वार्षिक प्रतिवेदन
Annual Report

भाकृअनुप
ICAR

2021

भाचाअनुसं
IIRR

भाकृअनुप-भारतीय चावल अनुसंधान संस्थान

ICAR-Indian Institute of Rice Research

Rajendranagar, Hyderabad - 500 030

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Preface

I am privileged to place before you the annual report of the ICAR-Indian Institute of Rice Research, for the year 2021.

We are responsible for coordinating the world's largest network on Rice research with 44 funded centres and around 100 voluntary centres, involving more than 300 rice scientists, in addition to pursuing lead research related to irrigated rice ecosystem. The year 2021 had a heavy toll on humanity around the world. We were faced with severe challenges for normal movement and execution of work. In spite of the pandemic conditions prevailing in the past year, we could produce a record 124.47 million tonnes of rice during 2020-21 and a target of 127 million tonnes for 2021-22. During this period, 113 varieties including 14 Hybrids for different ecologies have been released by both central (45) and state (68) varietal release committees. Of these 6 varieties were developed at this institute. Breeder seed production of rice varieties and parental lines of rice hybrids was organized at 44 centres across the country as per DAC indent and a record 9218 quintals of breeder seed was achieved.

On the research front, in addition to institute funded projects, the Consortia Research Platforms (CRP) on Bio fortification, Hybrid technology, Agro-biodiversity, Molecular breeding and Incentivizing research and 45 other externally funded projects are presently in operation in the Institute and 8 new projects were sanctioned with an funding of Rs. 3.11 crores. Around 116 post graduate and doctoral students are also pursuing their research work in the institute. In view of the ongoing pandemic, the institute utilized the virtual mode for its outreach activities, advisories and extension services.

The institute brought several accolades during the reporting period including patent and copyright applications and commercialization of technology. The notable is the publishing of draft genome of yellow stem borer. One scientist was deputed abroad as consultant. I congratulate and appreciate all the staff members who have been bestowed with awards and recognitions in various research and development platforms.

On a personal note, I take this opportunity to express my sincere gratitude to Dr. T. Mohapatra, Secretary DARE and DG (ICAR); Dr. T.R. Sharma, DDG (Crop Science), Dr. D.K. Yadava, ADG (Seeds), Dr. R.P. Singh, ADG (F&FC), Dr. A.K. Tyagi, 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, AICRIP centres and sister ICAR institutes for their tremendous support during the pandemic for showcasing consistent progress in rice improvement

Dr R. M. Sundaram
(Director)

कार्यकारी सारांश

Executive Summary

अखिल भारतीय समन्वित चावल सुधार परियोजना (अभासचासुप)

फसलसुधार

2020 के दौरान देशके सात क्षेत्रों में 28 राज्यों और 2 केंद्रशासित प्रदेशों में 123स्थानों (45 वित्त पोषित और 78 स्वैच्छिक केंद्रों) पर 806 प्रयोगों में 46 किस्मों के परीक्षण और चार संकर चावल परीक्षण किए गए।

229 जाँचको सहित 1443 प्रविष्टियों के साथ गठित 50 परीक्षणों में 22 आशाजनक लाइनों की रिलीज (मोचन) के लिए पहचान की गई।

केंद्रीय विविधता पहचान समिति ने 2021 के दौरान विभिन्न राज्यों में रिलीज (मोचन) के लिए 36 किस्मों और 9 संकरों की पहचान की।

पिछले 3वर्षों (2018-2020) में अभासचासुप प्रविष्टियों का विश्लेषण अधिकांश नामांकन पूर्वी और दक्षिणी क्षेत्रों से थे, जिनमें भाकृअप-एनआरआरआई (राचाअसं) और भाकृअप-भाचाअसं द्वारा किए गए नामांकनों का 37% था। इसी प्रकार बासमती और लवणता परीक्षण नामांकनों में से अधिकांश नामांकन भाकृअप-भाकृअसं (आईसीएआर-आईएआरआई) और भाकृअप-केंमृलअसं (आईसीएआर-सीएसएसआरआई) से थे। उनके बाद नवसारी, लेम्बोचेरा, रायपुर और मरुतेरू केंद्र क्रम में आते हैं।

अभासचासुप (एआईसीआरआईपी) के लिए नामित प्रविष्टियों के विकास में उपयोग की जानेवाली पैतृक जातियो (लाइनें) मे 95% योगदान लोकप्रिय किस्में का थीं, जबकि जंगली और संबंधित प्रजातियोंने केवल 2% का योगदान दिया।

पैतृक जातियो (लाइनें) लाइनों के रूप में उपयोग किए जाने वाले लोकप्रिय किस्में बीपीटी5204, स्वर्णा, एमटीयू1010, बेहतर-सांबामहसूरी और नवीन थीं।

अंचाअनुसं (IRRI), मारुतेरू, भाकृअप-भाचाअसं, भाकृअप-राचाअसं और पूसा द्वारा विकसित अभिजातवर्ग प्रजनन सामग्री का अधिकांश संस्थानों द्वारा प्रविष्टियों के विकास में बहुत अधिक उपयोग किया गया था।

56 वीं वाचासबै (वार्षिक चावल समूह की बैठक-एआरजीएम) के दौरान आयोजित किस्म पहचान समिति (वीआईसी) द्वारा 33 किस्मों और 5 संकरों सहित कुल 38 प्रस्तावों पर विचार किया गया था और 25 किस्मों और 2 संकरोंसहित 28 प्रविष्टियों की पहचान की गई थी।

2020-21 के दौरान केंद्रीय और राज्य दोनों प्रकारकी वीआईसी (सेंट्रल-45; स्टेट-68) द्वारा विभिन्न पारिस्थितिकी के लिए 14 संकरों और 96 किस्मों सहित कुल 113 किस्में जारी की गई हैं।

देश के विभिन्न राज्यों में वाणिज्यिक खेती के लिए सीएससीसीएसएन एंड आरवी द्वारा छह संकर (सभी केंद्रीय मोचन) जारी और अधिसूचित किए गए थे।

फसल उत्पादन

सस्य-विज्ञान

चावल और चावल आधारित फसल प्रणालियों में किफायती प्रौद्योगिकियों को विकसित करने के लिए 49 स्थानोंपर कुल 229 प्रयोग किए गए थे।

आईईटी-25121, आईईटी-26356, आईईटी-25746, आईईटी-26027, आईईटी-25997, आईईटी-25785, आईईटी-25269, आईईटी-26263, आईईटी-25793, आईईटी-25856, आईईटी-22836, आईईटी-25059, आईईटी-26168, आईईटी-26383 औरआईईटी -26375 को विभिन्न पारिस्थितिकी के एनवीटी परीक्षणों के तहत उम्मिदजनक पाया गया था।

सभी जगह पर हाथ से किया हुआ प्रत्यारोपण की तुलना में यांत्रिक प्रतिरोपण के परिणाम स्वरूप अधिक अनाज की उपज हुई।

उच्चतर आरडीएफ के 25 से 50% के प्रयोगसे अनाज की अधिक पैदावार हुई।

एकान्तर गीला और सुखा करना (5.75 से 6.39 टी / हेक्टेयर) फसल विकास और संतृप्ति रखरखाव के दौरान बाढ़ के साथ बराबर अनाज की उपज प्रदान किया है।

एकान्तर गीला और सुखाने से Rs. 3800 प्रति हेक्टेयर की किफायती बचत हुई थी।

समेकित खरपतवार प्रबंधन ने आईपीएम कार्यान्वित भूखंडों में अधिक अनाज उपज लाभ दिया।

प्रणालीगत उद्भवपश्चात खरपतवार नाशक थियोबेनकार्ब (thiobencarb) @ 5 ली प्रति हेक्टेयर उम्मिदजनक पाया गया।

चावल-दलहन प्रणाली ने चावल-चावल प्रणाली पर अनाज की पैदावार में वृद्धि की।

मृदा विज्ञान

रबी-2019-20 और खरीफ-2020 के दौरान विशिष्ट मिट्टी और फसल प्रणालियों और महत्वपूर्ण चावल उत्पादक क्षेत्रों का प्रतिनिधित्व

करने वाले 19 स्थानों पर कुल 8 परीक्षण किए गए थे।

•आरबीसीएस में दीर्घकालिक मृदा उर्वरता प्रबंधन पर अध्ययन के 32 वें वर्ष में, आरडीएफ + एफवाईएम और आरडीएफ उपचार समान थे और अन्य उपचारों से काफी बेहतर थे।

•मृदा गुणवत्ता सूचकांक में विभिन्न किसानों की श्रेणियों में मृदा की गुणवत्ता और स्वास्थ्य में भिन्नताएं दिखाई गई हैं।

क्ष ार युक्त (सोडिक) मिट्टी में क़िस्म एसएस-3 और एसवीएल-2 को उच्चतम उपज और उर्वराक के सेवन के साथ उम्मिदजनक पाया गया।

अम्ल सहिष्णु क़िस्म श्रेयस, एसवीएल 1, एनएच 2, एसवीएल 3 और जीपीवी 4 को उच्चतम उपज के साथ उम्मिदजनक पाया गया।

•फसल अवशेषों को बिना किसी उपज दंड के अनुशंसित नाइट्रोजन के लगभग आधे हिस्से को प्रतिस्थापित करने के लिए तैनात किया जा सकता है।

किस्मों, ARRH 7576, सीएनएन-5, सीएनएन-3, सीएनएन-1, ने अधिकांश स्थानों पर अधिकतम पैदावार और नाइट्रोजन उपयोग कार्यक्षमता दर्ज की।

जैविक चावल की खेती में, 625 टन प्रति हैक्टेयर की द रसे धाइनचा हरी खाद + 100 कि प्रति हैक्टेयर नीम केक + स्यूडोमोनास + आरडीएफ 100% के साथ बीज उपचार के संयोजन से अधिक पैदावार हुई।

पादप कर्यिकी

अभासचासुप के अंतर्गत शारीरिक अध्ययनों का गठन आठ वित्त पोषित केन्द्रों, दो भाकृअप संस्थानों और छह स्वैच्छिक केन्द्रों में छह परीक्षणों में किया गया था।

•सिलिकॉन के इस्तेमाल से IIRRH-132, IRRH-131, JKRH-3333 और US-314 में औसत अनाज उपज में सकारात्मक प्रतिक्रिया का प्रदर्शन किया।

जाती आईईटी 28241, आईईटी 28242 और सहभागीधन अनाज पैदावार, बायोमास, कटाई सूचकांक और परीक्षण वजन केआधार पर वर्षा सिंचित खेती के लिए उपयुक्त पाया गया ।

उष्मागत तनाव के अंतर्गत आईईटी 29156 और उसके बाद आईईटी 29157 में जाँच (चेक) पर अनाज की उपज में प्रतिशत कमी के आधार पर उपज में सबसे कम कमी दर्ज की गई।

•सीआर-3918-आईएल-160, आईईटी 24426, एसी-35764, एसी-34975 और दुबराज को कई अजैविक तनावों के प्रति सहनशीलता के युक्त पाया गया।

•जलमग्न सहनशीलता के लिए जांच से चावल की एसी-41585 और उसके बाद आईईटी24434 क़िस्म

में सर्वाधिक पौध जीवित प्रतिशत पाया गया है। सीओ -50, आईईटी 24434, आईईटी 24426, सीआर -3918-आईएल -160, सीआर -2826-आईएल -204 और दुबराज ने 70% से अधिक पौध जिवित प्रतिशत दर्ज किया।

कम प्रकाश के दबाव में, स्वर्णप्रभा (जाँच क़िस्म) के बाद आईईटी 27537, आईईटी 28283, आईईटी 29032 औरआईईटी 26744 द्वारा उच्च अनाज की पैदावार दर्ज की।

फसल संरक्षण

21 राज्यों और 2 संघशासित प्रदेशों में 42 स्थानों पर 244 प्रयोगों को शामिल करते हुए सात प्रमुख परीक्षण किए गए।

13 कीटों के लिए पोषिता पौध प्रतिरोध के लिए कुल 1583 प्रविष्टियों की जांच की गई और उन्मे से 97 प्रविष्टियों को उम्मिदजनक के रूप में पहचाना गया।

•हॉपर के खिलाफ 21 प्रविष्टियों को उम्मीदजनक पाया गया | परीक्षण के दूसरे वर्ष में छह प्रविष्टियां हैं।

IBT-WGL-4 और IBT-WGL-5 को उम्मीदजनक के रूप में पहचाना गया हैं। MTU1010 (gm3+Gm4+Gm8), Aganni, ENTGP 2018-178, और 14 पिरामिड लाइनें (MTU1010 (Gm4 + Gm8)) को गाल मिज के खिलाफ उम्मिदजनक पाया गया।

14 प्रविष्टियां, PTB 18 (Cul M9) की एक उत्परिवर्ती जाती तथा जया के दो प्योर लाइन चयन (जेएस 1 और जेएस 3) को लीफ फोल्डर के खिलाफ उम्मिदजनक पाया गया ।

14 प्रविष्टियों को (स्टेम बोरर) का प्रतिरोध / सहिष्णुता के लिए उम्मीदजनक के रूप में पहचाना गया था।

कुलएम9, एसकेएल 07-8-720-63-147-182-276, बीके 35-155, जेएस 5, आरपी 5587-बी-बी-बी-262, औरजेजीएल 33440 को कई कीटोंके प्रतिरोध के युक्त पाया गया।

IIRR-NSN1 में; आईईटी नंबर 27804, 28084, 27 पी 63

(हाइब्रिडचेक), 28827, 27263 (आर) 28544, 28673, 28519, 28703, 28386, 27632 (आर), काव्या, पीटीबी 33 और अगन्नी को आशाजनक पाया गया। IIRR-NSN2 में; आईईटी 29510, पीटीबी -33 औरआरपी 2068-18-3-5 को आशाजनक पाया गया। एनएसएन पहाड़ियों में, आईईटीनंबर। 26594 (आर)28925, विवेकधन 62 और विवेकधान 86 उम्मिद्जनक थे।

Gm8 और Gm1 गाल मिज प्रतिरोध के लिए सभी स्थानों भर में बेहतर थे। एकल महिला संतानों द्वारा जीन भिन्नता के मूल्यांकन से पता चला है कि वारंगल आबादी अगन्नी (Gm8) पर पट्टांबी आबादी की तुलना में कम उग्र थी, लेकिन RP 2068-18-3-5 (gm3) परअधिक उग्र थी।

प्लांट हॉपर विशेष स्क्रीनिंग परीक्षण में, पीटीबी 33 (बीपीएच 2 + बीपीएच 3 + अज्ञातकारक) औरआरपी 2068- 18-3-5 (बीपीएच 33 (टी)) 8 मेंसे 7 स्थानों में आशाजनक रहे थे।

•स्टेमबोरर, डब्ल्यूबीपीएच और जीएलएच को कम करने में सभी कीटनाशक मॉड्यूल बेहतर पाया गया था। सबसे कम सिल्वरशूट क्षति सभी वनस्पति उपचार में दर्ज की गई थी और सभी कीटनाशकों मॉड्यूल के बराबर थी। नीमाज़ल + नीमकातेल + ट्राइफ्लुमेज़ोपाइरिम बीपीएच के खिलाफ प्रभावी पाया गया था। परीक्षण किए गए कीटनाशकों और वनस्पतियों को लाभकारी जीवों के लिए सुरक्षित पाया गया।

स्टेमबोरर, गाल मिज, वोर्ल (whorl) मैगोट, केसवर्म और प्लांट हॉपर्स की घटनाएं शुरुआती और सामान्य की तुलना में देर से रोपण में अधिक थीं; पत्तीफ़ोल्डर सामान्य रोपण में उच्चतम था; हिस्पा शुरुआती रोपण में गंभीर था और वोर्ल (whorl) मैगोट रोपण की तारीखों से अप्रभावित था।

रोपाई विधि में नीले बीटल की घटना काफी अधिक पाई गई थी।

स्टेमबोरर, गाल मिज, पत्तीफ़ोल्डर और बीपीएच की घटनाएं सुखे में सीधे बोए जाने वाले चावल में अधिक थीं। रोपाई विधि में नीले बीटल की घटना काफी अधिक थी।

चावल पत्ती फ़ोल्डर और पीले स्टेमबोरर और बहु-प्रजाति मिश्रण के धीमीगति से रिलीज फेरोमोन मिश्रण हैदराबाद और अदुथुराई में प्रभावी थे।

पारिस्थितिकीय इंजीनियरिंग वै एकान्तर गीला और सुखा करने के साथ-साथ कीट के संक्रमण को कम करता है, बेहतर पैदावार और लाभ-लागत अनुपात के साथ प्राकृतिक दुश्मनों का समर्थन करता है।

•बीआईपीएम प्रथाएं स्टेमबोरर घटनाओं को कम करने और उच्चप्राकृतिक दुश्मन आबादी का समर्थन करने में प्रभावी थीं।

•उच्च उपज और लाभ-लागत अनुपातवाले सभी जगहों पर कीटों, रोगों और खरपतवारों के प्रबंधन के लिए समेकित कीट प्रबंधन मॉड्यूल को प्रभावी पाया गया।

•लाइट ट्रैप अध्ययनों ने संकेत दिया कि पीले-स्टेमबोरर, पत्तीफ़ोल्डर और हॉपर्स प्रमुख कीट बने रहे और गाल मिज एक स्थानिक कीट बना हुआ है। हालां कि, केसवर्म, सफेद-स्टेमबोरर, गुलाबी-स्टेमबोरर, काला बग, गुंधीबग और ज़िगज़ैग-लीफहॉपर ने घटनाओं के प्रसार और तीव्रता में वृद्धि दिखाई दी।

पादप रोग विज्ञान

•पोषिता पौध प्रतिरोध, प्रमुख रोगजनकों की विषाणुता की क्षेत्र निगरानी और रोग प्रबंधन विधियों पर 50 स्थानों पर कुल 15 परीक्षण किए गए।

1263 प्रविष्टियों के मूल्यांकन से दो से चार प्रमुख रोगों के विरुद्ध 69 प्रविष्टियां मध्यम रूप से प्रतिरोधी पाई गई थीं।

Pyricularia grisea के विषाणु की क्षेत्र निगरानी कई स्थानों पर रोग ज़नक़ प्रोफ़ाइल संरचना में एक बदलाव का पता चला. एचआर -12 एक अति संवेदनशील जांच, कुछ स्थानों पर दर्ज प्रतिरोधी प्रतिक्रिया।

Xa1, Xa3, Xa4, xa5, Xa7, xa8, Xa10, Xa11 और Xa14 जैसे एकल जीवाणु ब्लाइट प्रतिरोध जीन रखनेवाले विभेदक अधिकांश स्थानों परअति संवेदनशील थे।

•देरसे बोई गई फसल में लीफ ब्लास्ट अधिकथा; बीएलबी और (sheath blight)शुरुआती बोई गई फसलमें अधिक था; भूरे रंग की धब्बा (ब्राउन स्पॉट) दोनों शुरुआती और देर से बोई गई फसल में उच्च था और शुरुआती बोई गई फसल में बेकाने (bakanae) की घटना अधिक थी।

कवकनाशी, आइसोप्रोथिओलेन 40% ईसी (1.5 मिलीलीटर प्रति लीटर), और किताज़िन 48% ईसी (1.0 मिलीलीटर प्रति लीटर) पत्ती और नेक ब्लास्ट रोग के खिलाफ प्रभावी थे। थिफ्लुज़ामाइड (Thifluzamide) 24% SC (0.8 ग्राम प्रति लीटर), डिफेनोकोनाज़ोल (difenoconazole) 25% EC (0.5

मिलीलीटर प्रति लीटर) और टेबुकोनाज़ोल (tebuconazole) 25.9% EC (1.5 मिलीलीटर प्रति लीटर) खोल क्षति (sheath blight) के खिलाफ प्रभावी थे। Difenoconazole 25% EC (0.5 मिलीलीटर प्रति लीटर) को खोल क्षति (sheath) सड़न और भूरे रंग के धब्बे की बीमारियों का प्रबंधन करने के लिए सबसे अच्छे अणु के रूप में पहचाना गया था।

बीज उपचार के साथ एकीकृत रोग प्रबंधन (कार्बेंडाजिम @2 ग्राम प्रति किग्रा) + बूटिंगचरणमें 04 ग्राम प्रति लीटर की दर से संयोजन कवकनाशी (ट्राइफ्लोक्सिस्ट्रोबिन 25% + टेबुकोनाज़ोल 50%) का एक व्यापक अनुप्रयोग बूटिंग चरण में प्रभावी था। ट्राइकोडर्मा के साथ बीज उपचार बूटिंग चरण में प्रोपिकोनाज़ोल के अनुप्रयोग के बाद पत्तीऔर नेक ब्लास्ट और, खोल क्षति के खिलाफ प्रभावी पाया गया था।

आईपीएम प्रथाओं ने लीफ ब्लास्ट, नेक ब्लास्ट और फाल्स स्मट रोग की घटनाओं को कम कर दिया।

7322, 6901, 660% लीफ ब्लास्ट, बैक्टीरियल लीफ ब्लाइट के रोग सूचकांक के कारण क्रमशः 569, 355 और 3409% की उपज में कमी आई।

सुखे में सीधे बोए जानेवाले चावल विधि में बैक्टीरिय ललीफ ब्लाइट की रोग तीव्रता कम (7.1%) थी। बैक्टीरियल लीफ ब्लाइट और लीफ ब्लास्ट की बीमारी की तीव्रता खरपतवारवाली जांच भूखंडों में कम पाई गई थी। बुवाई के तरीकों में, गीला बोए जानेवाले विधि में फाल्स स्मट रोग की घटनाओं के लिए सबसे अनुकूल स्थिति थी।

प्रौद्योगिकी प्रशिक्षण और हस्तांतरण

2020 के दौरान, 12 अभासचासुप (एआईसीआरआईपी) केंद्रों द्वारा 10 राज्यों में सर्वेक्षण किया गया था।

उत्तरप्रदेश, हरियाणा, गुजरात और बिहार जैसे राज्यों में संकर (हाइब्रिड) चावल की किस्मों ने एक महत्वपूर्ण क्षेत्र प्राप्त कर लिया है और कर्नाटक और महाराष्ट्र जैसे राज्यों में इसका क्षेत्रफल बढ़ रहा है।

तेलंगाना और उत्तरप्रदेश के कुछ भागों में लीफ ब्लास्ट और फाल्स स्मट की उच्च तीव्रता दर्ज की गई थी जबकि तटीय आन्ध्रप्रदेश, महाराष्ट्र के कोंकण क्षेत्र और तेलंगाना के कुछ भागों में जीवाणुओं का प्रकोप तीव्र था।

•स्टेम बोरर, लीफ फोल्डर और बीपीएच जैसे कीट बहुत व्यापक रूपसे फैले हुए हैं। महाराष्ट्र के कोंकण क्षेत्र में स्टेम बोरर की तीव्रता अधिक थी।

प्रमुखअनुसंधान

फसल सुधार

पादप प्रजनन

तेलंगाना, ओडिशा, झारखंड, बिहार, हरियाणा और गुजरात में खेती के लिए डीआरआरधन 54 (आईईटीनंबर 25653) एक एरोबिक किस्म जारी की गई थी। डीआरआरधन 56 एक जीएसआर किस्म है जो 2020 के दौरान पंजाब और हरियाणा के लिए जल्दी रोपाई की स्थिति के लिए जारी की गई थी।

•डीआरआरधन-60 (आईईटी-28061); उच्च उपज वाले पतला दाने वाली किस्म कम फॉस्फोरस वाली मिट्टी के के प्रति सहनशील और बैक्टीरियल ब्लाइट के लिए प्रतिरोधी, डीआरआरधन 63 (आईईटी 26383); उच्च Zn के साथ अधिक उपज देनेवाली किस्म की पहचान VIC के माध्यम से की गई।

प्लांटहॉपर के प्रतिरोध के लिए जेनेटिक स्टॉक अर्थात आरपी 5690-20-6-3-2-1 (राष्ट्रीयआईडी: आईएनजीआर-21176); के प्रति सहिष्णुता, नेकब्लास्ट के प्रतिरोध और लीफब्लास्ट के प्रतिरोध के लिए उत्तर पूर्वी स्थानीय किस्म फोगक (21087; आईसी0 639794 आईएनजीआर21093) और कम फॉस्फोरस वाली मिट्टी सहिष्णुता के लिए वज़ूहोफेक (21091; आईसी0639795 आईएनजीआर21112) को राब्यूपौआअनु (एनबीपीजीआर) के साथ पंजीकृत किया गया था।

स्थानीय किस्मों का संग्रह (जर्मप्लाज्म) का मूल्यांकन कृषि-रूपात्मक और सूक्ष्म पोषक तत्व के लिए किया गया था और 28.5 पीपीएम तक जस्ता (ज़िंक) युक्त वाले जीनोटाइप और 12.20 पीपीएम तक लोहा (Fe) युक्त की पहचान की गई थी।

उन्नत ब्रीडिंग लाइन विकसित की गई और अधिक उपज वाले, पानी के कुशल उपयोग करने वाले, कम अवधि के चावल संकर और किस्मों की पहचान करने के लिए चयन किया गया।

WBPH qDS2 के प्रतिरोध के लिए एक प्रमुख क्यूटीएल की पहचान 24.1 एमबीपी से 26.3 एमबीपी के बीच के क्षेत्र में स्वर्ण/सिन्नासिवप्पू की एक आरआईएल आबादी से की गई थी।

13.44% तक प्रोटीन युक्त अनाज, 69.8% तक हेड राइस रिकवरी (HRR) और 29.12% तक एमाइलोज युक्त जैसे महत्वपूर्ण गुणवत्ता मानकों वाले किस्म की पहचान की गई। अनाज की प्रोटीन युक्तता में वृद्धि; चावल में अनाज की उपज और एचआरआर के साथ विपरीत रूप से जुड़ी हुई पाई गई।

अवायवीय अंकुरण सहनशीलता के लिए संभावित दाताओं जैसे खाओहलान ऑन (केएचओ) की पहचान की गई और ओरीज़ा सैटिवा/ओरिज़ा ग्लाबेरिमा का उपयोग करते हुए अंतर-विशिष्ट (interspecific) नक़्शा (मैपिंग) आबादी (mapping population) का उपयोग जाँच और क्यूटीएल मैपिंग के लिए सीधे बोए जानेवाले चावल के लक्षणों जैसे प्रारंभिक अंकुर शक्ति और खरपतवार प्रतिस्पर्धात्मकता के लिए किया गया।

40 के तापमान पर 90% से अधिक स्पाइकलेट (छोटी बाल) प्रजनन क्षमता वाले उच्च तापमान तनावटॉलरेंट किस्म की पहचान की गई और ऊष्मासहिष्णु (हीट टॉलरेंट) अभिजात वर्ग की किस्मोंऔर बहु-मूलउन्नतपीढ़ीअंतर जातिमिलाप (मल्टी-पैरेंट एडवांस जनरेशन इंटर-क्रॉस--मैजिक) आबादी को विकसित करने के लिए संकरण (हाइब्रिडाइजेशन) में उपयोग किया गया।

मजबूत तना (कल्म) विशेषता का पता लगाने के लिए स्वर्ण/आईआरजीसी 39111 के क्रॉस से मैपिंग आबादी विकसित किया गया था। जीडब्ल्यूएएस-एसोसिएशन मैपिंग (एएम) पैनल का गठन 226 किस्मों के साथ किया गया था, जिसमें मजबूत कल्म, अनाज संख्या और अधिक उपज के लिए दानकर्त्ता किस्मों को शामिल किया गया था और इन लक्षणों के संयोजन के लिए आनुवंशिक संसाधन विकसित किए गए थे, जिसमें एलीट इंडिका कल्टीवेटर, ट्रॉपिकल जैपोनिका एक्सेस और जैविक और अजैविक तनाव के लिए दानकर्त्ता किस्म शामिल थे।

रासी x उन्नत सांबा महसूरी और वज़ुहोफेक x कम फॉस्फोरस वाली मिट्टी कीस्थितियों के लिए उन्नत सांबा महसूरी की आबादी में उपज लक्षणों के लिए आशाजनक कम फॉस्फोरस सहिष्णु किस्मों और प्रमुख क्यूटीएल की पहचान की गई थी।

कम फास्फोरस सहिष्णुता के लिए विभिन्न तनाव सूचकांकों की गणना की गई और तनाव सहिष्णुता सूचकांक (एसटीआई), उपज स्थिरता सूचकांक (वाईएसआई), और ज्यामितीय माध्य उत्पादकता (जीएमपी) को किस्म के चयन के लिए आदर्श सूचकांक के रूप में पाया गया, जिन्होंने तनाव और सामान्य दोनों के तहत अच्छा प्रदर्शन किया।

MTU1010 / O. rufipogon, Swarna / O. nivara and KMR3 / O. rufipogon के इंटरस्पेसिफिक CSSLs से और व्युत्पन्न उप आबादी को उपज, गुणवत्ता और जैविक तनाव से संबंधित मापदंडों की और आशाजनक लाइनों की पहचान के लिए जाँच कि गई।

दो स्वर्ण/ओ.निवारा बीआईएल से प्राप्त एफ2:3:4 आबादी का उपयोग करते हुए उपज लक्षणों के लिए क्यूटीएल मैपिंग ने टीजीडब्ल्यू8.1 को ओ. निवारा से अनाज के वजन के लिए एक सुसंगत क्यूटीएल के रूप में प्रकट किया।

लोकप्रिय किस्मों और देशी सुगंधित छोटे और मध्यम अनाज चावल के बीच आबादी के परिणामस्वरूप *badh2* जीन के साथ उच्च उपज देने वाली लाइनों की पहचान हुई।

संकर चावल

रिपोर्ट की अवधि के दौरान देश के विभिन्न राज्यों में वाणिज्यिक खेती के लिए सीएससीसीएसएनएंडआरवी द्वारा 6 संकर (सभी केंद्रीय रिलीज) जारी किए गए और अधिसूचित किए गए।

इंडिका//उष्णकटिबंधीय जपोनिका जीनोम अनुपात का अनुमान इंडिका//उष्णकटिबंधीय जपोनिका क्रॉस के माध्यम से व्युत्पन्न दो नई विकसित व्यापक संगत पुनर्स्थापक लाइनों (RP6367 और RP6368) में लगाया गया था। व्युत्पन्न लाइनों RP6367 और RP6368 में उष्णकटिबंधीय जपोनिका जीनोम अनुपात का प्रतिशत क्रमशः 50% और 55.55% पाया गया। और 50 एसएसआर मार्करों और 45 इनडेल का उपयोग करके, दो नई पहचानी गई विस्तृत संगत पुनर्स्थापक लाइनों सहित 12 चावल किस्मों के बीच आणविक विविधता का अध्ययन किया गया।

डीआरआर धन 55 (आईईटी 26194) एक एरोबिक किस्म को केंद्रीय उप-समिति के माध्यम से फसल मानकों अधिसूचना और कृषि फसलों के लिए किस्मों को जारी करने के लिए एस.ओ. 500 (ई) के माध्यम से डीटी। 29 जनवरी 2021 [CG-DL-E-03022021-224901 बिहार (जोन III) और छत्तीसगढ़ (जोन V) राज्यों के एरोबिक पारिस्थितिक तंत्र में खेती के लिए अधिसूचित किया गया था॥

डीआरआर धन 57 (आईईटी 26171), एक एरोबिक किस्म को केंद्रीय उप-समिति के माध्यम से फसल मानक, अधिसूचना और कृषि फसलों के लिए किस्मों को जारी करने के लिए एस.ओ. के माध्यम से अधिसूचित किया गया था। 8 (ई) डीटी। 24 दिसंबर 2021 [CG-DL-E-04012022-232406] जोन III (झारखंड) और जोन V (छ.ग.) के एरोबिक पारिस्थितिक तंत्र में खेती के लिए।

आंशिक पुनर्स्थापक सुधार कार्यक्रम से प्राप्त अधिक उपज, कम फॉस्फोरस सहनशीलता (एलपीटी) किस्म आरपी5964-82 (आईईटी 28821) एआईसीआरआईपी एलपीटी परीक्षण में परीक्षण के तीसरे वर्ष के अधीन है।

रूपात्मक विशेषता-आधारित चयन BC1F2 पीढ़ी पर किया गया था और 50 पौधों का चयन किया गया था। आणविक मार्कर के लिए उनका विश्लेषण किया गया और परिणाम से पता चला कि नौ पौधे IR 58025B के समान हैं, 17 पौधे दाता माता-पिता के प्रकार के थे और शेष 24 पौधे IR 58025B के लिए विषमयुग्मजी (heterozygous)थे और उपज बढ़ाने वाले जीनजैसे Gn1, Spl 14, SCM2, Ghd7, GS5 और TGW6 के लिए अंतर्मुखी (introgressed) किस्में थीं ।

डार्विन सॉफ्टवेयर का उपयोग करके 6 जांच किस्मोंके साथ 112 हाइब्रिड चावल पैतृक लाइनों (70 पुनर्स्थापक और 42 अनुरक्षक लाइनों) की रूपात्मकविशेषताकेआधारपर क्लस्टरिंगकिगई। डार्विन ने 118 किस्मों को 8 समूहों (7 प्रमुख और 1 नाबालिग) में बांटा। वृक्ष की दूरी 0.289 से 17.66 तक थी और औसत वृक्ष की दूरी 6.99 थी। प्रत्येक समूह में पुनर्स्थापकों और अनुरक्षकों का संयोजन होता है।

जैव प्रौद्योगिकी

LOC_Os11g42430 को 298 किस्मों वाले चावल विविधता पैनल 1 (44K एसएनपी डेटा का उपयोग कर के बनाहै) के जीनोम-वाइड एसोसिएशन स्टडी (GWAS) के माध्यम से अनाज संख्या के संबंध में अनाज भरने के लिए अन्य एसएनपी के अलावा पुष्पगुच्छ(पैनिकल) के निचले हिस्से की कुल अनाज संख्या के साथ संबद्ध होने के लिए पहचाना गया था।

चावल संकर KRH2 (IR58025A/KMR3R) से 125 स्थिर, डब्लडहैप्लोइडकिस्मों(डीएचएल) का एक सेट तैयार किया गया था। 126 पॉलीमॉर्फिक एसएसआर मार्करों के साथ क्यूटीएल मैपिंग ने उपज से संबंधित लक्षणों से जुड़े 24 प्रमुख और मामूली प्रभाव वाले क्यूटीएल की पहचान की। उनमें से, बारह प्रमुख प्रभाव क्यूटीएल थे, जो कि 2.72–16.51 के एलओडी स्कोर रेंज के साथ फेनोटाइपिक विविधता के 29.95–56.75% कोस्पष्टकरते हैं।

वज़ूहोफेक क़िस्म से खोल क्षति (Sheath blight) से संबंधीत एक प्रमुख क्यूटीएल गुणसूत्र संख्या 3 पर पहचाना गया।

उपज बढ़ाने वाले जीन, जैसे Gn1a, SCM2 और OsSPL14 को मार्कर-सहायता प्राप्त बैकक्रॉस ब्रीडिंग के माध्यम से इलीटकिस्मों जैसेकीस्वर्ण, MTU1010, अक्षयधन, सांबा महसूरी और बेहतर सांबा महसूरी की आनुवंशिक पृष्ठभूमि में स्थानांतरित किया गया। उपर्युक्त चावल की किस्मों के उन्नत संस्करणों में प्रति दाना अधिक संख्या में अनाज, बेहतर पुष्पगुच्छ शाखा और मजबूत तना (कल्म) होता है। एक प्रजनन किस्म RP6294-1096-1101-22-3, सांबा महसूरी की आनुवंशिक पृष्ठभूमि में, उपज बढ़ाने वाले जीन SCM2 और OsSPL14 रखने वाले को AICRIP के परीक्षण के अंतिम वर्ष (AVT2-IL परीक्षण) में पदोन्नत किया गया था।

आरएनए-अनुक्रमण का उपयोग करते हुए, क्यूटीएल और क्यूटीएल-सीक्यू क्षेत्रों में स्थित पूर्ण पुष्पगुच्छ (पैनिकल) एक्ससर्शन म्यूटेंट (सीपीई) में स्थित कई ट्रांसक्रिप्ट्स की पहचान जंगली किस्मों और उत्परिवर्ती किस्मों के बीच अंतर व्यक्त करने के लिए की गई थी। उन क्षेत्रों में पड़े कुछ एसएनपी को कॉम्पेटिटिव एलील-स्पेसिफिक पीसीआर (केएएसपी) assays के माध्यम से सत्यापित किया गया था। चयनित एसएनपी मार्कर जीन में स्थित होते हैं जो एपी 2/ एथिलीन-उत्तरदायी तत्व-बाध्यकारी प्रोटीन, साइक्लिन-जैसे एफ-बॉक्स डोमेन-युक्त प्रोटीन, पुष्प उत्प्रेरक, और सेरीन/थ्रेओनीन-प्रोटीन फॉस्फेट को कूट लेखन (एन्कोड) करते हैं। सीपीई और ट्रांसक्रिप्टोम डेटा के साथ एसएनपी मार्करों का कड़ा जुड़ाव सीपीई में इन जीनों की संभावित भूमिका का संकेत है।

संपूर्ण-जीनोम ट्रांसक्रिप्टोम और क्यूआरटी-पीसीआर विश्लेषण का उपयोग करते हुए, एक आशाजनक उम्मीदवार जीन OS10G0416500 जोकीएक नवीनतमचीटिनेसेजीन का कूट लेखन करता हैं,को शीथ ब्लाइट रोग प्रतिरोध के लिए पहचाना गयाहै।

MADS4 जीन के लिए एलील-विशिष्ट निशान (Allel specific marker) को एरोबिक अनुकूलित किस्मों के लिए विशिष्ट एम्प्लिकॉन (141 बीपी) के साथ विकसित किया गया था।

डीआरआर धन 58, एक उच्च उपज देने वाली, पतले-दाने वाली, लवणता के प्रति अत्यधिक सहनशील और बैक्टीरियलब्लाइट (जीवाणु क्षति) के प्रतिरोधी किस्म को विकसित किया गया। नई किस्म की पैदावार सांबा महसूरी की तुलना में ~ 12% अधिक और लवणता वाले क्षेत्रों में बेहतर सांबा महसूरी से होती है। डीआरआर धन 58 में प्रमुख क्यूटीएल है जो लवणता सहिष्णुता से जुड़ा है और साथ ही बैक्टीरियल ब्लाइट प्रतिरोध जीन, Xa21, xa13 और xa5 भी है।

