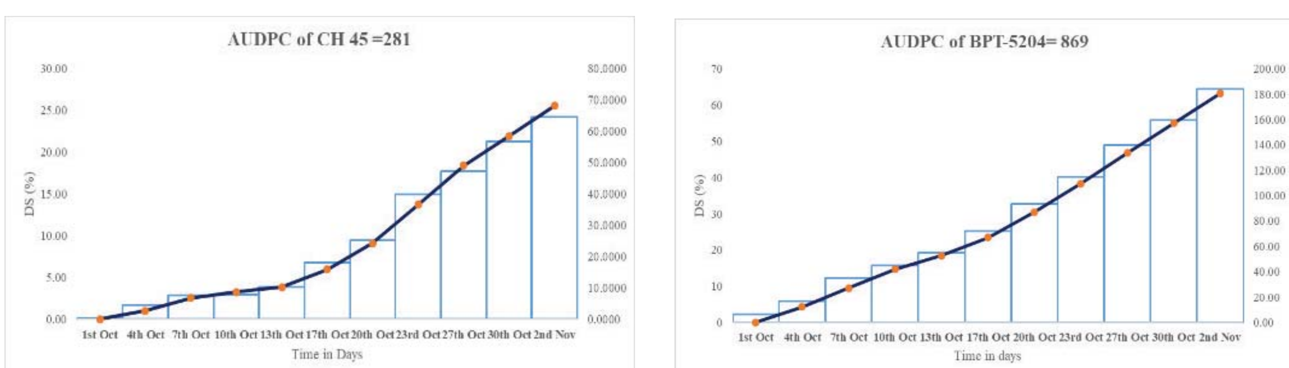
HRP/CPT/PATH/24: Survey, host plant resistance to brown spot disease of rice and its management

In *Kharif* 2023, extensive brown spot survey was conducted in Jharkhand and Chhattisgarh. In Jharkhand, surveyed disease severity was high to very high (50-70%) in Chaibasa, Kunti, Hazaribag, Koderma and Giridih districts. Disease severity in different villages of Gumla, Lohardaga, Latehar, Daltonganj, Chatra, Dhanbad and Palamu was observed to be low to moderate (20-30%); while in Ramgarh, Rampur, Saraikala, and parts of Jemshedpur showed low to very low disease severity (<10%). In Chhattisgarh, disease severity was high in villages of Jagdalpur, Bilaspur, Bemetera, Mungeli, Korba and Ambikapur districts; while it was low to moderate in parts of Kabeerdham, Kanker and Kondagaon. Lowest disease severity was reported in Raipur district. In general, disease severity more in the field having local cultivars with poor management, and low incidence and severity observed in hybrid rice field. About 200 diseased samples collected and isolation is under process.

Out of 190 interspecific population derived from IR64*1/*Oryza glabarrima* was screened during *Kharif* 2022 and *Kharif* 2023. Four lines (GL- 46, 81, 90 and 166) were found as resistant with score of 3 or disease severity of less than 5 based on the two-year average data.

Resistant lines identified from the interspecific population derived from O. glabberima x IR-64 population

The pooled data of two years for progression of disease on 19 different popular varieties revealed that, BPT 5204, Swarnadhan, Gangavathi Sona, RP-Bio-226 and Purple rice as highly susceptible; while CH-45, Tetep, Tadukan and Rasi as moderately resistant. The varieties/cultivars such as purple putti (878), BPT 5204(869), RP-Bio-226(852) and Gangavathi sona (841) showed higher AUDPC. Apparent rate of infection (r) varied among the different varieties and with the progression of the disease. It was more during the initial progression; while decreased during middle of the progression cycle and again slightly, increased when disease progressed towards its terminal severity.



Relationship between disease progression and AUDPC on Susceptible (BPT 5204) and moderate resistant (CH 45) varieties

HRP/CPT/ PATH/25: Studies on host plant resistance and management of stem rot and sheath rot diseases of rice

Total 24 samples were collected from the Telangana and Andhra Pradesh, out of which 18 isolates of *Sarocladium oruzae* were isolated and purified. The pathogenicity of all the 18 isolates were done on the susceptible cultivar TN-1. Among all the isolates, the isolate S0 13 from Jagtial showed 56.1% PDI. The least virulent isolate is from Morthad village of Nizamabad (3.5%PDI).

Integrated disease management of stem rot of rice with the biocontrol agent *Bacillus sp*, the organic amendment karanja cake and the fungicide Tebuconazole was taken up.

The combination of *Bacillus* seed treatment, soil application of karanja cake and foliar spray of Tebuconazole (T7) was the best combination for the control of stem rot disease as it recorded 75.69% disease reduction over control.

HRP/CPT/PATH/14: Assessment of host plant resistance and development of diagnostic tools for rice tungro disease

During the *Kharif* 2023, a roving survey was conducted in three districts (Ranga Reddy, Nalgonda and Yadadri Bhuvanagiri) of Telangana State and collected the suspected samples of tungro virus disease (apparently tungro infected). During the survey the vectors like green leaf hopper (*Nephotettix virescens*) and zig zag leaf hopper (*Recilia dorsalis*) were observed in the fields and collected. The weeds like *Cyprus rotundus, Cynodon doctylon, Echinocloa crusgulli, E. colonum, Dinebra retroflexa, Digitaria sangninalis, Chloris barbata* and *Dactylacteniuem aegyptium* were identified in the fields. The soils collected from the sites are mostly alkaline and sodic in nature except one site which belongs saline soils. All the collected isolates are being maintained at glass house, IIRR and the confirmatory diagnostic tests are under progress.

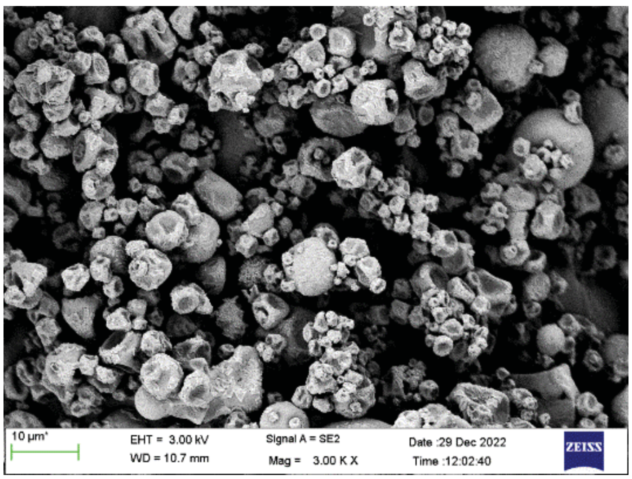
Eleven weed host species (*Eleusine indica, Digitaria sanguinalis, Hexasepalum teres, Eragrostis amabilis, Dinebra retroflexa, Cyprus esculentus, Echinochloa colonum, Cynodon dactylon, Dactyloctenium aegyptium, Echinochloa crusgualli, Chloris barbata and Euphorbia hirta)* were randomly collected within or surrounding rice plots regardless of the presence of symptoms. Plants at the borders and between the greenhouse units were also sampled. The plant species of the collected samples were identified according to the botanical classification. DNA has been isolated from the weeds and confirmation of RTD through PCR is being done.

A total of 149 back crossed wild rice introgressed lines were tested in the forced- tube inoculation method. The rice genotypes comprised of 81 introgression lines of BPT 5204 x *Oryza rufipogon* and 68 advanced backcross generation of Swarna x *Oryza nivara*. Among 149 rice genotypes 5 rice genotypes viz., 4B, 5B, 6B, 24B and 25B obtained from the back cross of BPT 5204 x *Oryza rufipogon,* produced mild or no symptoms and recorded disease score of three (3) at the time of scoring were on par with the resistant check Vikramarya and were considered as resistant genotypes. Five resistant genotypes were observed in genotypes obtained from the advanced back cross generation of Swarna x *Oryza nivara*.

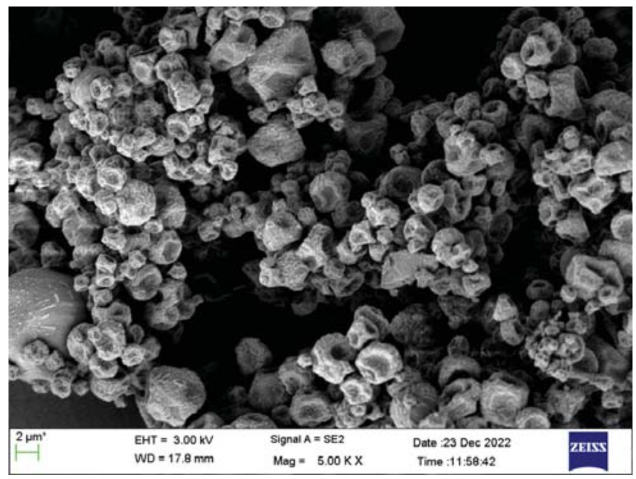
HRP/CPT/ PATH/20: A consortia approach to the biological management of diseases in rice Biological control

Bio-agent *Pseudomonas putida* (PIK1) against stem rot pathogen was isolated and characterized by morphological and whole genome sequencing and submitted to NCBI Gene Bank (Accession No: ON778610). Secondary metabolites of PIK1 characterized and accordingly a pure compound viz., 2MP (expand) was obtained. The structure of the compound was confirmed as 2-Methyl Pyrazine and checked for its antagonistic ability against *S. hydrophilum* and *U. virens* using poisoned food technique and agar disc diffusion technique.

Secondary metabolites from TAIK1 (*Trichoderma asperellum*) and PIK1 (*Pseudomonas putida*) were encapsulated using different process. Here the selected core particles for microencapsulation are conidia of TAIK1 and cells of PIK1 and for nano scale encapsulation TAIK1 pyrone metabolite and PIK1 methyl pyrazine. The coating material/ wall materials are maltodextrin, carboxy methyl cellulose, gaur gum, sodium alginate, gelatin and hardening agents $CaCl_2$. Culture and spore suspension were prepared with cfu/ml of 1.86 x 10^8 for PIK1 and 2.26 × 10^7 for TAIK1 maintaining OD_{600nm}~1.0. Extrusion, emulsification and spray drying methods were tested and compared. Survival and viability rates of the microcapsules were achieved using a combination of maltodextrin (2%), gelatin (1.5%), and CaCl2 (2%) as the wall material, along with optimized spray drying conditions i.e., inlet temperature of 130°C and flow rate of 60 mL/h for TAIK1; and inlet temperature of 120 °C and flow rate of 60 mL/h for PIK1. The encapsulation of the spores and cells are expected to protect them from various biotic and abiotic stress factors and promote promising potential for practical applications.



SEM image of encapsulated TAIK1 spores [Maltodextrin (2%) + gelatin (1.5%) + $CaCl_2$ (2%)]



SEM image of encapsulated PIK1 spores [Maltodextrin (2%) + gelatin (1.5%) + $CaCl_2$ (2%)]

TTI - Training, Transfer of Technology and Impact Analysis

TTI/TTT/EXT/18: Small holder Rice Production in India: Problems and Prospects

This study was carried out in the North Indian state of Uttar Pradesh in Gorakhpur district. A total of 200 small and marginal farmers were selected and information elicited by using an interview schedule. The methodology used in this study is Farming systems approach. Farming systems analysis is a conceptual framework which considers the heterogeneity of smallholders and is useful for designing appropriate agricultural development strategies. It defines the interactions between a household, its activities, and the resource base as a farm system, where the biophysical, socio-economic, and human elements are interdependent

The de-peasantization process is very fast due to the increase in cost of cultivation also lot of opportunities in the non-agricultural sector with assured income. Almost 71 percent of the farm families across the caste groups opined that their wards are not at all interested to agriculture as an occupation to earn their livelihood. The prefer to migrate to urban areas to do the jobs which are having less drudgery, and reasonably good income.

Result from the study indicates most of the small and marginal farmers are selling their land and joining in the category of agricultural labors and the reason being listed out by them are i) increasing cost of cultivation (78%), ii) less inclination by the younger generation (71%), iii) income from agriculture is not enough for the household throughout the year (67%), iv) income from agriculture is not constant (61%) v) vagaries of monsoon and climate change, (58%), vi) increasing cost of critical inputs (55%), vii) risk involved in agriculture (47) viii) lack of procurement policies (40%)and ix)unable to compete with the big and very big farmers (35%).

TTI/EXT/16: Smart village strategy for accelerated rice technology transfer

A situational analysis of rice cultivation practices and constraints was undertaken under the Institute project, Smart village strategies for accelerated rice technology transfer in Shanker Konda Tanda of Amangal Mandal, Ranga Reddy District, Telangana. Awareness on varietal replacement with new improved cultivars like DRR Dhan 64, DRR Dhan 52 and DRR Dhan 54 in place of MTU 1010 and Improved Samba Mahsuri (ISM) and DRR Dhan 48 in place of BPT 5204 developed by ICAR-IIRR was created among the tribal farmers.

Drones offer a cost-effective alternative to traditional manual labor for spraying and monitoring activities, reducing operational expenses and providing increased efficiency. The willingness to pay (WTP) for a drone service was elicited from the farmers. Majority of the farmers were willing to pay between Rs.800-1000/acre to avail drone services for spraying for pest control.

Skill training was imparted on use of Rice IPM App and the farmers could easily match the damaged plant samples with the visible symptoms feature in the app to identify the pest damage and follow the remedial measures suggested.

Awareness was created about Pradhan Mantri Kusum Yojana for solar pump sets among farmers of adopted villages. Farmers were facilitated to register online to avail the benefits of the scheme as a means of climate resilient and smart irrigation interventions. Creating email id for farmers is challenging and printed literature in local language was prepared and distributed.

Custom Hiring Centre for destitute women to hire out power sprayers and earn a decent income was established at Manchal Village, Telangana with the financial support of IIRR- SCSP.

TTI/TTT/EXT/14: Innovations in group-based extension approaches: Accelerating rice technology transfer through farmer-based organizations

Profiling studies for the selected twenty FPOs was undertaken to identify their technological needs as per the members of their FPOs. The genesis and activities undertaken namely providing quality inputs and extension support through the input shops and trained extension staff, Training activities, procurement activities were documented.

IIRR – FPC interventions comprised of demonstrations on IIRR technologies like biofortified rice varieties like DRR Dhan 48, Seed Production of IIRR varieties, Need-based Information sharing (through digital and non-digital means), Rice Check Meeting, exposure visits to IIRR & other FPCs were specifically designed and undertaken. A survey was conducted among the 120 respondents from FPO members. Farmers expressed their satisfaction in growing DRR Dhan 48 that exhibited better yield advantage (35%). Regarding the training module for the FPOs, members preferred Pest & disease diagnosis (92.5%), Information on Farm equipment (80%), latest management practices (72.5%), Irrigation management & Nutrient management (70%), Seed availability (60%). Demonstration of DRR Dhan 48 is being undertaken with Natural Farms & Agro Products Producer Co. Ltd, Kolhapur.

A database on Farmer Producer Organisations is being maintained and updated. State wise details of FPOs under Central Sector Scheme for Formation and Promotion of 10,000 FPOs by SFAC as on 21-07-2023, 2543 FPOs are registered. Uttar Pradesh has the maximum number of FPOs (512) followed by Madhya Pradesh (245). NABARD is also promoting FPOs in 30 states covering 495 districts by promoting 2065 FPOs with 991975 shareholders. In case of NABARD promoted FPOs, Tamil Nadu has the maximum number of FPOs (170) followed by Madhya Pradesh (160) and Karnataka (159).

TTI/TTT/ECON/4: Economic, Energy and Sensitivity Analysis of selected Rice Production Technologies

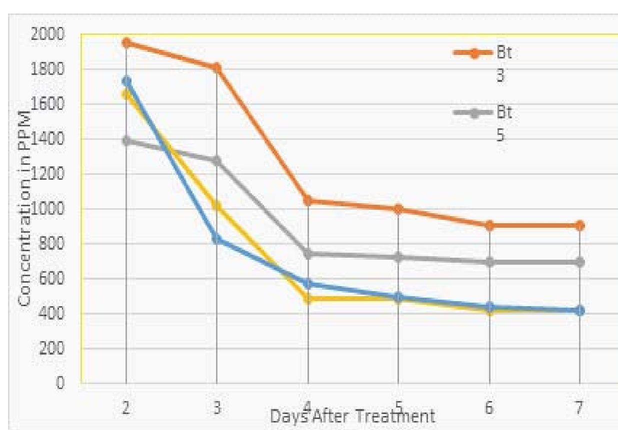
A study on the energy economics of mechanized Direct Seeded Rice (DSR) was conducted in Andhra Pradesh. Primary data were obtained through a survey with a structured questionnaire, key informant interviews, focus group discussions, and field observations. The data obtained through the survey were analyzed. The adoption of DSR has resulted in reducing the total cost of cultivation per hectare by 13%. The BC ratio for conventional and DSR methods was 1.2 and 1.3 respectively. The energy consumption for DSR and the conventional method was estimated. From the literature review, equivalent energy inputs were determined for all input and output parameters for rice energy sources. Total energy input was calculated based on energy inputs for various operations from land preparation to harvest and energy output was based on grain and straw yields. Energy calculations like Energy use efficiency, Energy Productivity, Specific energy, and Net energy benefit were worked out for DSR and conventional methods of rice cultivation.

The adoption of DSR ensured higher productivity with higher energy efficiency and returns. The energy use efficiency obtained for the DSR method was 7.8, while for the conventional method, it was 5.9. The average energy productivity was 0.29 kg/MJ for DSR method and 0.22 kg/MJ for the conventional method, which means 0.29 kg of paddy is produced per unit energy in the DSR method and 0.22 kg of paddy is produced per unit energy in the conventional method. The results of the specific energy indicate that the conventional method requires 5.4 MJ of energy to produce a kilogram of paddy while with the DSR method, about 4.1 MJ of energy is consumed to produce one kilogram of rice. The conventional method has a net energy gain of 1,68,812 MJha-1, whereas DSR method has a net energy gain of 1,71,657 MJha-1. The results indicated that the DSR method is more energy-efficient as compared to the conventional method.

TTI/TTT/EXT/17: On-Farm Adoption of IPM Technologies and impact analysis

Varietal demonstration was carried out in three villages *viz*., Kanchiraopalle (Mandal-Pebbair), Annaram and Dondaipalle (Mandal-Pangal) with nine varieties released from ICAR-IIRR (DRR Dhan 48, 49, 50, 53, 55, 59, 60, 62 and 64). Each variety was planted in around 500 square metres area in the demonstration field, which facilitated the local farmers to have first-hand perception about the performance of the variety in their area. The IPM strategies were adopted by 78 farmers spread over six villages (Mallepally, Jammapuram, Rainpally, Chikkapally, Dondaipally and Kanchiraopally) planted with DRR Dhan 50 (50 acres) and DRR Dhan 51 (28 acres). The IPM farmers adopted the following IPM components, Alleyways i.e. leaving one row after every 10 rows, clipping off leaf tips during transplanting for removing egg masses of stem borer

The participatory farmers sprayed one or two sprays compared to 3 to 4 sprays by other farmers. The IPM farmers obtained an average yield of around 59.3 Q/ha compared to that of 57.2 Q/ha by other farmers with a cost: benefit ratio of 3.1 and 2.4 respectively. Six, *Bacillus thuringiensis* (Bt) isolates and one *Alcaligenes faecalis* isolate (collections of ICAR-IIRR) were tested for bio-efficacy against Castor semilooper *Achaea janata*. Out of this three Bt isolates *viz*. Bt3, Bt5 and Bt6 as well as *A. faecalis* isolate were found to be highly effective with lower LC50 values.



LC50 values of *Bacillus thuringiensis* and *Alcaligenes faecalis* isolates against castor semilooper

TTI/ECON/5: Competition and equity issues in Indian rice sector

Review of literature, documenting new policy initiatives with respect to carbon markets both at global level and national level in India was carried out. Collected secondary data from Carbon registries that is Verra carbon project and Gold Standard carbon project websites. It was observed that under Verra registry, India's share in global level registered number of Agriculture, Forestry and Land use change based carbon projects was 3 percent. In the case of gold standard carbon registry, India's share in global level registered number of Agriculture, Forestry and Land use change based carbon projects was 6 percent. In India, with reference to rice, carbon projects proposals were focused on (i) promoting cultivation systems like Alternate Wetting and Drying (AWD), System of Rice Intensification (SRI), and Intermittent flooding (ii) rice husk-based co-generation projects. From the economic perspective integrating mandatory and voluntary carbon credit markets is a key issue. Identifying appropriate carbon credit pricing models (i) social cost-based pricing or demand based pricing or compensating pricing and (ii) pricing by differentiating between carbon removal projects and carbon reduction/avoidance project are the key challenge identified.

TTI/TTT/STAT 4: Statistical modelling and soft computing approaches for genomic selection in Rice

The genomic prediction models developed in this project were validated in Rice 3K SNP-seek database. Six different models, namely Bayes A, Bayes B, Bayes C, Bayesian LASSO (BL), Bayesian Ridge Regression (BRR), and Bayesian Reproducing Kernel Hilbert Space (RKHS) models, were employed. A 5-fold cross-validation scheme was used for model building and validation. The RKHS model performed better compared to other models as it resulted in highest R^2 and lowest RMSE values among the six models tested.

SAS IML program for analyzing AICRIP multiplication trails were developed and used for analyzing various AICRIP breeding trails. In the reporting period, mainly genetic gain modeling of AICRIP data was carried out for two irrigated trails namely AVT IM and AVT ETP, these trails were chosen based on the availability of continuous data. Yearly data of all the zones were collected from volume I AICRIP report and then averaged to get the mean across all the zones. Along with overall mean, best entry yields and best check yield was also considered. For AVT IM data from 1981 to 2022 was considered and for AVT ETP 1980 to 2022 data was considered. To begin with the modeling linear trend equation was fitted to the data. For AVT IM overall mean yield, best entry yields and best check yield the regression equations (1 to 3) are as follows and resulted significant parameter with probability of significance $p<0.0001$and R^2 values 0.646, 0.68 and 0.62 respectively.

$Y=35.89X+4131.9$ … (1)

$Y=41.64X+4526.8$ … (2)

$Y=38.62X+4281.3$ … (3)

For AVT ETP trails. overall mean yield, best entry yields and best check yield the regression equations (4 to 6) are as follows and resulted significant parameter with probability of significance $p<0.0001$and R^2 values 0.548, 0.552 and 0.474 respectively.

$Y=45.41X+3473.7$ … (4)

$Y=47.705X+4059$ … (5)

$Y=44.995X+3692.8$ … (6)

The result indicates genetic has positive significant impact over the years, indicating AICRIP system has contributed positively in genetic yield gain of Rice.

As the data under consideration was autocorrelation as confirmed by Box-Pierce non-correlation test ($p<0.0001$ for the six series) therefore trend analysis using Mann-Kendall and modified Mann-Kendall test was performed and in both the test, the parameter tau was significant confirming the presence of significant trend in genetic gain for both the data sets. Sen's slope method was employed to estimate the magnitude of rate if change, the results reveal parameters were positive and significant for all the six data sets.

Later Pettitt's statistic for change point detection was employed to identify the change points. The result indicates, for AVT IM trails year 2001, 2002 and 2001 were the change points and for AVT ETP year 1997, 1998 and 2000 were change points for mean yields, best entry yields and for best check yield respectively. These change points were significant as the probability values were significant ($p<0.0001$). The change point indicates the possible technological interventions happened in the AICRIP system.

Additionally, interventions model was developed using change points and among all the models, ANN intervention model yield lowest RMSE values for forecasting future yield.