डीआरआर धन 59, जो की अक्षयधन की आनुवंशिक पृष्ठभूमि में अधिक उपज देने वाली, लंबे पतले दाने वाली किस्म, जो जीवाणु क्षति के लिए प्रतिरोधी विकसित की गई थी।

डीआरआर धन 60, एक उच्च उपज देने वाली, पतले दाने वाली चावल की किस्म, कम फास्फोरस की मिट्टी के स्थिति के प्रति अत्यधिक

सहिष्णु होने के साथ-साथ बैक्टीरियल ब्लाइट प्रतिरोध विकसित किया गया था। यह फॉस्फेटिक उर्वरकों की अनुशंसितखुराक के 40% उपयोग पर भी सामान्य रूप से विकसित और उपज दे सकता है और इसमें बैक्टीरियल ब्लाइट प्रतिरोध जीन, *Xa21, xa13* और xa5 होते हैं।

फ़सल उत्पादन

सस्य विज्ञान

एडब्ल्यूडी पद्धति के माध्यम से पानी के प्रयोग से फसल वृद्धि अवधि के दौरान कुल पानी की आवश्यकता का लगभग 11-14 प्रतिशत बचाया गया। खेती की प्रणालियों में, यंत्रीकृत एसआरआई विधि में सबसे कम पानी की आवश्यकता होती है (क्रमशः ड्रम सीडिंग और सामान्य रोपाई की तुलना में 11.61% और 13.21% कम औसत उपयोग किए गए पानी)।

प्रत्यारोपित चावल के भूखंडों में दर्ज खरपतवार वनस्पतियों में इचिनोक्लोएक्रसगल्ली, साइपरसडिफोर्मिस, साइपररसरोटुंडस, एक्लिप्टा अल्बा, अम्मानियाबैकीफेरा और मार्सिलिया क्वाड्रिफोलिया शामिल हैं।

खरपतवार आबादी ने 30 डीएटी पर घास-सेज-ब्रॉड लीफ वीड्स (बीएलडब्ल्यू) का समूहवार प्रभुत्व दिखाया; सेज-घास-बीएलडब्ल्यू 45 डीएटी पर; 60DAT पर BLW-घास-सेज। घासों में इचिनोक्लोआ क्रूसगल्ली प्रमुख प्रजाति थी और दो वर्षों में प्रजातियों की उपस्थिति में कोई बदलाव नहीं देखा गया था।

रोपित चावल आधारित चावल-मक्का प्रणाली की उत्पादकता पांच वर्षों के प्रयोग (2016-21) के दौरान गीली सीधी-बीज आधारित चावल-मक्का प्रणाली से बेहतर थी। पारंपरिक जुताई वाली मक्का प्रणाली की उच्चतम प्रणाली उत्पादकता 2018-19 (12.54 टन/हे.) में दर्ज की गई थी।

न्यूनतम जुताई वाले मक्का के परिणामस्वरूप पारंपरिक जुताई वाली मक्का प्रणाली की तुलना में मिट्टी की 0-5 सेमी गहराई पर बहुत अधिक लेबिल (~33.5%) और लेबिल (~33.2%) कार्बन संकेंद्रणहोत है।

तीन स्थापना विधियों जैसे कि गीला-डीएसआर (पुडल, डिब्लिंग), वेट-डीएसआर (पुडल, ब्रॉडकास्टिंग) और पारंपरिक ट्रांसप्लांटिंग, पोखर मिट्टी में डिब्लिंग ने प्रसारण (ब्राडकास्टिंग) (6.04 टन) की तुलना में काफी अधिक अनाज उपज (6.77 टन प्रति हेक्टेयर) का उत्पादन किया और पारंपरिक रोपाई (5.90 टनप्रतिहेक्टेयर)का।

परिणामों से पता चला कि उर्वरक की 100% अनुशंसित खुराक (आरडीएफ) + अवशेष प्रतिधारण ने प्रति मीटर स्क्वायर पुष्पगुच्छ संख्या (286), पुष्पगुच्छ वजन (4.4 ग्राम), परीक्षण वजन (21.7 ग्राम) की उच्च संख्या दर्ज की जिसके कारण अनाज की उपज में वृद्धि हुई (5.8 टन प्रति हेक्टेयर) और भूसाउपज (6.6 टन प्रतिहेक्टेयर)।

मृदा विज्ञान

परीक्षण की गई 21 लोकप्रिय किस्मजैसे पीएसवी 190, पीएसवी 469, पीएसवी 344, पीयूपी 221 और वर्धन ने अन्य किस्मों की तुलना में उच्च पैदावार के साथ-साथ उच्च नाइट्रोजन उपयोग निपुणता सूचकांकों के साथ अच्छा प्रदर्शन किया। एन-(एन-ब्यूटाइल) थायोफॉस्फोरिक्ट्रिमाइड (एनबीपीटी) और एलिसिन जैसे बेहतर N_2 स्रोतों ने एनसीयू की तुलना में उपज में वृद्धि दर्ज की। एनबीपीटी1000 पीपीएम के साथ एनयूई काफी अधिक था।

ग्रीनहाउस गैसों के उत्सर्जन पर अध्ययन में, पारंपरिक प्रतिरोपित (टीपीआर) की तुलना में, एसआरआई में मीथेन उत्सर्जन में 40 प्रतिशत से अधिक की कमी आई और एडब्ल्यूडी में क्रमशः 5 और 10 सेमी पर 49 और 54 प्रतिशत की कमी आई।

N_2O-N उत्सर्जन, एसआरआई में 31 प्रतिशत और गीला और सुखाने (AWD) में क्रमशः TPR की तुलना में 42 और 44 प्रतिशत अधिक था। कम मीथेन उत्सर्जन के कारण AWD और एसआरआई विधियों ने ग्लोबल वार्मिंग क्षमता को कम किया।

2016-17 से शुरू होने वाले मल्टी-डेट मोडिस का उपयोग स्वतंत्र रूप से उपलब्ध सॉफ़्टवेयर, टाइमसैट का उपयोग करके टाइम सीरीज़ विश्लेषण बनाने के लिए किया गया था।

तेलंगाना राज्य से संबंधित मृदा स्वास्थ्य कार्डों से प्रक्षेप तकनीकों द्वारा 12 विभिन्न मृदा विषयगत नक्शा तैयार किए जा रहे हैं और डुप्लिकेट और गलत प्रविष्टियों को समाप्त करके डेटा को क्यूरेट किया गया था।

चावल पारिस्थितिकी को इसकी मिट्टी कार्बनिक कार्बन और उनके स्टॉक के लिए विवरण करने के पहले प्रयास में चार अलग-अलग चावल पारिस्थितिकी के बीच>70% तक की एक बड़ी भिन्नता पाई गई, जोउच्चभूमि/पहाड़ी चावल पारिस्थितिकी की तुलना में चावल पारिस्थितिकी में सतही मिट्टी कार्बनिक कार्बन में दो गुना तेजी से गिरावट का संकेत देती है।

अंकुरण के दौरान जिस दर पर बीज भंडार का उपयोग किया गया था, उस तंत्र को समझने के लिए अंकुरण और अंकुरण पश्च्यात वृद्धि पर

एक्टिनोबैक्टीरियल आइसोलेट्स के साथ बायोप्रिमिंग काक्याप्रभाव होताहैउसका अध्ययन किया गया। बीजों में उच्चतम अंकुर भंडार उपयोग निपुणता (0.613 मिलीग्राम प्रति मिलीग्राम) उन बीजों में देखी गई जो एक्टिनोबैक्टीरिया के साथ मिलाई गई थी।

पोषण की उपलब्धता और अधिग्रहण के संबंध में विभिन्न चावल स्थापना विधियों में सूक्ष्मजीवी जनसंख्या गतिशीलता अध्ययन ने संकेत दिया कि एरोबिक विधि सबसे अधिक संख्या में माइक्रोबियल आबादी के साथ पाई गई थी। N_2-मुक्त मीडिया पर कुल 35 नाइट्रोजन फिक्सिंग बैक्टीरिया को अलग किया गया था और 21 अद्वितीय मोर्फोटिपस को शुद्ध किया गया था और एसिटिलीन कम करने वाले परीक्षण (एआरए)के माध्यम से नाइट्रोजनेज गतिविधि के लिए मूल्यांकन किया गया था।

नैनो ZnO (250 पीपीएम) की बढ़ती खुराक और दोहरे फुहारेने नियंत्रण से उपज में 1.45 गुना तक महत्वपूर्ण सुधार दिखाया है। उच्चतम केटालेज़ (Catalase) एंजाइम गतिविधि ZnSO4 फुहारे (3.20 यूनिट प्रति मिनट प्रति ग्राम ताजा वजन) में पाई गई थी। दोनों धातु नैनो कणों की बढ़ी हुई सांद्रता के साथ, केटालेज़ एंजाइमों की गतिविधि स्पष्ट रूप से कम हो गई थी।

एफवाईएम + 75% आरडीएफ + हाइड्रोजेल @ 10 किग्राप्रतिहेक्टेयर ने 26% अधिक अनाज उपज और 19% अधिक भूसा उपज नियंत्रण (अकेले एनपीके) की तुलना में दर्ज की। पुष्पगुच्छ आरंभअवस्थाके दौरान, हाइड्रोजेल मिलायेहुए भूखंडों में बिना हाइड्रोजेल मिलायेहुए भूखंडों की तुलना में मिट्टी की नमी की मात्रा में 6 से 38% की वृद्धि दर्ज की गई। कटाई के समय, हाइड्रोजेल मिलायेहुए भूखंडों में नमी की मात्रा में वृद्धि बिना हाइड्रोजेल मिलायेहुए भूखंडों की तुलना में12 से 46% तक थी।

पादप कार्यिकी तथा जीव रसायन

प्रकाश संश्लेषक दक्षता (पीएनP_N), रंध्र चालकता (जीएस), वाष्पोत्सर्जन दर (ई) और अंतर सेलुलर CO_2 एकाग्रता (Ci) के लिए परीक्षण की गई किस्मों के बीच महत्वपूर्ण भिन्नता देखी गई। परिणामों ने पीएन के जीएस, ई और कार्बोक्सिलेशन दक्षता (सीई) के साथ सकारात्मक जुड़ाव का खुलासा किया।

फूल आने की अवस्था में 4 ग्राम/लीटर की दर से सिलिकॉन का प्रयोग इष्टतम था।

समान एमाइलोज (एसी) वाली किस्मों के जीन अभिव्यक्ति विश्लेषण से पता चला कि शाखाओं में शाखाओं की लंबाई भिन्नता से अनाज की गुणवत्ता में भिन्नता होती है।

संगणक अनुप्रयोग

इस वर्ष के दौरान 70% से अधिक केंद्रों ने अभासचासुप(AICRIP) इंट्रानेट के माध्यम से डेटा भरडाला(अपलोड किया। अभासचासुप इंट्रानेट में आरबीडी और स्प्लिट एनालिसिस मॉड्यूल, मौसम डेटा प्रविष्टि के लिए एक्सेल कॉपी इंटरफेस, वर्चुअल फील्ड मॉनिटरिंग और फसल की स्थिति इंटरफेस पर मासिक टिप्पणी जैसी नई सुविधाओं को अभासचासुप इंट्रानेट में जोड़ा गया था।

मौसम संवेदकों को तैयार करने के क्रम में, Google शीट्स में सेंसर से डेटा प्रकाशित करने के लिए पायथन प्रोग्राम विकसित किए गए थे और उष्णकटिबंधीय मिट्टी (क्यूईएफटीएस) मॉडल की उर्वरता के मात्रात्मक मूल्यांकन का उपयोग करके अभासचासुप के दीर्घकालिक मिट्टी उर्वरता प्रयोगात्मक डेटा के साथ पोषक तत्व आवश्यकता मॉड्यूल को सत्यापित किया गया था।

कृषि अभियांत्रिकी

0.5hp विद्युत 3 फेज मोटर और स्टैंड का उपयोग करते हुए एक मिट्टी की पोखर बनाने वाली मशीन का निर्माण किया गया।

फसल सुरक्षा

कीट विज्ञान

दो लैंड रेस, IC 8968 और IC 8646 को ब्राउन प्लांट हॉपर के लिए अत्यधिक प्रतिरोधी और IC 8691-2 को व्हाइट बैकेड प्लांटहॉपर के रूप में पहचाना गया।

उन्नत प्रजनन किस्मों वाली 2000 प्रविष्टियों में से, भूरे रंग के प्लांट हॉपर प्रतिरोध के लिए जांच की गई जर्मप्लाज्म अक्सेशन, सत्ताईस प्रविष्टियां अत्यधिक प्रतिरोधी थीं, बासठ प्रविष्टियां प्रतिरोधी थीं और अड़तीस प्रविष्टियां ब्राउन प्लांटहोपर के लिए मध्यम प्रतिरोधी थीं।

*Bph*genes की आणविक रूपरेखा से पता चला कि Bph6+Bph20 (IC 519101), Bph2+Bph6 (IC 515974, IC 517008 और IC 75883), Bph2+Bph6+Bph17 (RP 2068-18-3-5 और RP 4918-230-S) और Bph32+Bph17 (PTB33) ने प्रतिरोधी प्रतिक्रिया दिखाई।

आरपी 5588-बी-बी-बी-बी- 226, आरपी 5588, बीके 64-116सीआरसीपीटी 7 और सीआरएसी 3992-2-1, किस्मोंमें पीले तना बेधक के प्रति सहनशीलता को वानस्पतिक अवस्था के दौरान पीड़ित पौधे में उच्च जुताई क्षमता द्वारा क्षति के मुआवजे के लिए जिम्मेदार ठहराया गया था।

स्वर्ण/ओरिज़ानिवारा आईआरजीसी81848 की बीआईएल की आशाजनक प्रविष्टियों पर किए गए विकास और उत्तरजीविता अध्ययनों से पता चला है कि मध्यम प्रतिरोधी किस्मों और अतिसंवेदनशील जांच की तुलना में 50 प्रतिशत से कम लार्वा प्रतिरोधी किस्मों पर वयस्कों में विकसित हुए हैं।

चावल की पत्ती के फोल्डर के धीमी गति से निकलने वाले फेरोमोन मिश्रण, पीले तना बेधक और लीफ फोल्डर और पीले तना छेदक दोनों के बहु-प्रजाति के मिश्रण सामान्य मिश्रणों से बेहतर थे।

प्रयोगशाला परिस्थितियों में सिट्रोनेला और लेमन ग्रास ऑयल टी. जैपोनिकम के प्रतिशत को कम कर देते हैं।

रिलेटिवरुटगालसूचकांक (आरजीआई) पर आधारित प्रतिरोधी चेक खाओपहक माव को छोड़कर, सभी परीक्षण की गई बीस उच्च उपज देने वाली किस्मों को चावल की जड़-गाँठ सूत्रकृमि के लिए अतिसंवेदनशील पाया गया।

खेतीकी एसआरआई विधि, एरोबिक चावल में हरी पत्ती मल्चिंग, और जैव-गहन कीट प्रबंधन (बीआईपीएम) प्रथाओं पौधे परजीवी नेमाटोड को दबाने वाले पाए गए। लाभकारी मुक्त-जीवित माइक्रोबायोरस नेमाटोड अधिक बीआईपीएम उपचार थे।

जैव-गहन कीट प्रबंधन प्रथाओं को अधिक और विविध प्राकृतिक शत्रु आबादी का समर्थन करतेहुए पाया गया।हाइमनोप्टेरा के ब्रोकोनिडे, ट्राइकोग्रामाटाइड और स्केलियोनिडे प्रमुख वर्गथे।

ड्रोन के साथ कीटनाशक के छिड़काव की बूंदों की विशेषताओं के विश्लेषण से पता चला कि बूंदों का औसत व्यास 839 से 1164 माइक्रोन (अल्ट्रा-मोटे श्रेणी) के बीच था, जो निचली फसल के छत्र में अच्छी पैठ और कम बहाव व्यवहार और एक समान छोटी बूंद के आकार के साथ था।

पादप रोग

डीआरआर धन 62, एक एमएएस व्युत्पन्न, टिकाऊ ब्लास्ट और बैक्टीरियल ब्लाइट प्रतिरोधी उच्च उपज, पतले दाने वाली चावल की किस्म जिसमें तीन प्रमुख बैक्टीरियल ब्लाइट प्रतिरोध जीन, Xa21+xa13+xa5 और दो प्रमुख विस्फोट प्रतिरोध जीन Pi-2+Pi54 विकसित किए गई।

यूनिफॉर्म ब्लास्ट नर्सरी के तहत जांच की गई 3173 लाइनों में से 580 लाइनों को ब्लास्ट के खिलाफ प्रतिरोधी पाया गया।

तेलंगाना के खम्मम जिले के कई गांवों में चावल के जीवाणु झुलसा (बैक्टीरियल ब्लाइट) का गंभीर प्रकोप दर्ज किया गया। *Xa21+xa13+xa5+Xa38* के साथ निगमित डीआरआर धन 53 चावल के बैक्टीरियल ब्लाइट से पूरी तरह मुक्त था।

1121विविध किस्मों की कृत्रिम रूप से या तो खेत में या ग्लास हाउस स्थितियों में जांच की गई। उनमें से 197 प्रतिरोधी लाइनों को अत्यधिक प्रतिरोधी के रूप में और 26 लाइनों को बैक्टीरियल ब्लाइट के खिलाफ मध्यम प्रतिरोधी के रूप में पहचाना गया।

Xoo के पच्चीस नए आइसोलेट्स एकत्र किए गए और बेसिलस एसपीपी के 29 आशाजनक उपभेदों को एकत्र किया गया। इन विट्रो स्थिति के तहत *Xoo* के खिलाफ विरोधी के रूप में पाए गए।

आर. सोलानी और राइजोक्टोनियासपीपी के पचहत्तर आइसोलेट्स 2021 के दौरान एकत्र किए गए थे और R. *Oryzaesativa* के 12 आइसोलेट्स और *R. oryzae* के 6 आइसोलेट्स के लक्षण वर्णन किए गए थे। आर. सोलानी के दो सौ बीस आइसोलेट्स को दीर्घकालिक भंडारण के लिए संरक्षित भीकिया गया था।

32 आर. सोलानी आइसोलेट्स के प्रतिदीप्ति (फ्लोरेसेन्स) सूक्ष्म अध्ययन से पता चला कि आर. सोलानी मायसेलियम के एकल सेप्टम में ~5 से 9 नाभिकों की संख्या होती है।

चार आरआईएल (वजुहोफेक/सुधारित सांबा महसूरी); पांच उत्परिवर्ती किस्मों और आशाजनक किस्मों की पैतृक किस्मों अर्थात, सावित्री, विक्रमरी, गायत्री को खोल क्षति (शीथब्लाइट) सहिष्णुता के प्रति अत्यधिक सहिष्णु के रूप में पहचाना गया। विभिन्न अभासचासुप परीक्षणों के तहत 50 सहिष्णु आरआईएल प्रविष्टियों को नामांकित किया गया था।

नए एंटिफंगल अणु “साइमीन” की पहचान थाइमस वल्गेरिस एल से शीथ ब्लाइट रोगज़नक़ आर। सोलानी के खिलाफ, इन विट्रो और विवो दोनों में की गई थी। डिफेनोकोनाज़ोल 25% ईसी (0.5 मिली/ली) को म्यान ब्लाइट प्रबंधन के लिए सबसे अच्छे अणु के रूप में पहचाना गया

क्रोमोसोम 5, 3 (जिसे qShbltol3.1 नाम दिया गया है) पर म्यान ब्लाइट टॉलरेंस के लिए एक प्रमुख क्यूटीएल की पहचान की गई थी, और अन्य क्रोमोसोम पर खोजे गए कुछ मामूली क्यूटीएल की पहचान की गई थी।

ग्लासहाउस और फील्ड परिस्थितियों में अधिक संख्या में जीनोटाइप की जांच के लिए कृत्रिम झूठी स्मट स्क्रीनिंग सुविधा स्थापित की गई थी। झूठी स्मट रोग के प्रति सहिष्णु के रूप में लगभग 35 विभिन्न जीनोटाइप लाइनों की पहचान की गई थी।

दालचीनी की छाल और दालचीनी की पत्ती के तेल जैसे आवश्यक तेलों ने यू. विरेन की वृद्धि को कम कर दिया और यूस्टिलागिनोइडेविरेन्स के शंकुधारी गुणन को कम कर दिया।

भूरे धब्बे रोग के लिए कृत्रिम सामूहिक जांच तकनीक को खेत की परिस्थितियों में मानकीकृत किया गया था। बीपीटी 5204, स्वर्णधन, गंगावथिसोना और पर्पल पुट्टू की किस्मों को अतिसंवेदनशील किस्मों के रूप में पहचाना गया; जबकि मध्यम प्रतिरोधी किस्मों के रूप में सीएच-45, टेटेप और आईआर-64।

म्यान सड़न रोग को शामिल करने के लिए टीकाकरण की इंजेक्शन विधि सर्वोत्तम सिद्ध हुई। स्टेम रोट फंगस के छत्तीस आइसोलेट्स को अलग किया गया और रोगजनकता साबित हुई। आइसोलेट (So15) की पहचान वायरल आइसोलेट के रूप में की गई थी।

ASD16 T2 समयुग्मजी विलोपन समयुग्मजी म्यूटेंट (18 म्यूटेंट) राइस टंग्रो रोग के खिलाफ कृत्रिम जांच के तहत या तो प्रतिरोधी (स्कोर 3) या मध्यम प्रतिरोधी (स्कोर 5) के रूप में पाए गए। इन पंक्तियों का उपयोग माता-पिता के रूप में अन्य इंडिका जीनोटाइप के लिए इस विशेषता का परिचय देने के लिए किया जा सकता है।

Trichoderma spp. and *Bacillus spp* के छह देशी आइसोलेट्स। चावल में जैव नियंत्रण और पौधों की वृद्धि को बढ़ावा देने वाली गतिविधियों की क्षमता की पहचान की गई।

ट्राइकोडर्माएस्पेरेलम (TAIK1, TAIK4 और TAIK5), बैसिलस वेलेजेंसिस (BIK2), बैसिलस कैब्रियल्सि (BIK3) और बैसिलस पैरालिचेनिफॉर्मिस का संपूर्ण जीनोम अनुक्रमण किया गया।

प्रौद्योगिकी प्रशिक्षण और हस्तांतरण

मध्य प्रदेश के 10 गांवों को कवर करते हुए 250 चावल किसानों के साथ जलवायु परिवर्तन और चावल की खेती पर किए गए एक खोजपूर्ण अध्ययन ने टिक्कमगढ़ जिले में किसान की धारणा और अनुकूलन रणनीतियों का दस्तावेजीकरण किया।

स्मार्ट ग्राम परियोजना के हिस्से के रूप में, डीआरआर धन 48 के साथ पोषण स्मार्ट हस्तक्षेप पर प्रदर्शनों ने 24 क्विंटल/एकड़ की औसत उपज दर्ज की और क्षेत्र की सीमाओं पर गेंदा रोपण के रूप में पारिस्थितिक इंजीनियरिंग हस्तक्षेपों के परिणामस्वरूप अतिरिक्त आय हुई। शक्ति और स्वतंत्रता की सीढ़ी पर काम किया गया और महिला किसानों की रैंकिंग एक डिग्री की शक्ति और फसलों / किस्मों को उगाने के निर्णय लेने की स्वतंत्रता का दस्तावेजीकरण किया गया।

अन्य एफपीओ के अनुभवों और बेंचमार्क विश्लेषण के आधार पर, सदस्य किसानों की विस्तार और सलाहकार सेवा आवश्यकताओं को पूरा करने के लिए चयनित यज़ली एफपीओ के लिए विस्तार और सलाहकार सेवा निर्धारण प्रणाली को अनुकूलित और विकसित किया गया है।

किसान के बीज प्रतिस्थापन व्यवहार विश्लेषण से पता चला कि 3 साल के इष्टतम प्रतिस्थापन समय के लिए आवश्यक उपज में लाभ की वार्षिक दर भारत के विभिन्न राज्यों में 50 किग्रा / हेक्टेयर की बीज दर से 0.8 से 2.3 प्रतिशत के बीच थी।

एकीकृत कीट प्रबंधन पर आर्थिक और ऊर्जा दक्षता अध्ययन से पता चला है कि आईपीएम में लाभ-लागत अनुपात और ऊर्जा दक्षता किसानों के अभ्यास की तुलना में अधिक थी। चावल की खेती में आईपीएम को अपनाना किसानों के अभ्यास की तुलना में ऊर्जा और मौद्रिक शुद्ध रिटर्न के मामले में किफायती है

खेत में आईपीएम प्रौद्योगिकियों को अपनाने और प्रभाव विश्लेषण अध्ययनों ने किसानों को मृदा परीक्षण आधारित पोषक तत्व प्रबंधन और आवश्यक तेलों सहित स्थानीय रूप से अपनाने योग्य आईपीएम घटकों पर प्रशिक्षित किया, जिसके परिणामस्वरूप महत्वपूर्ण आईपीएम प्रथाओं को अपनाने में वृद्धि हुई जिससे उच्च उपज और रासायनिक स्प्रे की संख्या कम हो गई।

तीन वातावरणों में लागू जीनोमिक भविष्यवाणी मॉडल फेनोटाइपिक डेटा से पता चला है कि एएनएन मॉडल ने प्रशिक्षण और परीक्षण डेटा सेट दोनों में शास्त्रीय प्रतिगमन, बायेसियन, रैंडम फ़ॉरेस्ट और एसवीआर मॉडल से बेहतर प्रदर्शन किया है। एएनएन मॉडल ने सबसे कम आरएमएसई और वास्तविक मूल्यों और जीईबीवी के बीच उच्चतम सहसंबंध प्राप्त किया है।

लगभग 10 प्रशिक्षण कार्यक्रम आयोजित किए गए और 220 से अधिक किसानों को बेहतर चावल उत्पादन प्रौद्योगिकियों और उपज और लाभप्रदता बढ़ाने के लिए अन्य पहचाने गए हस्तक्षेपों पर प्रशिक्षित किया गया।

चावल से संबंधित प्रौद्योगिकियों के कैफेटेरिया से आठ राज्यों में कुल मिलाकर 2480 आदिवासी किसान परिवार लाभान्वित हुए। चावल की खेती की तकनीकी जानकारी और कैसे करें के बारे में विषय-वस्तु प्रशिक्षण प्रदान करके, तकनीकी अंतराल के साथ-साथ विस्तार अंतराल को कम किया गया।

आईसीएआर-आईआईआरआर-एससीएसपी के तहत, धान के बीज (2,630), सुखाने की चादरें (650), स्प्रेयर (290), उर्वरक (120), फेरोमोन ट्रैप और ल्यूर (58), शाकनाशी (58), कीटनाशक (58) जैसे महत्वपूर्ण इनपुट) और कवकनाशी (58) अनुसूचित जाति के लाभार्थियों को वितरित किए गए। आईपीएम, अच्छी कृषि पद्धतियों, आईएनएम पर प्रशिक्षण कार्यक्रम आयोजित किए गए।

All India Coordinated Rice Improvement Project (AICRIP)

Crop Improvement

- A total of 113 varieties including 14 Hybrids and 96 varieties for different ecologies have been released by both central and state varietal release committees (Central-45; state-68) during 2021.
- Forty-six varietal trials and four hybrid rice trials were conducted involving 806 experiments at 123 locations (45 funded and 78 voluntary centres) in 28 states and 2 union Territories across seven zones of the country during 2020. A total 1443 entries including 229 checks were tested and twenty-two promising lines were identified for release.
- Analysis of AICRIP entries in past 3 years (2018-2020) showed that majority of the nominations were from eastern and southern zones with 37% of the nominations made by ICAR-NRRI and ICAR-IIRR. Similarly, majority of the basmati and salinity trial nominations were from ICAR-IARI and ICAR-CSSRI respectively.
- The parental lines used in the development of entries nominated to AICRIP were mostly popular cultivars viz., BPT 5204, Swarna, MTU1010, Improved Samba Mahsuri and Naveen contributing to 95%, while wild and related species contributed to only 2%.
- A total of 38 proposals including 33 varieties and 5 hybrids were considered by Varietal Identification Committee (VIC) held during the 56th ARGM and 28 entries including 25 varieties and 2 hybrids were identified.
- Breeder seed production as per the DAC indents at 44 centers across the country, involving 320 varieties and parental lines of 4 rice hybrids produced a total of 9217.33 quintals of breeder seed.

Crop Production

Agronomy

- A total of 229 experiments were conducted at 49 locations to develop cost-effective technologies in rice and rice-based cropping systems. Rice-pulse system increased grain yield over rice-rice system.
- IET-25121, IET-26356, IET-25746, IET-26027, IET-25997, IET-25785, IET-25269, IET-26263, IET-25793, IET-25856, IET-22836, IET-25059, IET-26168, IET-26383, IET-26375 were found promising under NVT trials of different ecologies.
- Mechanical transplanting resulted in higher grain yield compared to manual transplanting across the locations and Application of 25 to 50% of higher RDF gave higher grain yields.
- Alternate wetting and drying (5.75 to 6.39 t/ha) continued to provide on par grain yield with flooding and was cost-effective saving of Rs. 3800/ha.
- Integrated Weed Management gave higher grain yield in IPM implemented plots. The systemic post emergence herbicide thiobencarb @ 5 l/ha was found promising.

Soil Science

- A total of 8 trials were conducted during rabi-2019-20 and kharif-2020 in 19 locations representing typical soil and crop systems and important rice growing regions.
- In the 32nd year of study on long term soil fertility management in RBCS, the treatments RDF + FYM and RDF were at par and significantly superior to other treatments.
- The soil quality index showed variations in the quality and health of the soil across different farmers' categories.
- In sodic soils the genotypes SS-3 and SVL-2 were found promising with highest yield and NPK uptake.
- The acid tolerant genotypes Shreyas, SVL1, NH2, SVL3 and GPV4 were found promising with highest yield.
- The crop residues can be deployed to substitute nearly half of the recommended nitrogen without any yield penalty.
- The varieties, ARRH7576, CNN 5, CNN 3, CNN 1, recorded maximum yields and nitrogen use efficiency at most of the locations.

- In organic rice cultivation, combination of dhaincha green manure @ 6.25 t/ha + 100 kg/ha Neem cake + seed treatment with *Pseudomonas* + RDF 100% gave higher yields.

Plant Physiology

- Physiological studies under AICRIP were constituted in six trials at eight funded centers, two ICAR institutions and six voluntary centers.
- Silicon application exhibited positive response in mean grain yield in IIRRH-132, IRRH-131, JKRH-3333 and US-314.
- The genotypes IET28241, IET28242 and Sahbhagi Dhan found suitable for rainfed cultivation, based on grain yield, biomass, harvest index and test weight.
- Under heat stress, IET 29156 followed by IET 29157 recorded the lowest yield reduction based on per cent reduction in grain yield over control.
- CR-3918-IL-160, IET 24426, AC-35764, AC-34975 and Dubraj were found to possess tolerance to multiple abiotic stresses.
- Screening for submergence tolerance in rice, AC-41585 followed by IET 24434 has shown the highest % survival of the seedlings. CO-50, IET 24434, IET 24426, CR-3918-IL-160, CR-2826-IL-204 and Dubraj recorded more than 70% seedling survival.
- Under low light stress, higher grain yield was recorded by check Swarnaprabha followed by IET27537, IET28283, IET29032 and IET26744.

Crop Protection

Entomology

- Seven major trials involving 244 experiments were conducted at 42 locations in 21 states and 2 Union territories.
- A total of 1583 entries were screened for host plant resistance to 13 insect pests and 97 entries were identified as promising.
- Twenty-one entries were found promising against plant hoppers of which Six entries were in the second year of testing.
- For gall midge, IBT-WGL-4 and IBT-WGL-5 were promising. MTU1010 (*gm3*+*Gm4* +*Gm8*), Aganni, ENTGP 2018-178, and 14 pyramided lines (MTU1010 (*Gm*4 + *Gm*8)) were found promising against gall midge.
- Fourteen entries, one mutant culture of PTB 18 (Cul M9), two pure line selections of Jaya (JS 1 and JS 3) were found promising against leaffolder.
- Fourteen entries were identified as promising for yellow stem borer.
- Cul M9, SKL 07-8-720-63-147-182-276, BK 35-155, JS 5, RP 5587-B-B-B-262, and JGL 33440 were found to possess resistance to multiple pests.
- In IIRR-NSN1; IET nos. 27804, 28084, 27 P 63 (hybrid check), 28827, 27263 (R)28544, 28673, 28519, 28703, 28386, 27632(R), Kavya, PTB 33 and Aganni were found promising. In IIRR-NSN2; IET 29510, PTB-33 and RP 2068-18-3-5 were found promising. In NSN hills, IET nos. 26594 (R)28925, Vivekdhan 62 and Vivekdhan 86 were promising.
- *Gm*8 and *Gm*1 were superior across the locations for gall midge resistance. Evaluation of the gene differentials by single female progeny revealed that Warangal population were less virulent as compared to Pattambi population on Aganni (*Gm8*) but more virulent on RP 2068-18-3-5 (*gm3*).
- In planthopper special screening trial, PTB 33 (*bph2*+*Bph3*+unknown factors) and RP 2068-18-3-5 (*Bph33(t)*) were promising in 7 out of 8 locations.
- All-insecticides module was found to be superior in reducing stem borer, WBPH, and GLH. Lowest silver shoot damage was recorded in all-botanical treatment and was at par with all-insecticides module. Neemazal + neem oil + triflumezopyrim was found effective against BPH. Tested insecticides and botanicals were found safe to beneficial organisms.
- Incidence of stem borer, gall midge, whorl maggot, case worm, and planthoppers was more in late planting as compared to early and normal; leaf folder was highest in normal planting; rice

Executive Summary

hispa was serious in early plantings and whorl maggot was unaffected by planting dates.

- Incidence of stem borer, gall midge, leaf folder and BPH was high in dry direct seeded rice. Incidence of blue beetle was significantly higher in transplanting method.
- Slow release pheromone blend of rice leaf folder and yellow stem borer and multispecies blend were fond effective at Hyderabad and Aduthurai.
- Ecological engineering along with alternate wetting and drying reduced insect pest infestation, supported natural enemies with better yields and benefit cost ratios.
- BIPM practices were effective in lowering stem borer incidence and supporting higher natural enemy population.
- Integrated pest management module was found effective for the management of insect pests, diseases and weeds, across the locations with higher yield and benefit cost ratio.
- Light trap studies indicated that yellow stem borer, leaf folder, and hoppers continued to be the major pests and gall midge continues to be an endemic pest. However, case worm, white stem borer, pink stem borer, black bug, gundhi bug, and zigzag leaf hopper showed an increase in the spread and intensity of incidence.

Plant Pathology

- A total of 15 trials were conducted at 50 locations on host plant resistance, field monitoring of virulence of major pathogens and disease management methods.
- 69 entries were found moderately resistant against two to four major diseases from 1263 entries evaluated.
- Field monitoring of virulence of *Pyricularia grisea* revealed a shift in pathogen profile structure at many locations. HR-12 a susceptible check, recorded resistant reaction at few locations.
- 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.
- Leaf blast was more in the late sown crop; BLB and sheath blight was higher in the early sown crop; brown spot was high both in the early and late sown crop and bakanae incidence was high in the early sown crop.
- Fungicides, Isoprothiolane 40% EC (1.5 ml/l), and Kitazin 48% EC (1.0 ml/l) were effective against leaf and neck blast disease. Thifluzamide 24% SC (0.8g/l), difenoconazole 25% EC (0.5 ml/l) and tebuconazole 25.9% EC (1.5 ml/l) were effective against sheath blight. Difenoconazole 25% EC (0.5 ml/l) was identified as the best molecule to manage sheath rot and brown spot diseases.
- Integrated disease management with seed treatment (carbendazim @2 g/kg) + one blanket application of combination fungicide (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage was effective. Seed treatment with Trichoderma followed by application of propiconazole at booting stage was found effective against leaf and neck blast, and sheath blight.
- IPM practices reduced incidence of leaf blast, neck blast and false smut disease.
- A disease index of 73.22, 69.01, 66.0 % leaf blast, bacterial leaf blight and sheath blight caused a yield reduction of 56.9, 35.5 and 34.09 % respectively.
- Disease severity of bacterial leaf blight was low (7.1%) in un-puddled direct seeding method. The disease severity of bacterial leaf blight and leaf blast was found to be the low in weedy check plots. Among the sowing methods, wet seeding method was the most favourable condition for the incidence of the false smut disease.

Production Oriented Survey

- During 2020, the survey was conducted in 10 states by 12 AICRIP centers.
- Hybrid rice varieties occupied a significant area in states like Uttar Pradesh, Haryana, Gujarat and Bihar and its area is increasing in states like Karnataka and Maharashtra.
- High intensity of leaf blast and false smut was recorded in parts of Telangana and Uttar Pradesh

while bacterial blight was severe in parts of coastal Andhra Pradesh, Konkan region of Maharashtra and parts of Telangana.

- Insect pests like stem borer, leaf folder and BPH were very wide spread. The intensity of stem borer was more in Konkan region of Maharashtra.

Lead Research

Crop Improvement

Plant Breeding

- DRR Dhan 54 (IET No. 25653) an aerobic variety was released for cultivation in Telangana, Odisha, Jharkhand, Bihar, Haryana and Gujarat. DRR Dhan 56 a GSR variety for early transplanted conditions was released for Punjab and Haryana during 2020.
- DRR Dhan 60 (IET 28061); high yielding fine grain variety tolerant to low soil phosphorous and resistant to bacterial blight, DRR Dhan 63 (IET 26383); high yielding variety with high Zn were notified.
- Genetic stock *viz.,* RP 5690-20-6-3-2-1(National ID: INGR 21176) for resistance to plant hoppers; North eastern landraces Phougak (21087; IC0 639794 INGR21093) for tolerance to sheath blight, resistance to neck blast and resistance to leaf blast and Wazuhophek (21091; IC0639795 INGR21112) for tolerance to sheath blight and low soil P tolerance were registered with NBPGR
- Germplasm comprising of landraces were evaluated for agro-morphological and micronutrient content and genotypes with zinc content up to 28.5 ppm and Fe content up to 12.20 ppm were identified.
- Advanced Breeding Lines were developed and selections were made to identify high yielding water use efficient short duration rice hybrids and varieties.
- A major QTL for resistance to WBPH qDS_2 was identified in a region between 24.1 Mbp to 26.3 Mbp from a RIL population of Swarna/ Sinnasivappu.
- Genotypes with important quality parameters like grain protein content up to 13.44%, head rice recovery (HRR) up to 69.8% and amylose content up to 29.12% were identified. Increase in grain protein content was found inversely associated with grain yield and HRR in rice.
- Potential donors for anaerobic germination tolerance *viz*., Khao Hlan On (KHO) was identified. Interspecific mapping populations of *Oryza sativa*/ *Oryza glaberrima* were used for screening and QTL mapping of direct seeded rice traits like early seedling vigour and weed competitiveness.
- Heat stress tolerant genotypes with more than 90% spikelet fertility at temperature of >40 were identified and utilized in hybridization to develop heat tolerant elite lines and Multi-parent Advance Generation Inter-cross (MAGIC) populations
- Mapping population were developed from the cross of Swarna/IRGC 39111 for explore strong culm trait. GWAS-Association Mapping (AM) Panel was constituted with 226 genotypes comprising of donors for strong culm, grain number and high yield and genetic resources were developed for these trait combinations involving elite *indica* cultivars, tropical *japonica* accessions and donors for biotic and abiotic stresses.
- Promising low P tolerant lines and Major QTLs for yield traits were identified in populations of Rasi x Improved Samba Mahsuri and Wazuhophek x Improved Samba Mahsuri for low soil Phosphorous conditions.
- Different stress indices for Low Phosphorus tolerance were computed and stress tolerance index (STI), yield stability index (YSI), and geometric mean productivity (GMP) were found as ideal indices for the selection of genotypes that performed well under both stress and normal conditions.
- Interspecific CSSLs of MTU1010 / *O. rufipogon,* Swarna / *O. nivara* and KMR3 / *O. rufipogon* and the derived sub populations were phenotyped for yield, quality and biotic stress related parameters and promising lines identified.
- QTL Mapping for yield traits using $F_{2:3:4}$ populations derived from two Swarna/ *O. nivara* BILs revealed *tgw8.1* as a consistent QTL for grain weight from *O. nivara.*

- Populations between popular cultivars and native aromatic short and medium grain rice resulted in identification of high yielding lines with *badh2* gene.

Hybrid Rice

- *Indica*/tropical *japonica* genome proportions were estimated in two newly developed wide compatible restorer lines (RP6367 and RP6368) derived through indica/tropical japonica crosses. The percentage of tropical japonica genome proportion in derived lines RP6367 and RP6368 was found to be 50% and 55.55% respectively. And the molecular diversity among 12 rice genotypes including two newly identified wide compatible restorer lines were studied using 50 SSR markers and 45 InDELs.

- DRR Dhan 55 (IET 26194), an aerobic variety was notified through Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops vide S.O. 500(E) on 29th January 2021 (CG-DL-E-03022021-224901) for cultivation in aerobic ecosystems of Bihar (Zone III) and Chhattisgarh (Zone V) states.

- DRR Dhan 57(IET 26171), an aerobic variety was notified through Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops vide S.O. 8(E) dt. 24th Dec 2021 [CG-DL-E-04012022-232406] for cultivation in aerobic ecosystems of Zone III (Jharkhand) and Zone V (Chhattisgarh).

- The high yielding, low P tolerance (LPT) genotype RP5964-82 (IET 28821) derived from the partial restorer improvement program is under third year of testing in the AICRIP LPT trial.

- Morphological trait-based selection was made on BC1F2 generation and 50 plants were selected. They were analyzed for molecular marker and result showed that nine plants are similar to IR 58025B, 17 plants were of donor parents type and remaining 24 plants were heterozygous for IR 58025B and introgressed lines for yield enhancing genes viz., Gn1, Spl 14, SCM2, Ghd7, GS5 and TGW6.

- Morphological clustering of 112 hybrid rice parental lines (70 restorers and 42 maintainer lines) along with 6 checks performed using DARWIN software. DARWIN grouped 118 genotypes into 8 clusters (7 major and 1 minor). Tree distance varied from 0.289 to 17.66 with a mean tree distance of 6.99. Each cluster consisting a combination of restorers and maintainers.

Biotechnology

- LOC_Os11g42430 was identified to be associated with the total grain number of the lower portion of the panicle in addition to the other SNPs for grain filling in relation to grain number through genome-wide association study (GWAS) of Rice Diversity Panel 1 comprising 298 genotypes using 44K SNP data.

- A set of 125 stable, doubled haploid lines (DHLs) were produced from the rice hybrid KRH2 (IR58025A/KMR3R). QTL mapping with 126 polymorphic SSR markers identified 24 major and minor effect QTLs associated with yield-related traits. Among them, twelve were major effect QTLs, explaining 29.95–56.75% of the phenotypic variability with LOD scores range of 2.72–16.51.

- A major QTL on Chr. 3 associated with tolerance to sheath blight from Wazuhophek was identified.

- The yield enhancing genes, *viz*., *Gn1a, SCM2* and *OsSPL14* were transferred into the genetic background of elite cultivars, Swarna, MTU1010, Akshyadhan, Samba Mahsuri and Improved Samba Mahsuri through marker-assisted backcross breeding. The improved versions of the above-mentioned rice varieties possessed a greater number of grains per panicle, better panicle branching and stronger culm. A breeding line RP6294-1096-1101-22-3, in the genetic background of Samba Mahsuri, possessing the yield enhancing genes *SCM2* and *OsSPL14* was promoted to final year of testing (AVT2-IL trials) of AICRIP.

- Using RNA-sequencing, multiple transcripts located in the QTL and QTL-seq regions in the complete panicle exsertion mutant (CPE) were identified to be differentially expressed between the wild type and the mutant lines. Certain SNPs lying in those regions were validated through Kompetitive Allele-Specific PCR (KASP) assays. The selected SNP markers are located in the genes that encode AP2/ethylene-responsive element-binding protein, cyclin-like F-BOX domain-containing protein, floral activator, and Serine/threonine-protein phosphatase. The tight association of the SNP markers with CPE and the transcriptome data are suggestive of the possible role of these genes in CPE.

- Using whole-genome transcriptome and qRT-PCR analysis, a promising candidate gene *OS10G0416500* encoding a novel chitinase was identified for sheath blight disease resistance.
- Allele-specific marker for MADS4 gene was developed with an amplicon (141 bp) specific for the aerobic adapted genotypes.
- DRR Dhan 58, a high-yielding, fine-grain, highly tolerant variety to salinity and resistant to bacterial blight was developed. The new variety yields ~12 % more than Samba Mahsuri and Improved Samba Mahsuri in salinity-prone areas. DRR Dhan 58 has the major QTL associated with salinity tolerance and also the bacterial blight resistance genes, Xa21, xa13 and xa5.
- DRR Dhan 59, a high-yielding, long-slender grain type variety in the genetic background of Akshayadhan, resistant to bacterial blight was developed.
- DRR Dhan 60, a high-yielding, fine-grain type rice variety, highly tolerant to low soil phosphorus conditions along with bacterial blight resistance was developed. It can grow and yield normally even at 40 % application of the recommended dose of phosphatic fertilizers and has the bacterial blight resistance genes, Xa21, xa13 and xa5.

Crop Production

Agronomy

- Application of water through AWD method saved around 11-14 per cent of total water requirement during crop growth period. Among the systems of cultivation, mechanised SRI method required lowest amount of water (11.61 % and 13.21 % less mean applied water than drum seeding and normal transplanting respectively).
- The weed flora recorded in transplanted rice plots included *Echinochloa crusgalli*, *Cyperus difformis*, *Cyperus rotundus*, *Eclipta alba*, *Ammania baccifera* and *Marsilea quadrifolia.*
- Weed population showed group wise dominance of grasses-sedges-broad leaf weeds (BLW) at 30DAT; sedges-grasses-BLW at 45 DAT; BLW-grasses-sedges at 60DAT. Among the grasses *Echinocloa crusgalli* was the dominant species and no change in species occurance was noticed over two years.
- Transplanted rice based, rice-maize system productivity was superior over wet direct-seeded based rice-maize system during five years of experimentation (2016-21). The highest system productivity of conventional tilled maize system was recorded in 2018-19 (12.54 t/ha).
- The minimum tilled maize resulted in significantly higher very labile (~33.5%) and labile (~33.2%) carbon concentration at 0-5 cm depth of soil compared to the conventional tilled maize system.
- Among the three establishment methods *i.e.* wet-DSR (puddled, dibbling), wet-DSR (puddled, broadcasting) and conventional transplanting, dibbling in the puddle soil produced significantly higher grain yield (6.77 t/ha) compared to broadcasting (6.04 t/ha) and conventional transplanting (5.90 t/ha).
- The results revealed that 100% recommended dose of fertilizer (RDF) + residue retention recorded higher no of panicles /m^2 (286), panicle weight (4.4 g), test weight (21.7 g) which led to increase in grain yield (5.8 t/ha) and straw yield (6.6 t/ha).

Soil Science

- Among the 21 popular varieties tested, PSV 190, PSV 469, PSV 344, PUP 221 and Varadhan performed well with higher yields as well as high nitrogen use efficiency indices compared to other varieties. Improved N sources such as N-(n-Butyl) thiophosphoric triamide (NBPT) and Allicin recorded a yield increase over NCU. NUE was significantly higher with NBPT1000 ppm.
- In the study on emission of greenhouse gases, methane emissions decreased by more than 40 per cent in SRI and by 49 and 54 per cent in AWD at 5 and 10 cm, respectively as compared to conventional transplanted (NTP).

- N_2O-N emissions were higher by 31 per cent in SRI and 42 and 44 per cent in alternate wetting and drying (AWD) at 5 and 10 cm, respectively over NTP. AWD and SRI methods lowered the global warming potential due to lower methane emissions.
- Multi-date MODIS starting from 2016-17 was used to create time Series analysis using freely available software, TIMESAT.
- 12 different soil thematic maps are being generated by interpolation techniques from the soil health cards pertaining to Telangana State and the data were curated by eliminating duplicate and erroneous entries.
- The first attempt to characterize the rice ecologies for its soil organic carbon and their stocks found a large variation up to the tune of >70% among the four different rice ecologies indicating a two times faster decline in surface soil organic carbon in the rice ecologies as compared to upland/hilly rice ecologies.
- The rate at which the seed reserves were utilized during germination was studied to understand the mechanism by which germination and post germinative seedling growth were influenced by biopriming with actinobacterial isolates. The highest seedling reserve utilization efficiency (0.613 mg/mg) was observed in seeds treated with actinobacteria.
- Microbial population dynamics study in different rice establishment methods in relation to nutritional availability and acquisition indicated that aerobic method was found with highest number of microbial populations. A total of 35 nitrogen fixing bacteria were isolated on N- free media and 21 unique morphotypes were purified and evaluated for nitrogenase activity through Acetylene Reducing Assay (ARA).
- Increasing dose of nano ZnO (250 ppm) and dual spray has shown significant improvement in the yield by 1.45 times over the control. The highest catalase enzyme activity was found at $ZnSO_4$ spray (3.20 unit/min/g fresh weight). With the increased concentration of both metal nano particles, the activity of catalase enzymes was markedly reduced.
- FYM + 75% RDF+ Hydrogel @ 10 kg/ha recorded 26 % higher grain yield and 19 % higher straw yield compared to control (NPK alone). During panicle initiation stage, hydrogel applied plots recorded 6 to 38 % increase in soil moisture content compared to untreated plots. At harvest, the increase in moisture content in hydrogel treated plots was to the tune of 12 to 46% compared to untreated plots.

Plant Physiology and Biochemistry

- Significant variation was observed between the tested varieties for photosynthetic efficiency (PN), stomatal conductance(gs), transpiration rate(E) and inter cellular CO_2 concentration (Ci). The results revealed positive association of P_N with gs, E and Carboxylation efficiency (CE).
- Silicon application @ 4g/L was optimum at flowering stage.
- Gene expression analysis of varieties with similar amylose (AC) revealed chain length variations in branching led to variation in grain quality.

Computer Applications

- During this year above 70% of centers uploaded data through AICRIP Intranet. New features like RBD and Split Analysis modules, excel copy interface for weather data entry, virtual field monitoring and monthly remarks on crop condition interface to User privilege were added in the AICRIP Intranet.
- In continuation to fabricating weather sensors, Python programs were developed to publish the data from sensors in Google Sheets and Nutrient requirement module was validated with long term soil fertility experimental data of AICRIP using Quantitative evaluation of the fertility of tropical soils (QUEFTS) model.

Agricultural Engineering

- A soil puddling machine using 0.5hp electrical 3 phase motor and stand was fabricated.

Agricultural Chemicals

- Neutral silica was comparatively very light having bulk density of 0.284 g/ml among the amorphous silica obtained from three different pH conditions-acidic, neutral and alkaline.

- Neutral silica @ 500 mg kg^{-1} seed of chickpea have great promise for management of bruchid beetle having lowest fecundity (3.67 eggs 100 g^{-1} seed), minimum number of seeds having eggs 100 g^{-1} seed (3.33 seeds), lowest hatchability (55.57 per cent), minimum adult emergence (1.33 adults), short adult span (3.33 days) and minimum seed weight loss (0.34 per cent).

Crop Protection

Entomology

- Two land races, IC 8968 and IC 8646 were identified as highly resistant to brown plant hopper and IC 8691-2 to white backed planthopper.
- Out of 2000 entries consisting of advanced breeding lines, germplasm accessions screened for brown planthopper resistance, twenty-seven entries were highly resistant, sixty-two entries were resistant and thirty-eight entries were moderately resistant to brown planthopper.
- Molecular profiling of *Bph* genes revealed *Bph6+Bph20* (IC 519101), *Bph2+Bph6* (IC 515974, IC 517008 and IC 75883), *Bph2+Bph6+Bph17* (RP 2068-18-3-5 and RP 4918-230-S) and *Bph32+Bph17* (PTB33) showed resistant reaction.
- In cultures RP 5588-B-B-B-B- 226, RP 5588, BK 64-116CRCPT 7and CRAC 3992-2-1, tolerance to yellow stem borer was attributed to compensation of damage by higher tillering ability in the infested plant during the vegetative stage.
- Development and survival studies conducted on promising entries of BILs of Swarna/*Oryza nivara* IRGC81848 revealed that less than 50 per cent larvae developed into adults on resistant lines as compared to moderately resistant lines and the susceptible check.
- Slow release pheromone blends of rice leaf folder, yellow stem borer and multispecies blends of both leaf folder and yellow stem borer were superior to normal blends.
- Under laboratory conditions citronella and lemon grass oils reduced per cent egg hatching *T. japonicum*.
- All the tested twenty high yielding cultivars were found susceptible to rice root–knot nematode, except the resistant check Khao Pahk Maw based on the relative root-gall index (RGI).
- SRI method of cultivation, green leaf mulching in aerobic rice, and bio-Intensive pest management (BIPM) practices were found to suppressed plant parasitic nematodes. Beneficial free-living microbivorous nematodes were more BIPM treatments
- Bio-intensive pest management practices were found to support more and diverse natural enemy populations. Braconidae, Trichogrammatide, and Scelionidae of Hymenoptera were the dominant taxa.
- Analysis of droplet characteristics of spraying of insecticide with drone revealed that the mean diameter of the droplets ranged from 839 to 1164 microns (ultra-coarse category), with good penetration in to the lower crop canopy, low drift behaviour and uniform droplet size.

Plant Pathology

- DRR Dhan 62, a MAS derived, durable blast and bacterial blight resistant high-yielding, fine-grain type rice variety having three major bacterial blight resistance genes, *Xa21+xa13+xa5* and two major blast resistance genes *Pi-2+Pi54*was developed.
- Out of 3173 lines screened under Uniform Blast Nursery, 580 lines were found as resistant against blast.
- Severe outbreak of bacterial blight of rice was recorded in several villages in Khammam district of Telangana. DRR Dhan 53 incorporated with *Xa21+xa13+xa5+Xa38* was totally free from bacterial blight of rice.
- 1121diverse genotypes were artificially screened either in field or in glass house conditions. Among them 197 resistant lines were identified as highly resistant and 26 lines as moderately resistant against bacterial blight.
- Twenty-five new isolates of *Xoo* were collected and 29 promising strains of *Bacillus* spp. were found as antagonistic against *Xoo* under *in vitro* condition.

- Ninety-five isolates of *R. solani and Rhizoctonia* spp. were collected during 2021 and cultural characters of 12 isolates of *R. oryzae sativae and* 6 isolates of *R. oryzae* were done. Two hundred and twenty isolates of *R. solani* were preserved for long-term storage.
- Fluorescence microscopic study of 32 *R. solani* isolates revealed ~5 to 9 nuclei count in a single septum of *R. solani* mycelium.
- Four RILs (Wazuhophek/Improved Samba Mahsuri); five mutant lines and parental lines of promising lines, Savitri, Vikramarya, Gayatri were identified as highly tolerant against sheath blight tolerance. Fifty tolerant RIL entries were nominated under different AICRIP trials.
- New antifungal molecule "cymene" was identified from *Thymus vulgaris* L. against sheath blight pathogen *R. solani*, both under *in vitro* and *in vivo*. Difenoconazole 25% EC (0.5 ml/l) was identified as the best molecule for sheath blight management
- A major QTL for sheath blight tolerance was identified on chromosome 5, 3 (named $qShbltol_{3.1}$), and a few minor QTLs discovered on other chromosomes.
- Artificial false smut screening facility was established to screen a greater number of genotypes both under glasshouse and field conditions. Around 35 different genotypes lines were identified as tolerant against false smut disease.
- Essential oils like cinnamon bark and cinnamon leaf oil reduced the growth and the conidial multiplication of *Ustilaginoidea virens*.
- Artificial mass screening technique for brown spot disease was standardized under field conditions. The varieties BPT 5204, Swarnadhan, Gangavati sona and Purple puttu were identified as highly susceptible varieties; while CH-45, Tetep and IR-64 as moderately resistant varieties.
- Injection method of inoculation proved best for the induction of sheath rot disease. Thirty-six isolates of stem rot fungus were isolated and pathogenicity was proved. The isolate (So15) was identified as virulent isolate.
- ASD16 T2 homozygous deletion homozygous mutants (18 mutants) were found as either resistant (score 3) or moderately resistant (score 5) under artificial screening against Rice Tungro Disease. These lines can be used as a parent to introgress this trait to other *indica* genotypes.
- Six native isolates of *Trichoderma* spp. and *Bacillus* spp. having potential for biocontrol and plant growth promoting activities in rice were identified.
- Whole genome sequencing of *Trichoderma asperellum* (TAIK1, TAIK4 & TAIK5), *Bacillus velezensis* (BIK2), *Bacillus cabrialesii* (BIK3) and *Bacillus paralicheniformis* were done.

Training and Transfer of Technology

- An exploratory study on climate change and rice farming conducted with 250 rice farmers covering 10 villages of Madhya Pradesh documented the farmer's perception and adaptation strategies in Tikkamgarh district.
- As part of SMART village project, demonstrations on nutrition smart interventions with DRR Dhan 48 recorded an average yield of 24 q/acre and ecological engineering interventions in the form of marigold planting on field borders resulted in additional income. Ladder of Power and Freedom was worked out and ranking of women farmers one the degree of power and freedom to make decisions to grow crops/varieties was documented.
- Based on experiences from other FPOs and benchmark analysis, Extension and Advisory Services scheduling system is customized and developed for selected Yazali FPO to cater the extension and advisory service needs of the member farmers.
- Farmer's seed replacement behaviour analysis revealed annual rate of gain in yield needed for optimal replacement time of 3 years ranged between 0.8 to 2.3 percent across different states of India at seed rate of 50 kg/ha.
- Economic and Energy efficiency study on integrated pest management revealed that the benefit–cost ratio and the energy efficiency in IPM

were higher than that of the Farmers' Practice. Adoption of IPM in rice cultivation is economical in terms of energy and monetary net returns, in comparison to Farmers' Practice

- On-Farm Adoption of IPM Technologies and impact analysis studies trained farmers on locally adoptable IPM components including soil test based nutrient management and essential oils that resulted in the increased adoption of important IPM practices leading to higher yield and reduced number of chemical sprays.
- The genomic prediction models implemented in three environments phenotypic data revealed that ANN model has outperformed over classical regression, Bayesian, Random Forest and SVR models in both training and testing data sets. The ANN model has yielded lowest RMSE and highest correlation between actual values and GEBV's.
- About 10 training programs were organized and 220 plus farmers were trained on improved rice production technologies and other identified interventions to enhance yield and profitability.
- Overall 2480 tribal farm families in eight states were benefitted with cafeteria of rice related technologies. 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.
- Under the ICAR-IIRR-SCSP, critical inputs like paddy seed (2,630), drying sheets (650), sprayers (290), fertilizers (120), pheromone traps and lures (58), herbicide (58), insecticide (58) and fungicide (58) were distributed to the SC beneficiaries. Training programmes on IPM, Good agricultural practices, INM were organized.

Introduction

Genesis

Mandate

Organization

Infrastructure

Linkages

Staff & Budget

Introduction

Genesis

The All India Coordinated Rice Improvement Project (AICRIP) was established in 1965 at Hyderabad, with the responsibility to organize multi-disciplinary, multi-location testing and develop suitable varietal and production technologies. AICRIP capitalized upon the available research infrastructure in different states of India and successfully introduced a national perspective in technology development and testing. AICRIP 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, AICRIP 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. Excepting 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 percent 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 (AICRIP) 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

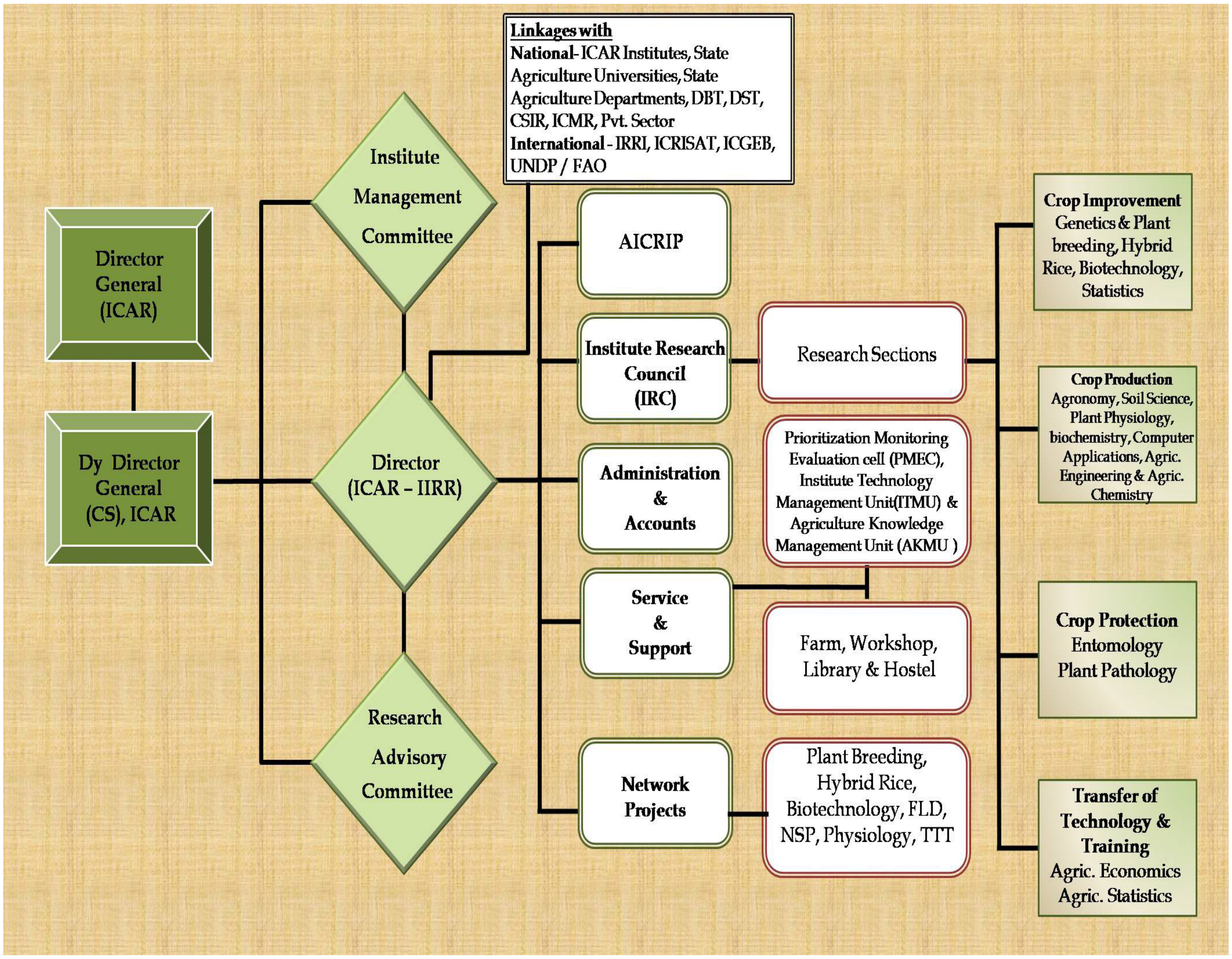
IIRR is an important constituent institute of ICAR under direct supervision of the Deputy Director General for Crop Sciences. The detailed organizational setup of the Institute is provided in the organogram. For fulfilling its mandate effectively, IIRR is organized into four sections and ten units along with centralized service wings and administration. AICRIP 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

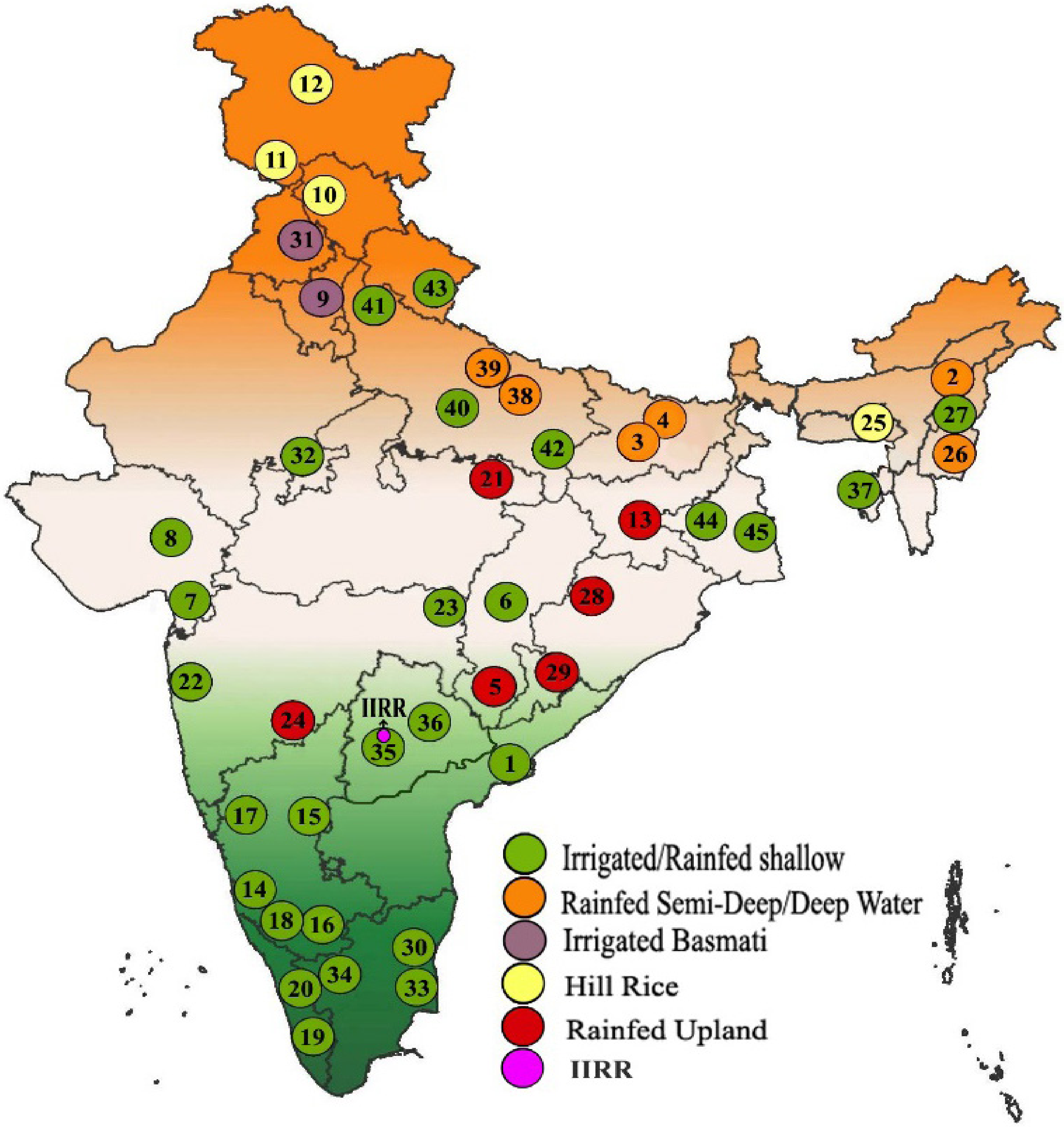
Coordination of multi-location testing to develop location specific varieties and technologies for various ecosystems

Dissemination of technologies, capacity building and establishing linkages



Organogram of the Institute

S. No.	Center	S. No.	Center	S. No.	Center	S. No.	Center
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 Rice Improvement Project

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. Under AICRIP, it 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 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 2021

S. No.	Category	Sanctioned	Filled	Vacant
1	Scientists	66	66	0
2	Administration	32	23	9
3	Technical	43	34	9
4	Supporting Grade	09	7	2
	Total	**150**	130	20

The Budget (2021)

(Rupees in lakhs) As on 31st March 2022

Item	2020-21	
	Outlay	Expenditure
IIRR, Hyderabad	4397.30	4396.72
AICRP Rice, Hyderabad	3894.59	3894.50

Research Achievements

Coordinated Research

Crop Improvement

New Varieties and Hybrids released

Crop Production

Agronomy

Soil Science

Plant Physiology

Crop Protection

Entomology

Pathology

Transfer of Technology

All India Coordinated Rice Improvement Project (AICRIP)

Crop Improvement

New Varieties and Hybrids released

During the year 2021, a total of 113 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 45 varieties and the State Varietal Release Committees released 68 varieties.

Rice Varieties Released during 2021_ CVRC

Sl. No	Variety Name	IET No	Cross Combination	50% FD	Eco-System	GT	Reaction to pest	Recommended State
1	***RH 150025 (Hybrid)***	26477	RH150025A/RH150025R	90	ETP	SB	MT -SB	CH, MH
2	***JKRH 2354 (Hybrid)***	26468	JKRA 1104/JKRR 10571	90	ETP	LB	MR-BLB, ShBl, BS	CH, MP, MH
3	***JKRH 2154 (Hybrid)***	24914	JKRA 1102/JKRR 10571	90	ETP	LB	MR-BLB, BS R-SB, LF	PU, HR, UP, BI, WB
4	CR Dhan 315	27179	Swarna/ARC 10075	100	Biofort	MS	MT-BS MR-SB	GU, MH
5	Aerobic Dhan-1	26178	Naveen/Kataktara	86	Aerob	SB	MT-ShBl, BS	KA, JH, CH
6	ICAR-NEH Hill Rice 14-8	24197	IR 78878-208-B-1-2/IR 74371-54-1-1	99	E (H)	LS	R-BLB, RTD, ShBl, BS	HP, KA
7	DRR Dhan 56	26803	Huang-Hua-Zhan*2/Phalguna	89	ETP	LS	R-BLB	PU, HR
8	Telangana Vari 3	26125	MTU 1010/JGL 11470	90	IME	MS	R-BLB, RTD, ShBl, BS	TS, KE
9	DRR Dhan 53	27294	Improved Samba Mahsuri*3/PAU 3554	101	NILs	MS	R-BLB	AP, TS, CH, MH, JH, OD, BI, GU, MH
10	DRR Dhan 55	26194	MTU 1010/IR 79915-B-83-4-3	87	Aerob	LB	MR-BPH, WBPH R-GM	BI, CH
11	DRR Dhan 54	25653	RP 5124-11-4-3-2-1/IR 78877-208-B-1-1	86	Aerob	SB	MR-BLB, BS, GM R- RTD	BI, OD, TS, JH, HR, GU
12	***PHI-17108 (Hybrid)***	26549	RA503F/RA511	105	MS	MS	R-BLB, MR-RTD, T-LF	TS, KA, AP
13	***PHI-16101 (Hybrid)***	25745	RA402F/R872	97	IME	LB	MR-BLB	UT, CH, MH
14	***Indam 100-012 (Hybrid)***	26999	IAHS 25A/IASN RB 30-22	100	Basmati	LS	T-SB, MR-GM	UP, PU
15	Telangana Vari 2	26027	MTU-1010/NLR 34449	108	IM	MS	MR-RTD, BPH, WBPH, LF	TS, AP, TN, KE
16	MTU Rice 1239	26263	MTU 1075/BM 71	110	MS	MS	MR-BLB	AP, TN, MH
17	MTU Rice 1223	25856	MTU 1081/MTU 1064	120	RSL	MS	MT-BLB, SB	OD, BI
18	VL Dhan 88	25819	Vivek Dhan 82/VL 31629	93	M (H)	LB	MR-BLB, ShBl	HP, ME, UT
19	***SAVA 127(Hybrid)***	22876	-	90	ETP	LB	MR-BL, BLB, ShBl	BI, PU
20	DRR Dhan 57	26171	BPT 5204/Azucena	90	Aerob	SB	MR-BL	JH, CH
21	DRR Dhan 58	28784	RP 6287-188-45-12-88	101	NILs	MS	R-BLB	AP, TS, TN, KA, JH, OD, CH, MH, GU, BI
22	DRR Dhan 59	27280	Akshayadhan*2/FBR1-15	100	NILs	LB	R-BLB	AP, TS, TN, KA, JH
23	DRR Dhan 60	28061	(RP 5970-2-6-19-16-24-1)	90	NILs	MS	R-BLB	AP, TS, TN, KA, JH, OD, CH, MH, GU, BI
24	DRR Dhan 62	28804	RP 6286-Bio Patho 5-156-24-7	100	NILs	MS	R-BLB	TS, AP, TN, KA, CH, OD, JH, BI, GU, MH
25	Pusa Basmati-1847	27722	Pusa Basmati 1509*2/Pusa 1790	94	Basmati	ELS	R-BL, BLB	DL, PU, WUP
26	Pusa Basmati-1885	28807	Pusa 1883/Pusa Basmati 1718	109	Basmati	ELS	R-BL, BLB	DL, PU, HR

Sl. No	Variety Name	IET No	Cross Combination	50% FD	Eco-System	GT	Reaction to pest	Recommended State
27	Pusa Basmati-1886	28808	Pusa 1884/Pusa Basmati 1728	109	Basmati	LS	R-BL, BLB	HR, UT
28	Pusa Basmati-1979	28812	PB 1121/Robin//PB 1121*4	102	Basmati	ELS	R-BL, BLB, ShBl	Dl, PU, HR
29	Pusa Basmati-1985	28814	PB 1509/Robin//PB 1509*3	87	Basmati	ELS	R-RTD, S-RTD, MR-ShBl. MS-BS	DL, PU, WUP
30	***NPH-XI (Hybrid)***	27332	NPS 2030/NPS 2342	90	ETP	SB	MR-BL, BPH, GM	JH, WB
31	***MR 8666 (Hybrid)***	24990	RA0159/RR0341	107	MS	MS	T-BLB, RTD, ShBl, BS	OD, UP, CH, AP
32	Swarna Unnat Dhan	27892	IR 81039-B-173-U-3-3/IR 81063-B-94-U-3-1	87	ETP	LS	MR-BL, BLB	OD, BI, WB, MP, MH
33	MTU Rice 1281	27438	(MTU 1075/MTU 1081)/ MTU 1121	110	MS	MS	MR-BL, BPH	AP, TS, TN, KA, PD, OD
34	CRR 807-1	27914	IR 10L146/IR 10L137	87	ETP	LS	MR-BL, BS, MT-SB, BPH, LF	BI, JH, WB
35	CR Dhan-318	27803	GSR IR1-8-S6-S3-Y2/GSR IR1-8-Y7-D2-S1	88	ETP	LS	MR-BL	BI, WB, UT, HR
36	CR Dhan-319	25530	Surendra/Annapurna	101	IM	MB	T-SB, MT-BPH	BI, OD
37	DRR Dhan 63	26383	IET 17280/Pusa Basmati 1	97	Biofort	SB	MR-BLB	UP, OD, KE
38	VL Dhan 69	26596	VL 10689/UPRI 2005-15	100	M (H)	SB	MR-BS, SB, BPH, WBPH	UT, SK, J&K
39	Telangana Vari 4	27869	MTU 1010/NLR 34449	90	ETP	LS	MR-RTD	BI, JH, OD
40	MTU Rice 1212	26819	IR 64/PLA 99-1-3-1-3	110	IM	MS	MR-BL, ShBl, BS, GLH, WBPH	AP, TS
41	MTU Rice 1280	27705	MTU 1001/KMP 150	105	IM	LB	MR-SB, LF	AP, TS, TN, KA
42	Kalinga Dhan 1201	26126	Kharavela/IR 62037-93	125	IME	LS	MR-BL, BLB, BS, GM, LF	CH, MH, OD
43	Kalinga Dhan 1202	26227	Pratikshya/IR 32253-7	130	MS	MS	MR-BS, BPH, GM	CH, MH, OD
44	Kalinga Dhan 1203	27117	Mutant of R-R-615	110	MS	MS	MR-SB, BPH, LF	CH, MH, OD
45	Kalinga Dhan 1301	26024	Birupa/IR 76561-AC-8-8	104	IM	LB	MR-BLB, SB, BPH	AP, TN, MH