As part of modeling of rice data activity, a hybrid zero inflated count time series forewarning model using artificial Intelligent (AI) algorithm, was developed to predict the population of the rice Yellow Stem Borer (YSB) across the country's hot spot locations. Statistical machine learning based ensemble models were also developed to predict the climatic variables. Furthermore, an AI-based nonlinear intervention model;

$$X_t = F(X_{t-t1}, X_{t-t2}, \ldots, X_{t-tc}, \delta_1^{\,t}, \delta_2^{\,t}, \ldots, \delta_m^{\,t}) + \varepsilon_t \qquad \ldots (7)$$

was developed to model and forecast the interrupted (policy interventions) the time series data.

Institutional Activities

Institutional Activities

Technologies Assessed and Transferred
Human Resource Development
Intellectual Property Management and Revenue generation
Awards and Recognitions
Patents/Copy rights/Mobile Applications
Deputations/Linkages and Collaborations
Important Institutional Meetings
Extension Activities
Personnel
Publications
Appendices

Transferable Technologies/ Patents/ Genetic stocks/ databases/ generated from recent research out put

Varieties released

DRR Dhan 70 (IET 29415), a high yielding line developed from MTU 1010 /WGL 505 for direct seeded aerobic cultivation. The overall mean grain yield of IET 29415 tested over zones was 4347 kg/ha, and in Zone III was 3989 kg/ha. IET 29415 has good hulling (78.85%), milling (70.40%) and head rice recovery (64.80%) with intermediate amylose content (21.26), alkali spreading value (3.0), gel consistency (38mm), long bold (LB) grain type (KL-6.14 mm; KB-2.20 mm). This culture exhibited moderate resistance to leaf blast, brown spot, sheath rot, rice tungro disease and grain discoloration. IET 29415 is recommended for Odisha and Bihar (Zone III) by the Varietal Identification Committee (VIC) Meeting held on 4th May 2023 during the 58th ARGM at Assam Agricultural University, Jorhat

DRR Dhan 71 (IET 29421) (RP 6324-123-14-4-1) was developed from CR 691-1/CR Dhan 202, a high yielding with better grain quality variety and tolerance to major diseases and insect pest for direct seeded aerobic cultivation. The overall mean grain yield of IET 29421 in Zone VI and VII was 4484 kg/ha. This culture exhibited moderate resistance to leaf blast (LB), neck blast (NB), sheath rot (ShR), brown spot, rice tungro virus, sheath blight and Grain Discoloration (GD) with moderate tolerance against plant hoppers. IET 29421 possesses intermediate amylose content (24.75), alkali spreading value (7.0), gel consistency (24mm), medium slender (MS) grain type (KL- 5.72 mm; KB- 2.06 mm) and other desirable grain quality parameters. IET 29421 is recommended for Odisha (Zone III), Gujarat (Zone VI) and Tamil Nadu (Zone VII) by the Varietal Identification Committee (VIC) Meeting held on 4th May 2023 during the 58th ARGM at Assam Agricultural University, Jorhat.

DRR Dhan 72 IET 28821 (RP5964-82) is a high-yielding variety derived from the cross KMR 3R X Swarna by back cross and pedigree breeding strategy. It has seed to seed maturity of 130-135 days and gives an average yield of 6.5 t/ha (under normal conditions; 60 kg/ha of P, i.e. recommended dose) and 5.3 t/ha (No P applied). ET 28821 (RP 5964-82) exhibited moderate resistance to neck blast, leaf blast, brown spot. It showed a resistance reaction against false smut disease. IET 28821 (RP 5964-82a) possesses a long bold grain type with high HRR (62.5%) and acceptable grain quality parameters of intermediate amylose content (24.11%), GC (22) and ASV (7.0). It was identified for low P soil conditions in Karnataka and Telangana (Zone VII) by the Varietal Identification Committee (VIC) Meeting held on 4th May 2023 during the 58th ARGM at Assam Agricultural University, Jorhat.

Genetic stocks

National identity	Donor identity	INGR No.	Year	Novel unique features
IC648978	RP6253-MV2 (Varadhan × MTU1010/2)	23002	2023	High Nitrogen Use Efficiency (NUE) under N-Low and N-50 input.
IC648592	MSM-3, TI-3, IET-28688	23003	2023	Increased root length and root volume. Better seedling vigour index.
IC648977	RPbio4918-166S	23005	2023	High photosynthetic rate. High seedling vigour.
IC648602	MTU IJ 206-7-4-1; MTU IJ 206-7-4-1 (BM 71)	23015	2023	Resistance to Brown Plant Hopper.
IC646828	SM-92; IIRR-BIO-SB-9; RP5977-BIO-SB-9	23065	2023	Tolerance to yellow stem borer.
IC650728	IL19273, 19273, FBL 19273	23068	2023	Multiple tolerance to sheath blight, sheath rot, RTD, leaf blast and neck blast diseases. Drought tolerance-high yield under reproductive stage drought stress
IC650729	IRGC 39111	23069	2023	Strong culm.
IC650730	IL 19101, FBL 19101, FBL 19102, IL 19102, RP 6614-101, RP 6614-102	23070	2023	Resistance to gall midge, bacterial blight, blast
IC650767	IL 19471, IET 29834	23071	2023	Reproductive stage drought tolerance. Resistance to blast and bacterial blight.
IC650732	IET29482 (RP6211-PR/RIL-Q181)	23074	2023	High grain Zn content (28.22ppm) in polished rice grain. High Protein content (8.08%) in polished rice grain
IC650734	IET29484 (RP6204-MB/RIL-J159)	23075	2023	High grain Zn content (24.32ppm) in polished rice grain.
IC650733	RP6257- SJ3 (Sampada× Jaya /3)	23076	2023	High and stable grain yield under N-Low, N-50 and N-100 fertilizer input. High Nitrogen use Efficiency under N-Low and N-50 input.
IC650735	RP6252-BV/RIL/1689 (CNN1)	23077	2023	High and stable grain yield under N-Low, N-50 and N-100 fertilizer input. High Nitrogen Use Efficiency under N-Low and N-50 input. High nutrient (NPK) uptake and high grain yield under native sodic soil conditions (without gypsum amendment; pH 8.5 – 10.0) across field locations under AICRIP testing.

NCBI Submissions

- BioProject ID: PRJNA851222 for STRONG CULM MutMap QTL-seq data (Strong culm mutant line TI-17 and wild-type BPT5204)
- SRA data: PRJNA846116 for MutMap QTL-Seq analysis of rice samples for root length and root volume (TI-128 and BPT-5204)
- BioProject accession ID: PRJNA916352 for complete panicle exertion (CPE 110)
- Bioproject accession ID: PRJNA715598 for submission of 42 isolates of *R. solani*

Human Resource Development

During the period, eight training programs were organized and overall, 768 stakeholders were trained

other identified interventions to enhance yield and profitability.

S. No.	Name of Training	Sponsored By	Date	Number of Participants
1	Value Chain Development of Paddy and Paddy based products for FPO members of Maharashtra (Bhandara District)	World Bank assisted SMART project of Maharashtra government	16th – 20th October 2023	23
2	Value Chain Development of Paddy and Paddy based products for FPO members of Maharashtra (Gondia District)	World Bank assisted SMART project of Maharashtra government	26th Oct to 1st November 2023	22
3	Multivariate Statistical Machine Learning Methods for Modelling Agricultural Data	SERB Sponsored High End Workshop	24 July – 4 August, 2023	25

Winter School on Development, Evaluation, and Biosafety Assessment of Genome Edited Crops: Hands-on Training

ICAR sponsored 21-day Winter School on "Development, Evaluation, and Biosafety Assessment of Genome Edited Crops: Hands-on Training" which was successfully conducted by ICAR-IIRR, Hyderabad, from 20th January to 9th February 2023 in collaboration with Agri Biotech Foundation (ABF), Hyderabad. This training course covered various in-vogue topics on Genomic Editing through a series of structured modules. Expert resource persons were identified from various ICAR institutes, SAUs, International Research Organisations, and other National Organisations who delivered the lectures, hands-on experience, and field visits. The inaugural function of this course was held in the forenoon of 20th January 2023. Dr. Ramesh V. Sonti, Director, ICGEB, New Delhi, inaugurated the program. Dr. P. Anand Kumar, former Director, ICAR-NRCPB and ICAR-IIRR, was the guest of honour, and Dr. R. M. Sundaram, Director of ICAR-IIRR, presided over the function. A total of 25 participants from various ICAR institutes and state agricultural universities covering 17 states/union territories attended the training. Dr. T. R. Sharma, DDG (CS), ICAR, was the chief guest, and Dr. Seema Jaggi, ADG (HRD), ICAR, was the guest of honour for the valedictory function. Dr. R. M. Sundaram, Director ICAR-IIRR, in his remarks, wished for the success of the winter school.

Training on Gene Editing and Technology Management in Agriculture, conducted by ICAR-NAARM and ICAR-IIRR, 10-14 July 2023

Off campus Training

Field visits, training cum awareness programmes on the management of stem borer and other problems in Kharif rice in Siddipet District along with the officials of PJTSAU. Dr AP Padmakumari, along with along with the officials of PJTSAU viz., Dr NRG Varma, Dr Spandana Bhatt, Dr S. Sridevi, Mr Vijayt and Ms Ramani, MEO, Narayanraopet mandal, AAO- Mr Nagarjuna, Sarpanch Sri Devaiah, *Rythu samanvaya samithi Adhyakshudu* Sri Nageswara Reddy organised a training cum awareness programme at Ibrahimpur, an adopted village, on 17.5.2023 to create awareness on management practices, pest management, with emphasis on rice stem borer management and demonstration of drones for spraying in kharif crop. Nearly 50 farmers, RAWEP students, scientists from ARS Tornala participated in the awareness meeting.

Integrated Pest Management Training in Mayurbhanj and Ganjam Districts, Odisha

A series of three IPM Stakeholder Workshop was conducted in collaboration with IRRI India under Climate PRO project to share the experiences of IPM demonstrations in 9 districts of Odisha under IRRI-ICAR collaborative project "Increasing productivity of rice-based cropping systems and farmers income. Drs. Chitra Shanker, B Sreedevi, D Krishnaveni, Brajendra, and P Muthuraman, conducted training sessions for Agri-Horti officers, FPOs, and farmers in Mayurbhanj, Ganjam and Balangir districts.

Integrated Farming Program towards Empowering farmers at Parushurampally Village

The Department of Horticulture, Agriculture, and the Seva Spoorthi Foundation collaboratively organized a programme on integrated farming practices for chilies, cotton, and paddy crops at Parushurampally village in Ghanpur Mulug Mandal, Bhupalpally district of Telangana on August 31, 2023. The event featured a demonstration and practical session on soil testing, utilizing a soil testing kit developed by ICAR-IIRR, Hyderabad.

Demonstrations to raise awareness of Spraying of Pesticides with Drones

A series of drone spraying demonstrations were conducted in several villages in Telangana state in association with the stakeholders to create awareness among farmers about the application of drone technology in agriculture.

Trainings/ workshops attended by IIRR staff in 2023

Scientific Staff			
Scientist	**Programme name**	**Organizers**	**Duration**
Papa Rao Vaikuntapu	Hands-on Training on Development, Evaluation, and Biosafety Assessment of Genome Edited Crops	ICAR-Indian Institute of Rice Research, Hyderabad	20 January - 09 February
Revathi P Fiyaz RA	Intensive Genomic Selection and Modern Experimental Design	ICAR_BMGF with IRRI, Philippines	February 12 - 24
R Gobinath Santosha Rathod	Statistical analysis and interpretation of Agricultural Data"	ICAR- Indian Agricultural Statistics Research Institute New Delhi	1-10 March
K. Sruthi	Data visualization using R (Online Mode)	ICAR-NAARM, Hyderabad	3 - 8 March
	Multivariate data analysis (Online Mode)	ICAR-NAARM, Hyderabad	20 - 27 March
S K Mangrauthia Jyothi Badri Fiyaz RA Divya Balakrishnan Suvarna Rani Sanjeeva Rao	3 Days Training Program on Grain Quality from conducted by IRRI at ISARC, Varanasi	International Rice Research Institute at ISARC, Varanasi	29 - 31 March
Santosh Rathod	ऑनलाइन हिन्दी कार्यशाला परीक्षण अभिकल्पना के अनुप्रयोग	ICAR- Indian Agricultural Statistics Research Institute New Delhi	28-29 March
V. Prakasam	Genome editing and technology management in agriculture	ICAR-NARRM, Hyderabad	10-14, July
V Chinna Babu Naik	Natural farming Prospects and Strategies for Soil and Crop Sustainability	RARS, TIRUPATHI, ANGRAU	1 -10 November
Non-Scientific Staff			
Technical Officers			
S. Amudhan K. Shravan Kumar	Motivation, Positive thinking and Communications skills for Technical Officers	NAARM-Hyderabad	11-15 September

Intellectual Property Management

IPR awareness programme

As per ICAR initiative, an Intellectual Property Rights (IPR) awareness programme "Workshop on IP Management" was organised on 25.09.2023 at ICAR-IIRR, Hyderabad for the scientists and technical staff. The programme was conducted under the Chairmanship of Dr RM Sundaram, Director, ICAR-IIRR, Hyderabad and Dr Vikram Singh, Senior Scientist, IPTM Unit, ICAR Headquarters was the Chief Guest of this programme. Dr Suvarna Nilakh, Assistant Professor, ILS Law College, Pune and Dr Ashwini Siwal, Assistant Professor, Faculty of Law, Delhi University have participated virtually as resource persons in the programme. Around 50 Scientists and 10 Technical Staff of ICAR-IIRR participated in this workshop.

World Intellectual Property Day

A webinar was organized on the occasion of "World Intellectual Property Day" with the theme of "Women and IP: Accelerating Innovations and Creativity" on 26.04.2023 at ICAR-IIRR, Hyderabad. A total of 100 participants, including Scientists, Research scholars, SARR members attended this webinar.

Lecture on Intellectual Property Rights (IPR)

A lecture on IPR "Understanding protection of plant varieties and commercialization process" for Ph.D Scholars of Department of Agril. Extension, PJTSAU-College of Agriculture, Hyderabad on 30.08.2023 at ICAR-IIRR, Hyderabad.

Awards and Recognitions

- Dr Papa Rao Vaikuntapu was the co author of the Best Oral Presentation paper titled "Prospects of genome-editing in oilseed crops", in the International Conference on Vegetable Oils 2023 (ICVO 2023) on "Research, Trade, Value chain and Policy" jointly organized by Indian Society of Oilseeds Research, Hyderabad and ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad during January 17-21, 2023 at Hyderabad, India.
- Dr V Chinna Babu Naik, received 'Best Scientist Award' from ICAR-Central Institute for Cotton Research on the foundation day, 1 April 2023.

- Dr V Chinna Babu Naik received "Best oral paper presentation Award" from Plant Protection Association of India during the 'International Conference on Plant Health Management ICPHM 2023: Innovation and Sustainability held at Hyderabad, from 15-18 November 2023.
- Dr Chavan SN, received "Young Scientist Award" from Plant Protection Association of India during the 'International Conference on Plant Health Management ICPHM 2023: Innovation and Sustainability held at Hyderabad, from 15-18 November 2023.
- Dr Somasekhar N, received Best Scientist (Senior Category) Award from Plant Protection Association of India for the outstanding contributions in the field of Nematology during the 'International Conference on Plant Health Management ICPHM 2023: Innovation and Sustainability held at Hyderabad, from 15-18 November 2023.
- Dr B. Nirmala received the 'Young Scientist Award' of the Society of Extension Education, Agra during the 1 st International Extension Education Congress-2023 held at RARI, Durgapura (SKNAU, Jobner) Jaipur, Rajasthan during December 18-20, 2023.
- Dr Amtul Waris was conferred the Society of Extension Education Fellow Award, conferred during the the 1st International Extension Education Congress (IEEC)-2023 Rural Transformation and Sustainable Agri-food System through Community Based Organisation (CBO) Oriented Extension Strategy, Organized by the Society for Extension Education, Agra, during December 18-20,2023 at the Regional Agricultural Research Centre, Jobner, Jaipur
- Dr Amtul Waris received the Best Oral Presentation Award for, Empowering Smallholder Farmers for Sustainable Agri-food Systems: A Case Study of Soil-SMaRT Interventions in Rangareddy District, Telangana, India at the1st International Extension Education Congress (IEEC)-2023 Rural Transformation and Sustainable Agri-food System through Community Based Organisation (CBO) Oriented Extension Strategy, Organized by the Society for Extension Education, Agra, during December 18-20, 2023 at the Regional Agricultural Research Centre, Jobner, Jaipur.
- Smt Kavuri Sarda Memorial Award-2019 for Best research paper, "S Vijay kumar, M Srinivas Prasad, R Rambabu, B Bhaskar, RM Sundaram, V Prakasam, D ladhalakshmi, GS Laha and M Sheshu Madhav. 2019. Marker assisted introgression of broad-spectrum blast resistance gene Pi-2 into an elite rice cultivar, Samba Mahsuri published in the Indian Journal of Plant Protection 47 (3&4), 154-163, 2019.
- Best oral presentation award received by V Prakasam, V M Manoj, Mamta Sharma, K Swaroopa, Ramana Gouda, M Vikraman, Kasi Rao Mediga, G S Laha, M S Prasad, Ch Padmavathi, Chitra Shanker, R M Sundaram (2023). Assessing the impact of elevated CO2 and temperature on the severity of rice sheath blight disease in the context of changing climate in International Conference on Plant Health Management ICPHM 2023: Innovation and Sustainability 15-18th November 2023, PJTSAU, Hyderabad, India.
- Best poster presentation award received by K. Swaroopa, V. Prakasam, B. Lavanya, V. M. Manoj, D. Bhanushree, M. Vikraman, G. S Laha, and M S Prasad (2023) Resistance monitoring for rice sheath blight pathogen (Rhizoctonia solani) against Azoxystrobin fungicide in International Conference on Plant Health Management ICPHM 2023: Innovation and Sustainability 15-18th November 2023, PJTSAU, Hyderabad, India.
- Sundaram RM was invited as Panelist in the session, "Transformative Innovations for Rice Production in 21st Century" during the 2nd Indian Rice Science Congress, 2023, ICAR-National Rice Research Institute, Cuttack, Odisha, India 11th to 14th February, 2023.
- Dr M Srinivasan Prasad recognised as Fellow award of the Plant Protection Association of India from Plant Protection association of India (PPAI) during International Conference on Plant Health Management ICPHM 2023 - Innovation and Sustainability, 15th -18th November 2023 held at PJTSAU, Hyderabad
- Dr D Krishnaveni recognised as Fellow award of the Plant Protection Association of India from Plant Protection association of India (PPAI) during International Conference on Plant Health Management ICPHM 2023 - Innovation and Sustainability, 15th -18th November 2023 held at PJTSAU, Hyderabad.
- Dr D Ladhalakshmi recognised as Fellow award of the Plant Protection Association of India from Plant Protection association of India (PPAI) during International Conference on Plant Health Management ICPHM 2023 - Innovation and

Sustainability, 15th -18th November 2023 held at PJTSAU, Hyderabad

- Dr V Prakasam recognised as Fellow award of the Plant Protection Association of India from Plant Protection association of India (PPAI) during International Conference on Plant Health Management ICPHM 2023 - Innovation and Sustainability, 15th -18th November 2023 held at PJTSAU, Hyderabad
- Best research paper award: Smt Kavuri Sarda Memorial Award by Plant Protection Association of India. S Vijay kumar, M Srinivas Prasad, R Rambabu, B Bhaskar, RM Sundaram, V Prakasam, D ladhalakshmi, GS Laha and M Sheshu Madhav for best research paper marker assisted introgression of broad spectrum blast resistance gene Pi-2 into an elite rice cultivar, Samba Mahsuri published in the Indian Journal of Plant Protection 47 (3&4), 154-163, 2019.

Deputations

Drs R M Sundaram, C N Neeraja, Satendra Kumar Mangrauthia, C Gireesh, Suneetha Kota, Jyothi Badri were deputed to attend the 6th International Rice Congress at Philippine International Convention Center, Manila, Philippines from 16 – 19 October 2023.

Dr Raman Meenakshi Sundaram participated in the 27th Annual Meeting of the Council for Partnership on Rice Research in Asia (CORRA) held on November 1-2, 2023 at Truntum Kuta Hotel, Bali, Indonesia.

Dr C N Neeraja participated in the "UKRI GCRF South Asian Nitrogen Hub (SANH) Annual Review Meeting" at Peradeniya University, Kandy, Sri Lanka from 02.10.2023 – 06.10.2023.

Dr R M Sundaram attended an International Symposium at the Huazhong Agricultural University, China from 03 to 09, September 2023 and delivered a lecture on the Development of climate-resilient rice in India.

P Revathi, Senior Scientist (Plant Breeding) deputed to participate in the International Plant Animal Genome conference (PAG 30), held in San Diego, CA, USA during January 13-18 2023 and presented an invited talk on "Genomics Assisted Breeding in Hybrid rice for Global Food Security and organized a workshop on "Genomics assisted breeding in hybrid crops for global food Security".

P Revathi and Dr Abdul Fiyaz deputed to participate in the training program on "Intensive genomic selection (GS) and modern experimental design" February 13 -24 th , 2023 at the International Rice Research Institute (IRRI), Headquarters, Philippines as part of ongoing ICAR-BMGF project on "Application of next generation breeding, genotyping and digitization approaches for improving the genetic gain in Indian staple crops

P Revathi deputed to present an invited talk on "Developing climate-smart rice hybrids for global food security" in the convening on "Leveraging Earth Observation for Impact Evaluations of Climate-Sensitive Agriculture" held on September 12-14, 2023 in Food and Agriculture Organization (FAO) Rome, Italy.

P Revathi deputed to present an invited talk on "Molecular and phenotypic characterization of potential restorers derived through GMS mediated population improvement in rice" in the 8 th International Hybrid Rice Symposium (IHRS) flagship event of International Rice Congress (IRC 2023) to be held in Manila, Philippines from October 18 - 19, 2023. She has also participated in annual hybrid rice development consortium (HRDC) meeting held at IRRI, Philippines on 20 October, 2023

P Senguttuvel presented a talk on "Development of climate resilient rice hybrids for abiotic stresses through conventional and molecular approaches" in the 6th International Rice Congress and 8th International Hybrid Rice Symposium (IHRS) held in Philippine International Convention Center, Manila, Philippines, October 16-19, 2023.

Linkages and Collaborations

ICAR-IIRR, Hyderabad, and M/s. SRIBIO Biotech Pvt. Ltd, Hyderabad entered into a material transfer agreement to develop field formulations of biocontrol agents viz. *Trichoderma asperellum* strain TAIK1, *Bacillus cabrialessi* strain BIK3, *Pseudomonas putida* strain PIK1, and active metabolite, pentyl-2H-pyran-2-one for use in rice. This collaboration aims to provide an efficient bioformulation for enhancing rice productivity.

An MOU was signed with the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB)


On the occasion of World Environment Day 2023, ICAR-IIRR, Hyderabad, signed a Memorandum of Understanding (MOU) with the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). This significant event took place in the presence of the esteemed Telangana State Ministers, Shri K Taraka Rama Rao, Minister for IT, and Shri Puvvada Ajay, Minister of Transport. The purpose of this collaboration is to conduct research and explore the utilization of municipal sludge as a valuable source of manure for rice cultivation. This partnership between ICAR-IIRR and HMWSSB marks a crucial step towards sustainable agricultural practices and environmental conservation. By harnessing the potential of municipal sludge, which is a byproduct of wastewater treatment, we aim to address two pressing issues simultaneously: the proper disposal of sludge and the need for organic fertilizers in rice farming. Under this MOU, ICAR-IIRR will spearhead research initiatives to evaluate the viability and effectiveness of utilizing municipal sludge as a nutrient-rich manure for rice crops.