Rice Varieties Released during 2021_ SVRC

Sl. No	Variety Name	IET No	Cross Combination	50% FD	Eco-System	GT	Reaction to pests	Recommend-ed State
1	***PNPH 24 (Hybrid)***	21406	PRN 1A (IR 58025)/PRN 24R	97	IME	LS	T-BL, BS	AS
2	Vikram Trombay Chhattisgrah Rice	27773	Safri-17, Local Variety of Chhttisgarh	93	IME	LS	T-SB	CH
3	CG Jawaphool Trombay	27027	Jawaphool, Local variety of Chhatisgarh	105	ASG	SS	T-BLB, SB	CH
4	Narendra Shishir	19117	CN 843-7-1/KDML 105//IR 49830-7-1-2-3	105	RSL	SB	MR-BLB, ShBl, SB, BPH, WBPH, GM	UP
5	Sabour Sampanna Dhan	25960	IR 91659-54-35//IR81896-B-B 195/2*IR05F102	125	RSL	SB	MR-BLB, BS	BI
6	VL Sikkim Dhan-4	26596	VL 10689/UPRI 2005-15	91	M (H)	SB	R-ShBl, BS	UT
7	Swarna Samriddhi Dhan	24306	IR72022-46-2-3-3-2/IR57514-PMI 5-B-1-2	105	RSL	LS	MR-BLB, RTD, ShBl, BS	BI
8	Swetha	22764	WGL 14280-1/NLR 30491	95	EDS	MS	T-BL	AP
9	Nellore Sona	20552	BPT 5204/NLR 145	110	IME	MS	T-BL, BPH, WBPH	AP
10	VL Dhan 159	26598	VL 66/HPR 2143	88	U (H)	SB	R-BS	
11	Tapi (GR 16)	26646	GR-5/Danteswari	100	EDS	LB	MT-SB	GU

Sl. No	Variety Name	IET No	Cross Combination	50% FD	Eco-System	GT	Reaction to pests	Recommended State
12	CG Barani Dhan-2	24690	IR 84887-B-153-CRA-25-1/ IR74371-51-1-1/IR 78877-208-B-1-1	77	EDS	MS		CH
13	Jammu Basmati 118	27733	Secondary selection from local traditional basmati	105	BT	LS	MR-BLB, BS, SB	JK
14	Jammu Basmati 123	27718	Secondary selection from local traditional basmati	125	BT	LS	MR-BLB, BS	JK
15	Jammu Basmati 138	27725	Secondary selection from local traditional basmati	125	BT	LS	MR-BLB, BS	JK
16	Kau Pournami (MO 23)	23739	NHTA 8/ MO 8	90	IME	MB	MR-ShBl, BPH, GM	KE
17	Kau Manu Rathna		Pure line selection from Hraswa	99	EDS	MB	MT-BL, BLB, ShBl	KE
18	Kau Akshya (PTB 62)	26951	Pranava x Chettadi	110	LATE	SB	MR-SB	KE
19	Lavanya (Kau-VTL-10)	25083	VTL-3 Mutant	83	CSTVT	SB	MS-SB	KE
20	Jyotsna (KAU, BIL4)	26057	Jyothi/FL 478/Jyothi//Jyothi	75	Saline	LS	MR-BL, ShBl, S- BL, MS-SB	KE
21	KAU Supriya (PTB 61)	27244	Pranava x Vellari	110	Rainfed	SB	MR-BLB	KE
22	Devli Kolam	27419	GAR 13/JGL 3828	83	MS	MS	MT-SB, WBPH	GU
23	Auranga	27043	Dandi/IET 15429	100	CSTVT	SB	MR-BLB	GU
24	Aarti	27941	IET 19347/RP-4075-129-07-3	73	Aerobic	LB	MR-BLB, SB, MR, T-BPH,	GU
25	JR 10	25535	NPT 29/R 296	95	Irrigated	LS	R-BL	MP
26	CO 54	24313	CB 04110/CB 05501	84	Irrigated	MS	MR-BL, BS, BPH	TN
27	Rice ADT 55	26770	ADT 43/IRBB 60	115	ETP	MS	MR-BL, LF	TN
28	Rice TRY 4	21730	ADT 39/CO 45	100	AL & ISTVT	MB	R-BL, BS, SB, GM, LF	TN
29	Trombay Chhattisgarh Sonagathi Mutant	27646	Sonagathi, A Traditional Rice Landrace	104	LATE	MB	MR-ShBl, BS, SB	CH
30	Trombay Chhattisgarh Vishnubhog Mutant	29386	Gamma ray induced mutant of Vishnubhog traditional variety of Chhattisgarh	94	ASG	SS	MR-LB, NB, SB, BS	CH
31	PR 128	28467	PAU 201/PAU 3699-13-2-3-1// PAU 201	111	Low land	LS	R-BLB	PU
32	PR 129	26127	PAU 201/PAU 3699-13-2-3-1// PAU 201	108	IME	LS	R-BLB	PU
33	Swarna Sukha Dhan	24692	IR 77080-B-34-3/IRRI 132	85	EDS	MS	MR-BLB, RTD, ShBl, BS	UP
34	Chhattisgarh Dhan 1919	26229	Shyamala/G 93-02	102	MS	MS	T-BS	CH
35	***CR Dhan 702 (Hybrid)***	25231	CRMS 31A/CRL 123R	115	LATE	LS	MR-BLB, RTD, BPH, WBPH, GM	OD
36	***CR Dhan 703 (Hybrid)***	25278	CRMS 32A/CRL 123R	115	LATE	LS	MR-BLB, RTD	OD
37	CRRI Gaurav-1	27267	IR 73963-86-1-5-2/CR 2324-1	111	NPT	LB	R-SB, MR-LF	OD
38	Roshan	24409	Tapaswini/Dhobanumberi	108	LATE	SB	T-BLB, ShBl, R-BPH	OD
39	Swaranjali	27852	ARC 10075/Swarna	108	Biofort	SB	MT-BLB, BS, R-LF	OD
40	NICRA Dhan, Lune Ambika	27852	Gayatri/SR 26B	101	CSTVT	MS	T-BLB, MR-BS, R-LF	OD
41	Reeta Panidhan	26696	Swarna-Sub 1/Reeta	124	RSL	SB	R-SB, BPH, WBPH, MR-LF	OD
42	Satrughan	25912	Gayatri/AC.38599	88	SDW	SB	MT-BLB, ShBl	OD

Sl. No	Variety Name	IET No	Cross Combination	50% FD	Eco-System	GT	Reaction to pests	Recommended State
43	Trilochan	26398	Pooja*3/Swarna-Sub 1	114	NILs	SB	R-RTD, SB, BPH, MR-WBPH, LF	OD
44	CSR 76	27070	CSR 27/MI48	100	AL&ISTVT	LS	MR-BLB,	UP
45	PDKV Sakoli Red Rice	28710	Selection from Local Ludka-Local ludka 7-3-2	106	Biofort	SS	MR-SB	MH
46	Rajendranagar Vari-1	27077	MTU 1010/NLR 34449	110	LATE	MS	MR-BLB, BS, SB, BPH, LF, S-GM	TS
47	Rajendranagar Vari-2	26143	RNR 17818/Vasumati	97	Basmati	LS	MR-BL, BS	TS
48	Warangal Vari-2	26094	BPT 5204/GEB 24//BPT 5204//Shatabdi	95	IME	MS	S-BLB, BPH, GM, MT-SB	TS
49	Kunaram Vari-2	26245	JGL 11727/JGL 17004	89	MLT	MS	MR-BL	TS
50	Kampasagar Vari-1	27816	MTU1001 x NLR 34449	110	AL&ISTVT	MS	MR-LB, NB	TS
51	VL Dhan 210	28929	VL Dhan 207/VL 30424	122	U (H)	LS	R-BL, BS, SB, LF	UT
52	VL Dhan 211	28924	VL Dhan 209/VL 30424	126	U (H)	SB	R-BL, BS, SB, LF	UT
53	Kalinga Dhan 1401	24297	A mutant of Rice Var. Lalat	112	LATE	MS	T-ShBl, BS	OD
54	Kalinga Dhan 1501							OD
55	Kalinga Dhan 1502							OD
56	Kalinga Dhan 1204							OD
57	Karjat Shatabdi							MH
58	Jai Bhawani	25882	NDRGR207/IR49906-B-B-B-10-GHT-1	115	DW	MB	MR-SB	UP
59	Sikkim Dhan-1	22948	Selection from IURON (BP 3180-MR-6)	100	M (H)	LB	MR-BLB, ShBl, BS, WBPH	SK
60	Sikkim Dhan-2	26579	HPU-741/HPR-1149	95	M (H)	LS	R-ShBl, BS, T-SB, LF	SK
61	Sikkim Dhan-3	25539	VL221/RP2421//IR53915	95	U (H)	LS	MR-BS	SK
62	IGKV DH Rice-1	28452	Safri-17/RP Bio-226	125	IM	MS	MR-BLB	CH
63	Kalinga Dhan 1205	22579	ORS 199-2/MRC 22909	110	IME	MS	MR-BL, BLB, BS	OD
64	***Sava 300 (Hybrid)***	24796	-	91	ETP	LS	MR-BL, T-GLH, BPH	MP
65	***Sava 200 (Hybrid)***	24901	-	91	ETP	LS	T-BLB, RTD, ShBl, SB	MP
66	RNR 15048	23746	MTU 1010/JGL 3855	87	IME	SS	BPT 5204	KA
67	Sahyadri panchmukhi							
68	Sahyadri Megha							

Coordinated varietal testing

ICAR-IIRR in collaboration with ICAR-NRRI and ICAR-IARI conducted 50 trials (46 varietal trials and 4 hybrid rice trials) in various ecologies including irrigated, rainfed and basmati ecologies coordinated by ICAR-IIRR, IACR-NRRI and ICAR-IARI respectively in 806 experiments at 123 locations in 28 states and 2 UTs across the country. Further, MAS derived Near Isogenic Lines (NILs) with introgressed genes/QTLs conferring tolerance/ resistance to various biotic/ abiotic stresses were evaluated in respective ecologies for NIL similarity confirmation and separate trait verification trials were also constituted. In the irrigated ecology, of the 536 entries evaluated in IVT trials in the 1st year of testing of which 126 were promoted to 2nd year of testing. Entries in 2nd year of testing were 225 and of them 39 were promoted to 3rd year of testing. In all, 22 entries were found promising in various irrigated trials.

Hybrid Rice

The total area under hybrid rice reached 3.5 million ha during the year 2020 and more than 80% of the area is in the states of Uttar Pradesh, Jharkhand, Bihar, Chhattisgarh, Madhya Pradesh, Odisha and Haryana.

So far, 127 hybrids have been released in the country for commercial cultivation.

Initial Hybrid Rice Trials

During Kharif 2020, totally 74 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 more than 10 per cent yield advantage over the varietal check and 5 percent over the hybrid check are identified as promising. Details of the top three ranking hybrids in each of the trials are given below.

Monitoring of AICRIP trials during 2021

During Kharif 2021 AICRIP monitoring of various zones were conducted either by visit to the AICRIP centers by Scientists of ICAR-IIRR and ICAR-NRRI or through a series of zone wise virtual field monitoring conducted by ICAR-IIRR and ICAR-NRRI. AICRIP centers have supported the assessment of entries of trials by nominating self-monitoring teams from their organizations.

Zone V virtual monitoring on 25th Aug 2021


Monitoring of AICRIP Trials at BAU Ranchi

Physical monitoring of AICRIP trials was taken up in Eastern Zone (Zone III) during 16-22, November 2021. Dr. Anantha M.S. Senior scientist (Plant Breeding), ICAR IIRR visited and monitored AICRIP trials at CRURRS Hazaribag, BAU Ranchi, Bankura and Hathwara.

Monitoring Team of Drs. R. Mahendra Kumar, A.V.S.R. Swamy, Y. Sreedhar, and C. Gireesh visited CSSRI regional Station Lucknow 4-10-2021 and monitored AL & ISTVT Trials. The team also visited CSAU Kanpur on 5-10-2021 and BHU Varanasi 6-10-2021. Dry DSR plots raised at Kasigunj in connection with ITC-IIRR joint programme in Varanasi area was also monitored.

Visit of Monitoring Team to Kanpur, UP


Visit of Monitoring Team to Sirsi, Karnataka

DUS tests in Rice

A total of 24 candidate varieties for DUS tests in rice were evaluated for first year during *kharif* 2021 at IIRR, Hyderabad. In addition, 35 new varieties along with F1s against 15 reference varieties under second year of testing, 2VCKs against 2 reference varieties and DUS characterization of 49 Farmers' varieties were included in the DUS testing as per DUS Test Guidelines.

Monitoring of DUS tests in rice was conducted by the PPV&FRA, New Delhi in virtual mode on 30th October, 2021

National seed project and Breeder Seed Production

Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized at 44 centers across the country, involving 320 varieties and parental lines of 4 rice hybrids. A total of 9217.33 quintals of breeder seed was achieved against a target of 4166.11 quintals during kharif 2020. At IIRR center, 24 varieties were included in breeder seed production with a total production of 527.35 quintals against the target of 316 quintals.

Crop Production

Agronomy

AICRIP experiments of crop production were conducted by Agronomists, Soil scientists and Physiologists at IIRR and different locations during *Rabi* 2019-20 and *Kharif* 2020. Agronomists conducted 229 experiments at 49 locations consisting of an evaluation of promising ANT-2 cultures (155 cultures) belonging to 23 groups *viz.,* early hill (irrigated), medium hill (irrigated), upland hill, early (TP & DS), irrigated mid-early, irrigated medium, medium slender, aerobic, aromatic short grain, alkaline & inland saline, rain-fed shallow lowland, basmati, NIL (Blast & BLB, Sub, CS), herbicide resistant mutants, Nitrogen and Phosphorus efficient cultures in the transplanted situation, for their response to integrated nutrient management at 50 and 100% recommended dose of fertilizer (RDF). Besides, six trials on cultural management, four trials each on weed management and rice-based cropping systems and climate-resilient agriculture. Among the trials, five collaborative trials {(Soil science (2), Entomology (2), Plant pathology (2) and Plant Breeding (25)} were executed to develop cost-effective technologies in rice and rice-based cropping systems.

Nutrient Management Trials

A total of 155 AVT-2 entries belonging to 23 categories were evaluated at different locations under different levels of nutrients, i.e., 50% and 100% of the recommended dose of nutrients of that location along with standard national and local cultivars to identify stable and efficient genotypes.

AVT-2 Early hill: IET 27471 (4.94 t/ha) at Almora, Shalimar Rice-4 (7.02 t/ha) at Khudwani and VL Dhan 86 (5.22t/ha) at Malan were found promising over other varieties.

AVT-2 Medium hill: IET 26594 at Almora (4.54 t/ha), IET 26596 (5.25 t/ha) at Malan were found promising.

AVT 2 Upland hills: IET 27504 was found to be promising across the locations.

AVT-2 early (transplanted): IET 27329 (4.59 t/ha) followed by IET 27328 (4.51 t/ha) were better over other entries. The application of 100% NPK recorded higher grain yield (18%) and also exhibited higher nutrient efficiency.

AVT2 Early (Direct seeded): IET 27523 was better over other entries, popular varieties and local checks. The application of 100% NPK recorded higher grain yield and also exhibited higher nutrient recovery.

AVT-2 IME: IET 27358 (5.12 t/ha) followed by IET

26126 (4.68 t/ha) performed better and recorded higher mean grain yield over the locations compared to other cultures. Application of 100% RDF gave 19% higher grain yield over 50% of RDF and found promising at all the locations.

AVT-2 IM: IET 27380, IET 27387 and IET 27384 (4.6, 4.54 and 4.52 t/ha) were found promising and recorded higher mean grain yield and nutrient response. Application of 100% RDF recorded higher grain yields (23%) and also exhibited higher nutrient recovery at all the locations.

AVT-2 MS: IET 27438, IET 27118 and IET 27117 were found to be promising with higher mean grain yield. The higher nutrient response was also recorded with application of 100% RDF.

AVT-2 Aerobic: IET 26178 recorded higher yield and promising (4.16 t/ha) across the locations.

AVT-2 ASG: A significantly higher mean maximum grain yield was recorded by IET 25419 across the location over other cultivars.

AVT-2 AL and ISTVT: Application of 100% RDF with IET 27077 (5.81 t/ha) was found to exhibit significant interaction and found to be promising entry and recorded higher grain yield.

AVT-2 RSL: Significantly higher mean maximum grain yield was recorded by Pooja (5.34 t/ha) as compared to IET cultures.

AVT2 NIL BL & BLB: Application of 100% of RDF was promising at both the locations and IET 28805 (4.73 t/ha) was found promising over the rest of the cultures.

AVT2 NIL DRT: Application of 100% of RDF was promising and none of the IET cultures were found promising at both the doses of RDF.

AVT-2 NIL SUB: Application of 100% of RDF was promising and IET 26744 (5.80 t/ha) was found promising over the rest of test entries.

AVT-2 NIL CS: IET 28008 (4.34 t/ha) was found to be promising over other varieties with higher nutrient response.

AVT-2 NIL HT: Trial conducted at ICAR-NRRIrevealed that Imazethapyr has resulted significantly higher crop growth, yield attributes and grain yield. The genotypes G1, G2 and G4 with no or low phytotoxicity to imazethapyr have contributed to higher crop growth and grain yield with standard pre and post-emergence applications of bispyribac sodium.

AVT2 NIL BAT-HT: IET 28812, IET 28813 and IET 28815 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 and bispyribac sodium.

AVT-1 NIL LNT: IET 28080, IET 28088, IET 28084, IET 28830 and IET 28831 were the high yielding and also high nitrogen use efficiency cultures.

AVT-1 NIL LPT: IET 28818, IET 27641, IET 28816, IET 28070 and IET 28065 (4.62 – 5.04 t/ha) are the high yielding in 'P' efficient cultures.

AVT- 2 Boro: The maximum grain yield was recorded by IET cultures (IET 26463, IET 26451 and IET 26431) 5.33 to 5.44 t/ha and found promising over standard checks.

Cultural Management Trials

Six trials on cultural management were conducted across various locations. In one trial mechanical transplanting recorded 2.0 to 20% higher grain yield than the corresponding transplanting method across the locations except for Chiplima. Mechanical transplanting resulted in 11.4% higher grain yield than transplanting method across the locations. At all the locations normal sowing resulted higher grain yield than late sowing except at Gangavati and Ragolu. Normal sowing time resulted in higher grain yield at Chatha (2.70 t/ha), Jagdalpur (3.25 t/ha), Kota (4.94 t/ha), Mandya (5.02 t/ha), Nagina (4.37 t/ha), Nawagam (4.05 t/ha), Pusa (3.69 t/ha), Rewa (4.62 t/ha) and Ranchi (4.61 t/ha). Local improved practices Chatha (dibbling SRI), Ragolu (Semidry rice with 20 x 15 cm spacing) and Ranchi (Rice + Sesbania) with grain yield of 3.32 t/ha, 6.17 t/ha and 4.82 t/ha, respectively found to be the best compared to all other practices. At Gangavati, dibbling sowing method resulted in the highest grain yield (4.09 t/ha). The mean cost of cultivation under the best treatment in wet-DSR in terms of grain yield at Chatha (Rs. 37500/-), Coimbatore (Rs. 37225/-), Khudwani (Rs. 64150/-), Mandya (Rs. 71713/-), Navsari (Rs. 48239/-), Nawagam (Rs. 42571/-), Puducherry (Rs. 49300/-), Pusa (Rs. 44302/-) and Warangal (Rs. 46727/-).

Trials were conducted to enhance the productivity of organic rice. Higher cost of cultivation was recorded under flooding throughout crop growth at Mandya (Rs. 66,917/-) and Nawagam (Rs. 42,432/-). Similarly, money saved due to adoption of alternate wetting and drying compared to flooding throughout crop growth was Rs. 3841/ha in Mandya. At Mandya, input water saved due to the adoption of alternate wetting and drying was 62.7 cm compared to flooding throughout crop growth.

Weed Management Trials

The grain yield loss due to weeds ranged from 18.58% at Chiplima to 55.06% at Aduthurai depending on the weed intensity and weed flora distribution during the critical period of crop growth. The mean grain yield varied from 2.72 t/ha at Malan with HPR 1068 to 6.60 t/ha at Puducherry with DRR Dhan 52. The crop establishment methods did not show a significant difference in grain yields at nine out of 16locations and proved the potentiality of direct seeding system in these regions. At seven locations, mechanical transplanting system was found superior where the soil type, water availability, other climatic factors were in favour of transplanting over direct seeding. At five out of seven locations the yield loss has above 50% indicating the severity of weed problem under aerobic cultivation and the necessity of efficient and economic weed management. At all the locations, chemical weed control was an economic, timely and efficient option along with a good weed competitive cultivar. The crop growth parameters, yield attributes and grain yield were significantly superior with the treatment of inter-cropping with legume recorded best performance followed by mechanical weeding once + post emergence herbicide application. The weed control efficiency showed the superiority of mechanical weeding once + post emergence herbicide weed control. Integrated pest management trial revealed that the mean weed population reduction over the locations was 44.36% and 39.82% at Active vegetative and panicle initiation stages respectively; the mean dry weed population reduction over the locations was 46.11% and 41.51% at active vegetative and panicle initiation stages respectively, resulted in yield advantage of 16.53%.

Resource Conservation Technologies in RBCS

Among the crop establishment methods, transplanting gave better yields at most of the locations *viz.*, ARI-Rajendranagar and Karjat (8.62 and 8.31 t/ha) due to reduced weed competition. The REY of system productivity was higher at three locations due to rice-residue incorporation in Vadagaon, Karjat and ARI-Rajendranagar (9.25, 7.59 and 8.59 t/ha). The results showed that, there is no significant reduction in grain yield due to delay in planting at most of the locations. The grain yield reduction ranged from 2 to 17% due to the delay of planting at Mandya and Aduthurai. The results indicate that PB1728 and PB1718 at Chatha, AD17037, ADT53 and AD17152 at Aduthurai, GNV1089 and NLR40024 at Gangavati, RNR15048 and CTH1 at Mandya, Bamleswari and IGKVR1244 at Jagadalpur and Luit and Dikhow at Titabar were found promising with better yields under late planting. In Rice-Sorghum sequence cropping system transplanting method gave comparable yields with wet DSR methods (4.89 t/ha to 6.00 t/ha) at Ragolu and Mandya. CSH 25 found promising over hybrids. The hybrids yield ranged (3.41 to 4.78 t/ha) only at Ragolu.

Soil Science

In the 32nd year of study on long term soil fertility management in RBCS, the treatment RDF + FYM resulted in maximum grain yield at all three locations but was at par to RDF at MND and MTU. FYM alone treatment was on par to RDF in *kharif* at MTU and TTB. There was an improvement in important soil properties with INM and addition of organics and reduction in NPK values was observed in omission plots compared to RDF plots at all three locations. Supplementary dose of FYM along with RDF recorded positive growth rate in productivity with 66, 82 and 65 kg/ha/year at MTU, TTB and MND, respectively compared to RDF where growth rate varied from -34 kg/ha/year at MND to 39 kg/ha/year at TTB.

The trial on assessment for bridging the yield gaps was conducted in farmers' fields at Chinsurah (46 farmers), Titabar (40 farmers), Pantnagar (50 farmers), Karaikal (24 farmers) and Ludhiana (30 farmers) to assess the variability in soil nutrient supply, its relationship with rice yields at current recommended and farmers' fertilizer practices and fine-tune the fertilizer nutrient requirement for specific target yields. Sharp variations in mean grain yields among low yielders to high yielders was recorded ranging from 2.34 t / ha to 4.2 t/ha at Chinsurah; 3.8 t/ha to 4.82 t/ha at Titabar, 3.67 t/ha to 7.79 t /ha at Ludhiana, 3.79 t/ ha to 4.67 t/ha at Karaikal and from 4.6 t/ha to 5.6 t/ ha at Pantnagar respectively. The poorest soil quality index was calculated for farmers from Ludhiana and Chinsurah, due to considerable variation among the farm sites and soil test values. The soil quality index was much superior at Pantnagar and at par for all other centres. The highest yield gap (52.9%) was recorded at Ludhiana.

Significant genotypic and location-specific differences were observed between the genotypes evaluated for tolerance to soil sodicity. At Faizabad, under native sodic conditions, the genotypes producing the highest yields were SS-3 (3.82 t/ha), NH-1 (3.70 t/ha), SVL-2 (3.65 t/ha), SVL-3 (3.60 t/ha), NH-2 (3.57 t/ha). At Pusa, the genotypes GPV-3, GPV-1, GPV-2, NH-4 and GPV-4 demonstrated better tolerance to sodicity with yields ranging from 2.68 to 3.01 t/ha.

Genotypic variability was observed in the tolerance to soil acidity. The acid tolerant genotypes at Moncompu were Shreyas, SVL1, NH2, SVL3 and GPV4 with grain yields of 10.57 t/ha 9.27 t/ha, 9.2 t/ha, 9.17 t/ha and 8.6 t/ha respectively. The highest yielding genotypes in acid soils of Ranchi were DRR 50 (6.29 t/ha), DRR 47 (6.18 t/ha), GPV-2 (6.18 t/ha), DRR 51 (6.05 t/ha) and GPV-1 (5.6 t/ha). At Titabar, no significant difference in yield among the genotypes was observed.

Residue management in rice based cropping systems initiated in 2018 was conducted at nine centres. Supplementing half of the recommended N through residues (50% N) in addition to either RDF (50% N) or green manure, green leaf manure yielded at par and either higher or on par with RDF (100% N) in terms of grain yield. Crop residues can be managed to substitute half of the recommended nitrogen without yield penalty. Combined application of crop residues with RDF/MC/GM resulted in nutrient uptake values (63-138 kg N/ha, 16 – 74 kg P/ha and 21-184 kg K/ha) which were on par with each other and higher than 100% RDF.

In a study on "Screening of rice germplasm for NUE, ten genotypes were evaluated at three nitrogen levels (0, 50 and 100% of recommended N) at six locations. The results indicated that grain yield was significantly higher at 100% RDN by 6-53% over 50% RDN and 21-154% over no N application. CNN5, CNN4 and ARRH7576 recorded higher yields across the locations. Maximum agronomic efficiency was recorded by CNN3 followed by CNN2 and ARRH7576 while maximum physiological efficiency by MTU 1010, Rasi and ARRH7576 and maximum recovery efficiency was recorded by CNN3, ARRH7576 and CNN 2.

A multi-locational trial (7 centres) was conducted to study the response of rice to varied edaphic conditions with recommended dose of fertilizers (RDF), 125% of RDF, 150% RDF, RDF + 2 sprays of micronutrients, fertilizers as per Nutrient Expert and farmer practice. Data analysis revealed that sites varied in responses even within a single treatment. Similarly, within a single site the treatments created variances. The fertilizer management based on Nutrient Expert recorded the highest grain yield in four out of seven centres underscoring the importance of balanced fertilization for maximization of yield. The yield differences across locations indicate the necessity of site-specific nutrient management for yield maximization.

In Karaikal area of Puducherry, variability in soil parameters of test sites explained 59.3% variability in yield followed by varieties (27.4%) and treatments 13.6%) highlighting significance of site-specific soil and crop management. Variability in soil texture in the test sites accounted for 11.1 % of variability in rice yield. Factor Analysis of soil data explained 76% of variability and indicated two factors, namely 'P limitation Factor' and 'Nitrogen availability factor', a linear combination of associated soil variables caused P limitation and enhanced nitrogen availability.

Organic interventions such as dhaincha green manure 6.25 t/ha + 100 kg/ha Neem cake + seed treatment with *Pseudomonas* + RDF 100% (120:40:40 NPK) at Puducherry (6.76 t/ha); in situ green manuring + 50% N by vermicompost + PSB & *Azospirillum* (Root dip) + Cow urine spray + Microbial culture spray at Raipur (4.81 t/ha) and 90 kg N (1/3 FYM+ 1/3 VC +1/3 NC + *Azospirillum* + PSB at Titabar (4.44 t/ha) gave higher yields. But at ten locations a positive response to 100%

inorganics was observed. At Karaikal, application of FYM (10 t/ha) + vermicompost (2.5 t/ha) + spray of liquid manure gave highest yield (3.92 t/ha) over other treatments, during *rabi.* Straw yield followed a similar trend as that of grain yield. At Chinsurah, most of the soil properties improved with FYM (5 t/ha) + 33.75 kg (FYM) + 16.88 kg N vermicompost + 16.88 neem cake, while 100% inorganic treatment improved soil NPK at Khudwani.

Plant Physiology and Biochemistry

Physiological studies were conducted at eight funded centres (Coimbatore, Maruteru, Pantnagar, Pattambi, Rewa, Raipur, Karjat and Titabar); two ICAR institutions (IIRR, Hyderabad and NRRI, Cuttack) and six voluntary centres (RARS Chinsurah, NDUAT Faizabad, PJNAR Karaikal, IGKV, Raipur and BAU Ranchi).

A trial was conducted on silica nutrition with ten entries at eleven locations spread across the country. The results revealed that there are no significant differences in grain yield among the genotypes (mean of all varieties & locations) with the application of silicon as compared to that control. IIRRH-132, IRRH-131; JKRH-3333, US-314 responded positively to Si application.

A trial was conducted with 26 entries and two treatments (rainfed and irrigated) at 5 locations to study the drought tolerance traits of rice varieties. The biomass and yield attributes indicate, IET28241, IET28242, Sahbhagidhan had maximum grain yield under rainfed and irrigated situations.

Heat stress tolerance trial revealed that heat stress reduced the Leaf Area Index (LAI) and the mean days to maturity by 3 days over control. All the yield components exhibited reduction under heat stress as compared to control. Based on percent reduction (< 15%) in grain yield over control under heat stress treatment, IET 29156 (13.8%) followed by IET 29157 (20.1%) has recorded the lowest yield reduction. IET 29152, IET 29159 and IET 29155 showed <25% grain yield reduction.

Screening for multiple abiotic stress tolerance was conducted at 7 centres for salinity & water stress (1% and 2%). All the genotypes recorded reduction in physiological traits such as root and shoot length, root and shoot dry weight and leaf chlorophyll content. Based on their performance under salinity stress, IET 24434, CR-3918-IL-160 and AC-34992 has recorded the least reduction in root dry weight. CR-3918-IL-160, IC551535 and AC-35764 and AC-34975 under 1% mannitol and AC-35764 and CR-3918-IL-160 under 2% mannitol recorded the least reduction in root dry weight. AC-35063, AC-41585 and IET 24426 recorded the least reduction in shoot dry weight in salinity test. CR-3918-IL-160, Dubraj and IET 24426 in 1% mannitol and AC-35764, Dubraj and AC-34975 in 2% mannitol test recorded the least reduction in shoot dry weight. On the basis of their performance in salinity and water stress CR-3918-IL-160, IET 24426, AC-35764, AC-34975 and Dubraj could be identified to possess tolerance to multiple abiotic stresses.

A trial for submergence tolerance in rice was conducted at five centres (Coimbatore, Cuttack, Pattambi, Faizabad and Titabar) with thirteen different rice genotypes. At Coimbatore, CO-50 recorded maximum % survival followed by IET 24434, IET 24426, CR-3918-IL-160 and CR-2826-IL-204 and Dubraj; at Pattambi in IET 24434 and CR-3918-IL-160, Swarna Sub-1 and AC-41585, while at Titabar and Cuttack, AC-41585 recorded maximum % survival. Overall response shows the % survival of the seedlings following submergence was highest in AC-41585 followed by IET 24434 and AC-39417 recorded the lowest.

Genotypes were screened for low light tolerance at 7 locations with 21 varieties and Swarnaprabha as check variety. Low light stress resulted in significant loss in yield and its components. Higher grain yield was shown by check Swarnaprabha followed by IET27537, IET28283, IET29032 and IET26744. Among the tested entries the biomass was highest in Swarnaprabha followed by Gayatri. Highest harvest index was observed in Swarnaprabha followed by IET27537, IET29025, IET29032 and IET29033.

Crop Protection

Entomology

Seven major trials encompassing various aspects of rice Entomology involving 244 experiments were conducted at 42 locations (IIRR, 32 funded and 9 voluntary centres) in 21 states and 2 Union territories. A total of 1583 entries were screened for host plant resistance to 13 insect pests and 97 entries (6.1% of the tested) were identified as promising. Twenty-one 21 entries (including 14 breeding lines 2 germplasm accessions two land races three checks) were found promising against plant hoppers in screening trials. Six entries were in the second year of testing.

In gall midge screening trial, IBT-WGL-4 and IBT-WGL-5 was identified as promising. MTU1010 (gm3+Gm4 +Gm8), Aganni, ENTGP 2018-178, and 14 pyramided lines (MTU1010 (Gm4 + Gm8)) were found promising in gall midge special screening trial. In Leaf folder screening trial, 14 entries, one mutant culture of PTB 18 (Cul M9), two pure line selections of Jaya (JS 1 and JS 3) were found promising. In stem borer screening trial, identified 14 entries as promising.

Cul M9, SKL 07-8-720-63-147-182-276, BK 35-155, JS 5, RP 5587-B-B-B-262, and JGL 33440 were found to possess resistance to multiple pests. In IIRR-NSN1; IET nos. 27804, 28084, 27 P 63 (hybrid check), 28827, 27263 (R)28544, 28673, 28519, 28703, 28386, 27632(R), Kavya, PTB 33 and Aganni were found promising. In IIRR-NSN2; IET 29510, PTB-33 and RP 2068-18-3-5 were found promising. In NSN hills, IET nos. 26594 (R)28925, Vivekdhan 62 and Vivekdhan 86 were promising. For gall midge resistance, Gm8 and Gm1 were superior across the locations. Evaluation of the gene differentials by single female progeny revealed that Warangal populations to be less virulent as compared to Pattambi populations on Aganni (Gm8) but more virulent on RP 2068-18-3-5 (*gm*3). In planthopper special screening trial, PTB 33 (*bph*2+*Bph*3+unknown factors) and RP 2068- 18-3-5 (Bph33(t)) were promising in 7 out of 8 locations.

All-insecticides module was found to be superior in reducing stem borer, WBPH, and GLH in Insecticide-botanicals evaluation trial. Lowest silver shoot damage was recorded in all botanical treatment and was at par with all- insecticides treatment. Neemazal + neem oil + triflumezopyrim was found effective against BPH. Tested insecticides and botanicals were found safe to beneficial organisms. All insecticides treatment resulted in highest yield of 6324.6 kg/ha with 44.2 per cent increase over control (IOC) followed by neemazal + neem oil + triflumezopyrim (5498.5 kg/ha with 25.3 per cent IOC).

Incidence of stem borer, gall midge, whorl maggot, case worm, and planthoppers was more in late planting as compared to early and normal. Leaffolder was highest in normal planting. Hispa was serious in early plantings. Whorl maggot incidence was unaffected by dates of planting. Incidence of blue beetle was found significantly high in transplanting method (58.3 – 67.7% damaged leaves) compared to wet seeding (17.2 – 26.2% damaged leaves) while, incidence of all other pests was unaffected by planting methods and sub-plot treatments of straw incorporation. Incidence of stem borer, gall midge, leaf folder and BPH was high in dry direct seeded rice (DSR) and was at par with normal transplanting method. Incidence of gall midge was high in dry DSR at Aduthurai and in drum seeding at Maruteru. Incidence of blue beetle was significantly high in transplanting method (58.3 – 67.7% DL) compared to wet seeding (17.2 – 26.2% DL). Slow release pheromone blend of rice leaf folder and yellow stem borer (35) and multispecies blend (35) were fond effective at Hyderabad and Aduthurai respectively as compared to the normal formulations.

Ecological engineering along with alternate wetting and drying and bund crops reduced insect pest infestation, supported natural enemies with better yields and benefit cost ratios. BIPM practices were effective in lowering stem borer incidence and supporting higher natural enemy population. Integrated pest management module was found effective for the management of insect pests, diseases and weeds, across the locations with higher yield and benefit cost ratio as compared to farmers' practices.

Light trap studies indicated that yellow stem borer, leaf folder, and hoppers continued to be the major pests and gall midge continues to be an endemic pest. However, case worm, white stem borer, pink stem borer, black bug, gundhi bug, and zigzag leaf hopper showed an increase in the spread and intensity of incidence.

Plant Pathology

During 2020, 15 AICRIP trials were conducted on host plant resistance, field monitoring of virulence of major rice pathogens and disease management. With respect to host plant resistance, 1263 entries were evaluated under various screening nurseries at 50 locations. Among the tested entries, 69 entries found moderately resistant against two to four diseases.

Multiple disease resistant/tolerant lines identified across the different screening nurseries during *Kharif* 2020

IET #/ Designations/Trial	Resistant/ Tolerant against
NSN-1 (15)	
27358	LB, NB, SHB, BLB
28178	LB, NB, SHB
28654	LB, NB, SHB
NSN-2 (1)	
29417	BLB, RTD
NSN-H (13)	
28880	SHB, BS, BLB
28913	LB, SHB, RTD
28890	LB, BS, BLB
NHSN-(19)	
28959	LB, SHB, BLB
28960	LB, SHB, BS
28965	LB, BS, RTD
28967	LB, BLB, RTD
28969	LB, NB, SHB
DSN-(21)	
HWR-16	LB, NB, SHB, BS
CB 16118	NB, SHB, BS
HWR-15	NB, SHB, BS
HWR-24	LB, NB, SHB
HWR-31	SHB, BS, RTD
RP-Bio-Patho-4	LB, NB, BLB
RP-Bio-Patho-5	LB, NB, BLB
RP-Patho-7	LB, NB, BS

LB- Leaf Blast; NB- Neck Blast; SHB- Sheath blight; BLB- Bacterial leaf blight; BS – Brown spot; RTD- Rice Tungro Disease.

Thirty-five cultivars were used at 25 hot spot locations to monitor virulence of *Pyricularia grisea*. The disease pressure was high at Mandya, Gangavati, Ghaghara and Imphal. Tetep showed susceptible reaction at Gudalur and Ghaghraghat and moderate susceptibility at Mandya, Mugad, Upper Shillong and Almora. HR-12 recorded resistant reaction at Karjat and Jagityal; Co-39 recorded resistant reaction at Karjat. The resistant check Rasi was highly susceptible at Mandya, Almora, Gangavati, Imphal, Rudrur and Rajendranagar. Results revealed that a shift in pathogen profile structure at many locations.

Trial on monitoring virulence of bacterial blight (BB) pathogen was conducted at 26 locations. The differentials consisted of eleven near isogenic lines (IRBB lines) possessing different single BB resistant genes in the genetic background of rice cultivar IR 24 along withTN1as susceptible check and Improved Samba Mahsuri as resistant check. Differentials possessing single bacterial blight resistance genes like *Xa*1, *Xa3*, *Xa4*, *xa5*, *Xa7*, *xa8*, *Xa10*, *Xa11* and *Xa14* were susceptible at most of the locations. BB resistance gene xa13 was susceptible in 10 locations while *Xa21* was susceptible in 11 locations.

Disease observation nursery trial was conducted at 10 locations with different sowing dates *viz*., early, normal and late. The incidence of leaf blast was found to be relatively less. The incidence was more in the late sown crops than early and normal sown. At Maruteru the highest incidence of BLB was recorded in the early sown crops. In general, the incidence of sheath blight was found to be more in the early sown crop. Maruteru had the highest percent disease severity of sheath blight in the early sown crop among all the other locations and all the sowing periods. At Kaul the incidence of Bakanae was reported in the early sown crop and the variety PB1121 was found to be more susceptible than CSR-30.

Different fungicides were evaluated against major rice diseases at 30 locations. The fungicidal molecules difenoconazole 25% EC, isoprothiolane 40% EC, kasugamycin 3% SL, kitazin 48% EC, propineb 70% WP, tebuconazole 25.9% EC and thifluzamide 24% SC. were evaluated against leaf blast, neck blast, sheath blight, sheath rot, brown spot and grain discoloration. Isoprothiolane 40% EC (1.5 ml/l) and kitazin 48% EC (1.0 ml/l) were effective against leaf and neck blast disease. Similarly, thifluzamide 24% SC (0.8g/l), difenoconazole 25% EC (0.5 ml/l) and tebuconazole 25.9% EC (1.5 ml/l) were effective against sheath blight. Difenoconazole 25% EC (0.5 ml/l) was identified as the best molecule to manage sheath rot and brown spot diseases. Similarly, tebuconazole 25.9% EC (1.5 ml/l) showed broad spectrum activity against sheath blight, sheath rot, brown spot and blast.

Integrated disease management trial was conducted at fourteen locations. The bioagent, *Trichoderma atroviride* was supplied by ICAR-NRRI, Cuttack. The treatment with fungicide (Seed treatment with carbendazim (2 g/

kg) + one blanket application of combination fungicide (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage) was effective in reducing disease severity over other treatments. Seed treatment with *Trichoderma* followed by application of propiconazole at booting stage was effective against leaf and neck blast, sheath blight. Two applications of biocontrol agent as seed treatment followed by application at 15-20DAT also gave good disease control.

Integrated pest management (special - IPM trial) was conducted at 6 locations. Area Under Disease Progress Curve of leaf blast and neck blast diseases indicated that the disease progress was significantly lower where IPM practices were followed. Similarly, the sheath rot disease progression was slow in IPM practices as compared to farmer's practices.

In *Kharif* 2020, trial on yield losses due to major rice diseases such as leaf blast, sheath blight and bacterial leaf blight was conducted. The highest leaf blast severity was recorded in treatment that received three times pathogen inoculation in all the four locations. Across the locations the leaf blast percent disease index of 73.22 %, 51.8%, 39.36% caused a yield reduction of 56.9, 40.2, and 22.7% respectively. In case of bacterial leaf blight, highest percent disease index of 69.01% reduced yield up to 35.5%. Rice yield reduction of 34.09 % was observed from the 66.0% sheath blight diseased plants from all five test locations.

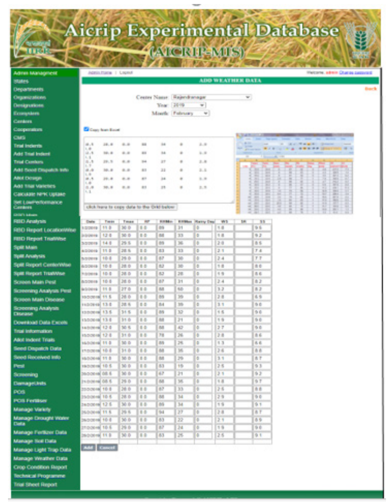
In collaboration with agronomy, trials were initiated to study the influence of different establishment methods and cropping system on rice diseases. Disease severity of bacterial leaf blight was low in un-puddled direct seeding method. In the case of different weed conditions in the plots, the disease severity of bacterial leaf blight and leaf blast was found to be the low in weedy check plots while brown spot disease severity was high. Among the sowing methods, wet seeding was the most favourable condition for the incidence of the false smut disease and both no-residue and retaining 15cm height of straw as residue was found to be on-par in suppressing the incidence of false smut disease.

Production Oriented Survey (POS)

During 2020, the survey was conducted in 10 states of India *viz.*, Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Telangana, Uttar Pradesh and Uttarakhand by 12 AICRIP centres. A total of 59 Scientific staffs from the different cooperating centres and state department of agriculture surveyed 78 districts in 10 states. Monsoon covered the entire country on 26th June 2020; 12 days before its normal date (8^{th} July). The season started with the severe cyclone, 'Amphan' in parts of Odisha and West Bengal; 'Nisarga' in Maharashtra coast. Another cyclone called 'Gati' affected parts of Kerala and 'Nivar' affected parts of Andhra Pradesh, Puducherry and Tamil Nadu. The cyclonic storm 'Burevi' affected parts of Tamil Nadu and Kerala. Rice hybrids occupied a significant area in states like Uttar Pradesh, Haryana, Gujarat and Bihar and its area is increasing in states like Karnataka and Maharashtra. Among the diseases, leaf blast, neck blast, brown spot, sheath blight, false smut, grain discoloration and bacterial blight were widespread. High intensity of leaf blast and false smut was recorded in parts of Telangana and Uttar Pradesh while bacterial blight was severe in parts of coastal Andhra Pradesh, Konkan region of Maharashtra and parts of Telangana. Among the insect pests, stem borer, leaf folder and BPH were very wide spread. Intensity of stem borer was more in Konkan region of Maharashtra.

AICRIP INTRANET

Many centers have uploaded data through AICRIP-Intranet http://www.aicrip-intranet.in). Plant Breeding, Hybrid Rice, Agronomy and Soil Science trials of 2021 were successfully analysed with PI privileges using RBD Analysis module and location wise treatment means with CD, CV, ranks over checks were generated using RBD report module of AICRIP Intranet. New features like RBD and Split Analysis modules, excel copy interface for weather data entry, virtual field monitoring and monthly remarks on crop condition interface to User privilege were added in the AICRIP Intranet.



User interface for uploading field monitoring images and excel copy for weather data entry- User (Co-operator) Privilege

Research Achievements

Lead Research

GEQ - Genetic enhancement of quality for domestic and 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

HRP - Host-plant resistance against pathogens and its management

IPM – Integrated pest management

TTI – Training, transfer of technology and impact analysis

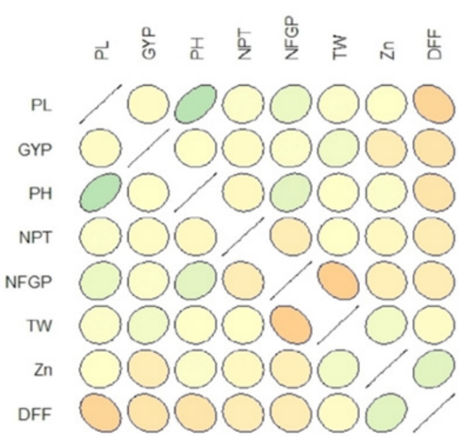
GEQ: Genetic enhancement of quality for domestic and export purpose

GEQ/CI/BR/8: Enhancing nutritional quality of rice through bio-fortification

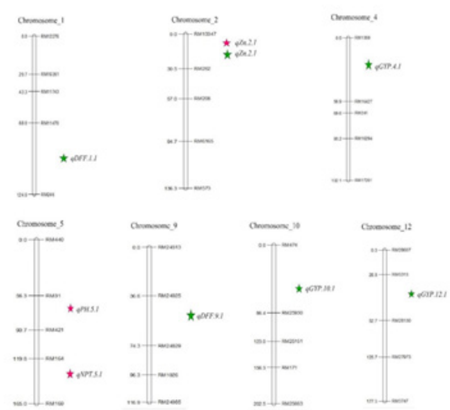
Involving high zinc lines/germplasm lines/high yielding varieties and farmers' varieties 30 fresh crosses were carried out during *kharif* 2021. Some of the varieties utilised in crossing were DRR Dhan 45, DRR Dhan 48, DRR Dhan 49, CSR 27, Chhattisgarh Zinc Rice-1, Chhattisgarh Madhuraj Dhan 55, Proteizin, etc.

27 F_2, 128 F_3 and 15 F_4, 8 F_5 and 30 fixed populations were evaluated during *kharif* 2021. In addition to this, a total of 97 lines comprising of local landraces were evaluated for agro-morphological and micronutrient content. Zinc content varied from 11.4 ppm to 28.5 ppm and Fe content varied from 5.90 ppm to 12.20 ppm. Thirteen promising rice genotypes which possess high Zinc content were bulk multiplied.

QTL mapping for agro-morphological traits and grain zinc content was carried out using 190 recombinant inbred lines (RILs) derived from MTU 1010 and BR 2655. 119 SSRs among 948 SSR markers were found polymorphic between the parental genotypes. Nine QTLs were detected for number of productive tillers per plant (qNPT-5.1) with a phenotypic variance of 7.54%. A stable QTL for grain zinc (qZn-2.1) was detected on chromosome 2 flanked between RM13347 and RM262 with phenotypic variance of 7.74% - 10.2%.



Correlogram: correlation matrix showing trait association between agro-morphological traits and Zn content



QTLs detected for grain Zn concentration, yield and yield related QTLs in RILs of MTU1010/BR2655 using IciMapping v4.2

160 F_2 Segregating population of a cross Chittimuthyalu / MTU1010 was phenotyped for yield and nutrient components and panicle weight was ranging from 0.7g -3.6 g and the single plant yield ranged from 0.64- 24.47g. Genotyping was carried out in the population using markers RM26402, RM7075, RM13639, RM23821, RM11307 and RM23772 linked to Iron and Zinc content, Gn1a indel 3 and SCM2 indel 1 for yield. High zinc and BPH resistance genotype GM-3 and high zinc genotype GM-86 was selected. Six crosses were made during the *Kharif* 2021 and F_1s were evaluated during *Rabi* 2021-2022. Zinc and Iron rich genotypes were also evaluated for brown planthopper (BPH) resistance through the help of standard seed-box technique at IIRR, Hyderabad and field screening techniques at RARS, Maruteru.

GEQ/CI/BR/26. Investigation into the role of major metabolites on rice grain quality

To understand the variation in similar amylose (AC) containing varieties, real-time-PCR analysis was performed with reported primers- ADPGP2a, ADPGP3, SDBE1, SDBE2, SDBE3, DP2, SS1, SS3b & SS4A. The result revealed variation in gene expression which indicates chain length variations in branching, leading to the variation in grain quality. Multiple correlation analysis indicates significant negative correlation between alkali spreading value (ASV) and gel consistency (GC), amylopectin content (AP) and GC, ASV and SBE1 and ASV and SBE2b. Protein content showed significant negative correlation with aging. ASV and kernel length after cooking (KLAC) showed marginal variations except in few varieties (names). Although GC, AC and AP variations are genotype dependent, GC showed significant negative correlation while AC and AP showed significant positive correlation with aging. Native RS content is different among the varieties. Maximum increase in RS content was observed at the end of 2nd cycle (cooking in autoclave and cooling at low temperature).

GEY : Genetic enhancement of yield and stress tolerance

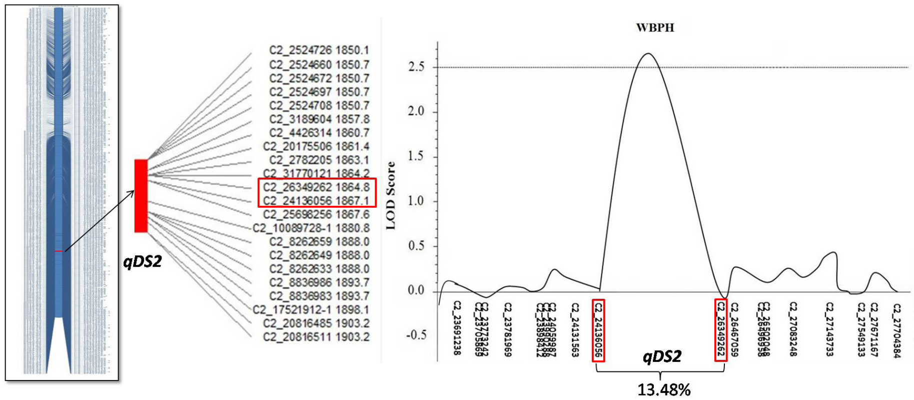
GEY/CI/ BR/26: Breeding for high yielding water use efficient short duration rice hybrids & varieties

Crosses were affected between 10 selected parents using half diallel. (MTU 1010, Prasanna (early), Rasi, Pooja, DRR Dhan 44, 42 (Drt), 50 (Drt+sub), DRR 45, 48 (Zn), MTU 1081 (HY, low shat), BPT 5204, WGL 14 (GT), ISM (BB), Tetep (BL), Akshayadhan, Swarna, 4 lines with strong culm). 36 F_1s were assessed for yield and other characters. A total of 84 INGER lines were raised in field and selections were made for duration, yield and 15 lines were retained for critical evaluation. In the Accelerated Genetic Gain in Rice-Irrigated Ecology (AGGRi-Alliance)-EST004d, an experiment was conducted with 270 entries *i.e.* Advanced Breeding Lines selected and supplied by IRRI in two replications during the *rabi* season of 2021. Data was recorded for the characters for yield and other morphological characters.

Selections Made from AGGRI alliance project 55 selections were made to assess water use efficiency and high yield

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

Genetic stock *viz.,* RP 5690-20-6-3-2-1 (National ID: INGR 21176) was identified with stable and durable resistance under Planthopper Screening Trial (PHS) of AICRIP entomology at hot spot centres *i.e.,* IIRR- Hyderabad, Maruteru Ludhiana and Pantnagar consistently for 2 years (2017 and 2018). It showed a mean DS: 3.2 against BPH; at IIRR, Hyderabad with resistance against WBPH (DS: 3.1) and moderate resistance reaction (DS: 4) at Maruteru against planthoppers. Molecular characterization with the reported linked SSR and gene specific markers revealed the presence of 4 reported BPH resistance genes (*bph4, Bph 9, Bph 17* and *Bph 32*) and 2 WBPH resistance genes (*wbph 9 & wbph 10*). A novel major WBPH resistance QTL was mapped in a RIL mapping population (n = 140) of Swarna/Sinnasivappu. The RILs were phenotyped at seedling stage using standard seed box method under glass house conditions during *Kharif* 2021. The results indicated monogenic dominant gene control of resistance as revealed by Chi square test of goodness of fit for the Mendelian segregation ratio of 1:1 for parental alleles at each SNP locus. Constructed a high-density linkage map using 3620 SNP marker data. QTL mapping with genotypic data of SNPs and phenotypic data on damage scores using QTL Ici Mapping version 4.1 was performed. A major significant QTL associated with resistance to WBPH namely qDS_2 was identified on Chr # 2 which was of 2.2 Mb region flanked by SNP markers C2-24136056 to C2-26349262 between 24.1 Mbp to 26.3 Mbp region on Nipponbare reference genome. The QTL explained 13.5% of the phenotypic variation for resistance with a LOD score of 2.69. The resistant alleles were contributed by the donor Sinnasivappu. No reported QTLs/genes governing resistance to BPH and WBPH are identified in qDS_2 region.

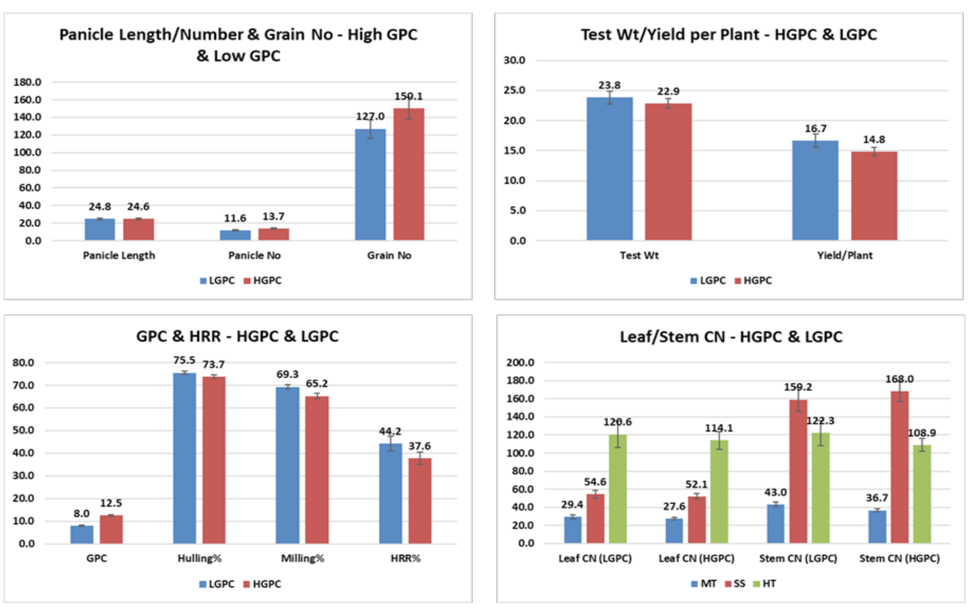


Mapping of qDS_2 region on chr # 2 with SNP markers in Swarna/Sinnasivappu RILs

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

Morpho-physiological and grain/nutritional (including grain protein content) quality evaluation of 147 lines was completed during 2021. The physiological characterization was done at three different stages: maximum tillering (MT), seed setting (SS) and reproductive phase/harvesting (HT). Grain protein content exhibited a range of 5.44 – 13.44% whereas, the grains/panicle, test weight and grain yield/plant showed 32.4 – 265.2, 11.0 – 35.4 g, and 3.6 – 41.7 g respectively. Important quality parameters like head rice recovery (HRR) and amylose content showed a range of 18.9 – 69.8% and 8.94 -29.12%. The results indicated certain specific differences in high grain protein content (HGPC) lines versus low grain protein content (LGPC) lines for important yield, protein content and physiological traits. The results further indicated that an increase in grain protein content is inversely associated with grain yield and HRR in rice. Also, the leaf and stem C: N was lower in HGPC lines compared to the LGPC probably indicating the translocation of grain.

Two high protein lines (JAK 13-1 – 12.25%; JAK 13-2 – 12.2%), medium slender grain type and moderately high yielders with high grain Zn content (~24.0 ppm) were identified along with several other high protein lines. Several of the earlier made crosses with high protein lines (JAK 686, JAK 713 & JAK 688) were not successful. The successful multiple crosses involving high protein lines (JAK 686 & JAK 688) with BPT 5204 and ISM were advanced to F_2 and will also be backcrossed (i.e. BC_1F_1) to the recurrent parent.



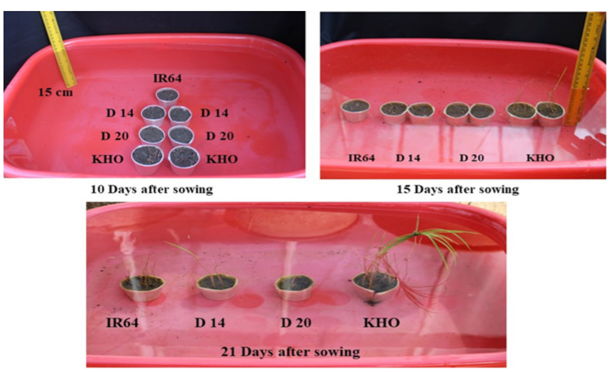
Comparison of high grain protein content (HGPC) lines versus low grain protein content LGPC for certain important traits

GEY/CI/ BR/22 Genetic Improvement of Direct Seeded Rice Traits Using Elite Varieties and Wild Species

Studies on direct seeded rice traits like early seedling vigour, uniform establishment, weed competitiveness and yield under DSR condition is being targeted for genetic improvement of DSR varieties using molecular breeding tools. Development of interspecific mapping population for exploring early seedling vigour and weed competitive traits in *Oryza glaberrima* identified two accessions EC861812 and EC861819 of *O. glaberrima* as potential donors for early seedling vigour and weed competitive traits. These two accessions were crossed with IR64 and 192 lines of BC_1F_7 populations were developed for mapping of genomic regions associated with direct seeded traits derived from *O. glaberrima*. The donor parents, IR64, AC39416A (D20), Khao Hlan On (KHO, D14) and IR 93312-30-101- 20-13-66-6 were screened for anaerobic germination tolerance,during *kharif* 2021. The studies have identified major QTL AG1 conferring anaerobic germination tolerance in Myanmar landrace, Khao Hlan On KHO. Another genetic material, IR 93312-30-101- 20-13-66-6 (D14) is near isogenic line of KHO possessing AG1 QTL. AC39416A is rice germplasm. The observations like germination percentage, shoot length and root length were recorded at 10, 15 and 21 days after sowing (DAS). The depth of water level was maintained at 15 cm throughout the experiment. The study identified KHO as potential donor for anaerobic germination tolerance.

Performance of rice genotypes under anaerobic germination condition

Genotype	10 DAS			15 DAS			21 DAS		
	G%	SH (cm)	RL (cm)	G%	SH (cm)	RL (cm)	G%	SH (cm)	RL (cm)
IR64	*	-	-	*	-	-	100	9	4
KHO	100	5	2	100	17	5	100	26	8.5
D14 (landrace)	60	1	0.5	60	4	2	70	12	5
DRR Dhan 44	*	-		*	-		20	5	2



Germination performance of rice genotypes under anaerobic condition, Khao Hlan On: D14 and D20 are rice landraces

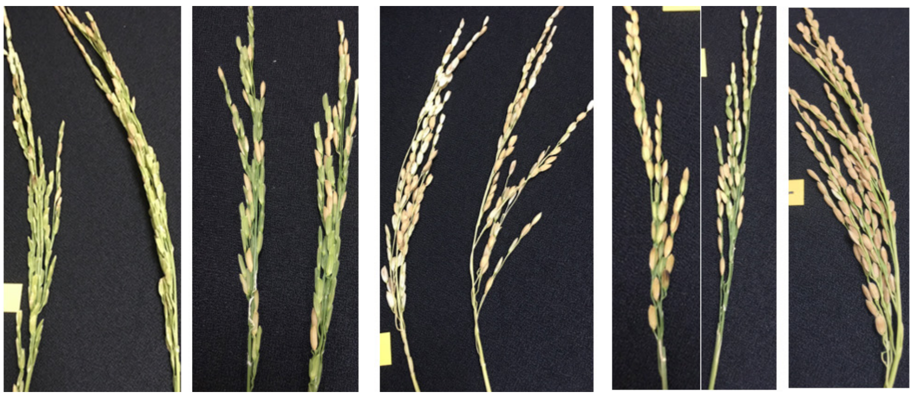
GEY/CI/ BR/27 Novel Genetic approaches for development of Climate Smart Rice Varieties

Development of Multi-parent Advance Generation Inter-cross (MAGIC) populations was undertaken with parents including elite lines with desirable traits such as heat tolerance, seedling and reproductive salinity tolerance, nutrient use efficiency, flood tolerance and yield enhancing genes Gn1, SCM2 and OsSPL14. The two inter crosses generated are being raised for four-way inter cross generation. Diverse germplasm and advanced genetic material were screened for heat tolerance during in 2020 and 2021 during *rabi* season. Overall about 500 germplasm lines were screened. Days to 50% flowering coincided with the maximum temperature of 35 to 41 °C with a mean of 38.4 °C in the months of April and May affected crop yield and yield components due to heat stress. Spikelet fertility is an important parameter to identify promising genotypes for heat tolerance. The drought tolerant genotypes like APO, Wayrarem and Moroberkan were found to be heat sensitive indicating the genetic loci governing the heat and drought tolerance may be different. The most promising genotypes which are highly tolerant to heat stress with more than 90% spikelet fertility are Lang Qian Che, Kaberi, Shabagi dhan, Derawa, ARC 12411, IR83388-B-B-129-4, Makalioka, BKN 7130-1017-2, Casibon, B 6136-3-TB-0-1-5, IR87728-59-B-B, NERICA-L-44, Rasi, SERATOES, NERICA-L-42B, IC 282803 and Bohoto Baloochestan at temperature of >40 °C. The genotypes which recorded more than 90% spikelet fertility are being utilized in hybridization to develop heat tolerant elite lines. About 619 entries of breeding material in advanced generation F8 and F9 generation were evaluated in two pedigree material and 102 promising lines were selected and 31 bulks were selected for evaluation in preliminary yield trials.

Variability among the germplasm screened for heat tolerance

Source	DFF	TMAX	TMIN	FSP	SSP	TGP	SF	TNP	PH	PL	SPY
Mean	102	38.48	23.34	71.50	19.94	90.27	79.05	10.50	86.92	21.65	12.21
Min	85	35	18.5	9	2	34	15.58	3.33	40.33	14.00	1.47
Max	128	41	26.5	174	89	190	95.51	24.67	138.00	26.33	26.57
SE	0.82	0.12	0.18	2.58	1.59	3.25	1.26	0.37	2.05	0.20	0.48
SD	8.72	1.25	1.89	27.38	16.89	34.51	13.42	3.93	21.55	2.14	4.83
Variance	76.00	1.57	3.58	749.6	285.15	1191.25	180.01	15.45	464.61	4.60	23.30

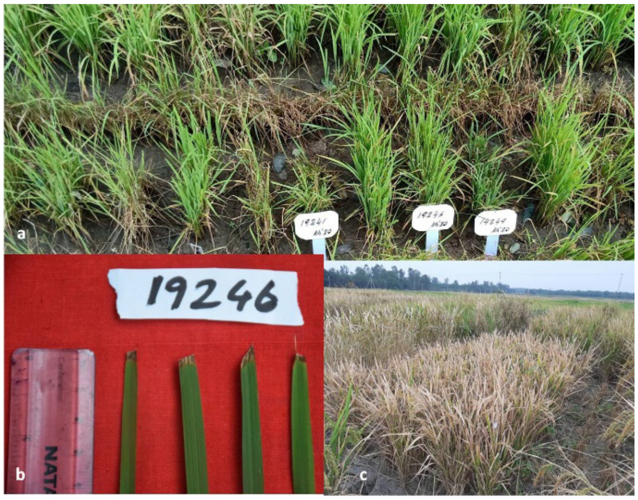
Min: Minimum; Max: Maximum; SE: Standard Error; SD: Standard Deviation; DFF: Days to 50% flowering; TMAX: Temperature Maximum; TMIN: Temperature minimum; FSP: Fertile spikelets per panicle; SSP: Sterile spikelets per panicle; TGP: Total grains per panicle; SF: Spikelet fertility; TNP: Tiller number per plant; PH: Plant height; PL: Panicle length; SPY: Single Plant Yield



Variability for spikelet fertility among the germplasm under heat stress

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

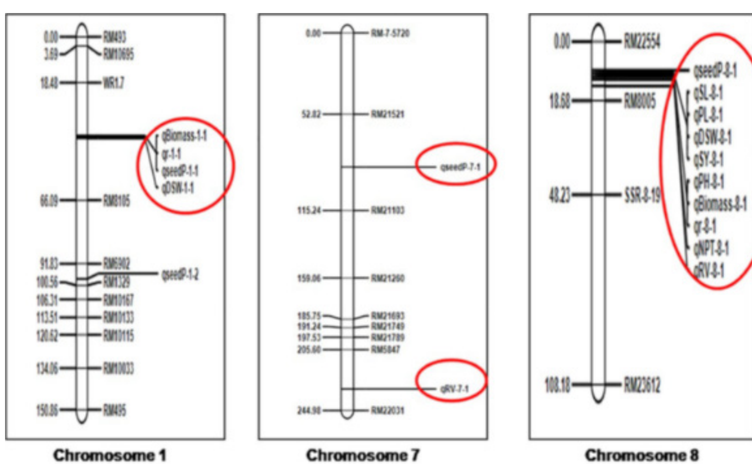
Twelve high yielding lines were nominated to ACIRIP and are under evaluation in various trials during *kharif* 2021. During *kharif* 2021, 34 high yielding advanced breeding lines (early-2, mid early-19, IM-2, late-6 and MS grain type-5) were selected from three-way and backcrosses involving elite *indica* cultivars, tropical *japonica* accessions and donors for biotic and abiotic stresses. With the objective of developing a genetic resource for traits combinations of high yield (HY), high grain number (HGN), strong culm (SC), a total of 412 lines (HY:84, HY+HGN:148, HY+SC+HGN:29, HY+SC:4, SC:19, HGN:112 and SC+HGN:16) were selected from ~ 7000 breeding lines derived from 150 three way and backcrosses involving elite *indica* cultivars, tropical *japonica* accessions and donors for biotic and abiotic stresses. Selections in segregating generations-from 331 F_3 families derived from 15 two-way, three way and back crosses involving elite *indica* and tropical *japonica* accessions, 76 single panicles were selected with superior plant type. From 26 F_2 populations raised during *kharif* 2021, a total of 1772 superior segregants (double cross-67; elite/breeding line-478; elite/LR-22; elite/TJP-1203) were selected. Mapping population (250) for strong culm trait from the cross of Swarna/IRGC 39111 was advanced to F_4 generation. Another population for GWAS-Association Mapping (AM) Panel was constituted with 226 genotypes comprising 9 SC donors, 72 breeding lines with SC+GN+HY/HY+SC/GN+SC, 10 checks, 30 tropical *japonica* accessions, 21 genotypes from 3K panel, 51 introgression lines derived from multi-parent intercrossing, 25 varieties and 18 elite breeding lines. Of the 24 advanced breeding lines derived from elite *indica* and tropical *japonica* accessions, selected for their high grain number (312-512) during *kharif* 2019 from 733 lines of 27 crosses, JBB 5952, 5960, 5962, 5964, 5966, 5967, 5973 were found to have high grain number (342-490) during *kharif* 2021.



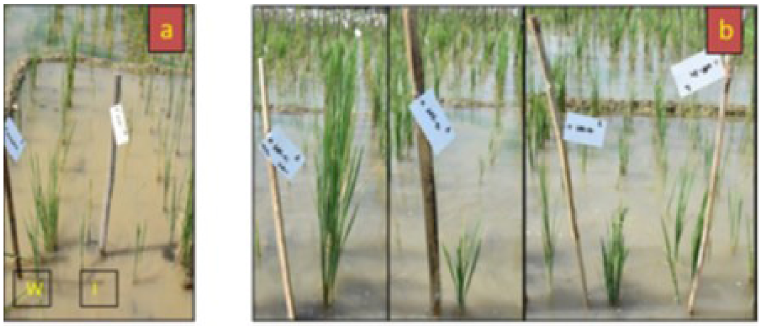
Multiple stress tolerance (resistance to blast, BB and drought tolerance) in the introgression line 19246 in the background of Krishnahamsa

GEY/CI/BR/24: Breeding high yielding rice cultivars tolerant to low soil phosphorus and nitrogen

A breeding population of 800 in F_5, F_6 and F_9 generation was evaluated under low soil phosphorus field and promising entries were identified for low P tolerance and small-scale seed multiplication was taken up. A total of 19 cultures were nominated to Station trial during Kharif 2021. Forty advance breeding lines (F8) were evaluated under low P, low N and normal fertilizer conditions. Under normal application, grain yield/plant varied from 17.9g to 36.2 g; Under low nitrogen plot, it ranged from 8.05g to 25 g whereas under low Phosphorous plot, it ranged from 3.95 g to 20.04 g. To identify low P stress-tolerant introgression lines, stress tolerance indices were computed. Different stress indices were computed *viz.*, stress tolerance index (STI), tolerance index, yield reduction ratio (YR), stress susceptibility Q3 index, yield stability index (YSI), yield index, yield reduction (YR), per cent yield reduction and geometric mean productivity (GMP). STI, YSI and GMP were identified as ideal indices for selection of genotypes under both stress and normal conditions. Based on these indices, *O. rufipogon* introgression lines Q4 (IL-24, IL-29 and IL-32) were identified as promising low P tolerant which exhibited better grain yield under both stress (YS) and normal (YP) conditions. QTL mapping for Low Phosphorous tolerance of Rasi x Improved Samba Mahsuri using 106 out of 155 polymorphic SSR markers between 47 highly tolerant and the 47 highly susceptible RIL's under Low Phosphorous condition revealed a total of 15 major QTLs for yield traits *viz.*, days to 50 % flowering, plant height, panicle length, root volume, dry shoot weight, dry root weight, straw weight, plant yield and test seed weight. QTL mapping using Wazuhophek x Improved Samba Mahsuri with SSR markers revealed a total of 16 QTLs for low soil P tolerance related traits. A QTL hotspot, was identified on the short arm of chromosome 8 with major effect QTLs for plant height, shoot length, number of productive tillers, panicle length and yield. Complex epistatic interactions were observed among the traits, grain yield per plant, days to 50% flowering, dry shoot weight, and P content of the seed. Two major QTLs on chromosome 1, associated with total biomass and root to shoot ratio were also identified. *In-silico* analysis of genomic regions flanking the major QTLs revealed the presence of key putative candidate genes, possibly associated with tolerance.



QTL mapping of traits associated with low soil phosphorous tolerance using Wazuhophek x Improved Samba Mahsuri RIL population. QTL hot spot of 10 QTLs were mapped on chromosome no. 8



Phenotypic screening of Wazuhophek x Improved Samba Mahsuri RIL population under low soil phosphorous plot at ICAR IIRR: W: Wazuhophek I: Improved Samba Mahsuri RIL population

GEY/CI/ BR/28: Genetic Enhancement of Specialty Rices of India

Total of 116 landraces along with coloured rice germplasm were collected from various sources. These were characterized for agro-morphological and yield related traits in the field. A total of 35 crosses were made during Kharif 2021 using selected specialty rices with different donors having favourable genes/ QTLs. 176 advanced populations were generated and 20 station trial entries were evaluated during Kharif 2021 and 35 F_1's crosses, 15 F_2's, 52 F_3 populations were evaluated during Kharif 2021. A total of 22 introgression lines homozygous for bacterial leaf blight, blast resistance and yield enhancing genes in the genetic background of Swarna and 14 introgression lines similar to recurrent parent (NDR359) and homozygous for yield enhancing genes were evaluated. 1162 germplasm consisting of lines collected from different states of India, IRRI Philippines, green super rice lines, INGER lines were evaluated and maintained. Total of 525 donor lines identified in AICRIP screening were also maintained.

Field view of coloured grain rice at ICAR-IIRR, Hyderabad

ABR/CI/ BR/29 Breeding high yielding stress tolerant rice varieties using interspecific wild introgression lines derived from *Oryza nivara* and *Oryza rufipogon*

Mapping populations generated from crosses among wild introgression lines, mutants and elite cultivars were raised in the field during *kharif* 2021 and *rabi* 2021. The populations were screened for identifying significant and stable breeding lines for yield contributing traits. 70 high yielding lines selected from 23 crosses were multiplied and evaluated for plot yield. 300 BC_4F_5 CSSLs of MTU1010 / *O. rufipogon* IC309814 [cross RP6166] and 290 BC_2F_{10} materials derived from *viz*., Swarna / *O. nivara* IRGC81848, Swarna / *O. nivara* IRGC81832 and KMR3 / *O. rufipogon* WR120 was raised for seed multiplication.

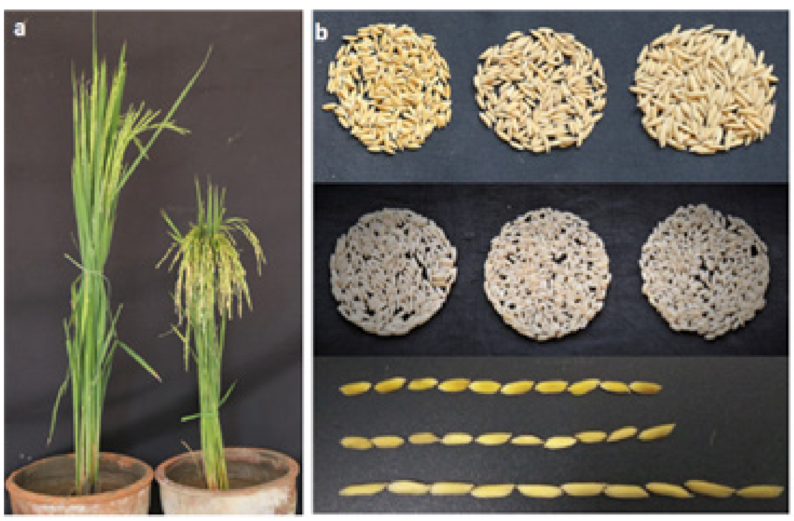
QTL mapping was carried out for quality traits in advanced introgression lines derived from Swarna / *O. nivara* BILs (RP6459 C2 -166S x14S) and identified major

Lead Research

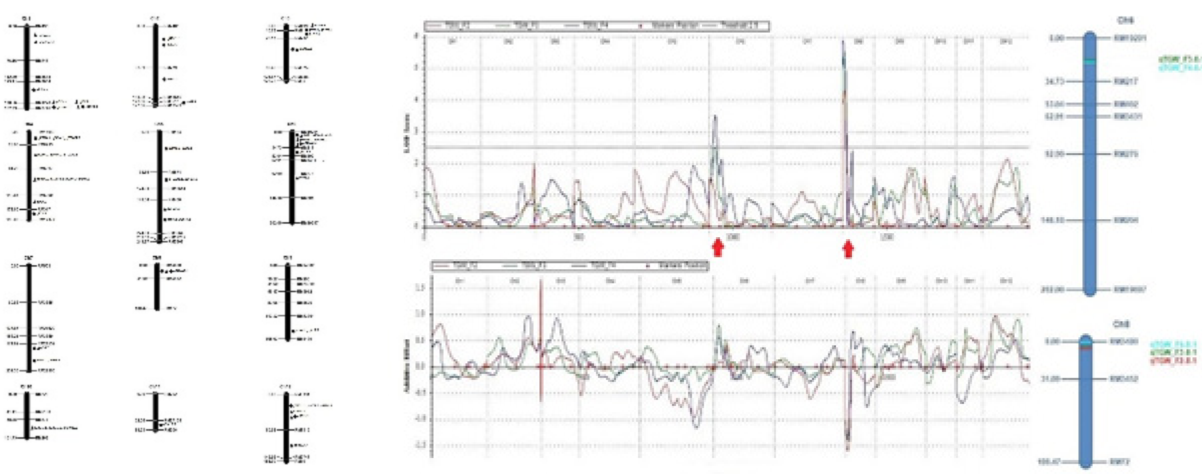
QTLs for Amylose content (*qAC4.1*), head rice recovery *(qHRR6.1)* kernel length after cooking *(qKLAC8.1)* with PVE > 10. Advanced introgression lines derived from Swarna / *O. nivara* BILs (RP6460-C3 166x148s) were raised and screened for yield traits with a focus on days to flowering, grain weight & grain size and seedling vigour related parameters. Populations were developed between popular cultivars and introgression lines *viz*., BPT5204/NSR86, BPT5204/MO22, PTB62/NSR86, PTB62/MO22, MO22/NSR86, MO22/PTB62 to identify genetic architecture of grain weight.