ICAR-IIRR signed a memorandum of understanding (MoU) with Vignan University, Guntur, for research collaboration, student training, and guest faculty. Dr T Ramesh Babu, Dean, School of Agriculture and Food Technology and Dr. D. Vijay Ramu, Dean, Promotions, Collaborations and Faculty Affairs from this University were present during the event.

Industry Interaction Meet

The ICAR-IIRR industry meet was conducted on November 7, 2023, in a hybrid mode under the chairmanship of Dr RM Sundaram, Director, ICAR-IIRR. Dr DK Yadava ADG (Seeds) served as the chief guest of the programme. The programme comprised a field visit to showcase promising ICAR-IIRR technologies and display of technologies at the meeting venue for interaction with participants from the Industry. A total of 60 experts, representing 40 different firms/companies attended the meeting.




ICAR – IIRR, Hyderabad, Annual Awards for Best Research Paper, 2023

Category	Name of the publication	Authors
Crop Improvement	Characterization of heterogeneity in popular rice landrace through field and molecular evaluation, Field Crops Research, 304, 2023,109181, https://doi.org/10.1016/j.fcr.2023.109181	K. Suman, P. Madhubabu, V. Jaldhani, Santosha Rathod, L.V. Subbarao, R.M. Sundaram, C.N. Neeraja,
Crop Production	Sustainable Intensification of a Rice–Maize System through Conservation Agriculture to Enhance System Productivity in Southern India. Plants. 2022; 11(9):1229. https://doi.org/10.3390/plants11091229	Tuti MD, Rapolu MK, Sreedevi B, Bandumula N, Kuchi S, Bandeppa S, Saha S, Parmar B, Rathod S, Ondrasek G, et al

Category	Name of the publication	Authors
Crop Protection	Potential of exogenous treatment with dehydroascorbate to control root-knot nematode infection in rice (2023). Rice, 16(1):29. NAAS rating: 11.64	Chavan S.N., Tumpa F.H., Khokon M.A.R. and Kyndt T.
Crop Protection	Insect Pest Incidence with the System of Rice Intensification: Results of a Multi-Location Study and a Meta-Analysis. Agronomy. 2023; 13(4):1100. https://doi.org/10.3390/agronomy13041100	Chintalapati P, Rathod S, Repalle N, Varma NRG, Karthikeyan K, Sharma S, Kumar RM, Katti G.
Social Science	Spatiotemporal Characterization of Drought Magnitude, Severity, and Return Period at Various Time Scales in the Hyderabad Karnataka Region of India. Water. 2023; 15(13):2483. https://doi.org/10.3390/w15132483	Patil R, Polisgowdar BS, Rathod S, Bandumula N, Mustac I, Srinivasa Reddy GV, Wali V, Satishkumar U, Rao S, Kumar A, et al.
Social Science	Essentially derived variety concept in plant variety rights protection system: underlying economic theories, and issues in implementation. Agricultural Economics Research Review 2023, 36 (1), 77-86.	P A Lakshmi Prasanna, L V Subba Rao, A S Hari Prasad, Amtul Waris, and S Arun Kumar

ICAR – IIRR, Hyderabad, Annual Awards for Best Researcher, 2023

Category	Award	Scientist
Crop Improvement	Best Young Scientist	Dr Fiyaz RA
Crop Production	Best Young Scientist	Dr R Gobinath
Crop Production	Best Young Scientist	Dr Bandeppa
Crop Protection	Best Scientist	Dr Satish Chavan
Social Sciences	Best Scientist	Dr B Nirmala
Social Sciences	Best Young Scientist	Dr Santosha Rathod

Externally funded projects

Sixteen new externally funded projects have been sanctioned during 2023 (Appendix 5) with a budget outlay of 480 lakhs. A total of 42 externally funded projects are currently being handled at the Institute (Appendix 6).

Patent Applied

- Azam MM and Sundaram RM (2023). Slow Releasing Botanical Formulation, Method of Preparation thereof and Controlling Pests using the Same. Indian Patent Application No. 202341023144 dated 29/03/2023.
- Azam MM and Sundaram RM. (2023). A Method for The Preparation of Powdered Alkali Metal Silicates of High Modulus Indian Patent Application No. 202341029032 dated 21/04/2023.

Copyrights

- IIRRSTAT software- ROC No. SW-16958/2023)

Databases

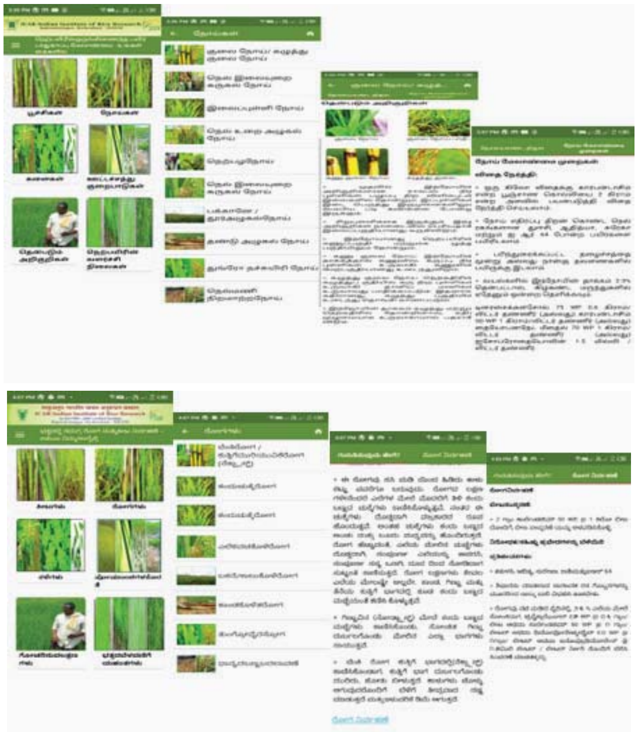
❖ 37 rice stem borer sequences of mtCOI gene were generated for four stem borers viz., YSB (15), PSB (14), GFSB (6) and DHSB (2) collected from rice plants in rice based cropping systems of coastal Andhra Pradesh and deposited in NCBI. The following are the accession numbers for the different species. Yellow stem borer (YSB), *Scirpophaga incertulas* (OP036690, OP036691, OP036692, OP617460, OP036693, OP028212, OP028213, OP615664, ON993889, ON989852, OP028211, OP036686, OP036687, OP036756, OP036689) submitted to NCBI database in association with college of Agriculture, Tirupati ANGRAU

- Pink stem borer (PSB), *Sesamia inferens* (OR484831, OR484835, OP036757, OP617461, OR592276, OP036760, OP003938, OP036761, OP036758, OR484833, OP036694, OP036759, OR484830, OP615679) submitted to NCBI database in association with college of Agriculture, Tirupati ANGRAU
- Gold fringed Stem borer (GFSB), *Chilo auricilius* (OP686451, OQ155236, OP684792, OP684346, OQ155253, OR481948) and Dark headed striped borer (DHSB), *Chilo polychrysus* (OR646743 and OR646739) submitted to NCBI database in association with college of Agriculture, Tirupati ANGRAU. The bar codes were also generated and BIN numbers were allotted.

Portals/Websites/Mobile Apps

Developing Rice Clinic App (Rice IPM) in Tamil and Kannada languages

A Rice IPM mobile app has been developed in Telugu, English and Hindi languages covering 11 major insect pests, 10 diseases and 18 weed species as well as nutrient deficiencies for identification of pests with symptoms of damage (both text and image) and recommended management practices. During this year, the content of the app was translated into Tamil and Kannada languages and two apps were developed.



Rice Clinic Mobile Apps developed in Kannada and Tamil languages

Rice Image Repository

Rice Image Repository has been developed to store and manage the images of Rice crop in the database format along with basic information on crop data. Images were grouped into five categories such as healthy, insect pests, diseases, weeds and abiotic stresses. The image upload interface facilitates image upload with basic information like location, variety, stage of the crop, contributor details etc. This repository was developed using MySQL and PhP. The home page displays dashboards of the count of the top 5 contributors, places and categories. This database will be further used with Artificial Intelligence app for diagnosing rice pests.

Home page - Rice Image Repository

Important Institutional Meetings

Annual Hill Rice group Meeting

The meeting of 10th Annual Hill Rice workshop was conducted on 28th February 2023 on virtual mode. Dr S. K. Pradhan, ADG (FFC) ICAR chaired the session and Dr R M Sundaram, Director (ICAR-IIRR) was the Co-chair and co-ordinated the session. Dr. L V Subba Rao and Dr R M Kumar were the conveners and Dr AVSR Swamy, Dr. C. Gireesh and Dr. Divya Balakrishnan were co-conveners of the session. The rapporteurs of the session were Dr. A. P. Padma Kumari, Dr. M. S. Anantha and Dr. Ch. Suvarna Rani. Scientists from ICAR-IIRR, ICAR-NRRI, ICAR IARI and scientists from different AICRIP cooperating centres participated in the workshop.

58th Annual Rice Group Meeting (ARGM)

The 58th Annual Rice Group Meeting (ARGM) was held at Assam Agricultural University (AAU), Jorhat in hybrid mode from May 4-5, 2023. Dr TR Sharma, DDG (Crop Science), ICAR, New Delhi, was the chief guest at the inaugural ceremony of the meeting. Other dignitaries present on the dais include Dr BC Deke, Vice Chancellor, AAU, Jorhat; Dr SK Pradhan, ADG (FFC), ICAR, New Delhi; Dr RM Sundaram, Director, ICAR-IIRR, Hyderabad; Dr AK Nayak, Director, ICAR-NRRI, Cuttack; Dr SR Das, Honorary Professor, OUAT, and Dr A Bhattacharya, Director of Research (Agriculture), AAU, Jorhat. Dr A Bhattacharya delivered the welcome address and Dr RM Sundaram, Director, ICAR-IIRR presented the progress of AICRP on rice and research highlights of AICRP and IIRR for the year 2022-23. Dr Nayak, Director, ICAR-NRRI, Cuttack stressed the importance of DSR and carbon credit to the farmers in his remarks. Dr SK Chetia, Chief Scientist, ARRI, Titabar presented the 100 years of glorious journey of Assam Rice Research Institute since its inception in 1923. Dr SK Pradhan, ADG (FFC) stressed developing nutritionally enriched varieties, development of low-cost machines, and value chain addition of rice products. Dr SR Das, Honorary Professor, OUAT urged the breeders to develop varieties with submergence tolerance, especially for Eastern India. Dr BC Deke, Vice Chancellor, AAU, Jorhat emphasized the need to shift from 'Green Revolution' to 'Green Commerce'. Dr TR Sharma, DDG (Crop Sciences), ICAR, New Delhi in his inaugural address stressed the importance of a multi-disciplinary mode of research. He advocated the development of specialty rice cultivars including low/ultra-low glycaemic index and high grain protein cultivars. He also emphasized the significance of speed breeding and genomic technologies in developing high NUE and WUE cultivars. Dr Sharma appreciated the efforts made by ICAR-IIRR led by Dr Sundaram. The inaugural session ended with the presentation of a vote of thanks by Dr MS Prasad, Convener, 58th ARGM. Ten publications, two websites, and two mobile apps were released on this occasion. About 400 delegates from across India and other countries actively participated in the program.

Varietal Identification Committee Meeting

Varietal Identification Committee (VIC) Meeting was held on 4th May 2023 during the 58th ARGM at Assam Agricultural University, Jorhat under the chairmanship of Dr TR Sharma, DDG (Crop Science), ICAR. A total of 60 proposals including 42 varietal entries and 18 hybrid entries discussed during the meeting.

Research Advisory Committee Meeting

The Research Advisory Committee (RAC) 2023 was successfully conducted on June 9, 2023, in a hybrid mode to accommodate both in-person and virtual attendees. The event commenced with a warm welcome from Dr. M.B.B. Prasad Babu (Member secretary, RAC), setting the tone for an engaging and productive gathering. Following this, Director Dr. R.M. Sundaram, provided an insightful overview of the IIRR programs, shedding light on the remarkable research endeavors undertaken. Dr. B. Mishra, Chairman of the RAC, gave introductory remarks, emphasizing the significance of the occasion and the importance of collaborative research efforts. The subsequent agenda encompassed the presentation of the Action Taken Report (ATR) and Research Achievements, which were meticulously shared section-wise by the esteemed heads of each Department. This approach allowed for a comprehensive understanding of the advancements made in various areas of study. Esteemed members of RAC, Dr. KK Jena (KIIT, Bhubaneswar), Dr. Seshashayee (UAS, Bangalore), and Dr. SK Pradhan (ADG, FFC) also actively participated in the deliberations and gave valuable suggestions.

Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) Meeting was organized in August 2022 spread over 8 days. All the scientists presented their progress and achievements in detail along with their future course of work to the IRC members. New project proposals were presented for approval.

Institute Biosafety Committee (IBSC) meeting

21st Meeting of the Institutional Biosafety Committee (IBSC) was held on 14 February 2023 at ICAR-IIRR. The meeting was attended by Dr R M Sundaram, Director, ICAR-IIRR (Chairman), Dr K Gopinath, Professor, University of Hyderabad (DBT Nominee), Dr Naveena B Maheswarappa, Principal Scientist, ICAR-National Research Centre on Meat, Hyderabad (External Expert) – attended virtual mode, Dr B Parameswari, Senior Scientist, ICAR-NBPGR-Regional Station, Hyderabad (External Expert), Dr Nuzhath Fatima, ICAR (Medical officer), internal members and special invitees. 22nd Institutional Biosafety Committee Meeting was held on 26 October, 2023. Dr S K Mangrauthia presented the status and progress related to IIRR-IBSC. He updated the progress made during the last year and emphasized the need for biosafety measures involved therein. The experts gave their inputs for better operation and management of transgenic and genome-edited products. The IBSC members along with a team of ICAR-IIRR scientists visited the ICAR-IIRR fields.

26th Institute Management Council Meeting on November 8, 2023

The Institute Management Committee (IMC) was conducted on 8th November, 2023. The official and ex-officio members participated in the meeting along with Dr D.K. Yadava, ADG (Seeds) from Council and approved the proposals.

Annual Review Meeting of CRP Biofortification

A review meeting of CRP Biofortification was held on 20.05.2023 and 21.05.2023 in virtual mode. Dr C N Neeraja, Principal Scientist, ICAR-IIRR welcomed Dr D K Yadava ADG Seeds, delegates, and participants from centers on Rice, Wheat, Low Immunogenic Wheat, Maize, Pearl Millet, Sorghum, and Small Millets. Dr R M Sundaram, Director, ICAR-IIRR presented opening remarks and briefed the project outlines. A total of 31 scientists presented research work progress across the centers. Discussions were made and the critical research points were discussed as per the agenda of the meeting.

Virtual Interface Meeting "Developing National standards for minimum levels of micronutrients in ICAR-AICRP-Rice" was organized by ICAR-IIRR on August 11, 2023 chaired by Dr. D K Yadava (Assistant Director General Seed), ICAR with participants from NIN-ICMR, FSSAI and HarvestPlus

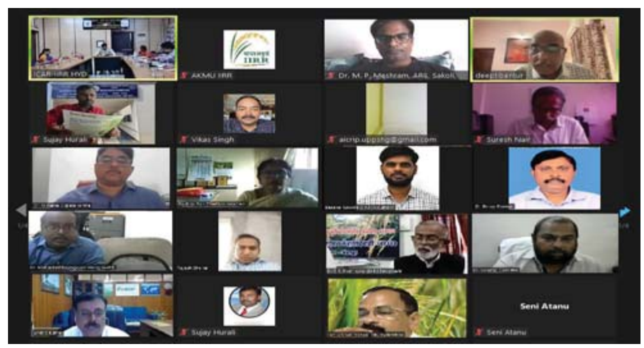
Activities under IARI Mega University Hyderabad hub

IARI Mega University Students Oriented at ICAR IIRR, Hyderabad on 24 Nov 2023. In a stride towards nurturing the next generation of agricultural leaders, students from the Hyderabad Hub of IARI Mega University were treated to a day of immersive orientation at ICAR IIRR, Hyderabad. The orientation program showcased not only the substantive expertise of the organizers and coordinators but also their commitment to providing students with a technically enriching and comprehensive experience in the realm of agriculture.

Other Institutional Activities

Brain storming session on Asian Rice Gall Midge - Present status and way forward"

ICAR-IIRR, organized a brainstorming session on "Asian Rice Gall Midge - Present Status and Way Forward" on July 4th, 2023, in a hybrid mode. The Asian Rice gall midge (*Orseolia oryzae*) is an endemic pest reported in nearly 12 Indian states. However, in recent years, there has been a change in the timing and intensity of its incidence. This brainstorming session was organized to review available options and develop a roadmap for the timely and critical management of this early-stage rice pest. Dr V Jhansi Lakshmi, Principal Scientist and Head, Entomology section, ICAR-IIRR, provided a brief background on the necessity of this brainstorming session. The session was chaired by Dr R M Sundaram, Director of ICAR-IIRR. Dr A P Padmakumari, Principal Scientist (Entomology), delivered a detailed presentation on the topic, highlighting the issues leading to the upsurge of infestations in certain endemic areas. This talk was followed by a panel discussion. The panellists included Dr J S Bentur, Dr Suresh Nair, Arturo Falaschi Emeritus Scientist (AFES) from ICGEB, New Delhi, Dr Arvind Kumar, DDG, ICRISAT, Hyderabad; Dr Ch V Durga Rani Prof & Head, PJTSAU, Hyderabad, Dr Shamkuwar ADR, ZARS, Sindewahi, Maharashtra, and Dr Vikas Kumar Singh, Coordinator of IRRI-SA Hub and Regional Breeding Lead, South Asia. In total, 90 participants deliberated extensively on this topic: 75 participants, comprising Entomologists and Plant Breeders from 12 different states, participated online, while 15 scientists joined offline, engaging in extensive discussions on various factors for managing this pest.



Parthenium Awareness Week

In a proactive move toward environmental stewardship and sustainable agriculture, ICAR-IIRR undertook a resolute initiative, the Parthenium Awareness Week, from August 16th to 22nd, 2023. The week-long event aimed to raise consciousness about the ill impacts of the parthenium weed and recommended effective strategies to curb its proliferation both within agricultural fields and in the vicinity of the campus. Dr. B. Sreedevi, Principal Scientist specializing in Agronomy, served as a pivotal figure during the awareness drive, enlightening attendees about the pernicious effects of parthenium. The event garnered substantial guidance and motivation from the esteemed Director, R. M. Sundaram, whose leadership inspired active involvement from the institute's staff. Not confined to the institute's premises alone, the

Parthenium Awareness Week was also observed across IIRR's research farms situated at Rajendranagar and Ramchandrapuram. IIRR staff across different categories profusely participated in the event.

Women Led Development and G 20 Events organized by ICAR-IIRR, 12-14 June, 2023

Under the Women Led Development as a side event of G 20 the following events were successfully organized by ICAR-IIRR during 12-14 June 2023 as JAN BHAGIDARI events.

An Awareness campaign was organized about the different GOI Schemes for Women and girls viz. Beti Padhao- Beti Bachao, Ujjwala Yojana, Sukanya Samriddhi Yojana, Working women's hostels and Poshan Abhiyan during the program organized for farm labour at ICAR-IIRR on June 12,2023. The program was attended by scientists and farm labour of ICAR-IIRR. The Director, ICAR-IIRR, Dr. RM Sundaram addressed the gathering and explained about the prestigious G 20 Presidency of India.

Display and Sale of NutriRiche edible rice products

The Hon'ble Agriculture Minister of Puducherry, Thiru. C. D. Jeyakumar inaugurated the display and sale of ready to eat and ready to cook products from IIRR rice varieties, Low GI(ISM) and High Zinc (DRR Dhan 48) prepared by Women's SHG groups and rice-based health care products developed at IIRR as a Jan Bhagidari event under the Women Led Development side event of G 20 on June 13,2023 at ICAR-IIRR.

Participation of ICAR-IIRR at the Global exhibition during the G-20 Agricultural Ministers Meeting at Hyderabad-June 15-17, 2023

ICAR-IIRR participated in the Global exhibition during the G-20 Agricultural Ministers Meeting from 15-17 June 2023 at Novotel, Hyderabad. The ICAR-IIRR exhibition stall showcased samples of new climate resilient rice varieties, hybrids and genome edited lines. Visual display of crop production and IPM technologies depicted the line of work being undertaken at ICAR-IIRR. The innovative health care products from rice and edible products from high zinc rice and low GI(ISM) rice varieties were a novelty and attracted lot of appreciation. The ground-breaking research and innovative solutions were greatly acknowledged by the Honourable Agriculture Minister of GOI and Ministers of G 20 Nations.

Participation of ICAR-IIRR during the G20 Technical Workshop on Climate Resilient Agriculture organized during 4-6 September 2023 at Hyderabad

ICAR-IIRR participated in the exhibition set up during the G20 Technical Workshop on Climate Resilient Agriculture organized during 4-6 September 2023 at Hyderabad to showcase the climate resilient rice varieties and technologies developed by ICAR-IIRR. The visual display of research activities and solutions for climate resilient rice production were highly appreciated by the G 20 delegates and ICAR officials.

Cancer Screening Camp for women employees

ICAR-Indian Institute of Rice Research in collaboration with Rotary club Krishi Rajendranagar and Rotary Club of Global Wizards along with MNJ Cancer Hospital, Hyderabad conducted a Cancer Screening camp for the women employees of the Institute. The Director Dr RM Sundaram inaugurated the camp in the presence of President of Rotary Club and other dignitaries. The camp aimed to detect early symptoms of cancer among the target groups for breast cancer, cervical cancer, oral cancer and other abdominal cancers. The target beneficiaries were tested with oral examination, abdominal sonogram + mammogram, digital mammogram in 50 Plus women and suspicious cases. There were about 105 beneficiaries including scientists, administrative, technical, skilled supporting staff and farm workers. A total of 105 women employees underwent the screening - 85 for oral screening, 26 for digital mammogram, 66 for sono-mammogram, 64 for Pap smear and 2 cases for FAMC.

Rice based product unit inaugurated

The Director, ICAR-IIRR inaugurated IIRR products unit on February 27,2023. The unit houses select equipment to prepare edible products (Ready to Eat & Ready to Cook) from rice varieties developed by ICAR-IIRR and machinery to produce botanicals to promote use of ecologically safe formulations. The long-term plan is to onboard women SHGs to produce rice-based products.

International Women's Day

International Women's Day was celebrated on March 9, 2023 at the institute auditorium. All the women personnel from scientific, technical, administrative and SSS were acknowledged and felicitated for their immense contribution to the institutes' progress by the Director Dr R M Sundaram. Dr K Surekha, PS & Head, Soil Science was the guest of honour along with Ms. Sudha Nair, AAO. The UN designated theme, "DigitALL: Innovation and technology for gender equality" was elaborated upon by defining the gender digital divide and on the positive side how digital literacy is enabling women to reach out to vulnerable women by Dr Amtul Waris. Women entrepreuners showcased digital apps developed by them on this occasion. An eclectic quiz on women achievers and cultural heritage of our Nation was also organized.

International Women's Day" was celebrated on March 9, 2023

International Yoga Day

ICAR-IIRR organized International Yoga Day with a lot of zeal and enthusiasm on the 21st of June on the theme "Yoga for Vasudhaiva Kutumbakam" (Yoga for the welfare of all in the form of 'One World-One Family'). Dr R Mahendra Kumar chaired the event and emphasized the vital role of yoga in promoting physical and psychological well-being and encouraged for buoyant and enthusiastic participation of Scientific and non-scientific staff to incorporate yoga into their daily lives. Certified Yoga trainer, Smt. Pavitra, was the guest of honour and spoke about 'The Positive Framework of Meditation'. She demonstrated asanas and body stretches as per the audience's priority and covered simple asanas for all age groups.

Selfie Point at ICAR-IIRR

Dr T.R. Sharma, Deputy Director General (DDG), Crop Science, ICAR inaugurated the renovated Selfie Point at ICAR IIRR on November 30, 2023. The Selfie Point serves as a visual chronicle of the institution's outstanding accomplishments, providing a unique and interactive showcase for visitors. Dr Sharma also visited the farm of the Institute and expressed his appreciation for the institution's progress and had an interactive meeting with the scientists of the Institute on various topics related to research and technologies developed by ICAR-IIRR, Hyderabad.

Awareness Programs on Mission LiFE (Lifestyle for Environment)

As part of the Mission LiFE (Lifestyle for Environment), a global initiative launched by the Honorable Prime Minister of India at the UN Climate Change Conference, an awareness program on climate resilient and water saving rice technologies on May 23, 2023, in Nalgonda district, Telangana along with the Action for Rural Development Society (ARDS). The awareness program focused on educating the farmers about the climate-resilient and water-saving rice technologies developed by the ICAR-IIRR. The program was attended by a large number of farmers, extension workers, scientists, and officials from the Department of Agriculture and other stakeholders.

A workshop and farmer group meeting entitled "Promotion and bringing awareness of Climate-resilient rice varieties was also organised on 27 May 2023. The workshop showcased the climate-resilient rice varieties developed by the ICAR-IIRR, which can withstand multiple stresses such as drought, flood, salinity, extreme temperatures, and diseases. The farmers shared their experiences and feedback on the performance of these varieties on their farms and also expressed their preferences for future varieties.

World Water Day Celebrations

World Water Day Celebrations 2023 was held at Farmers Training Centre, Dathappagudem, Yadadri Bhuvanagiri District, Telangana on 28th March 2023.

Visits to farms affected by untimely rain

Scientists of ICAR-IIRR visited various farms affected by untimely rain during the third week of March and interacted with the farmers to advise them on post-rain crop care.

Tribal sub –Plan Activities

Over 4200 tribal farm families of Andhra Pradesh (650), Assam (500) Chhattisgarh (300), Jharkhand (500), Jammu and Kashmir (300) Karnataka (300), Kerala (250), Odisha (500) Tamil Nadu (300) and Telangana (600) were benefitted with cafeteria of rice related technologies. The targeted farm household were given improved rice varieties and other critical inputs capable to breaking the yield barriers. The inputs include metal plough, neem coated urea, micro nutrients, herbicides, neem oil, sprayers, tarpaulins, rodenticide, water pipes, zinc sulfate, pheromone traps, gunny bags and storage bins. By imparting the subject matter training about the technical know –how and do- how of rice cultivation, the extension gaps were minimized along with technological gaps. The yield increase was observed minimum of 15% in Jharkhand and maximum of 22% in Telangana and Andhra Pradesh. The major tribal groups covered under this scheme are Baiga, Bhil, Badugas, Irulas, Korba, Lambadas, Chenjus, Kurumbas, Kattunaikans, Oron, Santhal, Todas and Siddhis and Yerukula.

IIRR-SC SP Activities

The HYV seeds of ICAR-IIRR was provided to the 1700 beneficiary farmers of Telangana. Drying sheets, sprayers, pheromone traps and lures, drum seeders, cono-weeders, herbicides, insecticides, and fungicides were provided to the beneficiaries. A total of 5600 demonstrations were organized during 2023-24 under ICAR-IIRR-SCSP. These demonstrations were organised in collaboration with Banaras Hindu University, SKUAST, Jammu, University of Agricultural Sciences Bangalore, PAJNCOA, and KVK, Pudhuchery, RARS, TNAU Aduthurai, Keezvelur, RARS Moncompu, Kerala, ORARS, Ottunakara, Kerala, KVK, Idukki, Kerala, SVBP University of Agriculture an Technology, Modipuram, Meerut, KVK Erode, Tamil Nadu, MSSRF, Jeypore Odisha, KVK, Kalikiri, Andhra Pradesh, Maruteru, ANGRAU, Vizianagaram, KVK,RASS, Andhra Pradesh, TNAU, Coimbatore, KVK, GRI, Dindigul, Annamalai University, KVK, Needamangalam, Thiruvarur, Tamil Nadu, KVK, Chamarajnagar, Karnataka, YFA-KVK, Wanaparthy, KVK, Medak, PJTSAU, Telangana, RRS, Chinsura, West Bengal, PANJANCOA, Puducherry, KVK, Durgapur, Amaravathi, Maharashtra, IGKV, Raipur, Chattisgarh, RRS, Nagina, and KVK, Sadanandapuram, Kerala. Twelve training programs on various aspects of rice production technologies were organised in Telangana and Andhra Pradesh under SCSP. The SC rice farmers were trained on 'Integrated Nutrient Management', 'Integrated Pest Management', 'Integrated Weed Management', preparation of Vermi-compost and Water saving technologies and Cyber Security.

Awareness and distribution of soil testing kits and Sprayers of ICAR-KVK, IDUKKI, Kerala State

Inputs distribution to ST farmers

Demonstration by Dr. Brajendra, IIRR

Special Address by Shri. Shitanshu Kumar, IIRR

Distribution of Fertilizers Pesticides and Fungicides in Banaras Hindu University

Distribution of Sprayers of Annamalai university of Cuddalore district of Tamil Nadu State

Distribution of Drying sheets (Tarpaulins) of Nagarkurnool District of Telangana State

Awareness and Training program of Organic Paddy cultivation in TNAU ICAR-KVK Needamangalam, Tamil *Nadu State*

Distribution of Inputs of RASS, KVK, Chittoor district of *Andhra Pradesh State*

Awareness and distribution of Soil testing kits of Kamareddy district of Telangana State

Distribution of inputs of ICAR-KVK, Chamarajnagar, Karnataka State

Inputs distribution of RARS, Maruteru of Andhra Pradesh State

ICAR-IIRR Celebrated Foundation day

The 9th Foundation Day of the institute was celebrated on 21 December 2023. at Dr SVS Shastry Auditorium Dr T R Sharma, Deputy Director General (Crop Science), ICAR was the Chief Guest of the event while Dr S K Pradhan, Addl. Director General (FFC), ICAR, Dr Ch Srinivasa Rao, Director, ICAR-NAARM, Dr D Raji Reddy, Fmr. Director of Research, PJTSAU, Dr Raghurami Reddy, Director of Research, PJTSAU were the guests of honour. Selected staff members of ICAR-IIRR were awarded for their contributions.

Foundation Day Celebrations

ICAR-Indian Institute of Rice Research, Hyderabad celebrated World Soil Day 5th of December 2023 on the theme of "Soil and Water: A Source of Life" the at the institute campus and Burgula and Jammikunta villages of Telangana state. The program was attended by 150 farmers from Raibaraily, Hamirpur, Banda, Prayagraj, and Chitrakut areas of Uttar Pradesh. Hands-on training on rapid, manual soil testing kits was imparted. Seed samples of the biofortified rice variety, DRR Dhan 48 were distributed. At Burgula Village, Farooq Nagar Mandal, Ranga Reddy District, Telangana, the soil health awareness program was attended by officials of the State Department of Agriculture and 240 farmers. Dr RM Sundaram, Director, ICAR-IIRR addressed the gathering and emphasized on the importance of soil testing, soil health cards and nutrient use efficient rice varieties for the benefit of farmer community. The scientists of ICAR-IIRR, demonstrated the soil testing kit developed by the institute and kits were distributed to 60 farmers. An awareness program was also organized at KVK Jammikunta, Karimnagar, Telangana with Sewa Spoorthy Foundation, Hyderabad. The soil testing kits were demonstrated and distributed to about 75 farmers of the region

World soil day celebration at Burgula Village, Telangana

Vigilance Awareness Week was celebrated at ICAR-Indian Institute of Rice Research, Hyderabad from 30 October to 6 November 2023. The theme of this was "Corruption free India for a developed Nation"- "भ्रष्टाचार मुक्त भारत - विकसित भारत". The main aim of Vigilance awareness week is to encourage all the stakeholders to collectively participate in preventing corruption in public life. Several awareness programs were organized during this week.

Sports & Games

A team of 12 members who were the winners during the ICAR- South Zone Sports Meet-2023, at Hyderabad, participated in the ICAR Inter-Zonal Sports Tournament at Karnal during September 9-12, 2023. The women's table tennis doubles team, consisting of Dr K Surekha and Dr G Padmavathi, clinched the Gold Medal, winning it for the 10th consecutive time.

Brainstorming Session on Direct Seeded Rice (DSR)

A virtual brainstorming session on Direct Seeded Rice (DSR) was organized on 12 April 2023, with the participation of more than 150 scientists from different research institutes. DSR is a water-saving method of sowing paddy, in which seeds are directly drilled into the fields without transplanting seedlings from a nursery. This technique reduces the water consumption, labor cost, and greenhouse gas emissions of rice production while maintaining or increasing the yield and profitability. The session aimed to identify the challenges and opportunities of DSR adoption in different regions, and to explore the best practices and innovations for enhancing its sustainability and scalability. The participants discussed various aspects of DSR, such as seed quality, weed management, pest control, nutrient management, water management, mechanization, and policy support. The session also highlighted the potential benefits of DSR for climate change adaptation and mitigation, as well as for improving the livelihoods of rice farmers.

Webinar on Women and IP: Accelerating Innovations and Creativity"

A webinar was organized on the occasion of "World Intellectual Property Day" on the theme of "Women and IP: Accelerating Innovations and Creativity" on April, 26, at ICAR-IIRR. About 100 participants including scientists and research scholars participated either online or offline. Dr RM Sundaram, Director, IIRR welcomed the speakers Dr Kalpana Sastri (Former Joint Director, ICAR-NAARM and Managing Director, Aghub, PJTSAU, Hyderabad), and Dr Divya Singh (Business Development and IP Officer, CSIR-CCMB, Hyderabad) and other online and offline participants. Dr RM Sundaram gave introductory remarks emphasizing the key role of women in India in scientific and administrative positions and their significant contributions. Dr Kalpana Sastri delivered a talk on Innovation and Enterprise Building. She briefed her experiences on IP work and the role of women in research and development in India. Success stories of women innovators and entrepreneurs from the grassroots level were explained in the presentation. She also explained about the initiatives in India, for women in science and scholarships and fellowships available for women scientists. Director, Dr RM Sundaram mentioned the support of Dr. Divya Singh, in the technology transfer of Improved Samba mahsuri, a collaborative Technology developed between IIRR and CCMB. Dr Divya Singh talked about "Technology Valuation, Commercialization, and Licensing: Public Sector Perspective". She gave a brief introduction about women in science and CCMB and further discussed technology licensing, transfers, commercialization, and issues faced by women in getting opportunities. Dr Sundaram, Director IIRR, discussed about technology sharing and the problems in receipt of the royalties and licensing of all ICAR technologies through Agri Innovate (Technology licensing wing).

***Azad ki Amrut Mahotsav* -Talks and webinars organized by ICAR- IIRR and Society for advancement of Rice Research 2023**

S.No.	Speaker	Topic	Date and time
1	Shri Sandeep Kondaji, CEO Krishitantra	"Digital technologies from LAN to Land".	27th January, 2023 at 3.00 pm (IST)
2	SR Das , CFAO, NIASM, Baramati	Virtual Meeting for "Pension and Retirement benefits and National Pension Scheme" on	July 7, 2023 at 2:30 PM
4	Prof Dr. Habil Joerg Fettke Head, Biopolymer Analytics University of Potsdam Institute of Biochemistry and Biology Karl-Liebknecht-Str. 24-25, Haus 2014476 Golm, Germany	Starch Metabolism in Plants: A way forward	13th March, 2023 at 2.00 pm (IST).
5	Dr Ravi Kiran Donthu, Scientist (Genomics and Bioinformatics), Mahindra University, Hyderabad	"Adaptive Evolution in Agricultural Pests and Honey Bee Diversity: A Genomic Perspective"on	7 December at 3.00 pm.

Distinguished Visitors

- Dr. Mangala Rai, Former DG, ICAR and Former Vice Chancellor, GBPUAT (G.B. Pant University of Agriculture and Technology, Pantnagar), visited ICAR-IIRR on 17th January 2023.
- Shri Suryapratap Shahi Ji, Minister of Agriculture, Agricultural Education and Agricultural Research, Govt. of Uttar Pradesh visited ICAR – Indian Institute of Rice Research (ICAR-IIRR), Hyderabad on 05 Feb, 2023 along with Officials of State Department of Agriculture, *viz.*, Shri. SB Singh, Sh. VP Singh and others. The Hon'ble Minister in his address to the staff of the Institute, applauded the achievements of ICAR-IIRR and emphasized on increased coordination and communication between ICAR institutes, State department of agriculture, KVKs, and State Agriculture Universities of Uttar Pradesh.

Director CIWA, Dr Mridula Devi, visited ICAR-IIRR on Friday, February 24, 2023 and discussed collaboration between CIWA and IIRR on areas of agriculture-nutrition linkages

Dr. P. L. Gautam, Former DDG, Crop Science, ICAR, National Member, NAHEP External Advisory Panel, Former Vice Chancellor (GBPUAT, Pantnagar) and Former Chairman, PPVFRA, New Delhi and Former Chairman, NBA, Chennai visited ICAR-IIRR Hyderabad on 13 March, 2023.

Dr H.R. Bharadwaj, Group Lead, Rice Breeding Innovation (RBI), IRRI visited ICAR-IIRR on 9 April, 2023

Dr H.R. Bharadwaj, Group Lead of Rice Breeding Innovation (RBI) at IRRI, along with his team from IRRI South Asia Hub, visited ICAR-IIRR on April 9, 2023. During the visit, Dr. Bharadwaj engaged in fruitful discussions with all the scientists at the institute. Subsequently, he embarked on a field visit to observe the various rice varieties grown in the IIRR farm. Dr. Bharadwaj expressed his enthusiasm for fostering active collaborations among scientists to enhance rice research and development.

Visit of the Hon'ble Agriculture Minister, Puducherry: Shri. Thiru C. Djeacoumar, Hon'ble Agriculture Minister, paid a visit to ICAR-IIRR on June 13, 2023, and interacted with the Director and

Heads of the various divisions of IIRR on the research programs of the Institute and the opportunities for collaboration for improving rice production in the state of Puducherry. He has also graciously inaugurated the exhibition and sale of our esteemed institution's ready-to-eat and ready-to-cook products. These products are derived from our exceptional rice varieties, namely Low GI (ISM) and High Zinc (DRR Dhan 48), which have been meticulously prepared by the talented Women's Self-Help Group (SHG) members. Additionally, innovative rice-based healthcare products, developed right here at IIRR were also showcased.

Delegates from the G-20 Meeting visited IIRR

Agriculture Ministers from several countries, including Turkey, Italy, Spain, and Vietnam, attended the G20 Meeting in Hyderabad and visited our institute on 17 June 2023. During their visit, IIRR scientists had a fruitful discussion with the delegates regarding potential collaborations and opportunities in the field of rice research. They exchanged ideas and insights on topics such as rice varieties, climate resilience, pest management, water efficiency, and nutrition enhancement. The visit was a successful event that showcased the achievements and potential of our institute and strengthened the ties between India and other countries in the field of rice research.

On September 5, 2023, a significant event unfolded at ICAR-IIRR as the esteemed Secretary of DARE (Department of Agricultural Research and Education) and Director-General of ICAR, Dr. Himanshu Pathak, graced the institute with a momentous visit. During the visit, the Honourable DG inaugurated two pivotal facilities, the Fast Breeding Facility and the Farm Section Storage Complex, crucial additions that promise to enhance the institute's research capabilities and infrastructure significantly. The occasion was marked by insightful interactions between the DG and the institute's scientific community. The Honorable DG elucidated on the latest initiatives undertaken by ICAR, shedding light on government policies aimed at realigning research activities.

Dr. S. K. Pradhan, ADG (FFC), ICAR, Dr. Ishwar Singh, PS, FFC, ICAR and Dr. Sunil Bhat from JK Agri Genetics Ltd (JKAL) visited ICAR-IIRR on 12 July, 2023.

Dr. T. Mohapatra, the Chairman of PPVFRA and former DG of ICAR, visited ICAR-IIRR on 2 September, 2023. Dr. Mohapatra showed keen interest and appreciated IIRR for their work on the genome-edited line developed by the institute. Dr. (Mrs.) C. Tara Satyavathi, Director of ICAR-IIMR, Dr Vishwanathan, Joint Director, IARI was also present during the visit.

Personnel and Staff

Scientific Staff

Name	Designation
Dr. R.M. Sundaram	Director
Plant Breeding	
Dr. L.V. Subba Rao	Principal Scientist Superannuated in May 2023
Dr. AVSR Swamy	Principal Scientist
Dr. S.V. Sai Prasad	Principal Scientist
Dr. G. Padmavathi	Principal Scientist
Dr. J. Aravind Kumar	Principal Scientist
Dr. Gireesh. C	Senior Scientist
Dr. Suneetha Kota	Senior Scientist
Dr. S. L. Krishnamurthy	Senior Scientist Joined on transfer 18/12/23
Dr. Jyoth Badri	Senior Scientist
Dr. M.S. Anantha	Senior Scientist
Dr. R. Abdul Fiyaz	Senior Scientist
Dr. Divya Balakrishnan	Senior Scientist
Dr. Suvarna Rani .C	Scientist
Hybrid Rice	
Dr. A.S. Hari Prasad	Principal Scientist
Dr. P. Senguttuvel	Senior Scientist
Dr. P. Revathi	Senior Scientist
Dr. Kemparaju K.B	Senior Scientist
Dr. K. Shruti	Scientist
Biotechnology	
Dr. C.N. Neeraja	Principal Scientist
Dr. S.K. Mangrauthia	Senior Scientist
Dr. Kalyani Kulkarni	Scientist
Dr. V Papa Rao	Scientist, Joined on transfer in April 2023
Agronomy	
Dr. R. Mahendra Kumar	Principal Scientist
Dr. B. Sreedevi	Principal Scientist
Dr. Mangaldeep Tuti	Senior Scientist
Dr. Aarti Singh	Scientist (Transferred to DSR, Mau, UP)
Dr. S. Vijaya Kumar	Scientist
Soil Science	
Dr. K. Surekha	Principal Scientist
Dr. M.B.B. Prasad Babu	Principal Scientist
Dr. DVK Nageswara Rao	Principal Scientist
Dr. Brajendra	Principal Scientist
Dr. P.C. Latha	Principal Scientist
Dr. Bandeppa	Scientist
Dr. R. Gobinath	Scientist

Name	Designation
Dr. V. Manasa	Scientist
Plant Physiology & Biochemistry	
Dr. P. Raghuveer Rao	Principal Scientist
Dr. Akshay Sakhare	Senior Scientist
Dr. D. Sanjeeva Rao	Senior Scientist
Agricultural Engineering	
Dr. Vidhan Singh	Principal Scientist Superannuated in Dec. 2023
Agricultural Chemicals	
Dr. M.M. Azam	Principal Scientist
Computer Applications	
Dr. B. Sailaja	Principal Scientist
Entomology	
Dr. B. Jhansi Rani	Principal Scientist Superannuated in Feb. 2023
Dr. V. Jhansilakshmi	Principal Scientist
Dr. N. Somashekar	Principal Scientist
Dr. A.P. PadmaKumari	Principal Scientist
Dr. Chitra Shanker	Principal Scientist
Dr. Ch. Padmavathi	Principal Scientist
Dr. Y. Sridhar	Principal Scientist
Dr. V. Chinna Babu Naik	Senior Scientist, Joined on transfer on 16/3/23
Dr. S. Chavan	Scientist
Plant Pathology	
Dr. M. Sreenivas Prasad	Principal Scientist
Dr. G.S. Laha	Principal Scientist
Dr. D. Krishnaveni	Principal Scientist
Dr. C. Kannan	Principal Scientist
Dr. Ladha Lakshmi	Senior Scientist
Dr.V. Prakasam	Senior Scientist
Dr. K. Basavaraj	Scientist
Dr. S. Jasudas Gompa	Scientist
Transfer of Technology & Training	
Dr. P. Muthuraman	Principal Scientist
Dr. Amtul Waris	Principal Scientist
Dr. Shaik N. Meera	Principal Scientist
Dr. P. Jeya Kumar	Principal Scientist
Dr. PA Lakshmi Prasanna	Senior Scientist
Dr. B. Nirmala	Senior Scientist
Dr. S. Arun Kumar	Senior Scientist
Dr. Santosha Rathod	Scientist

Technical Staff

Dr. M.N. Arun	Chief Technical Officer
C. Sadanandam	Assistant Chief Technical Officer
Srinivasan Amudhan	Assistant Chief Technical Officer
Chirutkar Prakash	Assistant Chief Technical Officer
Uddaraju Chaitanya	Assistant Chief Technical Officer
M. Ezra	Assistant Chief Technical Officer
U. Pullaiah	Assistant Chief Technical Officer
K. Padmaja	Senior Technical Officer
M. Vijay Kumar	Senior Technical Officer
Mohd. Tahseen	Technical Officer
Emkolla Nagarjuna	Technical Officer
Mohd. Sadath Ali	Technical Officer
K. Ramulu	Technical Officer
Dr. Y. Roseswara Rao	Technical Officer
Kova Shravan Kumar	Technical Officer
Tupakula Venkaiah	Technical Officer
C. Muralidhar Reddy	Technical Officer
K. Janardhan	Technical Officer (Driver)
P. Chandrakanth	Senior Technical Assistant
K.H. Devadas	Senior Technical Assistant
Koteswara Rao Potla	Senior Technical Assistant
K. Narasimha	Senior Tech. Assistant (Driver)
M. Chandrakumar	Senior Technician
S. Vijay Kumar	Senior Technician
A. Ramesh	Senior Technician (Driver)
D. Srinivasa Rao	Technician
V. Srinivas	Technician
R. Sathamaiah	Technician
S. Yadaiah	Technician

Administrative Staff

Shitanshu Kumar	Chief Administrative Officer
K. Srinivasa Rao	Finance & Accounts Officer Superannuated in March 2023
T.D.S. Prakash	Senior Finance & Accounts Officer, Joined Institute in March, 2023
O. Suneeta	Principal Private Secretary
Sudha Nair	Asst. Administrative Officer
P. Lakshmi	Asst. Administrative Officer Superannuated in Dec. 2023
B. Vidyanath	Asst. Administrative Officer
R. Udaya Kumar	Private Secretary
Aparna Das	Private Secretary
Bommakanti Ramesh	Private Secretary
S. Hemalatha	Private Secretary
Sandiri Rama Murthy	Personal Assistant Transfer to IIMR on promotion
Ashfaq Ali	Personal Assistant
Uppalapati Rama	Assistant
Shaik Ahmed Hussain	Assistant
Bharath Raju	Assistant
K. Mallikarjunudu	Assistant
Vanitha	UDC (Upper Division Clerk)
Kota Jashwanth	UDC (Upper Division Clerk)
S. Rekha Rani	UDC (Upper Division Clerk)
Navneet Kumar	Stenographer Gr, III
Chander	Skilled Supporting Staff (SSS)
M. Anthamma	Skilled Supporting Staff (SSS)
B. Susheela	Skilled Supporting Staff (SSS)
Ahmed Ullah Khan	Skilled Supporting Staff (SSS)
V. Golu Naik, Retd.	Skilled Supporting Staff (SSS)