Mapping of QTLs for yield traits using $F_{2:3:4}$ populations derived from two alien introgression lines 166S [IET27223] and 14S [IET 26772] helped to identify for QTLs *qSPY4.1*, *qSPY6.1, qPH1.1*, *qTGW6.1*, *qTGW8.1, qGN4.1* and *qTDM5.1* for yield related traits were from *O. nivara*. QTLs of the yield contributing traits were found clustered in the same chromosomal region. *qTGW8.1* was identified in a 2.6Mb region between RM3480 and RM3452 in all three generations with PV 6.1 to 9.8%.

Seventeen high yielding lines were nominated to AICIRIP and are under evaluation in various trials and eighteen newly identified lines were tested under station trials during *kharif* 2021. Various wild introgression lines were submitted under NSN and MRST trials for screening of resistance. Four high yielding lines with consistent bacterial blight resistance *viz*., NPS19-1, NPS56-2, NPS58-1 and NPK77-3 derived from Swarna/ *O. nivara* crosses (IRGC81848 and IRGC81832) were advanced and multiplied at normal irrigated conditions and submitted for multi-location testing for varietal identification as improved high yielding Swarna with BB resistance.



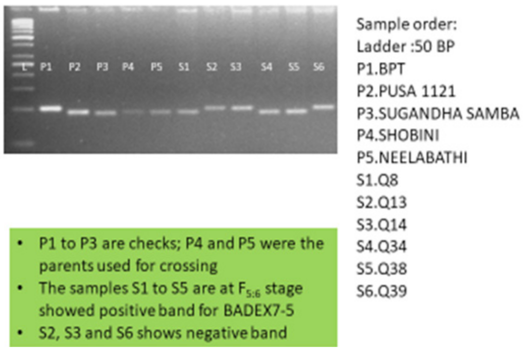
Variation in introgression lines 166S [IET27223] and 14S [IET 26772] for Plant type and grain related parameters



QTLs identified for yield traits using $F_{2:3:4}$ QTL mapping from a cross 166S [IET27223] / 14S [IET 26772]

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

New cross combinations were attempted using the cultivars like NLR 40045, Shobini, Dubraj, Sugandha Samba, BPT 5204, Danaguri. Two generations *viz.*, F5 and F6 were raised during the *rabi* 2021 and *kharif* 2021. The selected lines which were under panel test during F5 stage were forwarded to next generation. The plants which are positive for aroma trait were cross verified with molecular marker BADEX7-5 to identify the *badh2* gene on chromosome 8. With BPT 5204 as negative check, Pusa Basmathi 1121, Sugandha Samba, Shobini as positive checks. Among the mapping population derived from cross combination of Shobini and Neelabathi, three were with positive band for BADEX7-5, while the others showed negative band similar to BPT 5204. Panel test was conducted using cooked rice samples to confirm the positive line for aroma

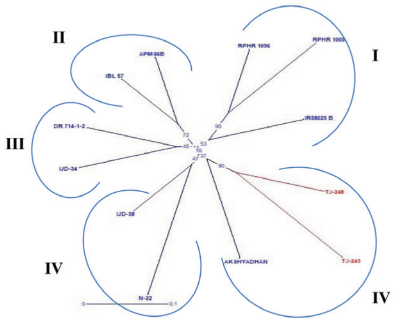


Amplification pattern of the marker BADEX7-5 in fragrant and non-fragrant rice breeding lines of the cross Shobini and Neelabathi

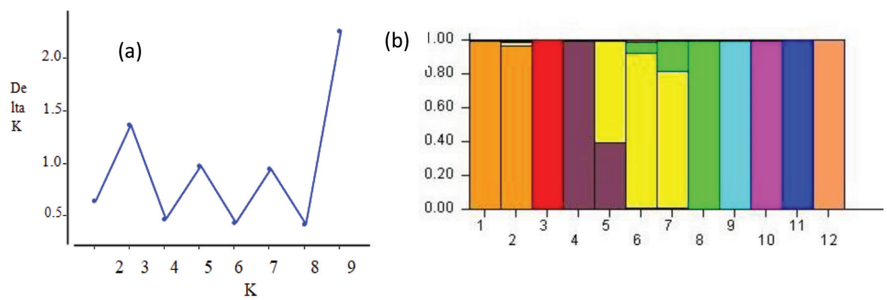
Cooked grains of aromatic breeding line SRB-2102-5-41-6-1

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

Indica/tropical japonica genome proportions were estimated in two newly developed wide compatible restorer lines (RP6367 and RP6368) derived through indica/tropical japonica crosses and the molecular diversity among 12 rice genotypes including two newly identified wide compatible restorer lines were studied using 50 SSR markers and 45 InDELs. The percentage of tropical japonica genome proportion in derived lines RP6367 and RP6368 was found to be 50% and 55.55% respectively. Cluster analysis was performed using Unweighted Pair Group Method with Arithmetic Mean (UPGMA) based on Neighbour joining algorithm in DARwin software ver 6.0.010. It resolved 12 genotypes into 5 clusters. Cluster I contain three genotypes RPHR1005 and RPHR1096, both *indica* restorer lines placed close to each other and IR58025B a maintainer line placed away from these two genotypes. Cluster II consisted of two genotypes APMS6B and IBL57, placed closely, belonging to maintainer and *indica* restorer lines respectively.



QTLs identified for yield traits using $F_{2:3:4}$ QTL mapping from a cross 166S [IET27223] / 14S [IET 26772]



(a) Estimation of optimum number of subpopulations using Delta K graph (b) Bar plot showing the population structure of 12 genotypes

Cluster III consisted of two genotypes DR714-1-2R and RP6367 which are *indica* restorer and *indica* tropical *japonica* derived restorer lines respectively. The cluster IV included two genotypes RP6368 and Nagina-22 of *indica* tropical *japonica* derived restorer line and typical *indica* respectively. RP6368 is a derived line of *indica* and tropical *japonica* so this cluster shows similarity between these two genotypes. The cluster V consists of three genotypes Akshayadhan, IRGC66651 and IRGC66755. Two tropical *japonica* genotypes IRGC66651 and IRGC66755 both clustered together.

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

DRR Dhan 55 (IET 26194), an aerobic variety was notified through Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops vide S.O. 500(E) dt. 29th Jan 2021 [CG-DL-E-03022021-224901 for cultivation in aerobic ecosystems of Bihar (Zone III) and Chhattisgarh (Zone V) states.

DRR Dhan 57(IET 26171), an aerobic variety was notified through Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops vide S.O. 8(E) dt. 24th Dec 2021 [CG-DL-E-04012022-232406] for cultivation in aerobic ecosystems of Zone III (Jharkhand) and Zone V (Chhattisgarh).

The aerobic hybrid IIRRH-124 (IET 27937) was promoted to AVT 2 aerobic trial. The hybrid IIRRH-115 (IET 27847) was promoted to AVT 2 of CSTVT trial. The hybrid IIRRH-147 (IET 29364) was found promising in AL&ISTVT- trial and will be further tested for its performance in AVT1 trial. Based on station trial evaluation, the new hybrid combinations namely IR 68897A/ RP 63340-NPVR48, and APMS6A/ RP 6341-PSV 729 possessing qDTY12.1+ qDTY1.1 and Saltol respectively were identified as promising hybrids and nominated in AICRIP 2021 for IVT-Aerobic and AL&ISTVT trials.

The grain Fe and Zn content for parental lines were negatively correlated with grain yield and hybrids exhibited positive correlation for grain Fe and Zn with grain yield under limited water conditions. The parents, IR79156A, HHZ12-SAL8-Y1-SAL1 and HHZ17-Y16-Y3-Y2 were proven to be good combiners for grain yield and micronutrient content. Parental lines and hybrids for heat tolerance were identified with different staggered sowing methods and three BILs, RP6338-9, RP6338-24 and RP 6338-155 performed well under high temperature stress. The entry RP6338-10 is a backcross derivative of KMR3*2/ N22 identified for high micronutrient content (zn-28.13mg/g and Fe -11.13mg/g), and also possessing qHTSF4.1 (heat tolerance) over three *rabi* seasons (2018- 2020), resistance to stem borer (score 3) and also possessing *Rf3*, *Rf4* showed yield superiority over parents under ambient and high temperature conditions.

For improvement of reproductive drought tolerance in KMR3R, out of 34 BILs identified, the two BILs, RP 6340-NPVR-32 & RP 63340-NPVR 1 possessing drought tolerant QTLs (*qDTY12.1, qDTY2.3, qDTY1.1* and *qDTY6.1*) and *Rf3* and *Rf4* genes performed well under drought conditions. Similarly, the ILs RP 6341-VTCP 56, RP 6341-VTCP45 possessing

Field view of newly notified high yielding varieties (A) DRR Dhan 55 and (B) DRR Dhan 57

Saltol and *Rf3* and *Rf4* genes, RP 6342-MB44 and RP 6342-TCP2 possessing SUB1 as well as *Rf3* and *Rf4* genes performed well under seedling stage salinity and submergence tolerance stress respectively over KMR3R. In the background of APMS6B, the IL RP 6343-BP10-5 with *Xa21, Xa38* + *Pup1* has been shown to be promising for low P tolerance. These improved parental lines can be registered as abiotic stress-tolerant genetic stock and exploited for the development of stress-tolerant hybrids for unfavourable ecologies.

GEY/CI/HY/12-Development of superior restorers and identification of new restorer (Rf) genes for WA-CMS system in rice by conventional and molecular approaches

The high yielding, low P tolerance (LPT) genotype RP5964-82 (IET 28821) derived from the partial restorer improvement program is under third year of testing in the AICRIP LPT trial. Restorer lines with multiple stress (BLB, blast, sheath blight, BPH, GM & drought, salinity, low P) resistance/tolerance were phenotypically evaluated using artificial screening facilities and promising restorer lines were identified. Potential restorers with biotic and abiotic stress resistance/tolerance were utilized in three-line hybrid rice breeding and experimental rice hybrids were developed and evaluated in the multi locations. Desirable grain quality restorers were identified based on grain quality analysis for developing acceptable grain quality rice hybrids. By utilizing hidden genes from wild species *viz*., *O. rufipogon* and *O. nivara* development of pre-breeding lines for improving hybrid rice parental lines for genetic diversity and out crossing, biotic and abiotic stress tolerances are under progress.

GEY/CI/HY/16: Genetic improvement of maintainer for yield and attributing traits with introgression of yield enhancing genes

There were 24 new maintainers (TCP 3758, 3759, 3760, 3764, 3771, 3789, 3791, 3793, 3802, 3808, 3818, 3822, 3849, 3852) identified from 300 test cross entries during reported period and promising maintainers were converted into CMS lines based on APMS 6A, IR 68897A, IR 79156A and IR 58025A.

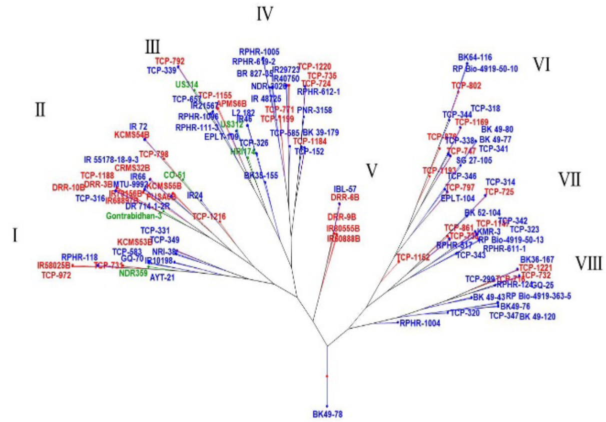
Maintainers in back cross nursery

Female Parent	Male parent	Female Parent	Male parent
IR 58025A	14RR1-12-P2	TCN 3844	TCP 3844
IR 58025A	14RR1-12-P2	TCN 3844	TCP 3844
IR 58025A	14RR1-20-P1	TCN 3873	TCP 3873
IR 58025A	14RR1-20-P1	TCN 3877	TCP 3877

Genetic male sterility facilitated recurrent selection were made on 75 plants in composite population. They were advanced by pedigree method of breeding procedure. Morphological trait-based selection was made on BC_1F_2 generation and 50 plants were selected. They were analysed for molecular marker and result showed that nine plants are similar to IR 58025B; 17 plants were of donor parents type and remaining 24 plants were heterozygous for IR 58025B and introgressed lines for yield enhancing genes *viz*., Gn1, Spl 14, SCM2, Ghd7, GS5 and TGW6.

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

A total of 118 genotypes consisting of 70 restorers, 42 maintainers and 6 checks were characterized for yield and its attributing traits during kharif 2021 using randomized complete block design (RCBD). Six checks namely, CO-51 (early duration and medium slender), Gontrabidhan-3 (mid early and medium bold) and NDR359 (medium and long bold) were under varietal checks and US314 (Early and medium slender hybrid), US312 (Mid early and medium slender hybrid) and HRI174 (Medium and long bold hybrid) were under hybrid checks. Analysis of variance revealed that significant difference was observed among the genotypes for plant height, panicle length, productive tillers and total number of tillers. Non-significant difference was observed among genotypes for single plant yield. Plant height varied from 65(IR60888B) to 137.8 cm (BK49-78), panicle length varied from 17.3 (IR80555B) to 27.7cm (TCP-797, TCP-320), productive tillers varied from 4 to 10, single plant yield varied from 3.5 (TCP583) to 12.9 (TCP-299). Morphological clustering of 112 hybrid rice parental lines (70 restorers and 42 maintainer lines) along with 6 checks performed using DARwin software. DARwin grouped 118 genotypes into 8 clusters (7 major and 1 minor) (Fig. 1). Tree distance varied from 0.289 to 17.66 with a mean tree distance of 6.99. Each cluster consisting a combination of restorers and maintainers. The check, NDR359 was placed in first cluster along with IR58025B and KCMS53B.The cluster II was dominated by maintainer lines along with two varietal checks, Gontra Bidhan-3 and CO-51. The cluster II and V were dominated by maintainers. Three hybrid checks were grouped under cluster III along with APMS6B.

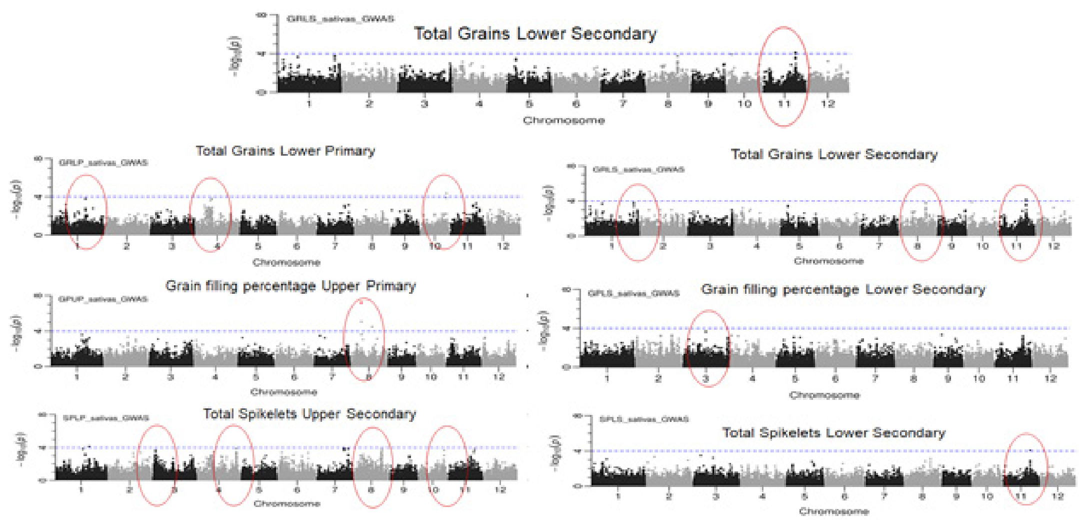


Morphological clustering pattern of 118 genotypes based on mean Euclidean distance

ABR : Application of biotechnology tools for rice improvement

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

Genome-wide association study (GWAS) of Rice Diversity Panel 1 for the traits associated with grain filling in relation to grain number has shown an interesting association of the total grain number of a lower portion of the panicle with the genomic region harboring the sugar transporter (STP) (*LOC_Os11g42430*), which is one of two candidate genes earlier identified at IIRR for grain filling *viz*., a sugar transporter (STP) (*LOC_Os11g42430*) and sucrose phosphate synthase (SPS) (*LOC_Os02g09170*) based on candidate gene mapping. Using the command line of Bio-Linux and the pipeline PIQUE developed by the University of Aberdeen, the genotypic associations were found for total grains on lower primary branches on chromosomes 1, 4 and 10; on lower secondary branches, for grain filling percentage of upper primary grains on chromosome 8 and of low secondary grains on chromosome 3 and number of total spikelets on upper secondary branches on chromosomes 3, 4, 8 and 10 and on lower secondary branches on chromosome 11.



Manhattan plots depicting the association of SNPs (each dot) with the phenotypic traits mentioned above each plot. The X-axis shows the chromosome position and Y-axis shows the negative log value of p for each SNP. The red circle indicates significant regions of marker-trait association.

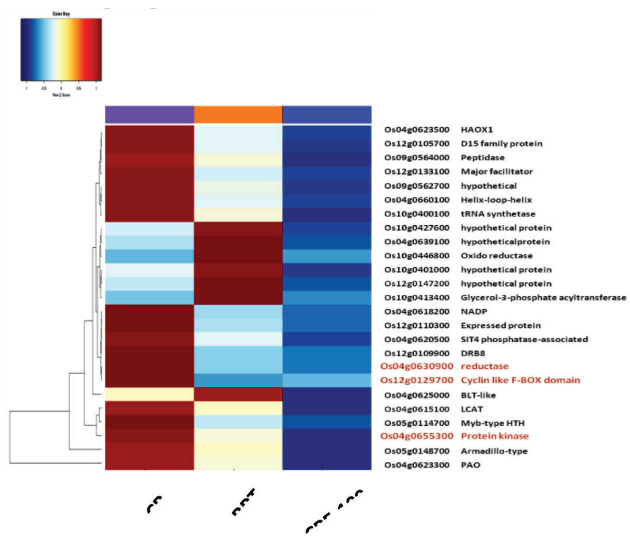
ABR/CI/BT/10: Genomic studies on grain yield heterosis and WA-CMS trait in rice

A doubled haploid (DH) population consisting of 125 DHLs derived from the popular rice hybrid, KRH-2 (IR58025A/KMR3R) was utilized for Quantitative Trait Loci (QTL) mapping to identify novel genomic regions associated with yield related traits. A genetic map was constructed with 126 polymorphic SSR and EST derived markers, which were distributed across rice genome. QTL analysis using inclusive composite interval mapping (ICIM) method identified a total of 24 major and minor effect QTLs. Among them, twelve major effect QTLs were identified for days to fifty percent flowering (*qDFF12*-1), total grain yield/ plant (*qYLD3*-1 and *qYLD6*-1), test (1,000) grain weight (*qTGW6*-1 and *qTGW7*-1), panicle weight (*qPW9*-1), plant height (*qPH12*-1), flag leaf length (*qFLL6*-1), flag leaf width (*qFLW4*-1), panicle length (*qPL3*-1 and *qPL6*-1) and biomass (*qBM4-1*), explaining 29.95–56.75% of the phenotypic variability with LOD scores range of 2.72–16.51. Chromosomal regions with gene clusters were identified on chromosome 3 for total grain yield/ plant (*qYLD3*-1) and panicle length (*qPL3*-1) and on chromosome 6 for total grain yield/plant (*qYLD6*-1), flag leaf length (*qFLL6*-1) and panicle length (*qPL6*-1). Majority of the QTLs identified were observed to be co-localized with the previously reported QTL regions. Five novel major effect QTLs associated with panicle weight (*qPW9*-1), plant height (*qPH12*-1), flag leaf width (*qFLW4*-1), panicle length (*qPL3-1*) and biomass (*qBM4-1*) and three novel minor effect QTLs for panicle weight (*qPW3*-1 and *qPW8*-1) and fertile grains per panicle (*qFGP5*-1) were identified. These QTLs can be used in breeding programs aimed to yield improvement after their validation in alternative populations.

ABR/CI/BT/16: Exploring the mutant resources for rice improvement

Comparative transcriptome analysis of complete panicle exsertion mutant

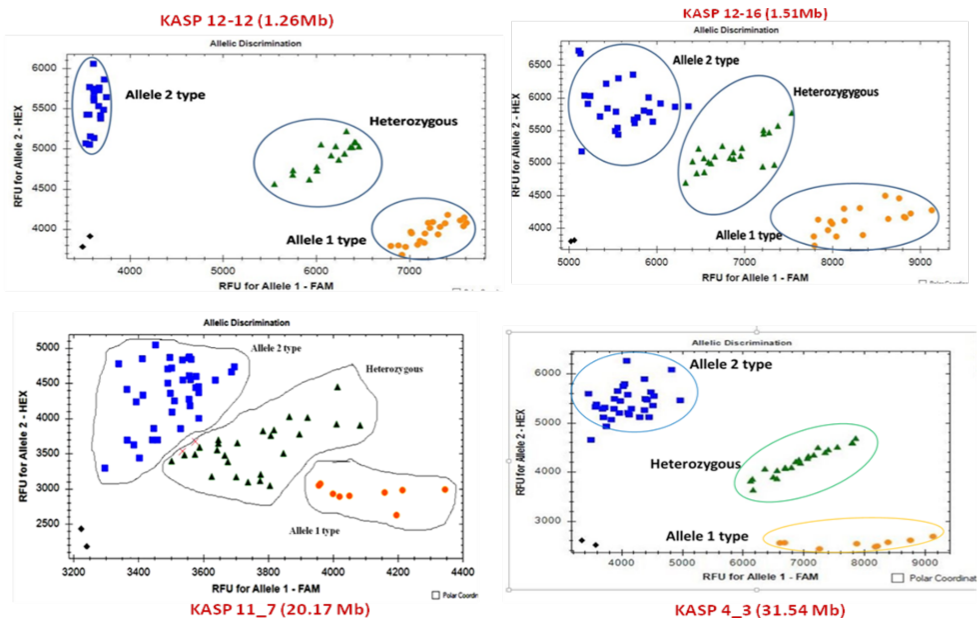
To identify the differentially expressed genes for complete panicle exsertion (CPE), RNA-seq was carried out in flag leaf sheath at the panicle development initiation stage, which might be the crucial stage for the exsertion of the panicle. RNA-sequencing of flag leaf tissues yielded 4.37 million raw from wild type (Samba Mahsuri) and 4.23 million raw reads from mutant (CPE-109). The KEGG pathway analysis revealed the enrichment of transcripts involved in the biosynthesis of secondary metabolites, and carbon metabolism. A total of 417 transcripts were up-regulated and 367 were down-regulated in the mutant (CPE-109) compared to the wild type (SM), among those, 25 differentially expressed genes (DEGs) were found in the five genomic regions identified through QTL-seq in our previous study. Ten DEGs (8 up and 2 down-regulated) and six (5 up and 1 down-regulated) were present in the genomic regions of chromosomes 4 and 12, respectively. The genes *Os12g0129700* coding for Cyclin-like F-box domain-containing protein, and *Os04g0630900* coding for reductase were expressed at a high level (7.74, 2.42 times) in CPE-109 than wild type and all the three down-regulated genes were hypothetical genes (Fig. 1). Genes coding for DUF domain-containing protein and protein kinases (wall-associated protein kinase, Brassinosteroid insensitive protein kinase, and protein kinase domain-containing genes) were upregulated and located in qCPE4 and qCPE11a & b. An AP2/ ethylene-responsive element binding protein which is a predicted transcription factor (members of this family are known to control ABA/GA balance) located in the qCPE-4 region was down-regulated, whereas an MYB 21 transcription factor located in the qCPE-11 region was up-regulated in the CPE-109 mutant. In addition to these, genes coding for ABC transporter F and G subgroup family members located in the qCPE-11 region were up-regulated.



Visualization of RNA- seq results with heat map plot of the differentially expressed genes (DEGs) of QTL seq regions on Chr 4, 5, 9, 10 & 12. Horizontal axis represents sample name; vertical axis represents the fold-change of DEG expression

Seventy-seven SNPs selected from the QTL-seq regions of 4, 5, 9, 10, 12 and SNPs selected from qCPE-11 were validated through KASP assay. Among these, four SNPs *viz.*, KASP 12-12 (Chr12:1.26Mb), KASP 12-

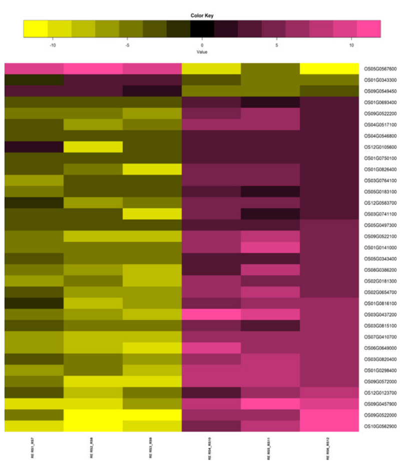
16 (Chr12:1.51Mb), KASP 11-7 (Chr11:20.17Mb) and KASP 4-3 (Chr4:31.54Mb) showed a strong association with CPE trait (having high PV and low p values) in the F_2 population. The SNP marker KASP12-12 target the mutation located in AP2/ethylene-responsive element binding protein (*Os12g0126300*); whereas KASP 12-16 SNP is located proximal to the gene *Os12g0129700* (1.43-1.45Mb) which codes for F-BOX domain-containing protein on chr12. KASP 11-7 and KASP 4-3 markers target mutations lying in the 5′UTR of autonomous floral activator (*Os11g0547000*, *OsFKF1*) and Serine/threonine-protein phosphatase 6 regulatory subunit 3 protein (*Os04g0620500*). These SNPs can be potentially used for transfer of the CPE trait from CPE-109 to other rice lines that do not exhibit complete panicle exsertion.



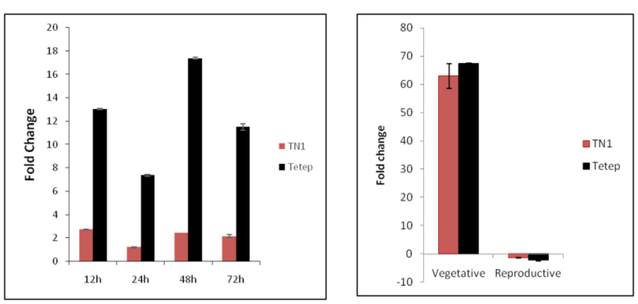
X- and Y-axes show relative amplification units (FAM for allele 1 & HEX for allele 2). Genotypes are shown in different colours; yellow ovals correspond to plants showing WT genotype, blue squares plants showing mutated genotype and green triangle plants showing HZ (heterozygous) genotype

ABR/CI/BT/14: Exploring RNAi Technology for Management of Rice Diseases

The comprehensive RNA-sequencing data obtained from control and *Rhizoctonia solani* infected six rice genotypes (TN1, BPT5204, Tetep, Pankaj, Vandana and N22) was used to mine the information of differentially expressed transcriptions factors and cell wall metabolism associated genes. Transcription Factors were retrieved from the DEGs by matching them with a list of 1862 TFs from the Plant TFDB database. A total of 507 differentially expressed TFs were identified in six rice genotypes, among which 33 TFs were differentially expressed commonly in all the genotypes. The TFs expressed among 33 are related to DREB, AP2/ERF, WRKY, MYB, C2H2, etc. ERF related TFs are DREB1A (*OS09G0522200*), DREB1H (*OS09G0522100*), AP2/ERF (*OS02G0654700*), RAV or AP2/ERF (*OS01G0693400, OS01G0141000*) ERFs (*OS04G0546800, OS05G0497300, OS07G0410700, OS09G0572000, OS09G0457900, OS09G0522000, and OS10G0562900*). WRKY TFs genes were OS01G0750100, OS01G0826400 (*WRKY24*), OS05G0183100 (*WRKY67*), OS05G0343400 (*WRKY53*), OS08G0386200 (*WRKY5*), OS02G0181300 and OS06G0649000. MYB TFs were OS05G0567600, OS04G0517100 (*MYB4*), and OS01G0298400 (*R2R3*). C2H2 TFs were OS03G0764100 (*ZF1*), OS12G0583700, OS03G0437200 (*ZFP36*), and OS03G0820400 (*ZFP37, ZFP15*). Some other TFs are G2-like (*OS12G0105600*), bHLH (*OS03G0741100*), NAC (*OS01G0816100, OS03G0815100, OS12G0123700*), GATA (*OS01G0343300*), and Nin-like (*OS09G0549450*). 57 of cell wall metabolism associated (CWMA) genes induced during the necrotrophic phase of *R. solani* in all the six rice genotypes were recovered. 15 major CWMA DEGs were found present in all six genotypes. Fifteen genes were induced in TN1 and BPT5204. Five chitinases belonging to the glycol hydrolases family (*OS04G0494100, OS06G0726200, OS10G0416500,* *OS03G0108300, OS02G0605900*), 4 xyloglucan endo-transglycosylases like proteins (*OS11G0539200, OS02G0823700, OS08G0237000, OS06G0335900*), extensin like cell wall protein (*OS01G0110200*), pectin esterase (*OS07G0675100*), COBRA like protein 7 (*OS03G0301200*) and some other uncharacterized proteins were expressed. Chitinase 1- *Oschib1* (*OS10G0416500*) gene showing very high expression in both TN1 and Tetep was chosen for further expression analysis using RT-qPCR. Its expression was analysed at different time intervals (12h, 24h, 48h, 72h, and 96h post inoculation) and growth stages (vegetative and reproductive stages). The *Oschib1* expression was up-regulated in all the stages in TN1 and Tetep during *R. solani* infection. *Oschib1* gene was highly up-regulated in Tetep from 12h to 96h (13.02 to 63.372-fold up-regulation) after infection with *R. solani,* whereas in TN1 the expression levels were high only at 96 hrs (63.017 fold up-regulation).



A heat map showing the expression pattern of 33 differentially expressed Transcription Factors in six rice genotypes

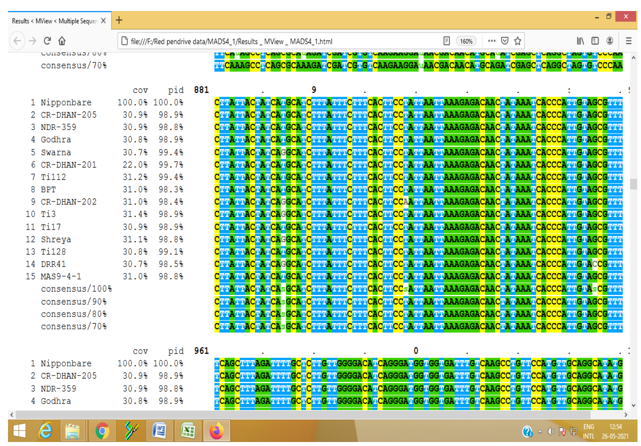


A B

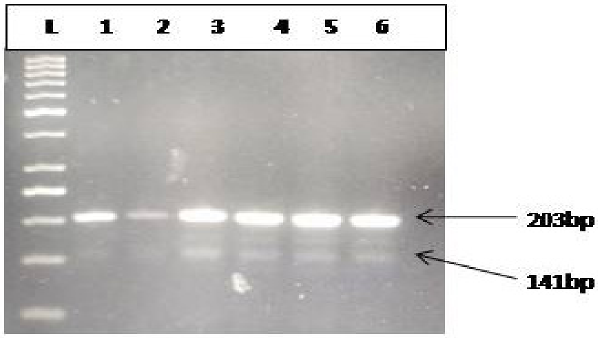
Expression analysis of chitinase1-*Oschib1* (*OS10G0416500*) at different time points after fungus inoculation A) 18h, 24h, 48h, and 72h) and growth stages B) Vegetative and reproductive stage of TN1 and Tetep plants. X-axis: Error bars indicate the mean S.E. of three biological replicates

ABR/CI/BT/15/ Molecular and functional characterization of useful root traits in rice

The genes up-regulated under the aerobic conditions were selected to develop allele-specific markers by using overlapping DNA amplification PCR. The genes *viz.* MT2C (Metalothionin gene), MDR (Multiple Drug Resistance gene), MADS4 (MADS-box 4), GLK2 (Transcription activator GLK2), NRT2.3 (Nitrate Transporter), PHT1.6 (Phosphate Transporter) were amplified in aerobic adapted and flooding adapted rice genotypes. The allelic difference for transcription factor MADS4 (*LOC_Os05g34940*) was observed in the five aerobic and anaerobic genotypes and allele-specific primer was designed for the 894th position (T/G). Interestingly, a member of MADS family, MADS80 (*LOC_Os02g06860*) spanning within 1000 bp region of the SSR marker, RM3188 was linked with seedling vigour index and shoot weight under aerobic conditions in the genome-wide association mapping. The members of MADS family transcription factors might be a key regulator for aerobic adaptation in rice.



Multiple sequence alignment results for the MADS4 gene sequenced through Sanger sequencing in each rice mutant line, genotypes and reference genome Nipponbare. MADS_4 gene allelic difference at 894th base position. Anaerobic varieties BPT 5204, Swarna, Gontra Bidhan, NDR-359, MTU 1010, Aerobic Varieties Swarna Shreya, CR DHAN 201, CR DHAN 202, CR DHAN 205, DRR Dhan 41, MAS 946-1, BPT 5204 mutant lines TI -12, TI-128, TI-17, TI-3

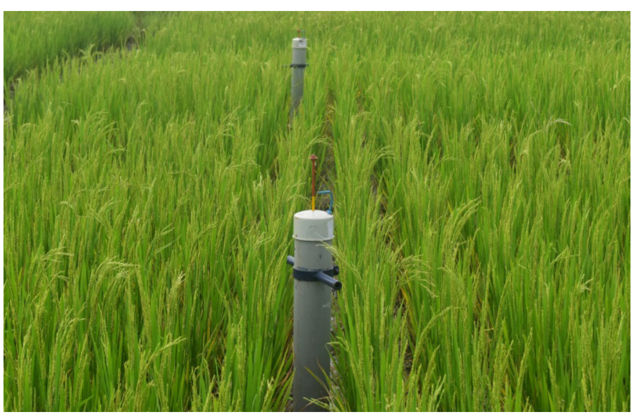


Allele-specific primer for MADS4 gene Ladder- 50 bp size 1-MTU1010, 2- BPT 5204, 3-CR DHAN-202, 4-DRR DHAN-41, 5 SWARNA SHREYA, 6-TI 128. The presence of 141 bp amplicon in aerobic adapted rice genotypes

RUE : Enhancing resource and input use efficiency

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

Application of water through alternate wetting and drying (AWD) saved around 11-14 per cent of total water requirement during crop growth period. Irrigation by AWD (implemented through water level indicator developed by ICAR-CIAE) recorded significantly superior irrigation water productivity and WUE. Among the systems of cultivation, mechanised SRI method required lowest amount of water (11.61% and 13.21% less of mean applied water than drum seeding and normal transplanting respectively). DRR Dhan 43 recorded higher water productivity as well as WUE as compared to other cultivars. AWD recorded significantly higher gross returns, net returns and B:C ratio as compared to saturation. Normal transplanting method required higher input energy.



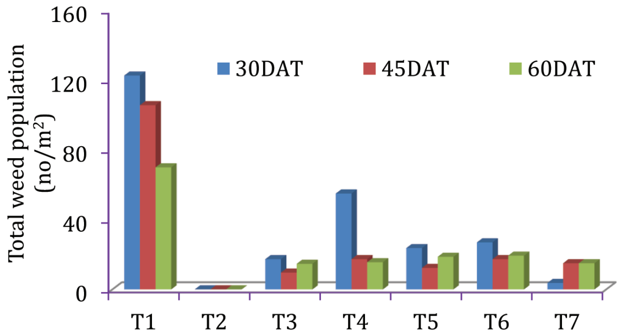
Water indicator in experimental plot

The gross energy output, net energy and EUE recorded were significantly superior in SRI than other establishment methods. DRR Dhan 43 recorded significantly higher gross returns, net returns and B:C ratio as compared to other cultivars followed by MTU-1010. Inferior gross returns, net returns and B:C ratio were observed in DRR Dhan 42. DRR Dhan 43 (long and bold grain type) or NLR-34449 (fine grain type) cultivars of rice were promising under SRI or drum seeding method of sowing with alternate wetting and drying irrigation system for higher yield and economic returns.

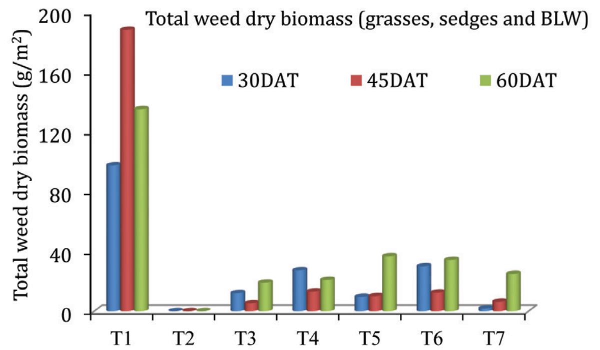
Under Direct seeded rice condition, the performance of iron coated treatment was significant under 1-2 cm water level condition caused by unpredicted rains. The crop establishment was significantly superior with Fe coating as compared to untreated. Delaying the sowing beyond 18th July caused reduction in grain.