Casual Labour regularised to Skilled Support staff

S. No.	Name
1.	Smt. V. Sukrutha
2.	Sri. B. Swamy (Demise on 10/12/23)
3.	Smt. G. Sivamma
4.	Smt. G. Vajramani
5.	Sri. I. Bikashpathi
6.	Smt. B. Balamma
7.	Smt. B. Sugunamma
8.	Smt. R. Kistamma
9.	Smt. D. Buchamma
10.	Smt. Ch. Swaroopa
11.	Smt. K. Durgamma
12.	Sri. M. Ramesh
13.	Smt. A. Sathamma
14.	Smt. K. Yadamma
15.	Smt. B. Sakkubai
16.	Smt. P. Pushpa
17.	Sri. G. Venkatesh
18.	Smt. M. Govindamma
19.	Smt. R. Amrutha
20.	Smt. D. Padmamma
21.	Smt. D. Laxmamma
22.	Smt. M. Narasamma
23.	Smt. M. Laxmamma
24.	Smt. R. Parvathamma
25.	Smt. D. Balamani
26.	Sri. M. Yadaiah
27.	Smt. R. Channamma
28.	Smt. M. Laxmi

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Appendix-1: Promising entries in Varietal trials, *kharif* 2022

S. No	IET No.	Designation	Cross Combination	Source Trial	Yield kg/ha	FD days	GT	Promising for
1	***28959***	***PHI 20101***	***Hybrid***	AVT-2ETP	6693	94	LS	Promising, for Uttarakhand, Odisha, Bihar, Uttar Pradesh Chhattisgarh, Maharashtra, Gujarat
2	***28950***	***HRI-207***	***Hybrid***	AVT-2ETP	6393	92	SB	Promising for Odisha, Bihar, Jharkhand, Maharashtra and Chhattisgarh
3	***28960***	***RRX-848***	***Hybrid***	AVT-2ETP	6369	92	LS	Promising for Haryana, Odisha, Bihar, Jharkhand, Chhattisgarh and Gujarat
4	***28954***	***Kaveri 7299***	***Hybrid***	AVT-2ETP	5930	91	LB	Promising for Haryana, Uttar Pradesh and Bihar
5	***28964***	***VNR 227***	***Hybrid***	AVT-2ETP	5800	107	LB	Promising for Odisha, Jharkhand and Maharashtra
6	29177	ORJ-1317-RP5530-23-1	Samba Mahsuri/ IRGC48960// MTU1081	AVT-2ETP	5704	99	LS	Promising for Kerala, Bihar, Chhattisgarh, Maharashtra
7	29142	JGL 35085	JGL 2017/ NLR34449// JGL20171	AVT-2ETP	5691	91	LB	Promising for Haryana, Rajasthan, Gujarat and Bihar
8	28506	CR 3849-2-1-2-1-2	Pooja/IR64	AVT-2IME	5582	101	LB	Promising for Odisha
9	29235	PNPK 7106	PNP 3/SR	AVT-2IME	6198	100	LS	Promising for Haryana, Chhattisgarh, Andhra Pradesh, Telangana and Maharashtra
10	29246	HRK 16-35),	HKR 47/HKR 99-60//HKR 47	AVT-2IME	5636	101	LS	Promising for Maharashtra
11	29236	(CR 3580-3-1-1-1-1-1-2)	Lalat/N22	AVT-2IME	5561	104	SB	Promising for Odisha and Gujarat

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S. No	IET No.	Designation	Cross Combination	Source Trial	Yield kg/ha	FD days	GT	Promising for
12	***28982***	***(RRX-809)***	***Hybrid***	AVT-2IME	6290	98	LB	Promising for Maharashtra
13	28489	BRR 2141	TTB 680-2-35-2 Selection	AVT-2 IM	6535	111	MS	Promising for the states of Chhattisgarh, Bihar
14	29268	OROI-8- IR 88228-33-3-5-2	IR 80410-B-197-4 / IR 64-Sub 1 // NCIC RC 158	AVT-2 IM	6223	106	LS	Promising for the state of Odisha only
15	27908	MTU 1275 (MTU 2385-123-1-2-3)	MTU 1075 / MTU 1081 // MTU 1121	AVT-2 IM	6195	112	MS	Promising for the state of Telangana
16	***29001***	***S-7004***	***Hybrid***	AVT-2 IM	6347	101	LB	Promising for the state of Andhra Pradesh
17	***28997***	***HRI-204***	***Hybrid***	AVT-2 IM	6393	101	LB	Promising for the state of Punjab
18	29349	R 2284-52-114-1	R 1670-3267-1-3920-1 / ARC 10550	AVT 2 & AVT 1-L	6539	116	SB	Promising in Zone V for the state of Chhattisgarh
19	29411	CR4161-5-6-IR 14L572	IR 10L146 / IR 10L149	AVT 2-AEROB	4628	83	LS	Promising in Haryana (Z II), Bihar (Z III) & Gujarat (Z VI)
20	29396	CRR 822-20-1-2-2	IR11L152 / Sabitri	AVT 2-AEROB	4168	79	LS	Promising in Haryana (Z II)
21	29409	TRC 2020–14	Hakuchuk 1 / Naveen	AVT 2-AEROB	4217	81	MS	Promising in Haryana (Z II) & Bihar (Z III)
22	29421	RP 6324-123-14-4-1	CR 691-1 / CR Dhan 202	AVT 2-AEROB	3813	78	MS	Promising in Gujarat (Z VI)
23	29412	US393	Hybrid	AVT 2-AEROB	5014	81	LB	Promising in Chhattisgarh (ZV)
24	29422	CRR 756-21	IR08L183 / MTU 1010	AVT 2-AEROB	3590	83	LS	Promising in Chhattisgarh (ZV)
25	29430	CR 4118-1-1-2-2-1	CR Dhan 201 / IR 84549-B-183-13-1-1-2	AVT 2-AEROB	4127	85	LS	Promising in Haryana (Z II) & Bihar (Z III)
26	29415	RP 6326-278-14-1	MTU 1010 / WGL 505	AVT 2-AEROB	4100	82	LB	Promising in Gujarat (ZVI) & Odisha (Z III
27	29436	CRR 821-21-2-1-3	IR09L337 / IR09L154	AVT 2-AEROB	4666	80	LB	Promising in Gujarat (Z VI) & Haryana (Z II)

Appendices

S. No	IET No.	Designation	Cross Combination	Source Trial	Yield kg/ha	FD days	GT	Promising for
28	29424	CR 4317-2-IR 97034-21-2-1-3	IR09L337 / IR09L154	AVT 2-AEROB	4455	82	LB	Promising in Odisha (Z III), Gujarat (Z VI) & Haryana (ZII)
29	28636	RP 6361-RAF-252-GSR-IR1-DQ146-L18-Y1	-	AVT 2-AEROB	3934	82	LS	Promising in Bihar (Z III) and Gujarat (Z VI)
30	29536	OR 2674-14-6-2	CRMS 32A / OR 1889-5	AVT 2–MS	6341	103	MS	promising for Maharashtra in Zone V
31	29523	R2054-685-1-205-1	R 1033-2559-1-1 / Gopal bhog	AVT 2–MS	5812	105	MS	promising for Chhattisgarh State
32	29365	CSR TPB 159	Trichy 1 / PB1	AVT 2 - AL & ISTVT	3022	84	LS	promising in Haryana state only.
33	29361	CSR CPB 69	CSR 89 IR15 / PB1	AVT 2 - AL & ISTVT	3531	93	MS	promising in Haryana state only
34	29354	CSR YET 59	CSR 27 / CSR36	AVT 2 - AL & ISTVT	3106	86	LS	promising in Haryana state only
35	28206	HPR 3106	HPR 2336 / AC 19146 // HPR 2143	AVT - 2- E (H)	4566	106	LB	Promising in Medium Northern Zone for the state of Uttarakhand
36	28883	VL 32585	VL 31290 / *O. minuta*	AVT - 2- E (H)	4122	103	LB	Promising in Medium Northern hill Zone for the state of Uttarakhand and Himachal Pradesh
37	28895	VL 32560	VL 31339 / BL 122	AVT - 2- E (H)	4836	105	LS	Promising in Medium Northern hill Zone for the state of Uttarakhand and Himachal Pradesh
38	28907	CAUS 124 (ULRC 26-11-2-1-1)	Kasalath / Borodhan	AVT 2-M (H)	3916	107	LB	promising only for the state of Manipur
39	28821	RP 5964-82	KMR 3 / Swarna	AVT 2 & 1 LPT)	5054		LB	promising for Karnataka and Telangana in Zone VII

Appendix-2: Centre-wise Breeder Seed Production during kharif, 2022 (as per DAC indent) (Quantity in Quintals)

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		Andhra Pradesh			
1	ANGRAU, Guntur	Amara (MTU-1064)	5.30	27.50 56.00*	78.20
		Bapatla Mahsuri (BPT 2295)	0.70	40.00	39.30
		Bhavathi (BPT 2782)	0.10	70.00	69.90
		Bheema (MTU 1140)	3.35	1.10 17.00*	14.75
		BPT 5204	40.40	700.00	659.60
		BPT 2411 (Sasya)	0.50	15.00	14.50
		BPT 2595 (Teja)	0.40	40.00	39.60
		Chandra (IET 23409) (MTU 1153)	70.55	61.60 130.00*	121.05
		Cottondora Sannalu (MTU1010)	176.80	400.00	223.20
		Maruteru Sannalu (MTU 1006) (IET 14348)	0.50	0.66 2.50*	2.66
		MTU 1061	7.00	65.00*	58.00
		MTU (1075) (IET 18482)	9.00	55.00	46.00
		MTU 1155	5.70	2.50 7.50*	4.30
		MTU 1156	72.10	104.93 150.00*	182.83
		MTU 1172	3.00	3.25 18.00*	18.25
		MTU 1210	13.70	9.61 18.00*	13.91
		MTU 1223	17.20	12.00 22.00*	16.80
		MTU 1224	9.60	34.98 70.00*	95.38
		MTU 1239	16.20	7.75 36.00*	27.55
		MTU 1262	7.80	46.75 63.00*	101.95

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		MTU 1281	0.30	1.00 7.50*	8.20
		MTU 7025#	2.60	0.00	-2.60
		MTU 7029	232.6	550.00	317.40
		Nellore Dhyanyarassi (NLR 3354)	0.90	6.00*	5.10
		Nellore Mahsuri (NLR 34449)	10.60	140.00*	129.40
		Nellore Sugandha (NLR40054)	0.10	1.00*	0.90
		NLR 4001	0.40	5.00*	4.60
		NDLR 7	2.75	25.00 25.00*	47.25
		Pandu Ranga (MCM 100)	0.30	6.00	5.70
		Pardhhiva (NLR 33892)	0.60	10.00	9.40
		RGL 2537	6.10	83.60	77.50
		Sona Mahsuri (BPT 3291)	4.80	45.00	40.20
		Vijetha (MTU 1001)	56.50	125.00	68.50
		Varam (MTU 1190)	2.40	2.25 7.50*	7.35
		Sri Dhruthi (MTU 1121)	14.70	162.00	147.30
		Total:	**795.55**	**3489.48***	**2693.93**
		Assam			
2	AAU, Titabar	Bahadur	1.10	49.45	48.35
		Bahadur Sub-1	8.62	43.40	34.78
		Disang [Dehangi) (IC-574471)]	0.50	0.50	-
		Gitesh	0.50	23.60	23.10
		Inglongkheri	0.50	0.13	-0.37
		Jalashri (TTB 202-3)	0.50	0.00	-0.50
		Jalkuwari	0.50	0.00	-0.50
		Ketakijoha	3.00	23.70	20.70
		Numali	5.00	72.50	67.50
		RANJIT SUB -1	83.45	209.45	126.00
		RANJEET (IET 12554)	1.60	99.00	97.40
		Total:	**105.27**	**521.73**	**416.46**

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		Bihar			
3	RAU, Pusa	RajendraBhagvati	2.00	2.00	-
		RajendraSawaswati (IET 23423)	10.30	9.00	-1.30
		Rajendra Mahsuri-1	7.50	15.00	7.50
		RAJENDRA SWETA	0.50	4.00	3.50
		R Neelam	10.00	15.08	5.08
		Sita	0.25	0.00	-0.25
		Total:	**30.55**	**45.08**	**14.53**
4	ICAR RC for Eastern Region, Patna	Swarna Shakti Dhan (IET 25640)	14.20	29.60	15.40
		Swarna Shreya	17.50	45.90	28.40
		Swarna Smriddhi Dhan (IET 24306)	15.00	51.80	36.80
		Total:	**46.70**	**127.30**	**80.60**
5	BAU, Sabour	Sabour Shree (RAU724-48-33) (IET18878)	60.05	169.00	108.95
		Sabour Harshit Dhan (IET 25342)	20.00	43.00	23.00
		Sabour Sampanna Dhan	60.00	83.00	23.00
		Sabour Surbhit	20.00	21.00	1.00
		Sabour Ardhjal (BRR 0007)	15.00	24.50	9.50
		Total:	**175.05**	**340.50**	**165.45**
		Total:	**252.30**	**512.88**	**260.58**
		Chhattisgarh			
6	IGKV, Raipur	CG Madhuraj Dhan-55	13.00	21.90	8.90
		Chhattisgarh Devbhog	18.00	45.00	27.00
		Chhattisgarh Zinc Rice -1	12.00	15.60	3.60
		Chhattisgarh Zinc Rice-2	15.40	15.40	-
		Dubraj Selection-1	18.00	20.00	2.00
		IGKVR-1 (IET 19569)	66.00	66.00	-
		IGKVR-2 (IET 19795)	10.00	10.00	-
		Indira Aerobic-1(R1570-2649-1-1546-1) (IET21686)	26.00	33.60	7.60
		IR-64	35.00	55.50	20.50
		IR-20	2.20	0.00	-2.20
		Mahamaya (IET-10749)	95.00	121.80	26.80
		Maheswari (IGRKVR-1244) (IET 19796)	14.00	14.00	-

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		Tarun Bhog Selection-1	22.10	23.10	1.00
		Bhadshabhhog Selection-1	22.50	23.10	0.60
		Vikram TCR	21.30	39.60	18.30
		CG Barani Dhan -2 (IET 24690)	4.30	8.40	4.10
		Protezin (IET 25470) (R-RHZ-R-56)	10.00	18.90	8.90
		Trombey Chattisgarh Dubraj Mutent-1	15.00	27.00	12.00
		Vishnubhog Selection-1	22.30	29.70	7.40
		ZINCO RICE MS	15.30	21.90	6.60
		Total:	**457.40**	**610.50**	**153.10**
7	IGKV, Jagdalpur	Baster Dhan 1	3.00	30.00	27.00
		Total:	**460.40**	**640.50**	**180.10**
		Gujarat			
8	AAU, Nawagam	Guj Anand Rice-14	0.10	0.25	0.15
		Gujarat Anand Rice-3 (GAR-3)	0.65	0.75	0.10
		GS-1	1.00	0.00	-1.00
		GAR-21	0.10	2.00	1.90
		GAR-22	0.05	1.00	0.95
		GNR-3	0.40	1.00	0.60
		GNR-5	0.30	0.50	0.20
		GNR-8 (Aarti)	0.10	0.50	0.40
		Total:	**2.70**	**6.00**	**3.30**
9	NAU, Navsari	GR 16 (Tapi) (NVSR-2233)	0.30	1.40	1.10
		GR 17 (Sardar)	0.55	4.76	4.21
		GR 18 (Devli Kolam)	0.10	1.40	1.30
		GR 19 (Auranga)	0.10	0.00	-0.10
		Total:	**1.05**	**7.56**	**6.51**
		Total:	**3.75**	**13.56**	**9.81**
		Haryana			
10	CSSRI, Karnal	CSR 76	2.10	3.50	1.40
		CSR-30	0.08	2.50	2.42
		CSR-43	1.50	7.50	6.00
		Total:	**3.68**	**13.50**	**9.82**

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
11	IARI Regional Station, Karnal	Pusa Basmati-1609	0.60	0.60	-
		PUSA BASMATI 1728	10.60	12.00	1.40
		Imp. Pusa Basmati-1(IET - 18990) (PUSA 1460-01-32)	0.60	0.60	-
		Pusa Basmati-1718 (IET 24565)	49.60	10.54	-39.06
		Pusa Basmati 1692 (IET 26995)	32.92	15.0	-17.92
		Pusa Basmati-1509(IET 21960) (PUSA 1509-03-3-9-5)	62.06	12.0	-50.06
		PUSA-1121 (PUSA SUGANDH-4)	30.69	17.0	-13.69
		PUSA BASMATI-6 (PUSA 1401) (IET 18005)	9.32	12.0	2.68
		PUSA BASMATI 1637 (IET 24570)	4.00	4.00	-
		Total:	**200.39**	**83.74**	**-116.65**
12	RRS, Kaul	BASMATI-370	12.00	15.00	3.00
		HKR-127 (HKR-95-222)	0.80	5.00	4.20
		HKR-47	0.43	5.00	4.57
		HKR-147	0.80	0.00	-0.80
		Total:	**14.03**	**25.00**	**10.97**
		Total:	**218.10**	**122.24**	**-95.86**
Himachal Pradesh					
13	CSKHPKVV, MALAN	HPR 2143	10.00	6.43	-3.57
		HPR-2656	15.00	14.85	-0.15
		HPR-2880	10.00	9.20	-0.80
		HPR-2795 (HIM PALAM DHAN-1)	10.00	3.53	-6.47
		Total:	**45.00**	**34.01**	**-10.99**
Jharkhand					
14	BAU, Ranchi	Birsa Vikas Dhan-111(IET 19848) (PY-84)	1.65	1.70	0.05
		Birsa Mati	0.50	1.00	0.50
		Birsa Vikas Dhan - 203	2.10	5.00	2.90
		Birsa Vikas Dhan- 109	0.50	0.60	0.10
		Birsa Vikas Dhan -110	0.50	0.60	0.10
		Birsa Vikas Sugandha - 1 (IET 18941)	2.10	11.00	8.90
		Total:	**7.35**	**19.90**	**12.55**

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
15	CRURRS, Hazaribagh	Sahbhagi (Sahbhagi Dhan IET-19576)	30.55	30.90	0.35
		Total:	**37.90**	**50.80**	**12.90**
		Jammu and Kashmir			
16	SKUAST, Khudwani	K 39	3.00	2.50	-0.50
		K-448	3.00	4.20	1.20
		Shalimar Rice-3	0.10	1.20	1.10
		Shalimar Rice-4	0.10	20.00	19.90
		Shalimar Rice-2	0.10	7.50	7.40
		Total:	**6.30**	**35.40**	**29.10**
17	SKUAST, Chatha	GIZA-14	6.00	7.00	1.00
		Total :	**12.30**	**42.40**	**30.10**
		Karnataka			
18	UAS, Bangalore	BR-2655	1.05	3.50	2.45
19	ZARS, Mandya	THANU	1.85	3.17	1.32
		TUNGA (IET-13901)	4.87	10.00	5.13
		Total:	**6.72**	**13.17**	**6.45**
20	ARS, Mugad	Intan	0.75	3.00	2.25
		Abhilash (KMD-2)	0.75	3.00	2.25
		Total:	**1.50**	**6.00**	**4.50**
21	SDRARS, Gangavati	Gangavati Sona (GGV-05-01)	0.30	0.50	0.20
22	UAHS, Shimoga	KKP-5 (IET 24250)	0.40	10.00	9.60
		Sahyadri Megha	0.05	3.00 5.00*	7.95
		Total:	**0.45**	**18.00**	**17.55**
		Total:	**10.02**	**41.17**	**31.15**
		Kerala			
23	KAU, Pattambi	Athira (PBT-51)	0.15	0.00	-0.15
		Jyothi	5.30	18.75 15.00*	28.45
		Total:	**5.45**	**33.75**	**28.30**
24	RRS, Moncompu	Bhadra (MO-4)	3.25	0.00*	-3.25
		MO 21 (Pratiksha)	0.25	2.23	1.98

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		UMA (MO-16)	12.9	3.04*	-9.86
		Total:	**16.40**	**5.27***	**-11.13**
		Total:	**21.85**	**39.02***	**17.17**
		Madhya Pradesh			
25	J.N.K.V.V, Jabalpur	Improved Chinnor	2.40	9.00	6.60
		Improved Jeera Shankar	3.70	10.00	6.30
		JR 767	16.50	16.55	0.05
		JR-81	28.00	110.00	82.00
		JR-206	58.40	150.00	91.60
		JRB-1	20.00	6.75	-13.25
		JRH-19	3.20	3.40	0.20
		KRANTI (R-2022)	2.05	10.00	7.95
		Total:	**134.25**	**315.70**	**181.45**
		Maharashtra			
26	RARS, Karjat	Karjat-2	0.40	16.80	16.40
		Karjat-3	4.60	30.00	25.40
		Karjat-5	1.00	6.80	5.80
		Karjat-7	1.50	12.90	11.40
		Karjat-8	0.52	3.00	2.48
		Karjat-9	0.80	9.30	8.50
		Trombey Karjat Kolam (BARCKKV 13)	0.20	5.70	5.50
		Total:	**9.02**	**84.50**	**75.48**
27	MPKV, Radhanagari	Bhogavati	1.00	5.70	4.70
28	ARS, Sakoli	SAKOLI-9	0.20	0.50	0.30
29	ARS, Shirgaon	Ratnagiri-1	0.40	10.00 7.50*	17.10
		Ratnagiri-5	0.60	6.00	5.40
		Ratnagiri-6	0.20	6.00 9.00*	14.80
		Ratnagiri-7	0.40	7.00 4.20*	10.80
		Ratnagiri-8	0.30	20.00 7.20*	26.90
		Total:	**1.90**	**76.90**	**75.00**

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
30	ARS, Vadagon	Indrayani (IET - 12897)	22.60	70.00	47.40
		Phule Samruddhi (VDN -99-29)	0.60	4.00	3.40
		Total:	**23.20**	**74.00**	**50.80**
31	PDKV, Sindewahi	PDKV TILAK (SYE-503-78-34-2)	4.30	15.00	10.70
		PKV KISAN DKL -22-39-31-25*3134	0.20	2.00	1.80
		PKV HMT	34.50	52.00	17.50
		Total:	**39.00**	**69.00**	**30.00**
		Total	**74.32**	**310.60**	**236.28**
		New Delhi			
32	IARI, New Delhi	Pusa 1592	0.20	0.40	0.20
		Pusa 1612	1.00	1.50	0.50
		Pusa Basmati 1847	7.48	7.00	-0.48
		Pusa Basmati 1985	6.50	3.00	-3.50
		Pusa Basmati 1885	2.56	5.00	2.44
		Pusa Basmati 1886	2.00	5.00	3.00
		Pusa Basmati 1979	0.08	1.00	0.92
		Total:	**19.82**	**22.90**	**3.08**
33	BEDF, Meerut	Pusa Basmati-1(IET 10364)	0.08	1.00	0.92
		Pusa-1121 (Pusa Sugandh-4)	30.00	25.00	-5.00
		Pusa Basmati 1637 (IET 24570)	4.00	0.00	-4.00
		Pusa Basmati-6 (Pusa 1401) (IET 18005)	10.00	8.00	-2.00
		Total:	**44.08**	**34.00**	**-10.08**
		Sub-Total:	**63.90**	**56.90**	**-7.00**
		Odisha			
34	NRRI, Cuttack	Ankit	5.30	14.00	8.70
		Annada	2.00	2.00*	-
		CR DHAN 201 (IET 21924)	1.00	1.00*	-
		CR DHAN 202 (IET 21917	0.30	1.50*	1.20
		CR DHAN 300 (CR2301-5) (IET 19816)	0.70	2.00*	1.30
		CR DHAN 304 (IET 22117)	0.50	0.00	-0.50
		CR DHAN 305 (IET 21287)	0.20	1.00*	0.80
		CR DHAN 306	0.60	1.00*	0.40

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		CR DHAN 315	3.05	10.00*	6.95
		CR DHAN 316	1.00	1.50*	0.50
		CR DHAN 318	0.30	0.00	-0.30
		CR DHAN 317 (Roshan)	1.00	3.00*	2.00
		CR DHAN 311 (MUKUL)	14.50	22.00	7.50
		CR DHAN 401(REETA) (IET 19969)	0.50	0.00	-0.50
		CR DHAN 505 (IET 21719)	0.10	0.00	-0.10
		CR DHAN 507	0.30	1.70	1.40
		CR DHAN 511	0.50	0.00	-0.50
		CR DHAN 601(IET 18558)	0.50	5.00	4.50
		ÇR DHAN 800 (SWARNA-MAS)	25.25	6.50 6.00*	-12.75
		CR DHAN 801 (IET-25667)	1.90	6.00*	4.10
		CR Dhan 802 (Subhar)	8.20	6.00*	-2.20
		CR DHAN 803 (Trilochan)	5.00	0.00	-5.00
		CR DHAN 1017	0.40	1.00	0.60
		CR DHAN 1018	0.20	1.50	1.30
		CR DHAN 1030	0.10	0.00	-0.10
		CR DHAN-203	12.45	13.00 8.00*	8.55
		CR DHAN-207	0.30	0.00	-0.30
		CR DHAN-209	0.30	1.00*	0.70
		CR DHAN-307	1.70	6.00	4.30
		CR DHAN-309	1.00	2.50*	1.50
		CR DHAN-310	26.90	27.00 12.00*	12.10
		CR DHAN-311	0.20	0.00	-0.20
		CR DHAN 407	0.20	0.00	-0.20
		CR DHAN 408	0.20	0.00	-0.20
		CR DHAN 409	0.60	15.00	14.40
		CR DHAN 410	0.37	0.00	-0.37
		CR Dhan 411 (Swaranjali)	1.00	0.00	-1.00
		CR Dhan 412	1.00	0.00	-1.00

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		CR Dhan 413	1.00	0.50	-0.50
		CR Dhan 506	0.20	0.00	-0.20
		CR Dhan 508	2.10	3.50	1.40
		CR Dhan 512	1.00	0.00	-1.00
		CR Dhan 702	1.00	0.00	-1.00
		CR Dhan 703	1.00	0.00	-1.00
		CR 1009	2.40	1.50	-0.90
		CR 1009 *sub1*	42.15	45.00	2.85
		CR Dhan 102 (IET 26121)	3.60	11.00	7.40
		CR Dhan 210 (IET 23449)	1.50	2.50*	1.00
		CR Dhan 308 (IET 25523)	1.50	4.00*	2.50
		CR Dhan 312 CR 3808-13 (IET 25997)	1.50	15.00*	13.50
		Geetanjali (CRM-2007-1) (IET 17276)	0.50	2.00*	1.50
		Luna Sampad (IET 19470)	0.50	0.00	-0.50
		Luna Suvarna (IET 18697)	0.50	0.00	-0.50
		Naveen (CR-749-20-2) (IET 14461)	3.20	6.00*	2.80
		Samba *sub1* (IET 21248)	17.55	0.00	-17.55
		CR Sugandh Dhan 908 (IET 23189)	1.12	0.00	-1.12
		Swarna *sub1* (CR 2539-1) IET 20266	78.10	85.00	6.90
		Varshadhan (CRLC-899) (IET 16481)	1.50	1.00	-0.50
		CR Dhan 602 (IET 26692)	1.50	3.00*	1.50
		CR Sugandh Dhan 910 (IET22649) (CR 2713-180)	1.30	0.00	-1.30
		Total:	**284.34**	**357.20***	**72.86**
35	O.U.A.T, Bhubaneswar	Ashuthosh	1.50	1.80	0.30
		Hasanta	1.80	5.00	3.20
		Improved Lalat	12.00	15.00*	3.00
		Kalachampa	46.60	54.00	7.40
		Lalat (IET 9947)	5.00	10.00	5.00
		Mandakini (IET 17847)	6.00	4.00 2.00*	-
		Mrunalini (OR 1898-18-) (IET 18649)	3.00	5.00	2.00

Appendices

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		Praijat (IET 2684)	1.00	1.40 1.00*	1.40
		Pradeep (IET 20923)	0.30	0.30	-
		Pratikshya (ORS 201-5) (IET 15191)	16.00	24.00	8.00
		Rani Dhan (IET 19148)	2.00	2.00	-
		Sebati (IET 11786)	2.00	0.00	-2.00
		Gobinda (OR 2324-8)	1.50	1.50	-
		Kalinga Dhan 1204	1.00	0.80 1.00*	0.80
		Kalinga Dhan 1205	1.00	1.00	-
		Kalinga Dhan 1401	1.00	0.40	-0.60
		Kalinga Dhan 1501	1.00	1.40	0.40
		Kalinga Dhan 1502	1.00	1.40	0.40
		Total:	**103.70**	**133.00**	**29.30**
		Sub Total:	**388.04**	**490.20**	**102.16**
Punjab					
36	PAU, Ludhiana	PR 121	26.29	30.00	3.71
		PR 122	5.74	15.00	9.26
		PR 127	3.50	10.00	6.50
		PR-113	0.43	10.00	9.57
		PR-114	0.48	10.00	9.52
		PR-124	3.03	10.00	6.97
		PR-126	37.66	40.00	2.34
		PR-128	12.10	16.00	3.90
		PR-129	9.00	19.00	10.00
		PR-130	1.98	10.00	8.02
		PR-131	1.48	0.00	-1.48
		Punjab Basmati 7	6.94	10.00	3.06
		Total:	**108.63**	**180.00**	**71.37**
Tamil Nadu					
37	TNAU, Coimbatore	CO 51	12.79	13.00	0.21
		Improved White Ponni	16.60	17.50*	0.90
		Total:	**29.39**	**30.50***	**1.11**

Appendices

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
38	TRRI, Aduthurai	ASD-16	0.2	1.00	0.80
		ADT-37	0.4	1.00	0.60
		ADT-39	0.4	1.00*	0.60
		ADT-45	0.2	1.00	0.80
		ADT (R)-46	0.2	0.50*	0.30
		Total:	**1.40**	**4.50***	**3.10**
		Total:	**30.79**	**35.00***	**4.21**
		Telangana			
39	IIRR, Hyderabad	Kasturi (IET-8580)	5.00	5.00	-
		Mahsuri	0.70	0.70	-
		BRRI Dhan 69	0.30	0.30	-
		BRRI Dhan-75 (HUA 565)	0.40	0.40	-
		Ciherang Sub-1	6.15	6.15*	-
		IET 5656	0.50	0.50	-
		BINA DHAN-11	23.60	23.60*	-
		BINA DHAN-17	10.60	10.60*	-
		DRR DHAN 50 (IET 25671)	39.80	39.80*	-
		DRR DHAN-45 (IET 23832)	7.85	4.00	-
		DRR DHAN-53	30.50	34.50	4.00
		DRR DHAN-39	10.00	5.00	-
		DRR DHAN-42	59.12	60.00	0.88
		DRR DHAN-43	10.50	35.00	24.50
		DRR DHAN-44	14.45	20.00	5.55
		DRR DHAN-46	3.90	3.90*	-
		DRR DHAN -47	0.30	0.30*	-
		DRR DHAN-48	0.20	80.00	79.80
		DRR DHAN-49	0.20	5.00	4.80
		DRR DHAN-51	11.00	11.00*	-
		DRR DHAN -52	0.90	0.90*	-
		DRR DHAN -54	20.20	1.00	-
		DRR DHAN -55	20.00	76.70	56.70
		Improved Samba Mahsuri	0.10	5.00	4.90

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		JAYA	11.80	12.00	0.20
		DRR Dhan -58	0.50	87.00	86.50
		DRR Dhan -62	0.30	45.00	44.70
		Total:	**288.87**	**573.35**	**284.48**
40	PJTSAU, Hyderabad	ErraMallelu (WGL-20471)	1.00	2.00*	1.00
		JGL-1798	2.92	2.92	-
		JGL-18047 (Bathukamma)	7.02	7.02	-
		JGL-24423	20.85	50.00	29.15
		JGL-17004	0.30	0.30	-
		JGL 11118 (Anjana)	0.40	0.40	-
		Kunaram Sannalu	101.55	101.55	-
		Kunaram Rice 1 (KNM 733)	0.40	0.40	-
		RNR-15048 (Telangana Sona)	47.15	50.00*	2.85
		Krishna (RNR-2458)	0.30	0.30	-
		Siddhi (WGL 44)	1.50	4.25	2.75
		Shobhini (RNR-2354) (IET- 21260)	0.80	1.00*	0.20
		Somnath (WGL-347)	1.30	1.50*	0.20
		Tellahamsa	0.75	0.00	-0.75
		Telangana Vari-1 (IET 25330) (WGL-739)	1.00	5.00*	4.00
		Telangana Vari-3 (JGL 21078)	0.10	0.10	-
		WGL-697 (IET 26027)	0.10	0.50*	0.40
		WGL-915	1.40	1.40	-
		Total:	**188.84**	**228.64**	**39.80**
		Sub-Total:	**477.71**	**801.99**	**324.28**
Uttarakhand					
41	VPKAS, Almora	VL DHAN 157 (VL 31611) (IET 22292)	2.50	0.00	-2.50
		VL DHAN 68 (VL 31611) (IET 22283)	2.00	0.00	-2.00
		VL DHAN 88	3.60	0.00	-3.60
		Total:	**8.10**	**0.00**	**-8.10**
42	GBPUAT, Pantnagar	PANT DHAN-18 (IET 17920) (UPRI 99-1)	1.00	9.00	8.00
		Pant Basmati-1	1.00	17.50	16.50
		PD-18	0.20	9.00	8.80

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		PANT DHAN-24	7.30	20.00	12.70
		PANT DHAN-26	3.30	9.00	5.70
		Total:	**12.80**	**64.50**	**51.70**
		Sub-total:	**20.90**	**64.50**	**43.60**
		Uttar Pradesh			
43	BHU, Varanasi	HUR-917	3.00	20.00	17.00
44	NDUAT, Faizabad	NDR 9930111	5.00	6.20	1.20
		NDR-359	1.00	1.50	0.50
		Narendra Dhan 97	0.10	0.50	0.40
		Sarjoo 52	1.00	122.00	121.00
		Total:	**7.10**	**130.20**	**123.10**
45	PRDF, GORAKHPUR	Bauna Kalanamak-102	0.90	5.00	4.10
		Bauna Kalanamak-101	0.90	2.00	1.10
		KN3 (Kalanamak)	0.10	2.00	1.90
		Kalanamak Kiran (PRDF-2-14-10)	1.50	11.50	10.00
		Total:	**3.40**	**20.50**	**17.10**
47	SHUATS, Prayagraj	SHIATS DHAN 5	3.00	2.00	-1.00
		SHIATS DHAN-4	6.00	3.00	-3.00
		Total:	**9.00**	**5.00**	**-4.00**
		Sub-total:	**22.50**	**175.70**	**153.20**
		West Bengal			
48	RRS, Chinsurah	Ajit	8.10	8.50	0.40
		Bhupesh (CN 1752-18-1-9-MLD-19)	0.20	0.50	0.30
		Chinsurah Nona -2 (GOSABA-6) (IET-21943)	0.70	1.00	0.30
		Chinsurah Rice (IET 19140) (CNI 383-5-11)	0.50	0.50	-
		CN1272-55-105 (IET-19886)	0.50	1.50	1.00
		Khitish (IET-4094)	4.00	5.00	1.00
		Manisha (IET 23770)	0.30	0.80	0.50
		Rajdeep (CN 1039-9)	0.30	2.00	1.70
		Sabita (IET 8970)	0.20	1.00	0.80
		Sukumar (IET 21261)	15.40	5.00	-10.40

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
		Muktashree (IET 21845)	1.30	2.00	0.70
		Shatabdi (IET 4786)	15.00	24.50	9.50
		Total:	**46.50**	**52.30**	**5.80**
46	BCKV, Nadia	Gontra Bidhan-1 (IET 17430)	9.25	10.00	0.75
		Gontra Bidhan-3 (IET 22752)	19.85	22.00	2.15
		Gontra Bidhan-4	0.50	0.00	-0.50
		BidhanSurchi (IET 25701)	10.55	12.50	1.95
		Total:	**40.15**	**44.50**	**4.35**
49	RRS, Bankura	Dhruba (IET-20761)	1.00	1.00	-
		Pushpa (IET 17509)	1.30	0.00	-1.30
		BNKR-1 (DHIREN) (IET 20760)	4.60	4.30	-0.30
		Total:	**6.90**	**5.30**	**-1.60**
50	ICAR-RC for NEH Region, Lembuchera	Gomati Dhan TRC-2005-1 (TRC-05-8-4-42-8-3-7) IET 21512	0.10	0.80	0.70
		Khowai TRC-2005-3 (TRC 05-2-6-4-39-3-6) IET 21564	0.05	0.72	0.67
		Tripura Chikandhan	0.10	0.49	0.39
		Tripura Aush	0.10	0.35	0.25
		Tripura Nirog	0.10	0.46	0.36
		Tripura Jala (IET 22167)	0.05	0.36	0.31
		Tripura Khara 1	0.05	0.24	0.19
		Tripura Sarat	0.10	2.90	2.80
		Total:	**0.65**	**6.32**	**5.67**
51	UBKV, Pundibari	Uttar Lakshmi (UBKVR-15) (IET 24173)	1.00	6.10	5.10
		UTTAR SONA (UBKVR-1) (IET-24171)	3.30	5.40	2.10
		Total:	**4.30**	**11.50**	**7.20**
52	RRS, Wangbal	RC Maniphou-13	0.30	3.00	2.70
		Total:	**98.80**	**122.92**	**24.12**
		Grand Total:	**3382.28**	**8053.74**	**4671.46**

*: indicates produced during Rabi 2022-23

Appendix 3: Parental lines of Hybrids

S. No.	Name of the Producing centre	Name of variety	Actual allocation as per BSP-I	Actual Production	Surplus (+) Deficit (-)
1	IIRR, Hyderabad	DRRH-2 (A Line)	0.10	0.00	-0.10
		DRRH-2 (A Line)	0.10	0.00	-0.10
		DRRH-2 (A Line)	0.10	0.00	-0.10
		Total:	0.30	0.00	-0.30
2	UAS, Bangalore	KRH 2 (A Line)	0.10	1.00*	0.90
		KRH 2 (B Line)	0.10	1.00*	0.90
		KRH 2 (R Line)	0.10	0.10	-
			0.30	2.10	1.80
		Total:	**3382.88**	**8055.84**	**4672.96**

*: indicates produced during Rabi 2022-23

Appendices

Appendix 4: List of Institute Research Projects (As approved by IRC)

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
CROP IMPROVEMENT			
PLANT BREEDING			
GEQ/CI/ BR/8	Enhancing nutritional quality of rice through bio-fortification	Dr L V Subba Rao	Dr G Padmavathi Dr CN Neeraja Dr J Aravind Kumar Dr AVSR Swamy Dr T Longvah (NIN)
GEY/CI/BR/26	Breeding for high yielding short duration and water use efficient rice hybrids and varieties	Dr AVSR Swamy	Dr R M Sundaram Dr R Mahender Kumar Dr P Senguttuvel Dr Jyothi Badri Dr R Abdul Fiyaz
GEY/CI/BR/31	Breeding for high yielding, medium to late maturing rice varieties with tolerance to biotic stresses and good grain quality	Dr S V Sai Prasad	Dr AVSR Swamy Dr J Arvind Kumar Dr M. Srinivas Prasad Dr V Jhansi Lakshmi
GEY/CI/ BR/16	Traditional and molecular approaches for breeding improved rice varieties with resistance to planthoppers	Dr G Padmavathi	Dr V Jhansi Lakshmi, Dr Divya Balakrishnan Dr V Papa Rao Dr ADVSLP Ananda Kumar (APRRI, Maruteru)
GEQ/CI/ BR/9	Development of Rice Cultivars with High Grain Protein Content and Quality Traits	Dr J Aravind Kumar	Dr LV Subba Rao Dr R Abdul Fiyaz Dr Jyoti Badri Dr Ch Suvarna Rani
GEY/CI/BR/29	Genetic Improvement of Direct Seeded Rice Traits Using Elite Varieties and Wild Species	Dr C Gireesh	Dr R M Sundaram Dr M S Anantha Dr B Divya Dr P Senguttuvel Dr R Mahendra Kumar Dr B Sreedevi Dr K Basavaraj Dr K B Kemparaju Dr Kalyani
GEY/CI/ BR/27	Novel Genetic approaches for development of Climate Smart Rice Varieties	Dr Suneetha Kota	Dr G Padamavathi Dr P Senguttuvel Dr C Gireesh Dr R M Sundaram Dr Santosha Rathod, Dr Akshay S. Sakhare Dr Brajendra Dr M D Tuti Dr S K Mangrauthia Dr Viswanathan C (IARI) Dr Girija Rani (ARS Machilipattinam) Dr Krishnamurthy SL (CSSRI Karnal) Dr Manohar K K (ICAR – CCARI, Goa)

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
GEY/CI/ BR/25	Broadening the genetic base of indica rice varieties and modify plant type by introgressing traits from tropical japonica	Dr Jyothi Badri	Dr Divya Balakrishnan Dr J Aravind Kumar Dr P Revathi Dr P Raghuveer Rao, Dr V Prakasam Dr Ch Padmavathi Dr B Sreedevi Dr Ch Suvarna Rani
GEY/CI/ BR/24	Genomic assisted breeding for development of low phosphorous and nitrogen stress tolerant rice varieties	Dr M S Anantha	Dr C Gireesh Dr R M Sundaram Dr R Mahender Kumar Dr C N Neeraja Dr P Senguttuvel
GEY/CI/ BR/28	Genetic Enhancement of Speciality Rices of India	Dr R Abdul Fiyaz	Dr R M Sundaram Dr J Aravind Kumar Dr MM Azam Dr K Basavaraj Dr LV Subba Rao Dr Suvarna Rani Ch
GEY/CI/BR/30	Breeding high yielding stress tolerant rice varieties using interspecific wild introgression lines derived from *Oryza nivara* and *Oryza rufipogon*	Dr Divya Balakrishnan	Dr G Padmavathi Dr Jyothi Badri Dr C Gireesh Dr D Ladha Lakshmi Dr B Kalyani
GEQ/CI/ BR/10	Breaking the yield plateau in native aromatic short and medium grain rice through classical and molecular breeding	Dr Suvarna Rani Chimmili	Dr G Padmavathi Dr J Aravind Kumar Dr Suneetha Kota Dr Jyothi Badri Dr C Gireesh Dr M S Anantha Dr Abdul Fiyaz
HYBRID RICE			
GEY/CI/HY/13	Development and evaluation of three-line hybrids with better grain quality and resistance to major pests and diseases.	Dr A S Hari Prasad	Dr P Senguttuvel Dr P Revathi Dr KB Kemparaju Dr K Sruthi Dr RM Sundaram
GEY/CI/HY/16	Genetic improvement of maintainer lines for biotic stress and yield enhancing genes	Dr K B Kemparaju	Dr Sruthi K Dr AS Hari Prasad
GEY/CI/HY/14	Establishment and validation of heterotic gene pools in hybrid rice	Dr K Sruthi	Dr AS Hari Prasad, Dr P Senguttuvel Dr P Revathi Dr B Kemparaju Dr R M Sundaram

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
GEY/CI/HY/15	Genetic enhancement of hybrid rice parental lines suitable for aerobic and tolerance to salinity conditions through conventional and molecular approaches	Dr P Senguttuvel	Dr AS HariPrasad Dr RM Sundaram Dr P Revathi Dr KB Kemparaju Dr K Sruthi Dr Sai Prasad Dr B Sreedevi Dr K Suneetha Dr C Gireesh Dr MS Anantha Dr G Padmavathi Dr Mahender Kumar Dr R Gopinath Dr N Somasekhar
GEY/CI/HY/17	Development and evaluation of biotic stress-resistant restorers and their hybrids for yield and grain quality traits by conventional and molecular approaches in rice	Dr P Revathi	Dr AS HariPrasad Dr P Senguttuvel Dr K Sruthi Dr J Aravind Kumar Dr C Gireesh DR CN Neeraja Dr S K Mangrauthia Dr M. Srinivas Prasad Dr GS Laha Dr V Prakasham Dr V Jhansi lakshmi Dr MD Tuti Dr P Raghuveer Rao Dr P Muthuraman Dr RM Sundaram
BIOTECHNOLOGY			
ABR/CI/BT/6	Identification of genes for grain filling in rice (*Oryza sativa* L.)	Dr CN Neeraja	Dr L V Subba Rao Dr M Sheshu Madhav Dr D Sanjeeva Rao Dr S K Mangrauthia Dr Kalyani M B
ABR/CI/BT/17	Application of genomic, transcriptomic and proteomic tools for understanding and improvement of yield heterosis in rice hybrids	Dr R M Sundaram	Dr C N Neeraja Dr A S Hariprasad Dr K Sruthi Dr P Senguttuvel Dr S K Mangrauthia Dr Kalyani M B Mr P Koteshwara Dr T M Gireesha
ABR/CI/BT/20	Genetic improvement of brown plant hopper (BPH) tolerance in rice through novel breeding technologies	Dr. Papa Rao Vaikuntapu	Dr. RM Sundaram Dr. V. Jhansi Lakshmi Dr. G. Padmavathi Dr. China Babu Naik

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
ABR/CI/BT/16	Exploring the mutant resources for rice improvement	Dr M Sheshu Madhav	Dr R M Sundaram Dr Kalyani MB Dr D Sanjeeva Rao Dr B Sreedevi Dr P Senguttuvel Dr LV Subba Rao Dr C Gireesh Dr M S Anantha Dr AP Padma kumari Dr Jhansi Lakshmi Dr Ch Padmavathi Dr Y Sridhar Dr GS Laha Dr MS Prasad Dr Ladha Lakshmi
ABR/CI/BT/18	Genomics and genome editing approaches for abiotic stress tolerance (low P and heat), biotic stress tolerance (sheath blight and bacterial blight), and yield improvement of rice	Dr S K Mangrauthia	Dr R M Sundaram Dr C N Neeraja Dr S V Saiprasad Dr G S Laha Dr Brajendra Dr P Revathi Dr Akshay Sakhare Dr V Prakasam
ABR/CI/BT/19	Elucidation of long non-coding RNAs and association of molecular markers for important root traits under aerobic condition	Dr Kalyani M Barbadikar	Dr. M. Seshu Madhav Dr S K Mangrauthia Dr C N Neeraja Dr R M Sundaram Dr P Senguttuvel
CROP PRODUCTION DIVISION			
AGRONOMY			
RUE/CP/AG/14	Strategic research on enhancing water Use efficiency and productivity in irrigated rice system	Dr R Mahender Kumar	Dr K Surekha Dr B Sreedevi Dr Ch Padmavthi Dr M. Srinivas Prasad Dr V Prakasham Dr N. Somashekhar Dr B Nirmala Dr Amtul Waris Dr AVS Swamy Dr Senguttuvel P Dr C. Kannan Dr Vidhan Singh T Dr Y Sreedhar Dr Bandeppa Dr MBB Prasad Babu Dr DVK Nageswar Rao Dr K Srinivas (CRIDA) Pranaadhara – A. P
RUE/CP/AG/13	Development of Climate smart and economic weed management technologies for changing rice establishment systems	Dr B Sreedevi	Dr Mahender Kumar Dr N Somasekhar Dr P Senguttuvel Dr M D Tuti