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

The trial was conducted for 2nd year in *kharif* 2021 in replicated randomized block design with weedy check, weed free, hand weeding twice, mechanical weeding at 20 and 40 days after transplanting (DAT) 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. The weed flora recorded in the trial included *Echinochloa crusgalli, 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 increased from active vegetative stage to heading stage. Weed population showed group wise dominance of grasses-sedges-broad leaf weeds (BLW) at 30DAT., sedges-grasses-BLW at 45 DAT and BLW-grasses-sedges at 60DAT. Among the grasses *Echinocloa crusgalli* was the dominant species over two years. The sedges population increased at 45 DAT and species population of *Cyperus rotundus* also has increased. Among BLWs, there was no specific change in species. Among the treatments, weed population and weed dry biomass at 30DAT was significantly low with sequential application of herbicides. At 45 DAT, Mechanical weeder was comparable with sequential herbicide application and at 60 DAT, Mechanical weeding twice using weeder and pre-emergence herbicide application followed by mechanical weeding were equally effective as chemical weed control treatments. The lower weed population and weed bimass contributed to better crop growth, higher yield attributes and grain yields.



Total weed population at 30, 45 and 60 days after transplanting under various treatments T_1: Weedy check, T_2: Weed free, T_3: Hand weeding twice, T_4: Mechanical weeding at 20 and 40 Days After Transplanting (DAT) using weeder, T_5: Sequential application of pre-emergence herbicide pretilachlor and post emergence bispyribac-sodium, T_6: Sequential application of pre-emergence herbicide pyrazosulfuron-ethyl and post emergence bispyribac-sodium and T_7: Sequential application of pre-emergence herbicide pretilachlor and mechanical weeder at 45 DAT



Total weed dry biomass at 30, 45 and 60 days after transplanting under various treatments T_1: Weedy check, T_2: Weed free, T_3: Hand weeding twice, T_4: Mechanical weeding at 20 and 40 Days After Transplanting (DAT) using weeder, T_5: Sequential application of pre-emergence herbicide pretilachlor and post emergence bispyribac-sodium, T_6: Sequential application of pre-emergence herbicide pyrazosulfuron-ethyl and post emergence bispyribac-sodium and T_7: Sequential application of pre-emergence herbicide pretilachlor and mechanical weeder at 45 DAT

Sowing in dry DSR/aerobic rice cultivation

In another trial lower weed population and biomass were recorded by mulching followed by post-emergence herbicide application, pre-emergence herbicide application followed by mechanical weeding treatments comparable with pre-emergence herbicide application followed by post emergence application (chemical weed control alone). The treatments with lower weed population and biomass have contributed to higher yield. Based on the four-year study of different cultural, chemical, mechanical and or combinations, it was confirmed that mulching with crop residue @5t/ha at sowing time and application of postemergence herbicide for second flush of weeds is economical, practical and environmentally sound weed control option for dry DSR/Aerobic cultivation.


Field preparation and mulching in dry DSR/aerobic rice cultivation

The weed population and weed biomass were recorded lower in the treatments of Pyrazosulfuron ethyl 70%WDG @21g *a.i.*/ha fb Penoxsulam+ cyhalofop butyl @150 g a.i./ha at 25-30 DAS; followed by Pyrazosulfuron ethyl 70%WDG @21g *a.i.*/ha fb Triafamone 20%+ Ethoxysulfuron 10%WG @67.5 g a.i./ha at 25-30 DAS.

A. Herbicide application and B. Field view of Herbicide treated plot

RUE/CP/AG/17: Comparative study of organic and conservation agriculture for enhanced resource use efficiency, yield and quality of rice

Field experiment was conducted during the *kharif* season of 2021 with six treatments T_1-100% RDF+ RI, T_2- Integrated nutrient management + RI, T_3- Need based nutrient application + RI, T_4-100% RDF -RI, T_5- Integrated nutrient management - RI, T_6- Need based nutrient application - RI. The results revealed that T_1- 100% RDF + RI retention recorded higher no of Panicles /m^2 (286), panicle weight (4.36), test weight (21.68 g) which led to increased grain yield (5.8 t/ha), Straw yield (6.63 t/ha).

Treatment	Panicles/m^2	Panicle weight (g)	Test weight (g)	% filled grains	Grain yield (t/ha)	Straw yield (t/ha)
T_1-100% RDF + RI	286	4.36	21.68	88.01	5.8	6.63
T_2-Integrated nutrient management + RI	263	3.63	19.53	84.72	5.6	6.28
T_3-Need based nutrient application + RI	271	3.84	20.25	85.46	5.7	6.55
T_4-100% RDF - RI	264	3.39	17.47	83.21	5.3	6.44
T_5-Integrated nutrient management - RI	250	4.15	18.96	84.23	5.6	6.62
T_6 - Need based nutrient application - RI	255	3.87	21.41	85.15	5.5	6.23
CD (p=0.05)	36.16	0.44	2.48	-	0.3	0.41

RUE/CP/ENG/6: Selective mechanization in rice cultivation

Fabricated soil puddling machine using 0.5hp electrical 3 phase motor and stand. A specially designed tool for puddling in drum has been fabricated and tested. The approximate time taken to puddle 25kg soil is 6 minutes. Machine has been demonstrated to Scientists.

Demonstration of Pot Puddling machine

RUE/CP/AC/1: Post Harvest Treatment of Rice and Rice By-Products for Health Benefits and on-farm application

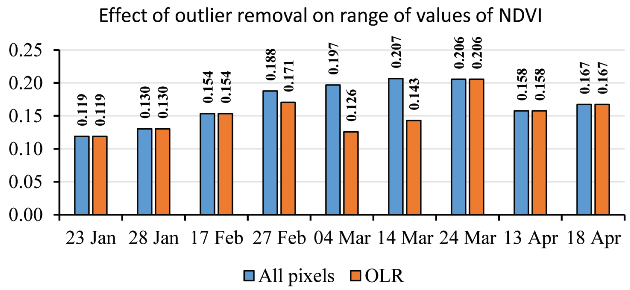
Synthetic amorphous silica was prepared under three different pH conditions- acidic, neutral and alkaline. All the products were purified by washing and dried in oven at 100 0C for 3 hours. They showed different bulk density. Silica obtained from acidic pH was heavier (SILA-58, bulk density, 0.923 g/ml) than the silica obtained from neutral (SINEU-57, bulk density, 0.284) and alkaline pH (SIBA- 55, bulk density, 0.309).A lab experiment was carried out to study the effect of silica products viz., amorphous silica (SILA-57) @ 250 and 500 mg, amorphous silica (SIBA-55) @ 250 and 500 mg, amorphous silica (SILA-58) @ 250 and 500 mg kg-1 seed, and diatomaceous earth @ 300 and 600 mg kg-1 seed on biology of bruchid beetle, *Callosobruchus chinensis* (Linnaeus) on chickpea. The experiment was laid out in completely randomized design and all the treatments were replicated thrice. Among the plant based silica products, amorphous silica (SINEU-57) @ 500 mg kg-1 seed showed superior performance over other treatments resulting in lowest fecundity (3.67 eggs 100 g-1 seed), minimum number of seeds having eggs 100 g-1 seed (3.33 seeds), lowest hatchability (55.57 per cent), minimum adult emergence (1.33 adults), short adult span (3.33 days) and minimum seed weight loss (0.34 per cent) and had a great promise in pest management.

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

Altogether 230 NDVI images for five water years covering from 2016 – 21, were stacked for Time series analysis using TIMESAT. An area of 30 acres in West Godavari was selected for phenology metrics of rice varieties and being analysed. Data pertaining to about 112000 soil health cards in Telangana State under Model Village Programme from Department of Agriculture, Government of Telangana was obtained and curated to eliminate the duplicate and erratic entries for generation of various soil theme maps including pH, EC, OC, N, P, K, S, Cu, Mn, Zn, Mn and B by interpolation techniques.

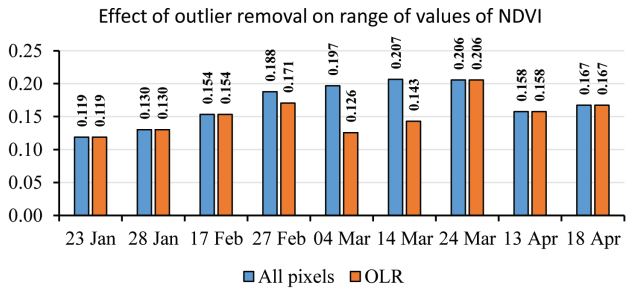
NDVI images were created from 'red' and "near infrared' bands of Sentinel data using SNAP (Sentinel Application Platform) tool during *rabi* season in 2020-21. A field cultivated with DRR Dhan 42 was selected and the boundary was obtained from Google Earth. This vector file was used to clip and extracted the pixels from NDVI images using geographic information system (GIS) tools. There were 50 pixels in this field and NDVI of these pixels in each image was subjected to outlier analysis to exclude the influential pixels from the analysis. There were outliers in the images pertaining to 27th Feb (one pixel), 04th March (four pixels), and 14th March (three pixels) while other images had all normal pixels (50).

Figures depicted the influence of outliers on the range of NDVI values (difference between minimum and maximum values) and the minimum NDVI values. The highest influence of removal of four pixels on the range was seen in the image of 4th March by lowering the difference. Similarly, the enhancement in minimum NDVI value also was noticed in same image.



Impact of removal of outliers on the range of values of NDVI

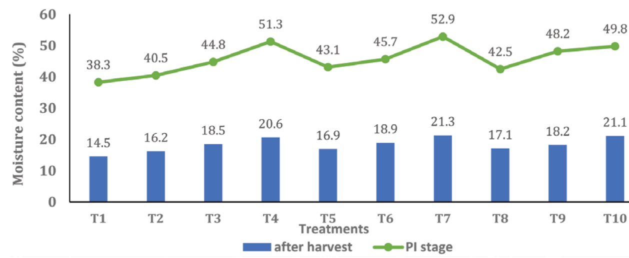
Lead Research



Impact of removal of outliers on the minimum value of NDVI

RUE/CP/SS/19: Efficacy of hydrogel on yield and soil properties of rice

Field experiment was conducted during *rabi* 20-21 to study the effect of graded doses of hydrogel in combination with FYM and different levels of recommended doses of fertilizers (100 % RDF and 75 % RDF) in a randomized block design with the variety DRR Dhan 44. Among the treatments, FYM + 75% RDF+ Hydrogel @ 10 kg/ha recorded highest number of tillers/ m^2 (292), panicles/m^2 (259), grain yield (4450 kg/ha) and straw yield (5955 kg/ha) which is 26 % higher grain yield and 19 % higher straw yield compared to control (only NPK). During panicle initiation stage, hydrogel applied plots recorded 6 to 38 % increase in soil moisture content compared to untreated plots. After harvest, the increase in moisture content in hydrogel treated plots was to the tune of 12 to 46 % compared to untreated plots.



Per cent moisture content in the soil at panicle initiation (PI) stage and at harvest

T1: Control (100% RDF); T2: 100% RDF + Hydrogel @ 2.5 kg/ha; T3: 100% RDF + Hydrogel @ 5 kg/ha; T4: 100% RDF + Hydrogel @ 10kg/ha; T5: 75% RDF + Hydrogel @ 2.5 kg/ha; T6: 75% RDF + Hydrogel @ 5 kg/ha; T7: 75% RDF + Hydrogel @ 10 kg/ha; T8: FYM + 75% RDF+ Hydrogel @ 2.5 kg/ha; T9: FYM + 75% RDF+ Hydrogel @ 5 kg/ha; T10: FYM + 75% RDF+ Hydrogel @ 10 kg/ha.

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

Rice crop sown on 15th July resulted in significantly the highest system productivity in 2016-17 (13.27 t/ha) and 2017-18 (12.76 t/ha). However, in later years (2018-19, 2019-20 and 2020-21) sowing time did not affect the system productivity. Transplanted rice-based system productivity was superior over wet direct-seeded system during all the five years of experimentation. The highest system productivity of transplanted rice was recorded in 2018-19 (12.63 t/ha). Conventional tilled maize-based system was superior over minimum tilled maize in initial three years. The highest system productivity of conventional tilled maize system was recorded in 2018-19 (12.54 t/ha). In later two years there was no significant difference between conventional tilled maize and minimum tilled maize system. Pooled analysis also reflected the same results as that of last two years.

Rice-maize productivity (t/ha) obtained under applied treatments during the 5-year period

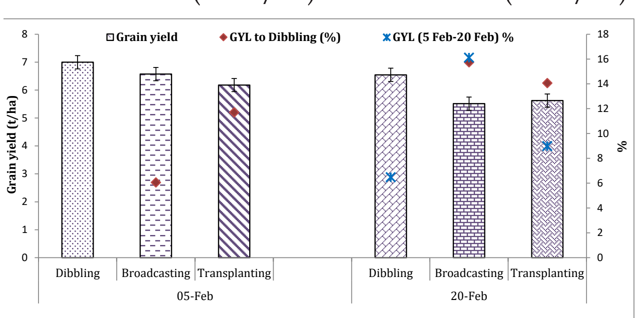
Treatment	Rice-maize productivity (t/ha)					
	2016-17	2017-18	2018-19	2019-20	2020-21	Pooled
Sowing time						
1st July	11.76	11.67	12.06	11.43	11.24	11.63
15th July	13.27	12.76	12.62	11.58	11.23	12.29
30th July	11.67	11.43	11.95	11.36	11.06	11.49
LSD (p=0.05)	1.13	1.11	NS	NS	NS	NS
Establishment method						
Transplanting	12.37	12.39	12.63	11.90	11.61	12.18
Wet direct seeded	11.11	10.92	11.71	11.81	10.85	10.97

LSD (p=0.05)	1.16	1.13	0.98	1.03	1.06	1.10
Tillage (Winter season)						
Conventional	12.36	12.05	12.54	11.84	11.32	12.02
Minimum	11.29	11.04	11.31	10.97	10.90	11.10
LSD (p=0.05)	1.01	1.00	1.10	NS	NS	NS

Different date of sowing and establishment methods did not impact the soil carbon pools. The minimum tilled maize system had significant impact on very labile and labile carbon pools, but not on less labile and non-labile carbon in the 0-5 cm soil layer (Table 9). The minimum tilled maize resulted in significantly higher, very labile (~33.5%) and labile (~33.2%) carbon concentration at 0−5 cm depth of soil compared to the conventional tilled maize system. However, in the deeper (5-15 cm) soil layer, neither pools of carbon (very labile, less labile and non-labile) differed significantly between the treatments.

SSP/CP/AG/16: Development of sustainable agro-techniques for direct seeded rice

DRR Dhan 42 along with MTU 3626 (Bondalu), a popular variety for direct sowing and one hybrid *i.e.* IIRRH 124 were evaluated under three establishment methods -. Wet-DSR (Puddled, Dibbling), Wet-DSR (Puddled, broadcasting) and conventional transplanting with two dates of sowing (two weeks apart). Results revealed that, mean grain yield was significantly higher with first sowing (6.58 t/ha) compared to the later sown crop (5.89 t/ha). Among the methods of establishment, dibbling in the puddle soil produced significantly higher grain yield (6.77 t/ha) compared to broadcasting (6.04 t/ha) and conventional transplanting (5.90 t/ha). DRR Dhan 42 produced significantly higher grain yield (6.49 t/ha) than MTU 3626 (6.08 t/ha) and IIRRH 124 (6.15 t/ha).



Grain yield and percent yield loss in different establishment methods

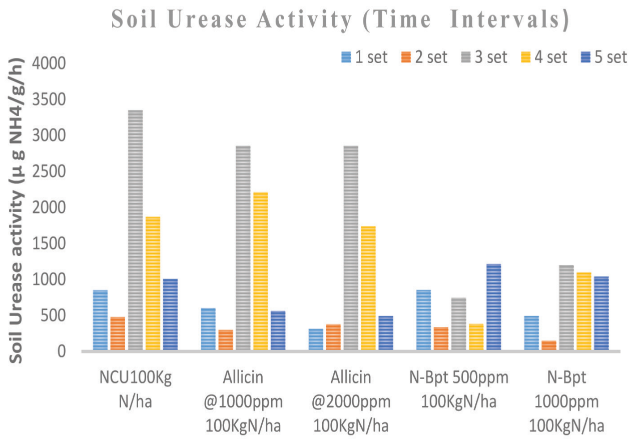
SSP/CP/SS/11: Assessment of genotypic variability and improving nitrogen use efficiency (NUE) in irrigated rice

To evaluate nitrogen-use efficiency of existing popular rice varieties and to identify efficient rice genotypes, field experiments were repeated under N-0 and N-100 kg/ha as main treatments and 21 popularly grown high yielding varieties and hybrids as sub treatments in a split plot design with 3 replications. In another experiment, six promising varieties including one hybrid, identified for high NUE from the initial screening were subjected to graded levels of N (0, 50, 75 and 100 kg N/ha). To improve nitrogen-use efficiency, slow release urea and neem coated urea and urease inhibitors (UI) were tested under field experiment with DRR Dhan 42.

Among the 21 varieties tested, PSV 190, PSV 469, PSV 344, PUP 221, PUP 223, and Varadhan performed well with higher yields as well as high nitrogen use efficiency indices compared to other varieties. Soil available N values decreased to 107 and 163 kg/ha in N0 and N100 plots, respectively, from the initial value of 210 kg/ha.

At graded levels of N, ARRH 7576 at lower levels of N (0, 50 and 75 kg/ha) and Varadhan at higher level of 100 kg/ha recorded higher yields than other varieties. The hybrid, ARRH 7576 and CNN 1697 recorded maximum values for most of the NUE indices confirming their superior performance at graded levels of N.

The results on improving NUE indicated significantly higher yields (7.73 and 7.05 t/ha) with NBPT1000 ppm and SRU 85@100kgN/ha, respectively. All the improved N sources recorded a yield increase over NCU by 7-37%. Urease activity (UA) estimated periodically was found less where UIs were added compared to NCU treatment thereby releasing N slowly and gradually. In general, maximum UA was observed in the third set, that is, around maximum tillering and it decreased gradually.



Soil Urease (µ g NH4/g/h) activity with different N sources

1 set: Before 1st nitrogen split dose, 2 set: After 1st nitrogen split dose 3 set: Before 2nd nitrogen split dose, 4 set: After 2nd nitrogen split dose

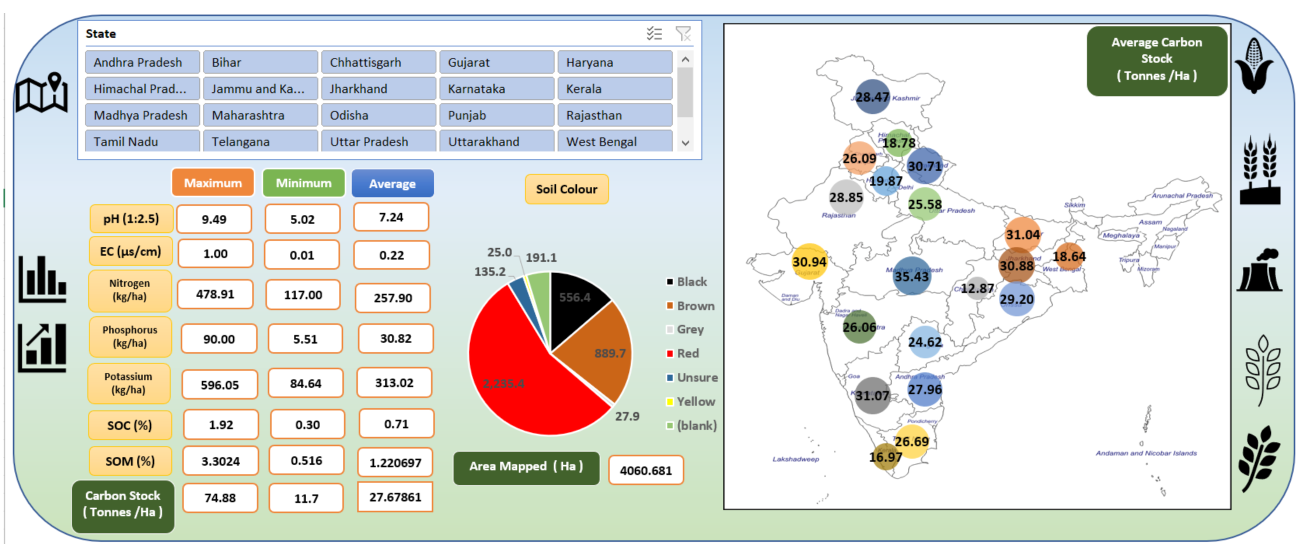
5 set: during grain filling stage.

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

More than 5000 soil samples were collected from various places across different rice ecologies and its soil organic carbon analysed. The data for soil organic carbon is being collated and integrated into continuous developments of series of soil organic carbon maps. This is a first attempt to characterize the rice ecologies for its soil organic carbon and their stocks. A large variation up to the tune of >70 % was noticed for soil organic carbon percentage and stocks among the four different rice ecologies. This ongoing study indicated that decline in surface soil organic carbon in the rice ecologies of India was two times faster than that of the upland/hilly rice ecologies.

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

Seed biopriming with endophytic actinobacteria was found to improve seed germination and vigour under *in-vitro* conditions. Five promising actinobacterial isolates were studied for their effect on dynamics of seed reserves for the formation of seedling, the seed reserve utilization efficiency and other associated parameters. Significant differences were observed in the quantity of seed reserve utilized during germination and their conversion into seedling tissue because of biopriming with actinobacteria. Treatment with all the actinobacterial isolates improved the weight of mobilized reserve (WMSR) by 6.5-14.84%, seed reserve depletion (SRDP) by 4.52-12.11% and root tissue conversion rate by 16.09-41.86%. The root-shoot ratio, though non-significant, increased by 22.5-38.4% due to actinobacterial treatments. The highest WMSR (0.106 mg/10 seeds) and SRDP (0.748 mg/mg) was observed in Isolate 3. Seed biopriming with Isolate 5 resulted in the maximum seed reserve utilization efficiency (0.613 mg/mg), seed metabolic efficiency (1.625 g/g) shoot and root tissue conversion rate (0.155 and 0.439 among all the treatments.

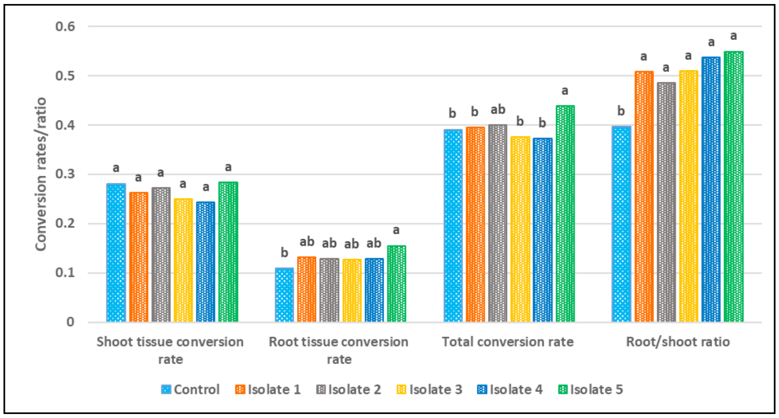


Average carbon stock and soil parameters in different states of India

Effect of actinobacterial seed priming on seed reserve dynamics

Treatment	Weight of mobilized seed reserve (mg/10seed)	Seed reserve depletion proportion (mg / mg)	Seed reserve utilization efficiency (mg / mg)	Amount of seed material respired (g)	Seed metabolic efficiency (g/g)
Control	0.092[b]	0.671[b]	0.583[ab]	0.039[bc]	1.409[ab]
Isolate 1	0.104[ab]	0.752[a]	0.525[bc]	0.049[ab]	1.11[b]
Isolate 2	0.101[ab]	0.724[ab]	0.554[abc]	0.045[abc]	1.257[ab]
Isolate 3	0.106[a]	0.748[a]	0.504[c]	0.053[a]	1.021[b]
Isolate 4	0.1[ab]	0.701[ab]	0.534[bc]	0.047[abc]	1.158[b]
Isolate 5	0.098[ab]	0.716[ab]	0.613[a]	0.038[c]	1.625[a]

Different letters within a column indicate significant differences at $p < 0.05$



Effect of actinobacterial seed priming seedling tissue conversion efficiency

SSP/CP/SS/15: Microbial population dynamics in different rice establishment methods in relation to nutritional availability and acquisition:

Soil samples were collected from farmer's field and IIRR research farm to estimate the microbial population dynamics and isolate potential nitrogen fixing microbes in different rice establishment methods. In the present study, the aerobic methods (275) had the highest number of microbial populations followed by alternate wetting and drying method (221) and flooded condition (190). A total of 35 nitrogen fixing bacteria were isolated on N- free media and 21 unique morphotypes were purified and evaluated for nitrogenase activity through Acetylene Reducing Assay (ARA). All twelve identified potential phosphate solubilizing isolates were deposited to NCBI and received the accession numbers.

List of Identified PSB isolates deposited to NCBI

SL. No.	Isolates	Identified PSB Bacteria	NCBI Accession No.
1	PSB1	*Citrobacter amalonaticus* IIRRPSB1	MZ914591
2	PSB3	*Bacillus flexus* IIRRPSB3	OM281705
3	PSB4	*Citrobacter amalonaticus* IIRRPSB4	MZ914685
4	PSB5	*Bacillus paraflexus* IIRRPSB5	OM283545
5	PSB6	*Bacillus sp.* IIRRPSB6	MZ914689
6	PSB7	*Bacillus oryzaecorticis* IIRRPSB7	OM281568
7	PSB8	*Bacillus aerius* IIRRPSB8	OM283596
8	PSB9	*Bacillus safensis* IIRRPSB9	OM230178
9	PSB10	*Bacillus pumilus* IIRRPSB10	MZ914697
10	PSB11	*Bacillus xiamenensis* IIRRPSB11	OM212982
11	PSB12	*Bacillus australimaris* IIRRPSB12	OM230184
12	PSB13	*Bacillus sp*. IIRRPSB13	MZ919329

SSP/CP/RUE/19: Evaluation of ZnO nanoparticles (NP) on performance of rice

The field level testing on nano ZnO was initiated during the year 2020, and the trial was formulated with two sprays of ZnO nanoparticles at 50, 100, and 150 mg /L with bulk ZnO at 500, 1000, and 1500 mg /L and 0.5% $ZnSO_4$. As per IRC recommendation, higher doses of nano ZnO @ 250,350,500 mg /L was taken for evaluation during the *Kharif* season 2021 along with IFFCO Zn. Application of these treatments did not have any impact on plant height, tiller number and panicle number. However, grain yield was significantly affected by the application of nano ZnO on foliage of rice plant. Two sprays of nano ZnO @ 150, 250, 350, 500 ppm increased the grain yield by 1.31, 1.45, 1.38 and 1.37 times respectively over control. However, application of $ZnSO_4$ registered the highest grain yield (5620 kg /ha), followed by nano ZnO @ 250 mg/L (5453 kg/ha). Rice leaf samples were collected and analysed for chlorophyll content and catalase enzyme activity expressed by the plant against the nano ZnO application. The highest chlorophyll 'a' content (28.2 mg /g fresh weight) was recorded when plants were treated with 500 ppm of nano ZnO in comparison to control. The highest catalase enzyme activity was found at $ZnSO_4$ spray (3.20 unit/min/g fresh weight) followed by 350 mg/L spray of nano ZnO (3.07 unit/min/g fresh weight). With the increased concentration of metal NPs, the catalase activity was markedly reduced.

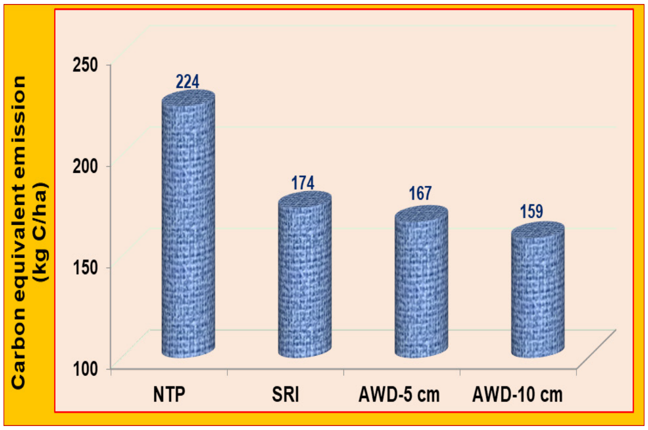
CCR : Assessing and managing crop response to climate change

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

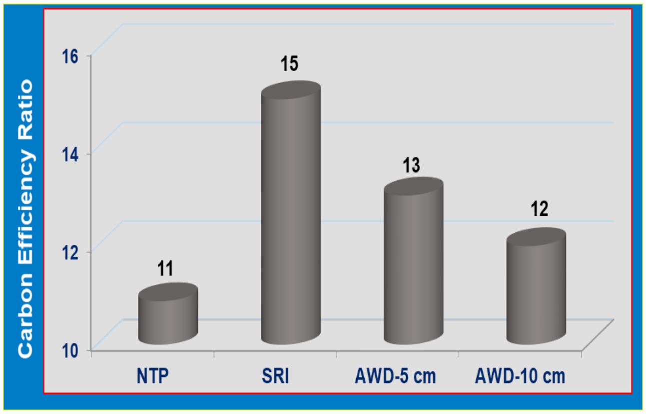
Field experiments were carried out in *rabi* 2020-21 and *kharif* 2021 with four planting/water management methods *viz*., conventional transplanted (NTP), system of rice intensification (SRI) and alternate wetting and drying (AWD) at 5 cm and 10 cm depletion of ponded water, with five replications, to study their impact on greenhouse gas emissions. The test variety grown was MTU1153.

The different establishment/planting methods significantly impacted both the greenhouse gas (GHG) *i.e*., methane and nitrous oxide emissions throughout the crop growth period. The seasonal integrated flux (SIF) for methane was the highest in NTP method (24.59 kg/ha) followed by SRI (14.64 kg/ha) and AWD methods resulted in lower flux values of 12.65 and 11.32 kg/ha with irrigation at 5 cm and 10 cm depletion of ponded water, respectively. Methane emissions decreased by more than 40 per cent in SRI and by 49 and 54 per cent in AWD at 5 and 10 cm, respectively as compared to NTP. The higher methane emissions under conventional NTP method were due to the depletion of oxygen under submerged condition leading to conducive anaerobic or reduced atmosphere throughout the crop growth season. The seasonal integrated fluxes of N_2O-N were the least in NTP (0.69 kg/ha) as compared to SRI (0.91 kg/ha) and AWD methods (0.99 and 1.00 kg/ha). N_2O-N emissions were higher by 31 per cent in SRI and 42 and 44 per cent in AWD at 5 and 10 cm, respectively over NTP.

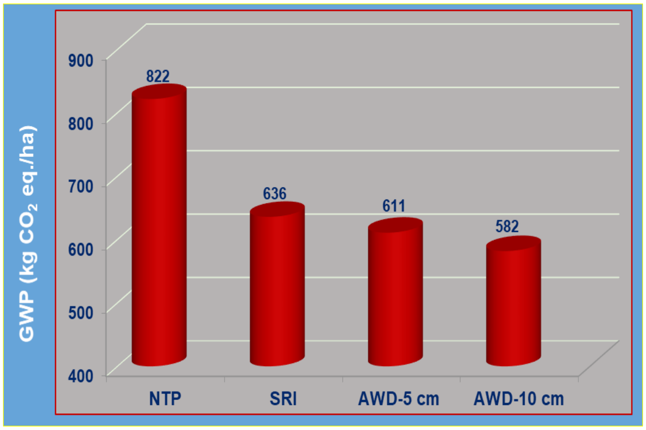
Carbon Equivalent Emissions (CEE) significantly varied with different establishment techniques. The CEE was the highest under NTP (224 kg C / ha). The lowest CEE values were observed under AWD methods at 5 and 10 cm (167 & 159 kg C / ha). The highest CEE in NTP was due to higher methane emissions during the entire crop growth period. Carbon Efficiency Ratio (CER) was the lowest in NTP method (11) and highest in (15) SRI. A low CER in NTP shows that more C is emitted and less C fixed where as in case of SRI the C emitted was significantly reduced as compared to the carbon fixed. The CER of conventional method was 27 per cent lower than SRI method, which shows that the latter is more efficient. SRI and AWD methods lowered the Global Warming Potential (GWP) due to lower methane emissions as compared to the conventional NTP method.



CEE of different crop establishment methods



CER of different crop establishment methods



GWP of different crop establishment methods

CCR/CP/ PP/11. Evaluation of genotypic variability in leaf photosynthetic efficiency and its associated factors in rice

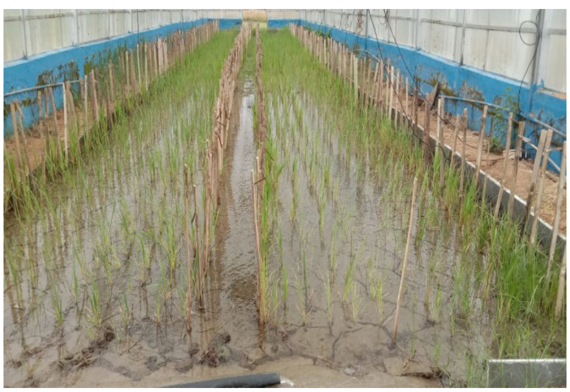
Leaf photosynthetic traits and chlorophyll fluorescence parameters were recorded on 13 popular rice varieties. Significant variation was observed between the tested varieties for photosynthetic efficiency (P_N), stomatal conductance(gs), transpiration rate(E) and inter cellular CO_2 concentration (Ci). Photosynthetic efficiency varied from 17.1 (Nidhi) to 22.9 (GQ-25) µmol (CO_2)/m^2/s^1. The *Fv/Fm* (maximal photochemical efficiency), quantum efficiency of PSII (YII) and apparent electron transport rate (ETR) were non-significant amongst the tested entries. The coefficient of non-photochemical quenching (*q*N) show significant difference ($p<0.05$) amongst the tested entries, ranging from 0.21(Heera) to 0.301(IR-64). Multiple correlation and regression analysis was performed to understand the relation between photosynthetic efficiency, gas-exchange traits, fluorescence parameters and other leaf parameters. The association of P_N with gs, E and Carboxylation efficiency (CE) was positive, however the association between P_N and *Fv/Fm*, YII, ETR though positive but non-significant.

CCR/CP/ PP/12. Role of Silicon in inducing abiotic stress tolerance in rice

In order to standardize the optimum dosage of silicon application and the crop stage, four dosages of silicon application in the form of potassium silicate were used (0g/L (Control), 2g/L, 4g/L, 8g/L). The results reveal that the optimum dose for silicon application is 4g/L at flowering stage. Oxygraph was used to study dark respiration, photosynthetic rate and light induced respiration (Photorespiration - LIR). Dark respiration increased with silicon application. While, LIR was more at 4g/L silicon treatment, photosynthetic rate was high at 8g/L silicon treatment. Chlorophyll (SPAD) was increased with increased dosage of silicon application. Morphological and physiological attributes along with yield parameters showed a positive relation with application of silicon particularly at 4g/L and 8g/L dosage. In leaf and stem samples of the variety Chandra, Silicon content was 3.25% per gram of leaf, 3.75% per gram of stem and 5.35% per gram of leaf + stem.

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

Phenotyping of rice germplasm for physiological traits related to heat stress tolerance was taken up in *kharif* season of 2021 at Rajendranagar farm of ICAR-IIRR Hyderabad. About 450 rice germplasm were sown in augmented block design with two treatments. 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. The rice germplasm was characterized on the basis of physiological traits such as canopy temperature depression, spikelet fertility, days to 50% flowering and days to maturity, plant height and yield and yield contributing parameters at reproductive stage.



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

HRI/CPT/ENT/11: Host plant resistance against insect pests and their management.

Three hundred and fifty land races were mass screened for resistance to brown planthopper and white backed planthopper. Two land races were identified as highly resistant, twenty-two land races as resistant and seven land races as moderately resistant to brown planthopper. One land race was highly resistant and thirty-one land races were found resistant to white backed planthopper. Screening of 2000 entries, consisting of advanced breeding lines, germplasm accessions for resistance to brown planthopper revealed that twenty-seven entries were highly resistant, sixty-two entries were resistant and thirty-eight entries were moderately resistant to brown planthopper. In another study thousand germplasm accessions were phenotyped and genotyped for their resistance to brown planthopper. One germplasm accession IC 518805 was highly resistant with damage score (DS) 0.9 and eleven germplasm accessions [IC 519101(DS 1.1), IC 75883(DS 1.2), IC 518849 (DS 1.5), IC 515511 (DS 1.9), IC 322922 (DS 2.1), IC 569465 (DS 2.1), IC 574971 (DS 2.3), IC 752742 (DS 2.4), IC 575211 (DS 2.7), IC 515838 (DS 2.9), IC 7577 8 (DS 2.9)] were found resistant to the brown planthopper.

Profiling of none *Bph* genes by 17 SSR markers revealed that combinations, *Bph6+Bph20* (IC 519101), *Bph2+Bph6* (IC 515974, IC 517008 and IC 75883), *Bph2+Bph6+Bph17* (RP 2068-18-3-5 and RP 4918-230-S) and *Bph32+Bph17* (PTB33) showed resistant reaction. *Bph3+Bph6* (200940), Bph3+Bph17 (IC 75885) and Bph2+Bph3+Bph6 (IC 75886) showed moderately resistant reaction.