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
SSP/CP/AG/15	Sustainable intensification of conservation agriculture practices in rice-maize system to enhance system productivity in Southern India	Dr Mangal Deep Tuti	Dr R Mahender Kumar Dr B Sreedevi Dr S Vijayakumar Dr B Nirmala Dr Bandeppa
RUE/CP/AG/ 18	Precision farming technologies to increase the resilience of rice production under changing climate scenarios	Dr S Vijayakumar	Dr B Sailaja Dr R M Kumar Dr D V K Nageswara Rao, Dr B. Sreedevi Dr M D Tuti Dr R Gobinath Dr M B B Prasad Babu Dr Santosha Rathod Dr S Pazhanivelan Dr N S Sudarmanian
SOIL SCIENCE			
CCR/CP/ SS/17	Studies on emission of greenhouse gases (GHGs) from rice soils and their mitigation	Dr M B B. Prasad Babu	Dr R Mahender Kumar Dr PC Latha Dr Brajendra Dr S Vijayakumar
SSP/CP/SS/11	Assessment of Genotypic variability in nitrogen use efficiency and improving NUE in irrigated rice	Dr K Surekha	Dr D V K Nageswara Rao Dr V Manasa Dr R Gobinath Dr R M Kumar Dr C N Neeraja Dr M M Azam
RUE/CP/SS/16	Study of rice vegetation in terms of crop stress to model the yield using NDVI	Dr D V K Nageswara Rao	Dr Santosha Rathod Dr V Manasa Dr R Gobinath
SSP/CP/SS/18	Studies on Soil Organic Carbon Status, Mapping and stocks in Rice Soils of India	Dr Brajendra	Dr B Sailaja Dr MBB Prasad Babu Dr P Muthuraman
SSP/CP/SS/19	Prospecting endophytic actinobacteria of rice for sustainable rice production	Dr PC Latha	Dr Bandeppa Dr MBB Prasad Babu
SSP/CP/SS/20	Development and evaluation of N fixing and P solubilizing microbial consortia for sustainable rice production	Dr Bandeppa	Dr P C Latha Dr K Surekha Dr M D Tuti Dr R Gobinath Dr V Manasa Dr Kalyani M B
RUE/CP/SS/22	Study on releasing pattern, kinetics and impact of nanoparticles in soils	Dr Gobinath, R	Dr Manasa Dr K Surekha Dr Bandeppa Dr Brajendra

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
RUE/CP/SS/21	Exploiting legacy phosphorus and enhancing phosphorus use efficiency in irrigated rice	Dr V Manasa	Dr R Gobinath Dr K Surekha Dr P C Latha Dr Bandeppa Dr M D Tuti Dr M M Azam
PLANT PHYSIOLOGY			
CCR/CP/PP/12	Role of Silicon in inducing abiotic stress tolerance in rice	Dr P Raghuveer Rao	Dr M M Azam Dr D Sanjeeva Rao Dr M D Tuti Dr Akshay S. Sakhare
CCR/CP/PP/13	Deciphering physiological basis of heat stress tolerance in rice	Dr Akshay S. Sakhare	Dr P Raghuveer Rao Dr Sanjeev Rao Dr Suneetha Kota Dr Kalyani M B Dr Brajendra Dr M D Tuti
GEQ/CP/PP/1	Selective biochemical and molecular analysis of natural and accelerated ageing in rice	Dr D Sanjeeva Rao	Dr P Raghuveer Rao Dr M Sheshu Madhav Dr P Senguttuvel Dr J Arvind Kumar Dr AVSR Swamy
AGRICULTURAL ENGINEERING			
RUE/CP/ENG/6	Selective mechanization in rice cultivation	Dr T Vidhan Singh	Dr R Mahender Kumar Dr B Nirmala
COMPUTER APPLICATIONS			
TTI/CP/CA/5	Smart precision models and Mobile Apps for real time advisories on Rice Crop Management	Dr B Sailaja	Dr Santosha Rathod Dr K Surekha Dr Ch Padmavathi Dr Brajendra Dr AP Padmakumari Dr D Krishnaveni Dr B Sreedevi Dr RM Kumar Dr GS Laha Dr S Vijaykumar
AGRICULTURAL CHEMICALS			
RUE/CP/AC/1	Post-Harvest Treatment of Rice and Rice By-Products for Health Benefits and on-farm application	Dr M.M. Azam	Dr P C Latha Dr R Mahendra Kumar Dr Amtul Waris Dr T Vidhan Singh Dr D Sanjeeva Rao Dr R. Abdul Fiyaz Dr AP Padmakumari Dr MS Prasad Dr GS Laha Dr V Prakasam Dr K Surekha Dr V Manasa Dr Aparna Kuna

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
CROP PROTECTION			
HRI/CPT/ENT/ 11	Assessment of host plant resistance to rice planthoppers viz., brown planthopper Nilaparvata lugens and whitebacked Planthopper Sogatella furcifera and their management	Dr V Jhansi Lakshmi	Dr D Sanjeeva Rao Dr Y Sreedhar Dr V. Chinna Babu Naik
IPM/ CPT/ ENT/29	Studies on Plant Nematode Interactions in Diverse Rice Phytobiomes	Dr N Somasekhar	Dr PC Latha Dr Sanjeeva Rao Dr P Senguttuvel Dr V. Chinna Babu Naik
HRI/ CPT/ENT/31	Understanding the interaction of internal feeders – stem borers and gall midge with rice for their management	Dr A P Padmakumari	Dr Y Sreedhar Dr K Suneetha Dr R M Sundaram Dr Kalyani M Barbadikar Dr V. Chinna Babu Naik
IPM/CPT/ENT/30	Enhancing biological control of rice pests through Chemical ecology	Dr Chitra Shanker	Dr B Jhansi Rani Dr M M Azam Dr Ch Padmavathi Dr N Somasekhar Dr C Kannan Dr V. Chinna Babu Naik
HRI/CPT/ENT/ 27	HPR to rice leaf folder and Semiochemical approaches for the management of insect pests of rice	Dr Ch Padmavathi	Dr Y Sridhar Dr Divya Balakrishnan Dr MM Azam Dr V. Chinna Babu Naik
IPM/CPT/ENT/28	Bio efficacy and toxicological studies of insecticides against insect pests of rice.	Dr Y Sridhar	Dr V Jhansi Lakshmi Dr A P Padma Kumari Dr Chitra Shanker Dr Ch Padmavathi Dr V. Chinna Babu Naik
IPM/ CPT/ENT/32	Studies on the genetics of inheritance of insecticide resistance and fitness cost in white backed Plant hopper *Sogatella furcifera* (Horvath) in India	Dr V. Chinna Babu Naik	Dr V. Jhansi Lakshmi Dr Y. Sridhar Dr Papa Rao Dr V. Chinna Babu Naik
IPM/ CPT/ENT/33	Investigations on genetics and mechanisms of resistance to rice root-knot nematode Meloidogyne graminicola	Dr Satish N. Chavan	Dr N. Somasekhar Dr P. Senguttuvel Dr Papa Rao Vaikuntapu Dr V. Chinna Babu Naik
PLANT PATHOLOGY			
HRP/CPT/PATH/15	Assessment of host plant resistance to rice blast disease and its management	Dr M S Prasad	Dr V Prakasam Dr Divya Balakrishnan Dr Basavaraj Dr G S Jasudasu Dr SV Sai Prasad Dr V Papa Rao

Appendices

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
HRP/CPT/PATH/13	Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice	Dr G S Laha	Dr D. Krishnaveni Dr D Ladhalakshmi Dr R M Sundaram Dr S K Mangrauthia
HRP/CPT/PATH/14	Assessment of host plant resistance and development of diagnostic tools for rice tungro virus disease	Dr D Krishnaveni	Dr GS Laha Dr C N Neeraja Dr Chitra Shanker Dr S K Mangrauthia Dr D Ladhalakshmi
HRP/CPT/PATH/20	Bioformulations of antagonistic microbes for disease management in rice	Dr C Kannan	Dr V Prakasam Dr Chitra Shanker Dr P C Latha Dr P Senguttuvel
HRP/CPT/ PATH/23	Variability in *Ustialginoidea virens* and management of false smut disease	Dr D Ladhalakshmi	Dr G S Laha Dr D. Krishnaveni Dr C Kannan Dr V Prakasam Dr K Basavaraj Dr Divya Balakrishnan Dr Sanjeeva Rao
HRP/ CPT/ PATH/22	Population dynamics of Rhizoctonia solani and sustainable management of rice sheath blight disease	Dr V Prakasam	Dr M S Prasad Dr G S Laha Dr D Ladhalakshmi Dr Jyothi Badri
HRP/CPT/ PATH/24	Host plant resistance to brown spot disease of rice and its management	Dr K Basavaraj	Dr M Srinivas Prasad Dr G S Laha Dr D Ladhalakshmi Dr V Prakasam Dr G S Jasudasu Dr C Gireesh Dr Divya Balakrishnan
HRP/CPT/ PATH/25	Investigations on Sheath rot and Stem rot diseases of Rice	Dr G S Jasudasu	Dr G S Laha Dr M Srinivas Prasad Dr D Krishnaveni Dr V Prakasam Dr K Basavaraj Dr D Ladhalakshmi
TRANSFER OF TECHNOLOGY & TRAINING			
TTI/TTT/EXT/19	Small holder Rice Production in India: Problems and Prospects	Dr P Muthuraman	Dr. Amtul Waris Dr P Jeya Kumar Dr. B Nirmala Dr P Jeyakumar Dr S. Arun Kumar Dr Santosha Rathod

Appendices

PROJECT CODE	PROJECT TITLE	PI	CO-PIS
TTI/TTT/EXT/12	Smart village(s) strategy for accelerated rice technology transfer	Dr Amtul Waris	Dr P Muthuraman Dr Shaik N Meera Dr P Jeykumar Dr PA Lakshmi Prasanna Dr B Nirmala Dr S Arun Kumar Dr S Rathod Dr K Surekha Dr C N Neeraja Dr Chitra Shanker Dr Jyothi Badri Dr Jhansi Lakshmi
TTI/TTT/EXT/17	On-Farm Adoption of IPM Technologies and impact analysis	Dr P Jeyakumar	Dr P Muthuraman Dr Amtul Waris Dr B Nirmala Dr S Arun Kumar
TTI/TTT/ECON/5	Competition and equity issues in Indian rice sector	Dr P A Lakshmi Prasanna	Dr Amtul Waris Dr S N Meera Dr S Arun Kumar Dr Santosha Rathod
TTI/TTT/ECON/4	Economics, Energy and Sensitivity Analysis of selected Rice production technologies	Dr B. Nirmala	Dr P Muthuraman Dr Amtul Waris Dr R Mahender Kumar Dr T Vidhan Singh
TTI/TTT/EXT/14	Innovations in group-based extension approaches: Accelerating rice technology transfer through farmer-based organisations	Dr S. Arun Kumar	Dr S N Meera Dr Amtul Waris Dr P Jeya Kumar Dr P Muthuraman Dr PA Lakshmi Prasanna, Dr LV Subba Rao
TTI/TTT/STAT/4	Statistical modeling and soft computing approaches for genomic selection in Rice	Dr Santosha Rathod	Dr C N Neeraja Dr C Gireesh Dr M S Anantha

Appendix-5: Newly Sanctioned Externally Funded Projects During 2023

Title	PI	Funding Agency	Budget in Lakhs
Monitoring of rice yellow stem borer susceptibility to insecticides	Dr Y Sridhar	Mitsui Chemicals India Ltd(MCIL)	12.98
Evaluation of Nano DAP in Irrigated Rice	Dr Manasa	Coraomandel International Pvt.Ltd	11.80
Evaluation of Microbial Consortium VAJRA on Productivity of Transplanted Rice	Dr P C Latha	Vaishavi Microbial Pvt. Ltd	8.71
(KARYASHALA) on Multivariate Statistical Machine Learning Methods for Modelling Agricultural Data	Dr Santhosha Rathod	SERB	5.00
Evaluation of Bio stimulant "SGNUF1A" in Irrigated Rice	Dr Surekha	Bioprime Agrisolutions Pvt. Ltd	7.34
Tackling emerging diseases and insect pests problems in rice through innovative genomic approaches	Dr G Padmavathi	DBT	109.07
Haplotype-assisted mapping of salinity tolerance at seedling and reproductive stages using MAGIC RILs for climate resilient rice	Dr K Suneetha	SERB	40.10
To improve the efficiency of genome editing with CRISPR-Cas9 and to create novel sources of epigenetic variation in plants	Dr R M Sundaram	DBT	8.00
Identification and characterisation od superior haplotypes for agronomically important traits in rice (*Oryza sativa*. L.)	Dr R M Sundaram Dr S K Mangrauthia	SERB	6.48
Maharashtra FPO Smart Trainning GONDIA Batch I	Dr Amtul Waris	ATMA	2.33
Strategies, design and development of RNAi-termiticides for termite pest management.	Dr R M Sundaram/ Dr Kanakachari Mogilicherla	DBT	83.16
Precise Gene Editing in Potassium Uptake/ Distribution Machinery to Develop Mineral Nutrient Deficiency Tolerant Rice[Hi"K"E]	Dr S K Mangrauthia	DBT	23.55
Evaluation of Physiological parameters, quality and yield benefits of Flupyrimin 2% GR in paddy crop	Dr D Sanjeeva Rao	M/s Arysta Lifescience India Ltd.	10.26
Trainning Programme: Community based Organization / Farmer producer company under World Bank assisted SMART Project	Dr Arun Kumar	ATMS, Bhandara	2.04
SERB- Molecular mapping of novel brown spot resistance in *Oryza rufipogon* derived introgression line and pathogen diversity analysis *of Bipolaris oryzae*	K Basavaraj	SERB	32.81
ICAR-IRRI Work Plan 2023-27			120.00
Total			~480.00 lakhs

Appendix-6: Ongoing Externally Funded Projects 2023

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
1.	ICAR-Consortia Research Platform on Molecular Breeding in crops	R. Abdul Fiyaz (PI) R.M. Sundaram P Senguttuvel M.S. Anantha M.S. Prasad G.S. Laha A.P. Padmakumari V. Jhansi Lakshmi	ICAR	2017-2026	68.32	The popular, bacterial blight resistant (possessing the resistance genes *Xa21, xa13* & *xa5*), high-yielding, fine-grain variety, Improved Samba Mahsuri has been improved for its resistance against blast (*Pi2* + *Pi54*) and BPH (*Bph33*), tolerance to salinity (*Saltol*) and low soil phosphorus (*Pup1*). Transfer of gall midge resistance genes (*Gm4* + *Gm8*) has been recently completed. Two varieties, viz., DRR Dhan 58 and DRR Dhan 60 have been developed in the genetic background of Improved Samba Mahsuri and possessing *Saltol* and *Pup1,* respectively have been developed and released by CVRC.
2.	ICAR Plan - Sub-project IV: Molecular genetic analysis of resistance/ tolerance to different stresses in rice, wheat, chickpea and mustard including sheath blight complex genomics	G S Laha (PI) R M Sundaram, V Prakasam, Jyothi Badri, D Ladhalakshmi Divya Balakrishnan	ICAR	2017-2026	125.00	**Sheath blight:** Out of 217 entries screened artificially, 100 entries showed tolerance to sheath blight. About 30 germplasm with highly tolerant to sheath blight *Viz.,* 466619, 577755, 579011, 461160, 450442, 216856, 337615, 256527, 426139, 343459, 75960, 75771 etc. RILs population (177) of IR 64 X Gumdhan (F_8) and 342 RILs of ISM and Phougak (F_5) were screened. Crosses were made between DRR Dhan 48 and four donors (IET 27118, 22272, 25157 & 24518) identified from repeated screening since 2013. From two crosses, DRR Dhan 48/ IET 28305 and DRR Dhan 52/IRGC 132408, F_2 populations were screened and selected 235 and 20 single plants respectively with sheath blight tolerance. 40 sheath blight pathogen isolates characterized through conventional and molecular methods. **False smut:** Mapping population of 200 lines from F_3 generation developed from the crosses HWR36 (NPT x *O. longistamina*)/Samba Mahsuri (100 lines) and HWR42 (NPT x *O. officinalis)* were screened by injection method of inoculation. Among them, lines *viz* 182, 184, 185, 190, 587, 588 and 596 showed tolerant reactions.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
3.	Imparting sheath blight resistance in rice (A DBT flagship project)	R.M. Sundaram (PI) C Kannan V Prakasam GS Laha	DBT	2019-23	108.00	Five major sheath blight QTLs were identified from the ISM / WZK RILs population (OsSBQTL1.1, OsQTL4.1, OsQTL6.1, OsQTL11.1, and OsQTL11.2 OsSBQTL1.1, OsQTL4.1, OsQTL6.1, OsQTL11.1, and OsQTL11.2) in chromosome 11 (LOD > 26%) from the Indian land race, Wazuhophek. *R. solani* isolates (n = 32) were characterized All 32 isolates were genome sequenced with 350 x throughput to produce 700.853 Gb sequence data. 5,046,121 SNPs were obtained by physically mapping the reads on the presently assembled BRS1 genome. A principal component analysis (PCA) based on the genomic distance divided the isolates into three different groups and a subgroup of admixture between group I and group II, suggesting natural hybridization among the isolates.
4.	Development of climate resilient lines of the bacterial blight resistant and low glycemic index rice variety, Improved Samba Mahsuri	R.M. Sundaram (PI) R. Abdul Fiyaz G.S. Laha L.V. Subba Rao S.M. Balachandran M.S. Prasad M.S. Madhav P. Senguttuvel	CSIR (Under FTT Scheme)	2019-23	86.26	The elite rice variety, Improved Samba Mahsuri has fortified with genes/QTLs conferring resistance against bacterial blight and blast along with drought and submergence tolerance QTLs
5.	Mainstreaming rice landraces diversity in varietal development through genome wide association studies: A model for large-scale utilization of gene bank collections of rice	C N Neeraja (PI) C Gireesh M S Anantha Ladha Lakshmi R. Abdul Fiyaz	DBT Net work	2020-2025	143.36	500 landraces have been evaluated under low Phosphorus condition plot (P content 2-5 ppm). We recorded the observations associated with low P condition like, number of tillers, productive tillers, grain yield per plant, days to 50% flowering etc. Landraces tolerant to low Phosphorus tolerance have been identified. F4 population of ISM x LR 279 (Non Pup 1) has been evaluated under low P condition. Approximately 200 polymorphic SSR markers have been identified ISM and LR 279.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
						In Rabi 2022-23 and Kharif 2023, 24 selected genotypes of the L2 set were artificially screened under field conditions. Among the tested genotypes, genotype RL 7303 (L2 set) showed moderate resistance reaction to false smut disease with a disease score of 3. In *Kharif* 2023, 65 genotypes of the L3 set and 250 genotypes of L4 were screened artificially. Among them, 76 genotypes showed moderate tolerant disease reaction with a disease score of 3. These genotypes will be screened further to confirm the disease tolerance.
6.	Breeding for High Zinc Rice	C N Neeraja (PI) L V Subbarao M S Anantha	IRRI	2020-2023	7.45	Out of 294 Advance Breeding Lines and 408 MAGIC multiplied, four selected promising lines based on yield, zinc content and grain type. were multiplied. Two lines were nominated to AICRP-Rice – Kharif 2023. The seed of 294 (AYT early/late, PYT and OYT) advanced breeding lines and 408 heat MAGIC lines was shared with Gangavati, AAU, CSSRI and IARI. Two mapping populations (IR14M110/JAMIR and IR14M141/KALIBORO) are evaluated at IIRR for agromorphological, yield and grain Zn data. 408 Heat Magic lines were evaluated during Rabi 2023 as two sets viz. one control set and other set with delayed sowing and transplanting to fit into the high temperatures of April 2023. The data analysis is under progress.
7.	Targeting *Pup1* independent mechanisms for improving low soil phosphorus tolerance and use-efficiency in rice	Satendra K Mangrauthia (PI) R.M. Sundaram MS Anantha	DBT	2021-2024	130.00	Detailed phenotyping of the two RIL mapping populations (Rasi/ISM and Wazuhophek/ISM) was done under low soil phosphorus (P) and normal soil P conditions.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
8.	CRP- Biofortification in selected crops for nutritional security	C N Neeraja (PI) R.M. Sundaram Satendra K Mangrauthia Kalyani M Barbadikar LV Subba Rao Amtul Waris K Surekha K Sruthi J Aravind kumar U Chaitanya	ICAR	2021-2026	250	Four major QTLs with high phenotypic variance and four minor QTLs were identified for QTLseq analyses of F7-8 RIL mapping population of MTU1010/Karuppunel. RNA-Seq analysis of six critical tissues in Karuppunel (high Zn and Fe) and MTU1010 (low Zn and Fe) identified significant differential expressed transcripts (DETs) across the tissues. One candidate gene HMA3 associated with high grain zinc is being cloned
9.	Harnessing haplotype diversity of genes controlling yield, stress tolerance and resource use efficiency traits in rice for accelerating genetic gains	C. Gireesh (PI) Kalyani Kulkarni MS Anantha	ICAR-NASF	2020-2023	250.85	A total of 282 accessions of the Indian Subset of the 3k panel were characterized for yield related traits. Haplotype analysis of seed related traits were carried out.
10.	CSIR-FBR Phase-II: Toward product development in rice using mutants that have traits of agronomic importance	M Sheshu Madhav (PI) Kalyani M Barbadikar	CSIR	2021-2023	60 .00	Four yellow stem borer tolerant promising mutant lines (SM92, SM74, SM72 & SM48); three sheath blight promising mutants (SM93, SB8 & SB6) have been deployed for developing mapping populations. One mutant line derivative (SP-M-MS-70 derived from TI140 X BPT-5204 showed an immune response with a '0' score against brown planthopper (Biotype 4) using the standard seed-box technique in ICAR-IIRR glass house and is being further characterized.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
11.	ICAR-Plan Scheme: "Incentivizing Research in Agriculture" Project: Genetic modifications to improve biological nitrogen fixation for augmenting nitrogen needs of cereals.	R.M. Sundaram (PI) P C Latha Kalyani M Barbadikar Bandeppa	ICAR	2021-2026	84	Metabolome analysis was performed to elucidate the metabolites and pathways underlying rice root (cv. BPT5204) response to interaction with two diazotrophic bacteria, *Bradyrhizobium japonicum* and *Gluconacetobacter diazotrophicus*, at an early stage (72 hpi). A total of 1578 differentially accumulated metabolites (DAMs) (766 upregulated and 812 downregulated) were observed in *B. japonicum* inoculated roots while *G. diazotrophicus* inoculation resulted in a total of 1511 DAMs, (836 upregulated and 675 downregulated) when compared to uninoculated roots. The significantly enriched DAMs were metabolites belonging to pathways like ABC transporters, purine metabolism, 2-oxocarboxylic acid metabolism, pyrimidine metabolism, and arginine and proline metabolism.
12.	Application of next generation breeding, genotyping and digitalization approaches for improving the genetic gain in India for staple crops	L V Subba Rao (PI-Retd) R. Abdul Fiyaz (PI) P. Revathi	ICAR - BMGF	2018-2024	5139.37	A total of 20 different varieties are selected which are released for cultivation in different years. These selected varietal entries are evaluated at 25 locations across India. This is the second year of the ERA trial. This data will be utilized for estimating the genetic gain of rice in India.
13.	CRP on Hybrid Technology (Rice)	A. S. Hari Prasad (PI) P. Senguttuvel P. Revathi K.B. Kemparaju K Sruthi	ICAR	2015-2026	23.00	Seven promising hybrids were nominated in AICRIP IHRT trials. Fifty promising genotypes were identified from the available breeding materials. Through the barrier isolation method, 40 new hybrids were produced and the seed will be used for preliminary evaluation in station trials.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
14.	Centrally sponsored scheme of PPVFRA under sub-mission on seeds and planting material-DUS Tests in Rice	L V Subba Rao (PI-Retd) J Aravind Kumar (PI), Jyothi Badri	PPV&FRA	2008 Long term	13.00	DUS testing included 30 and 58 entries in 1st (Typical/Farmer's varieties), and 2nd year (Candidate hybrids, F1's from Shimoga, and Typical) respectively. Another 26 entries which were not tested during 2021 were also evaluated for DUS traits. Among the 1st year entries, seven recorded very poor germination (1-5%), and two (2223-4 and 22RF6) did not germinate; whereas, among the 2nd year entries, 2122H22, 2122N1 and 2122-34 recorded poor germination. The DUS tests were carried out as per statutory requirement of the PPV & FR Act, 2001 and the recorded data was submitted to the authority in time in the specified format. The monitoring of DUS trials was conducted on 06-12-2022 by a team comprising Dr BC Patra, PS, NRRI, Cuttack; and Dr T Srinivas, PS, ANGRAU, Guntur.
15.	AICRP on Seeds (National Seed Project & Mega Seed Project)	L V Subba Rao (PI-Retd) R Abdul Fiyaz (PI), AVSR Swamy U. Chaitanya	ICAR	2006 Long term	8.0/year	Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized at 52 centers across the country, involving 365 varieties and parental lines of 2 rice hybrids. At IIRR centre, 27 varieties and 3 hybrid parental lines were included in breeder seed production with a total production of 573.35 quintals against the target of 288.87 quintals.
16.	ICAR-IRRI Seed dissemination and production of nucleus & breeder seed of stress tolerant varieties.	L V Subba Rao (PI) R Abdul Fiyaz	IRRI	2017 2022	5.80	Drought tolerant varieties such as DRR Dhan 42, DRR Dhan 44, DRR Dhan 46 and DRR Dhan 50; Heat tolerant varieties DRR Dhan 47 and DRR Dhan 52 seeds were produced and supplied to different farmers for field demonstration and frequent monitoring was taken up.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
17.	Accelerated Genetic Gain in Rice-Irrigated Ecology (AGGRi-Alliance)	A.V.S.R. Swamy (PI) J Aravind Kumar, A. Padma kumari, Ladha Lakshmi	IRRI	2020-2024	30.00	Experiment was conducted with 270 entries *i.e.* Advanced Breeding Lines selected and supplied by IRRI in two replications during the Wet season of 2023. Data was recorded for the characters of yield and other morphological characters. 10 selections which are of medium slender grain type, were made, to assess them critically for water use efficiency and high yield. Another set of 40 advance breeding lines under stage II are also evaluated in two replications and data pertaining to morphological and yield characters are recorded and the data is submitted to PI IRRI for further statistical analysis and drawing conclusions.
18.	From QTL to Variety: Genomics-Assisted Introgression and Field evaluation of Rice Varieties with Genes/QTLs for yield under Drought, Flood and Salt Stress	G. Padmavathi (PI) Jyothi Badri GS Laha, V Jhansilakshmi Satendra Kumar Magrauthia.	DBT	2018-2023	71.95	Two drought yield QTLs, *qDTY1.1* and *qDTY2.2* were pyramided into the genetic background of DRR Dhan 50 (*qDTY2.1* + *qDTY3.1*) through marker assisted breeding to enhance grain yield under reproductive stage drought stress. After genotyping BC_2F_3 lines with foreground selection markers (RM 324 for *qDTY 2.1*, RM 16030 for *qDTY 3.1*, RM 11943 & RM 431 for *qDTY 1.1* and RM 279 for *qDTY 2.2*) a set of 19 pyramided lines were selected possessing 3 QTLs (*qDTYs 3.1+2.1+2.2*), 17 lines with another new set of 3 QTLs (*qDTYs 3.1+2.1+1.1*) and 5 pyramided lines with all 4 QTLs (*qDTYs. 3.1+2.1+1.1+2.2*) with 85 to 88% genome recovery of DRR Dhan 50
19.	Global rice Array	G. Padmavathi (PI)	IRRI	2017-2023	0.83	Evaluated 50 Antenna panel genotypes and detected two promising alkaline tolerant entries namely IR84984-83-15-481-8 (3300 Kg/ha) and NSIC RC 240 (3021 Kg/ha) compared to alkaline tolerant check, CSR 36 (2850 Kg/ha) under high alkaline stress (EC; 1.9 dSm-1 and pH: 9.8-10.4 at ARS, Kampasagar, Hyderabad .

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
20.	DST – SERB Project: Mapping Genomic Regions Associated with Bacterial Leaf Blight Resistance Derived from *Oryza glaberrima*	C. Gireesh (PI) R.M.Sundaram G. S. Laha, M.S.Anantha	DST SERB	2021- 2024	27.57	BC1F7 population was phenotyped for bacterial leaf blight resistance using IX-020 isolate during Kharif, 2022. Genotyping of mapping population (n=187) was done using genotyping by sequencing (GBS) to identify the polymorphic markers between the parents. QTL analysis is being carried out to identify the genomic region associated with bacterial blight resistance derived from *O. glaberrima*
21.	Genomic selection for development of rice genotypes tolerant to low soil Phosphorus	MS Anantha (PI)	DST SERB	2021-2024	38.75	Association panel of 350 genotypes was screened in the low soil P plot at ICAR-IIRR in Augmented Block Design. Biometric observations associated with low Phosphorus tolerance were recorded. The association panel was genotyped with 1K Rica SNP platform and mapping of novel QTLs/genes is under progress.
22.	Marker-assisted introgression of genes associated with yield enhancement and resistance against bacterial blight and blast diseases into an elite rice variety, 'Jaya'	R. Abdul Fiyaz (PI) R.M. Sundaram, G.S. Laha, J Aravind Kumar, L.V. Subba Rao and Basavaraj K.	DST-SERB	2021-2024	36.96	This involves introgression of one yield enhancing gene 'Gna1' (grain number per panicle) and two biotic stress resistant genes Xa21 (Bacterial leaf blight resistance) and Pi54 (Blast resistance). The recurrent parent used is 'Jaya' and donor parent is an 'Isogenic line of MTU 1010 containing genes '*Xa21+Pi54+Gn1a*'. Of the total 50 F1 plants, 15 true F1 plants were confirmed using the functional marker PTA248. All the true F_1 hybrids were used in crossing programmes to produce BC1F1 seeds. A total of 34 BC_1F_1 seeds were produced. Foreground and background selection were done and promising introgression lines were selected to cross with recurrent parent to generate BC_2F_1 seeds during Kharif 2022.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
23.	Exploring Chromosome Segment Substitution Lines from interspecific crosses to decipher the genetics of grain weight and earliness	Divya Balakrishnan (PI) N Sarla	DBT	2019-2024	43.00	Various wild introgression lines were studied for grain weight and earliness across generations. Fine mapping of QTL qTGW3.1 in Swarna / *Oryza nivara* using genotyping by sequencing revealed *Os03go103400* which encodes GRAS transcription factor is one of the causative gene for grain weight with a PVE of 48%. The introgression lines (ILs) derived from interspecific crosses with wild accessions were subjected to stability analysis and QTL mapping for yield related traits for three seasons. QTL mapping for yield traits detected seven yield QTLs with LOD > 2.5 on chromosomes 2, 5, 6 and 11. Multi-environment testing for QTL analysis detected 52 QTLs on three environments and among the QTLs, two QTLs *qPTN2.1* on chromosome 2 and one QTL *qBM11.1* on chromosome 11 were consistent in two environments within the same marker intervals.
24.	Molecular tagging of genes related to early seedling vigour using landraces and wild introgression lines to develop climate smart rice varieties	Divya Balakrishnan (PI) Dr LV Subbarao	DST SERB	2021-2024	36.00	A set of wild introgression lines derived from advanced back cross breeding of Swarna with *Oryza nivara* species were characterized for grain size and seedling vigor related traits. Mapping of quantitative trait loci (QTL) using simple sequence repeat (SSR) and single nucleotide polymorphism (SNP) genotyping identified 18 QTL for seedling vigor- and grain size-related traits. Among these QTL, three major QTL (*qAS7.1*, *qPL7.1* and *qL7.1*) were detected for grain size-related traits on chromosome 7, explaining 21.44%, 19.11% and 22.60% of phenotypic variation, respectively. Similarly, for seedling vigor traits, seven major QTL, viz., *qSDW3.1*, *qTDW3.1*, *qSVI2-3.1*, *qSL3.1*, *qTL3.1*, *qSVI1-6.1*, and *qRDW8.1*, were detected, explaining 18.3–26.38% of phenotypic variation.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
25.	DST-ICRISAT Center of Excellence on Climate Change Research for Plant Protection (CoE-CCRPP): Pest and disease management for climate change adaptation (PI)	V Prakasam (PI) M S Prasad, G S Laha, Ch Padmavathi, Chitra Shanker, S K Mangrauthia, P. Muthuraman	DST-GOI	2018-2023	87.96	Impact of elevated CO2 and temperature on rice sheath blight differentials were studied under CO2 and temperature gradient tunnel in ICRISAT. Observed the high level of variation in physiological and pathological parameters among the treatments and rice sheath blight differentials. Inoculation was standardized under the CO2 growth chamber. Response of six monogenic resistant lines to Rice blast were tested against eCO2 under open top chamber. Initiation of rice blast was fast and severe at 700 ppm in HR-12 and BL-25. To know the impact of climate change on Rice and Brown Planthopper (BPH), studies were conducted under CTGT and ambient conditions with 18 differentials. There is significant variation in the reaction of BPH to the differentials under both conditions.
26.	IRRI – India Sub project: Insect-Pest and Disease Forecasting and Decision Support Systems in rice.	Ch. Padmavathi (PI) B Sailaja Santosha Rathod MS Prasad	IRRI	2019-2023	12,36,015	A "Rice pest pheno-forecasting portal" was developed with interfaces with details on Insect Pests, Diseases and Weeds, Thermal maps, Forecast maps and other details of the project. AI-based temperature prediction was made with NASA POWER data and IMD gridded data as historical data sources. AI & ML models used include i) Long Short-Term Memory (LSTM); ii) Artificial Neural Network (ANN); iii) Autoregressive Integrated Moving Average (ARIMA); and iv) Random Forest (RF) model.
27.	Development of superior haplotype based near isogenic lines (Haplo-NILs) for enhanced genetic gain in rice"	Jyothi Badri (PI) Aravind Jukanti V Prakasam V Jhansi Lakshmi MS Prasad A. P. Padma kumari	DBT	2020-24	117.90	Trait characterization: With DRR Dhan 48 as common parent, bi-parental mapping populations for grain number (DRR Dhan 48/Moudamani-279) and panicle length (DRR Dhan 48/Anfuzhan-300 and DRR Dhan 48/ADT12-169) are in segregating generations.Superior Haplo-NIL development: For the traits panicle length 39 BC_2F_3 plants from the cross of DRR Dhan 48/ADT12 and for the trait grain yield, 17 BC_2F_3 and 19 BC_1F_3 plants from the cross of DRR Dhan 48/NX3533 were selected combining the results of genotyping with superior haplotype based foreground markers and phenotyping for the target traits.

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28.	South Asian Nitrogen Hub (SANH) Work Package (WP) 2.1b	C N Neeraja	UKRI	2020-2024	88.00	Data collected from BAAP screening for three consecutive seasons (wet season_2021, dry season_2022 and wet season_2022) was entered in common template provided for SANH partners
29	AICRP – Biocontrol	Chitra Shanker (PI)	ICAR	2017- 2026	4.00	BIPM demonstrations were taken up at Miriyalguda, Nalgonda and Manchal, Ibrahimpatnam, Rangareddy. Population of natural enemies of rice pests were significantly higher in bio intensive pest management modules as compared to farmers practice with insecticide application. The economics of crop production of various treatments indicated that, the BIPM 2 with *Bacillus cabrialesii* BIK3 treatment gave the maximum benefit with a BC ratio of 1.94
30	Direct Seeded Rice Consortium (DSRC) a)Dry DSR popularisation b)Bio-efficacy of IMI-herbicides on weed control in wet-DSR	Mahender Kumar R	IRRI	2020-2026	6.50	a) Mechanization of Dry DSR in collaboration with NGO extended in more than 600 acres b) Higher number panicles per sq. m was found in weed free on par results with T4 treatment (Pretilachlor fb Kifix) the same significant difference was observed with T4 with other treatments in case of other yield attributes viz, panicle length, panicle weight, number of grains per panicle and test weight. Higher grain yield was found in weed free on par with T4 with Pretilachlor fb Kifix followed by Pretilachlor fb Bispyribac treatment. Weedy check recorded lower number of panicles per sq. m and grain yield. There were minimal symptoms of yellowing and necrosis of rice crop (within the range of 0-10% for crop phytotoxicity rating).
31	Increasing the Health potential in rice by lowering glycaemic index response in high yielding lines (Low GI Rice)	Aravind Kumar J	IRRI	2020-2026	4.50	Seed multiplication of two low glycemic index (GI) lines (IRRI 162 and IRRI 147) supplied by IRRI was taken up at IIRR during Rabi 2022. These lines would be nominated for multi-location testing. Further, these two lines have been incorporated into the quality breeding program and crossing was initiated. Two crosses involving IRRI 162 were successful *i.e.* ISM X IRRI 162 and DRR Dhan 53 X IRRI 162; would help in identification of lines with BLB tolerance and low GI. We have also crossed IRRI 162 with a high grain protein lines i.e., JAK 686-1 to identify lines with high grain protein and low GI.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
32	Biofortification of rice (Harvest Plus)	G Padmavathi LV Subba Rao C. N. Neeraja, D. Sanjeeva Rao, K. Surekha M.B.B. Prasad Babu	CIAT, Columbia & IFPRI, USA	2018-2023	80.00	Evaluated HPMET- Set 2 during Kharif, 2022 at RC Puram farm, Hyderabad with 34 elite entries developed and shared among the partner centres including checks (Yield: Samba Mahsuri; Micro Nutrient checks: DRR Dhan 45, 48 and 49) in 5m^2 plots. At ICAR-IIRR, Hyderabad, in the early duration group (≤ 100 days flowering duration), two entries namely CR Dhan 310 (IET 24780) with 97 days flowering duration and 4933 Kg/ha yield outperformed the check, IR 64 by 9.8% yield gain. The 2nd entry NVSR 522 (99 days) with mean yield 4778 Kg/ha also recorded 6.4% yield gain over the check IR 64. In the medium and late duration group (> 100 days flowering duration), CSR HZR 17-8 (110 days) yielded 4661 Kg/ha with 10% yield superiority over, Samba mahsuri check.. Zinc estimation in test entries is in progress
33	Characterization and understanding the genetics of resistance of *Ustilaginoidea virens* and Identification of false smut disease tolerant sources in rice	D Ladha lakshmi (PI)	SERB	2019-2023	33.30	Survey was made in the false smut-infected rice fields of Telangana and Tamil Nadu. Disease incidence was varied from 86.90% to 90% along with 7.27% and 11.73% spikelet infection. In the molecular variability study with ISSR primers, 60 isolates were grouped into two major clusters I and II and exhibited genetic variability and clustered across geographical variations. In the virulence study, Raigod isolate recorded maximum inhibition and was found as virulent. Around 700 genotypes were screened under field conditions using the standardized method of artificial inoculation. Maximum Percentage of disease incidence was 72% and maximum of 25 smut balls/panicles were recorded. Among the screened lines, germplasm line 200 (IC334233) was identified as a tolerant donor for false smut disease. Crosses were made with Samba Masuri (BPT-5204). Eight hundred forty-eight SSR markers from the Gramene database were used to screen for the polymorphism between parental lines. Out of 848 markers, only 88 SSR markers were found to be polymorphic.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
34	Evaluation of BAS 750-02-F400 g/l SC (Mefentrifluconazole 400 g/l SC) against sheath blight and grain discoloration of rice"	V Prakasam (PI) M S Prasad K Basavaraj G S Jasudasu M Surendran (Moncompu) Ramanathan, (TNRRI, Aduthurai)	BASF India	2018-2023	17.00	Identified Mefentrifluconazole 400 g/l SC 3.5 and 4 ml/l is effective in reducing the sheath blight in the field at three locations, Hyderabad, Moncompu (Kerala), Aduthurai (Tamil Nadu) compared to other treatments. There is no phytotoxicity among the treatments of test molecule.
35	Bioefficacy of 'ME5382 2% GR' against insect pests of paddy	B. Jhansi Rani Y. Sridhar	United Phosphorus Limited.	2021-2023	5.95	One application of ME5382 2% GR at vegetative stage @150 g a.i. per ha resulted in lower dead hearts (73%), white ears (51%) and brown planthopper population (53%) with significant yield increase (26%) over control.
36	"IRRI-India Frontiers in Rice Science-New Science-Sub project 1: Resource re-mobilization during grain filling under drought"	Jyothi Badri (PI) D Subrahmanyam	IRRI	2021 -2023	3.79	Stem carbohydrate remobilization of high-harvest index lines was compared with drought tolerant varieties. Under drought stress, highest resource remobilization % was recorded in DRR Dhan 54 (56.29%), RIL 14 (55.22%) and RIL 15 (50.86%). Under irrigated conditions- resource remobilization % >50% was recorded in five released varieties (IR 64, DRR Dhan 47, Swarna Shreya, DRR Dhan 54 and Swarna Shakti Dhan) and two RILs (RIL Nos. 9 and 16)
37	Collaborative project with PJTSAU Marker assisted pyramiding of BPH resistant genes into "Telangana Sona", a popular rice variety of Telangana using candidate gene and SSR based markers	V. Jhansi Lakshmi	DST-SERB	2021-2024	11.50	BC_2F_2 population of the cross RNR15048X10-3 was phenotyped for brown planthopper resistance in the greenhouse by using modified mass tillering screening technique in kharif 2022.

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
38	ICAR-Consortia Research Platform on Hybrid Technology (Rice)	A. S. Hari Prasad P. Senguttuvel, P. Revathi, K.B. Kemparaju, K Sruthi	ICAR	2015-2026	23	DRRH 4, world's first public bred aerobic hybrid (IET 27937), released, and notified for Aerobic ecologies of Punjab, Odisha, Chhattisgarh, Tripura and Gujarat. DRR Dhan 64 [IET 28358 (RP 5599-212-56-3-1)], an early maturing (115-120 days) and N use efficient rice variety. It's released and notified for irrigated ecosystems of Bihar and West Bengal. Registered two parental lines namely RP6338-9 and RP5593-83-12-3-1 (MTP-1)/IET26168 for high temperature and sodic conditions respectively with NBPGR as novel genetic stocks.
39	DBT-Nanoscale Zeolite-Zinc-Carbo-Mycolizers to improve the productivity of Rice	C. Kannan (PI) R. Gobinath	DBT	2022-2025	67.84	The synthesised Zn-loaded Zeolite was characterised for their size and shape etc and taken up in invitro-level investigation under controlled conditions i.e. pot culture study under a Greenhouse set up with the graded levels of material i.e. 2.5, 5.0, 7.5, 10.0, 12.5, and 15.0 mg/kg soil.
40	Response of POLY-4 (Di hydrate Polyhalite) fertilizer on growth, yield, and soil health of irrigated rice crop	R. Gobinath (PI)	Anglo American Crop Nutrients	2022-2024	24.0	Application of Polyhalite fertilizer recorded significant changes in the grain yield and nutrient content of the rice Replacement with Poly 4 can reduce the dependence on MOP in the longer run and maintain of nutrient status of soil.
41	Evaluation of nano urea in irrigated rice	R. Gobinath (PI)	Coromandel International pvt ltd	2022-2024	24.0	Two sprays of nano urea in addition to a recommended dose of nitrogen-RDN (3 splits) registered on par yield with 100% Recommended Dose of Nitrogen than other combinations i.e. 50 and 75% with nano urea sprays.
42	Deciphering and deploying low phosphorus tolerance and nitrogen use efficiency in rice using targeted genomics approach	C N Neeraja M S Anantha Brajendra	NASF	2022-2026	69.44	F_2 seeds generated from 5 different crosses were received from NRRI, Cuttack and F_2 seeds generated from 9 different crosses received from CAU, Imphal were evaluated in N_50 during Kharif'2023. The F_2 seeds of BPT5204/BV24 (FB112) and ISM/BV24 were evaluated in N_low during Kharif'2023. Promising lines were selected

S. No.	Title	Investigators	Funding source	Duration	Budget in lakh Rs.	Brief Progress of work[a1]
43	Resistance Monitoring Study for Rice Sheath blight Pathogen (Rhizoctonia solani) against azoxystrobin fungicide	Dr. V Prakasam Dr. M S Prasad Dr. G S Laha Dr.D Krishnaveni Dr. C Kannan Dr. S Arun Kumar	Syngenta India Ltd	2022-24	23.91	Sheath blight disease samples were collected from different rice ecosystems in India. About 130 isolates from Punjab, Haryana and West Bengal were characterized. These isolates were studied their sensitivity
44	Evaluation of Penflufen 240 g/l fs (Emesto Prime) against sheath blight of rice.	Dr. V Prakasam Dr. M S Prasad Dr. G S Laha Dr. G Jesudasu Dr. K Basavaraj Dr. D Ladhalakshmi	Bayer Crop Science Ltd.	2022-24	12.74	New fungicidal molecule Penflufen 240 g/L FS was tested against sheath blight through artificial inoculation at field for K-2022 and K-2023. The recorded bio-efficacy data's are being analysed.
45	Evaluation of isotianil 120 G/L + Trifloxystrobin 100G/L SC on rice crop against bacterial leaf blight, leaf blast and dirty panicle.	Dr. G S Laha Dr. K Basavaraj Dr. G Jesudasu Dr. V Prakasam Dr. M S Prasad Dr. D Krishnaveni	Bayer Crop Science Ltd.	2022-24	11.33	New molecule was tested against BLB at field through artificial inoculation for K-2022 and K-2023. The recorded bio-efficacy data's are being analysed.
46	Evaluation of propineb 70 % WG on rice crop against leaf blast and brown spot.	Dr. G. Jesudasu Dr. K Basavaraj Dr. G S Laha Dr. M S Prasad Dr. V Prakasam Dr. C. Kannan	Bayer Crop Science Ltd.	2022-24	8.50	New molecule was tested against blast and brown spot at field through artificial inoculation for K-2022 and K-2023. The recorded bio-efficacy data's are being analysed.

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