Reaction of rice land races to brown planthopper and white backed planthopper

Highly resistant (damage score<1)	Resistant (damage score<1.1-3.0)	Moderately resistant (damage score<3.1 -5.0)
Brown planthopper		
IC 8968 (0.6) and IC 8646 (0.9)	IC 8686 (1.1), IC 8922 (1.1), IC 8507 (1.2), IC 7705 (1.6), IC 8903 (1.6), IC 8656-2 (1.6), IC 7166 (1.7), IC 8869 (1.9), IC 8466 (1.9), IC 7345 (2.0), IC 7886 (2.0), IC 7573-1 (2.1), IC 7564 (2.2), IC 7704 (2.3), IC 8909 (2.3), IC 7795-1 (2.3), IC 7196 (2.5), IC 7761-2 (2.6), IC 7647 (2.7), IC 7825 (2.8), IC 7960 (2.9 and IC 7529 (3.0)	IC 7557-2 (3.2), IC 7615 (3.3), IC 7809(3.5), IC 7782-1 (3.8), IC 7586 (3.8), IC 7707-1 (4.0) and IC 7369 (5.0)
White backed planthopper		
IC 8691-2 (0.7)	IC 8646 (1.2), IC 8684-1 (1.6), IC 7704 (1. 7), IC 7615 (1.7), IC 7697 (1.9), IC 7760-1 (1.9), IC 7847 (1.9), IC 7825 (1.9), IC 7522 (2.0), IC 7693 (2.1), IC 8019 (2.2), IC 7699 (2.2), IC 8686 (2.2), IC 7926 (2.2), IC 8536 (2.3), IC 8975 (2.3), IC 7978 (2.4), IC 8639-1 (2.5), IC 8931 (2.6), IC 7506 (2.6), IC 8365 (2.6), IC 7549-3 (2. 7), IC 8438 (2.8), IC 8638-1 (2.8), IC 8683-3 (2.9), IC 8671-3 (2.9), IC 7573-1 (2.9), IC 7507 (3.0), IC 7705 (3.0), IC 7761-2 (3.0) and IC 8466 (3.0)	

Reaction of rice advanced breeding lines and germplasm accessions to brown planthopper

Highly resistant (damage score<1)	Resistant (damage score<1.1-3.0)	Moderately resistant (damage score<3.1 -5.0)
WS-18-OYT-4/BPH (0.2), IBT-BPHM13 (0.6), RP 5594-147-23-1 (0.6), CR 4331-74-2-2-1 (0.6), PHI-20102 (0.7), HPR 3203 (0.7), RCMR-42 (1.0), RP 6330-179-3-9-1 (0.8), IET 29750 (0.9), AD 13280 (1.0), RP 6317-RMS-S35-BC_2F_4-49-25-12-24 (0), RP 6112-SP-M-MS-70-52-2-6-9-8-6-11 (0.2), WGL-1495 (0.2), CR 3006-8-2 (0.4), Jeeraphool Mutant-5 (0.4), MSN 114 (0.6), RP 6317-RMS-S35-BC2F4-49-25-12-18 (0.6), P.3313 (0.6), TR 15045 (0.8), WGL-1485 (0.8), RP 6317-RMS-S35-BC2F4-49-25-8-26 (0.9), RP 6317- RMS-S35-BC2F4-49-25-5-10 (0.9), CR 3954-607-116-541-117 (1.0)	CAUS 127 (1.2), HPR 2900 (RB 10) (1.4), CAUS 126 (1.9), IET 29226 (1.2), MEPH-159 (1.3), RP 6317-S35-BC2F4-49-25-6-21 (1.3), PHI-20103 (1.3), IET 29236 (1.4), Gontra Bidhan-3 (2.0), OR 2573-4 (2.0), Bio-799 (OBCH-2) (2.0), IET 29743 (2.1), IET 28357 (2.1), CR 3849-2-1-2-1-2 (2.2), CR 4331-85-1-1-1 (2.3), IET 29749 (2.3), HRI-207 (2.4), HRI-202 (2.6), NDR-359 (2.6), BPT 3050 (2.7), CSR 449S-13 (3.0), E-171 (1.3), E-147 (1.4), E-159 (1.5), E-163 (2.1), E-173 (2.7), E-116 (2.9), E-176 (3.0), RPGP-1311-20-5-4-2-3 (1.5), JGL 38190 (2.6), WGL 1613 (2.8), WGL 1508 (2.8), RP-GP-3000-179-3-9-1 (2.9), JGL 38125 (3.0), PTB 33 (1.4), RP2068-18-3-5 (1.6)	IET 29764 (3.1), UPR 4130-1-1-1-1 (3.2), OR 2523-6 (3.2), IET 29757 (3.4), IET 29753 (3.7), MTU 1351 (MTU 2223-29-2-1-1) (4.7), HRI-204 (4.8), ShuatsDhan 6 (4.9), TRC BN 793-B-B-27-4-1 (4.9), JKRH-1601

HRI/CPT/ENT/23: Insect-plant interactions with special reference to rice pests - yellow stem borer and gall midge

The dead heart (DH) damage due to yellow stem borer up to ten per cent could be compensated by regeneration of tillers at vegetative phase. Breeding lines derived from RP5587, RP5588 and KMR 3 were evaluated in field at vegetative phase to study the regeneration capacity following infestation with stem borer by pinning egg masses. Among the screened

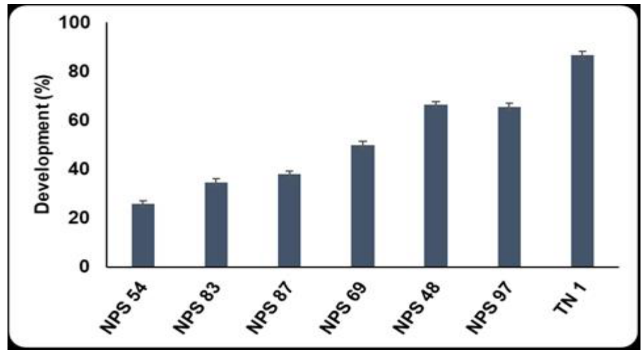
61 lines, DH damage varied from 16.6% (DS3.0) to 42.1% (DS7.0). Despite heavy damage, some lines have recovered and yielded better. Regeneration capacity was expressed as the ratio of total panicle bearing tillers (TPBT) at harvest to total tillers (TT) at vegetative phase (TPBT/TT). The ratio was ≥1.0 in RP 5588-B-B-B-B-226, RP 5588, BK 64-116CRCPT 7 and CRAC 3992-2-1, suggesting higher regeneration capacity in these lines responsible for recovery resistance conferring tolerance to yellow stem borer. TPBT/TT was negatively correlated with loss in tillers (r= -0.8013, P=0.000, N=61).

With respect to rice gall midge, RP 6505-8 (INRC18108 X TN1) and three lines of RP 6504 (INRC17470 X TN1) were free from damage against biotypes 1 and 4M. Former line is in second year of testing. In greenhouse conditions it is observed that the gall midge infestation predisposed stem rot infection that hampered gall development and failure of adult midge emergence. Level of infection varied across with the genotypes.

Sclerotia at the base of the gall midge infested plant

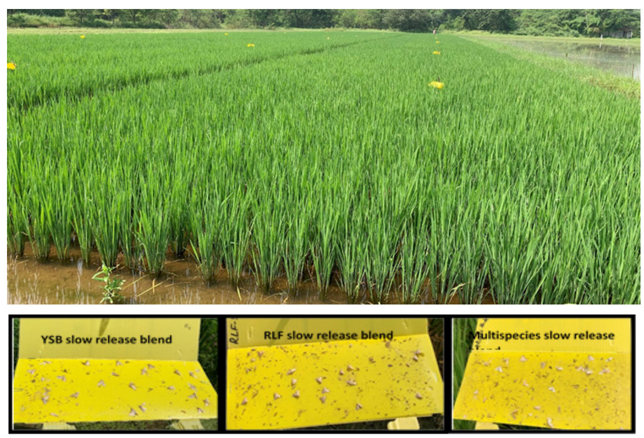
HRI/CPT/ENT/27 Assessment of host plant resistance to leaf folder and semio-chemical approaches for the management of insect pests of rice

A C2 population (162 RILs) of two stable backcross alien introgression lines 166s and 14s derived from Swarna/*Oryza nivara* IRGC81848, that were found as moderately resistant against leaf folder were phenotyped in the field using rapid screening method during *Kharif* 2021. Based on the assessment of area of leaf fed by one third instar larva for 48 hr, damage score was given on a scale of 0 to 9. Data revealed 12 RILs as resistant (damage score 3.0) and 20 as moderately resistant (damage score 5.0). Development and survival studies revealed that less than 50 % larvae developed into adult moths on resistant lines as compared to moderately resistant lines (65.55 – 66.35%) and susceptible check, TN1 (86.50%).

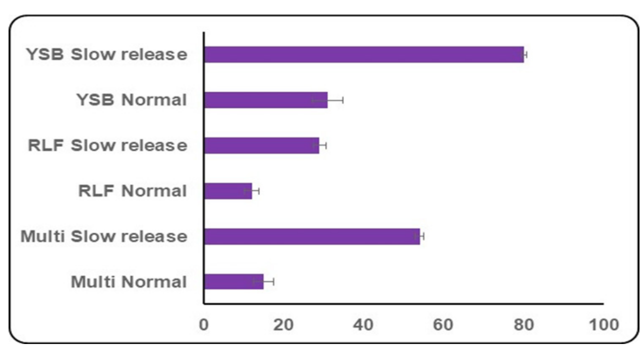


Development of leaf folder larvae on different BILs

Normal and slow release pheromone blends of rice leaf folder (RLF), yellow stem borer (YSB) and multispecies blends were formulated and evaluated for both leaf folder and yellow stem borer at IIRR farm. In the second year of testing, slow release blends had maximum cumulative catches of RLF (29), YSB (80) and multispecies (54) as compared to the normal blends.



Field view of evaluation of pheromone blends at IIRR farm during *Kharif* 2021 and trap catches (inset)



Cumulative catches of rice insects in different blends

IPM : Integrated pest management

IPM/CPT/ENT/21: Botanicals for sustainable management of major pests of Rice

Evaluation of ITK formulations against yellow stem borer indicated that SDCU-FD (full dose) formulation recorded 38 per cent reduction in per cent dead hearts (DH) over untreated control followed by HPPM-FD, SDCU-DD (double dose) (33.2 and 29.0 per cent reduction). With respect to per cent white ears (WE), highest per cent reduction was recorded in AA-AZCC-DD over control (48.1) followed by NSKE and SDCU-FD (45.8 and 45.3 per cent reduction). In case of brown planthopper, except SDCU-FD all the ITK formulations showed reduction in BPH population over control. Per cent reduction was highest in HPPM-HD (half dose) (15.1 %) followed by SDPA-FD (13.3 %). Formulation SDCU-DD recorded highest reduction (44.5 %) in per cent damaged leaves over control followed by SDPA-HD (35.6%). Highest yield of 6306.6 kg/ha was recorded in AA-AZCC-FD treatment with an increase of 14.2 per cent over control (Fig. 1).

Five essential oils were tested for safety to the egg parasitoid yellow stem borer (*Trichogramma japonicum*). Highest emergence (10.5%) was observed in citronella oil while, lowest (7.9%) was recorded in lemon grass oil as compared to the untreated control (14.8%).

Documentation of floral biodiversity under irrigated rice systems was done during *rabi*, 2020 and *kharif* 2021 at Rajendranagar (Rangareddy) and Venkatapuram (Vanaparthi). A total of 26 plant species in Rajendranagar and 28 species in Venkatapuram were recorded that included medicinal plant species (*Eclipta alba, Cleome viscosa, Euphorbia hirta, Sida cordifolia, Tridax procumbens, Tribulus terrestris, Bacopa monneri, Tinospora cordifolia, Psoralea coryfolia*), food plants (*Alternanthera sessaslis, Amaranthus viridis, Celosia argentia*) and aromatic plants (*Ageratum conozoides, Lantana camera and Blumea lacera*).

IPM/CPT/ENT/22: Investigations on nematodes of importance to rice cultivation

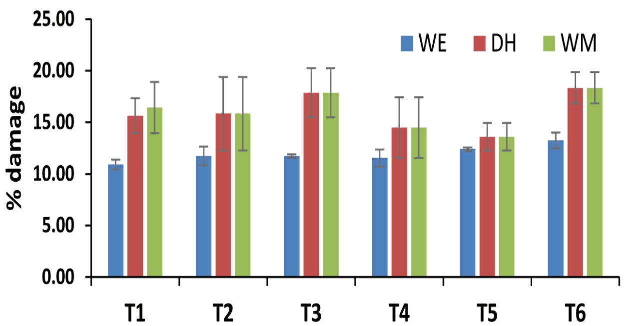
Twenty high yielding rice cultivars were screened for resistance against rice root-knot nematode *Meloidogyne graminicola* in pot culture experiments. All cultivars except Khao Pahk Maw (resistant check) showed susceptible reaction based on the relative root-gall index (RGI).

Long term studies on influence of crop establishment methods, moisture and fertilizer management regimes in rice on soil nematodes revealed that the total nematode abundance increased under SRI system over normal transplanted system. However, the relative abundance of plant parasitic nematodes (PPN) was observed to be low in SRI system (0.42) compared to the normal transplanted system (0.62). The PPN community in experimental plots was dominated by rice root nematode, *Hirschmanniella* spp. (>60%) and ectoparasitic nematodes like *Helicotylenchus* spp., *Psilenchus* spp., etc. Comparison of nutrient management regimes in both the systems showed that density of plant parasitic nematode population was low (100-120 nematodes/100cc soil) in treatments receiving organic fertilizers compared to that receiving inorganic fertilizers (149-176 nematodes/100 cc soil). Field experiments on weed management in aerobic rice revealed that green leaf mulching with neem leaves suppressed plant parasitic nematodes.

Bio-Intensive Pest Management (BIPM) practices involving application of organic manures, biocontrol agents and PGPR have recorded significantly low numbers of plant parasitic nematodes (59.8-66.0 nematodes/100 cc soil) compared to the farmers' practice (115.8 nematodes/100 cc soil) and untreated control (119.8 nematodes/100 cc soil). On the other hand, the relative abundance of beneficial free-living microbivorous nematodes was observed to be more (0.56-0.63) in BIPM treatments as compared to that observed in farmers' practice (0.41) and untreated control (0.43).

IPM/CPT/ENT/26: Bio-intensive pest management with emphasis on biological control of rice pests

Bio-intensive pest management modules were tested at Indian Institute of Rice Research, Rajendranagar and in farmer's field in Nalgonda District, Telangana to study the abundance and diversity of pests and natural enemies in different organic/bio-intensive pest management practices (BIPM). BIPM practices like bund cropping, seed priming with bio agents had a positive impact on natural enemy populations. Chemical applications lowered natural enemy populations in the farmers practice modules. A total of 5982 natural enemies were recorded by various observation methods during the *rabi* season. The most abundant natural enemy order at Nalgonda was Hymenoptera (2873 individuals) predominantly represented by Braconidae (19 %) (*Apanteles* sp., *Cotesia* sp., *Bracon* sp.), Trichogrammatidae (18%) (*Trichogramma* sp., *Oligosita* sp.) and Scelionidae (35%). Maximum benefit cost ratio (1.72 -1.94) was observed in BIPM modules with highest in *Bacillus subtilis* seed treatment and least (1.32 -1.54) in farmers' practices and insecticide use.



WE – white ears; DH – dead hearts; WM – whorl maggot

Shannon – Wiener diversity index for hymenopteran parasitoids was highest in plots treated with *Trichoderma* (1.11). Similarly, Simpson Index echoed highest diversity in *Trichoderma* treatment (0.46) followed by *Pseudomonas* treated plots (0.53). The stem borer damage was 13 -18 % dead hearts and 10.9 -13.23 % white ears among various treatments at the IIRR farm and the whorl maggot damage ranged from 13. 59 % - 18.34 %.

Pest incidence in various modules: T1 – Recommended package of practices, T2 to T4 – Organic practices with seed priming with bioagents *Trichoderma asperellum* Strain TAIK1, *Pseudomonas fluorescens* Strain PIK1 and *Bacillus cabrialesii* BIK3 T5 – Organic practices without seed treatment, T6- Absolute control

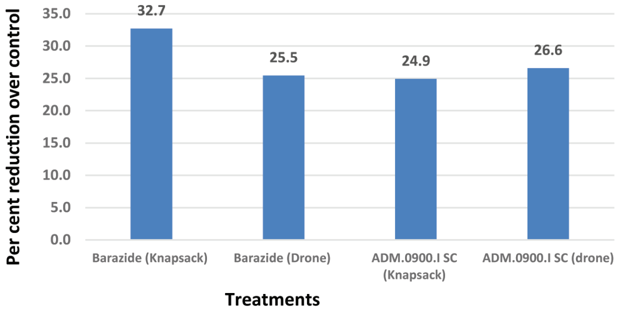
IPM/CPT/ENT/28: Bio efficacy and toxicological studies of Insecticides against insect pests of rice

A field experiment was conducted during 2021 *Kharif* to evaluate the efficacy of newer insecticides sprayed with drone against major insect pests of rice. Highest per cent reduction in damage due to rice defoliators (leaf folder, whorl maggot, and case worm) was recorded in barazide (knapsack) (32.7%) followed by barazide (drone) (25.5%). Test chemical (ADM.0900.I SC) efficacies by knapsack and drone were comparable with 24.9 and 26.6 per cent reduction over control.

Spray droplet characteristics of drone and knapsack sprayer were recorded using water sensitive paper. In knapsack spraying, droplets were too large and coalesced making further analysis not possible. Droplet characteristics of drone spraying revealed that the mean diameter of the droplet ranged from 839 to 1164 microns (ultra-coarse category). Density of the droplets on the top and bottom layers of the crop canopy was comparable indicating good penetration. DV0.1, 0.5, and 0. 9 (DV-volume mean diameter) values were high indicating low drift behaviour of the spray droplets.

Wolf spider and red ant *Solenopsis* sp. feeding on leaf folder larvae

Values of the relative span (1.3-1.5) of the spray droplet indicates uniformity of the spray droplets.



Efficacy of newer insecticides and application methods against rice defoliators

Field view of insecticide spraying with drone

Characteristics of drone spray droplets

Treatments	No. of drops/ sq.cm		Dia. (µm)		*#DV 0.1 (µm)		*#DV0.5 (µm)		#DV0.9 (µm)		Relative span	
	T	B	T	B	T	B	T	B	T	B	T	B
Untreated Control (water) (Drone)	190	168	1129	1164	562	607	991	1064	1968	2013	1.4	1.3
ADM.0900.I SC (drone)	158	147	1095	779	553	393	985	657	1819	1293	1.3	1.4
Barazide (drone)	317	103	839	907	388	461	711	855	1485	1550	1.5	1.3

*T-top canopy B-bottom canopy #DV=Volume mean diameter

HPR : Host-plant resistance against pathogens and its management

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

DRR Dhan 62, a MAS derived, durable blast and bacterial blight resistant, high-yielding, fine-grain type rice variety having three major bacterial blight (BB) resistance genes, *Xa21+xa13+xa5* and two major blast (BL) resistance genes *Pi-2+Pi54* was developed. It recorded average Severity Index of 4.0 (BL), 3.4 (BB) for two years as compared to the recurrent parent, Improved Samba Mahsuri. The variety also showed good level of resistance to neck blast, brown spot and sheath rot.

A. Severe incidence of Blast under field conditions; B. DRR Dhan 62, a fine grain variety incorporated with blast and BLB resistant genes

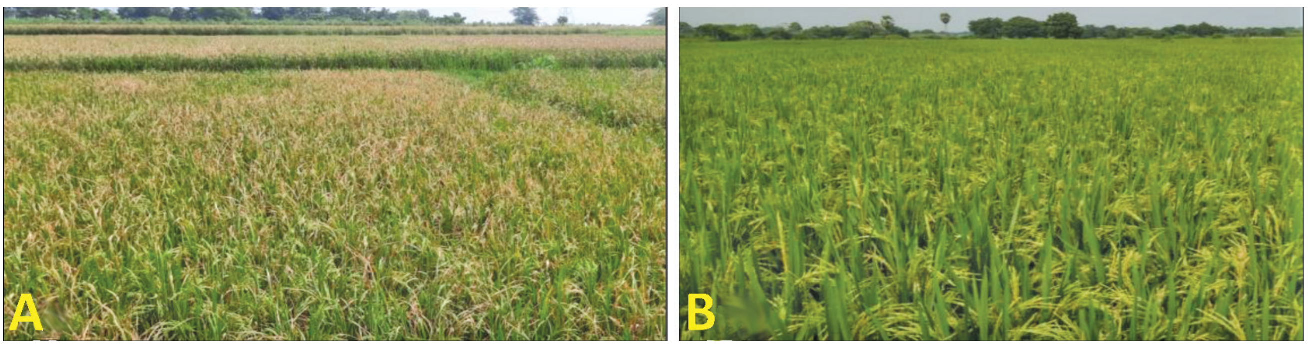
A total of 3173 lines consisting of advanced breeding lines, near isogenic lines, marker assisted introgression lines, 3K rice genome Panel, breeding lines of aerobic restorer, Rasi X ISM populations, high yielding Swarna lines etc., were evaluated in the Uniform Blast Nursery under artificial inoculation with the virulent blast isolate. The data was recorded when the score on the susceptible line reached to 9 on SES scale. Of these,588 lines were found resistant.

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

Severe outbreak of bacterial blight (BB)disease (>80% disease incidence) was recorded in several villages in Wyra, Thallada, Kalluru and Sattupally mandals in the Khammam district of Telangana. Most affected rice variety was BPT 5204. Demonstration fields of newly released bacterial blight resistant rice variety, DRR Dhan 53 (*Xa21+xa13+xa5+Xa38*), similar to BPT5204, was totally free from disease. Twenty-five new isolates of *Xoo* were collected from different BB hot spot areas of Andhra Pradesh and Telangana.

1051 germplasm of 3K panel, wild rice introgression lines, MAS generated (Krishna Hamsa x WGL 14) BC_2F_5 generation lines and germplasm entries were screened with *Xoo* isolate IX020 and 166 lines were found as resistant. Screening of 41 promising entries from AICRIP Pathology 2020 against two virulent *Xoo* isolates (IX 020 and IX 027) indicated 11 entries from NSN-1(4) & NSN-2 (7) with very high level of resistance. Out of 29 *O. glaberrima* accessions screened against 5 diverse *Xoo* strains (IX027, West Bengal; IX007, Assam; IX200, Uttarakhand, IX-020, Telangana and IX 212, Chhattisgarh) two genotypes (CG 210, CG 211) showed high level of resistance to all the five *Xoo* strains and 20 accessions showed resistance to 3-4 *Xoo* isolates.

Forty-four wild rice introgression lines (ILs) (genetic background of IR54, IR72 and a new plant type introgression lines from different wild rice accessions) were screened with *Xoo* strain IX-020. HWR 36 (IL IR75083-49-25-9-5-B-B-B; an IL of *O. longistaminata*), HWR 23 (IR 75084-15-3-B-B, an IL of *O. officinalis*) and HWR 42 (IR 75085-35-5-2-B, also an IL of *O. officinalis*) showed very high level of resistance. These ILs did not show the presence of three major genes *Xa21*, *xa13* and *xa5* when analysed with gene specific markers indicating that these resistance in these accessions may be novel.



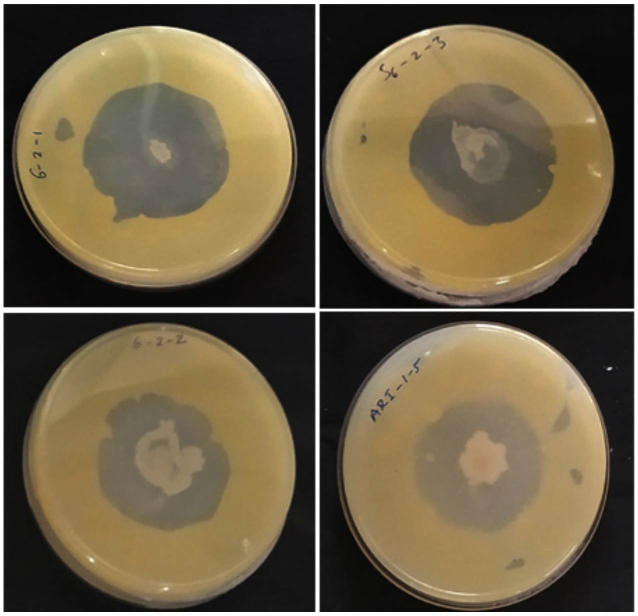
A. Severe bacterial blight incidence on BPT 5204 in Khammam, October, 2021; B. Healthy crop of bacterial blight resistant rice variety DRR Dhan 53 in Khammam, October 2021

Reaction of selected introgression lines to multiple isolates of *Xoo*

Xoo strains	Lesion length (cm) ± SE				
	IR 75084-15-3-B-B (HWR-23)	IR75083-49-25-9-5-B-B-B (HWR-36)	IR 75085-35-5-2-B (HWR-42)	Improved Samba Mashuri(ISM)	Samba Mashuri (SM)
IX-020	1.5±0.9 (1)	0.2±0.2 (1)	1.7±1 (1)	0.4±0.1 (1)	6.8±0.9 (7)
IX-007	2.08±0.9 (1)	0.2±0.2 (1)	2.28±1.1 (1)	0.14±0.0 (1)	7.44±0.3 (7)
IX-015	8.92±0.7 (7)	7.34±1.0 (7)	9.66±0.9 (9)	0.26±0.1 (1)	9.9±0.6 (9)
IX-212	1.96±0.7 (1)	0.74±0.2 (1)	1.34±0.3 (1)	0.34±0.1 (1)	8.84±0.7 (7)
IX-206	1.12±0.3 (1)	1.6±0.4 (1)	1±0.4 (1)	0.14±0.1 (1)	7.8±0.7 (7)
IX-027	9.12±0.5 (7)	6.04±0.5 (7)	9.4±0.9 (9)	0.14±0.0 (1)	8.08±0.5 (7)
IX-200	10.9±0.8 (9)	8.74±0.4 (9)	8.9±0.7 (7)	1.34±0.2 (1)	12.3±0.6 (9)
IX-071	8.8±0.9 (7)	6.4±0.6 (7)	8.72±1.0 (7)	1.66±0.4 (1)	8.8±0.8 (7)

The figures in parentheses indicate disease score

Twenty-nine strains of *Bacillus* spp. isolated from different field soils were evaluated for their antagonistic activity against *Xoo* under *in vitro* condition using double layer technique. All the *Bacillus* spp strains were found to be antagonistic to *Xoo* and produced typical inhibition zone. The diameter of the inhibition zone ranged from 11 mm to 80 mm.

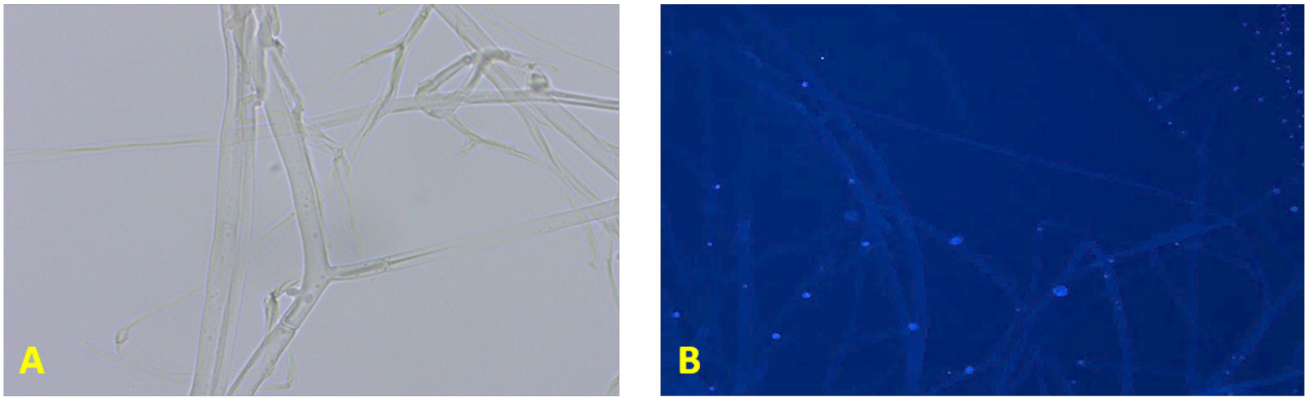


Antagonistic activity of the selected *Bacillus* spp. against *Xoo*

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

Ninety-five isolates of *R. solani and Rhizoctonia* spp. were collected from Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Jammu and Kashmir, Himachal Pradesh, Gujarat and characterized based on cultural characters. In addition, 12 isolates of *R. oryzae sativae and* 6isolates of *R. oryzae* were also characterized. Two hundred and twenty isolates of *R. solani* were preserved for long-term storage. Fluorescence microscopic study of 32 *R. solani* isolates revealed ~5 to 9 nuclei count in a single septum of *R. solani* mycelium.

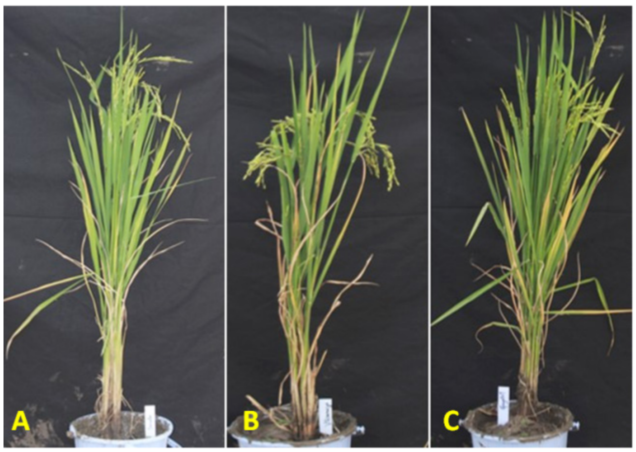
Based on the phenotyping of 330 RILs (during *Kharif* - 2017 to 2020), and genotyping results, 4 RILs (R36T, R 38T, R 47T and R158T) were identified as highly tolerant. Parent donors Savitri, Vikramarya and Gayatri showed tolerant reaction with a disease score of 5.



Identification of nuclei in the *mycelia of R. solani* isolate using Fluorescence microscopic study; A- Mycelium of *R. solani* with Septum; B – Fluorescence of *R. solani* nuclei

Sheath blight phenotypic reactions of genotypically selected tolerant RILs

Entries	K-2017	K-2018		K-2019	R-2020	K-2020				K-2021 IIRR
		IIRR	ICRISAT			Field 1	Field 2	Glass House	Detached leaf assay	
R-78	3	5	5	5	5	5	3	5	5	5
R-210	5	3	5	5	5	5	5	3	5	3
R-45	5	3	5	5	5	5	5	3	5	3
R36	5	5	5	5	5	5	3	5	3	5
R38T	5	5	3	3	5	5	3	5	5	3
R47T	5	5	3	3	5	5	3	5	5	5
R158T	5	3	5	5	3	5	3	5	5	3
WP	3	3	5	3	3	3	3	3	1	5
ISM	9	9	9	9	7	9	7	9	7	7



Tolerant Donors identified from the promising entries of AICRIP testing across multiple locations (A) Savitri (B) Vikramarya (C) Gayatri

A total of 128 SSR polymorphic markers were identified between ISM and Wauzhophek. A subset of RILs (n = 112) was used for the linkage analysis and a major QTL for sheath blight tolerance was identified on chromosome 3 (named *qShbltol*$_{3.1}$), and a few minor QTLs on other chromosomes. Based on the phenotypic data of 300 genotypes (3K panel) and SNP genotypic data, major sheath blight tolerant novel QTL in chromosome 3 and 5 was identified. Fifty tolerant RIL's (Wazuhophek/Improved Samba Mahsuri) selected based on their five-year consistent performance under different environments were nominated in the Donor screening nursery (based on the key parameters like relative lesion height, Yield, AUDPC and other quantitative parameters). Among them, 8 promising RILs were nominated under different AICRIP breeding trials.

Trial on yield reduction due to sheath blight revealed that100%, 50%, and 30% disease incidence caused 39.25%, 18.86%, and 14.16% percent yield reduction over control respectively. The increase in disease severity can cause rice grain yield reduction in the ratio of 2:1.

New antifungal molecule "cymene" identified from Thyme (*Thymus vulgaris* L.) against sheath blight pathogen *R. solani* based on the *in vitro* and *in vivo* studies. Fungicidal molecules difenoconazole 25% EC, isoprothiolane 40% EC, kasugamycin 3% SL, kitazin 48% EC, propineb 70% WP, tebuconazole 25.9% EC and thifluzamide 24% SC were evaluated against sheath blight and difenoconazole 25% EC (0.5 ml/l) was identified as the best molecule.

HRP/CPT/ PATH/23: Variability in *Ustilginoidea virens* and management of false smut disease

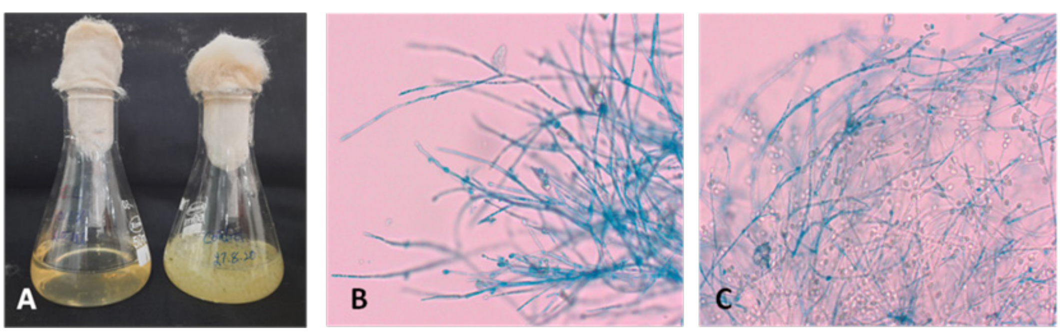
False smut infected samples were collected and eleven isolates of *U. virens* was done during *Kharif* 2021. Pure culture of around 170 isolates of *U. virens* is being maintained at 4^{0}C in Potato sucrose agar slants. A reproducible artificial screening technique was standardized for false smut screening and the screening facility was established at ICAR-Indian Institute of Rice Research, Hyderabad, both under glasshouse and field conditions. During *Kharif* 2021, 520 germplasms, mutant lines, wild introgression lines and land races were artificially inoculated under field conditions. The field was provided with sprinkler system along with green shade net to make conducive weather conditions for false smut infection.

False smut pathogen was multiplied in rice leaf extract broth followed by potato sucrose broth and germinated conidia were inoculated at booting stage. Data on percentage disease infection and number of infected spikelets/ panicle were recorded. Genotypes were artificially inoculated at booting stage from Second week of September, 2021 onwards. For each genotype, 2 - 4 panicles were artificially inoculated. Among the different genotypes, around 35 lines were identified as tolerant which will be confirmed further.

Artificial screening facility for identification of promising donors against false smut at IIRR under field conditions

A &B. Artificially inoculated rice genotypes expressed false smut symptom; C. Tolerant genotype (IC334233) identified under artificial screening against false smut

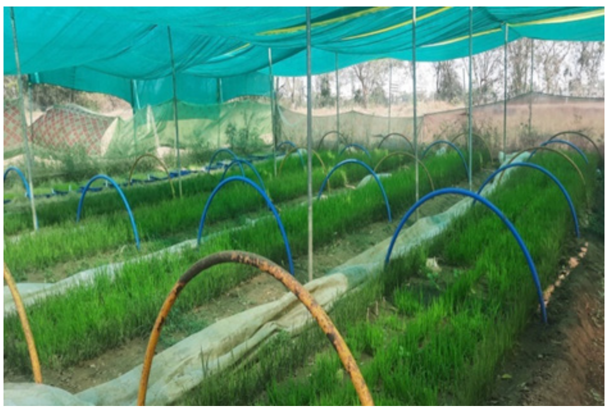
Nine essential oils were tested under *in vitro* at different concentrations (0.1% to 0.5%) against false smut pathogen. Among the oils tested, cinnamon bark and cinnamon leaf oil completely inhibited the mycelial growth of *U. virens* at all the five concentrations. Lemon grass oil and Clove oil inhibited the mycelial growth of *U. virens* at 0.2% and 0.3% concentrations onwards, respectively. Citronella oil and Cedarwood oil were effective at 0.5% concentration. Effective essential oils at different concentrations (0.1% to 0.5%) were tested against *U. virens* conidia using potato sucrose broth (PSB). Required concentration of PSB prepared with the oils, inoculated with *U. virens* conidia and incubated in the shaker. Both cinnamon bark and cinnamon leaf oil reduced the growth of *U. virens* and reduced the conidial multiplication compared to control.



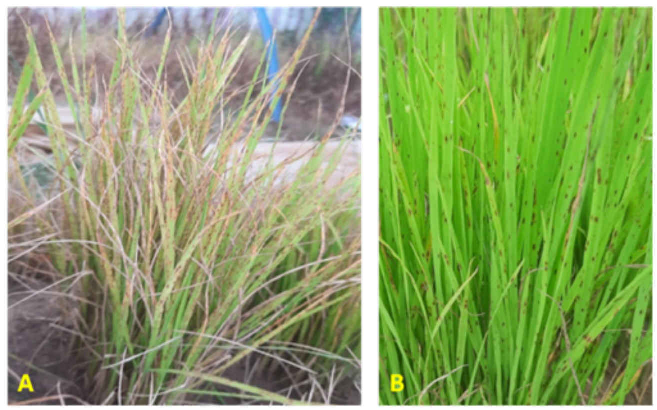
Effect of Cinnamon bark oil against *U. virens*; A- Inhibition on the growth of *U. virens* compared to control; Microscopic observation on *U. virens*; B –inhibited the conidial multiplication; C- Control

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

In *Kharif* 2021, brown spot disease incidence and severity was low in Khammam district while it was moderate to severe in Nandyal mandal of Kurnool district on variety NDLR-7. The pathogen *B. oryzae* was isolated from brown spot infected samples collected from Khammam and Kurnool districts (~20 isolates). Artificial mass screening technique was standardized to identify the resistant sources against brown spot disease under field conditions. Different genotypes were sown on raised beds by adopting the sandwich method wherein, every five test entries were surrounded by the susceptible variety (BPT 5204) as a border. Pure culture *B. oryzae* was mass multiplied on rabbit food agar medium at 27 ± 2^{O}C for 5 days and later exposed to alternate 12 hours to near UV light and dark conditions for conidial induction. Conidia were harvested in sterile distilled water and sprayed in the evening hours (10^5 conidia/ml). The inoculated plants were covered with plastic sheet for 48 h to provide a congenial humidity condition for the germination and infection by pathogen conidia. The symptoms of brown spot disease appeared after 5 days after inoculation on most of the genotypes as small reddish-brown spots. The beds were covered with plastic sheet in night time to enhance the spread of disease for 15 days.



Artificial screening nursery for brown spot disease under field condition



High disease pressure of Brown spot disease
A. BPT 5204; B – Gangavati Sona

All the screened varieties showed varied level of susceptibility. The disease progression was slow and it took around 25-30 days to attain the score of 9 in the susceptible varieties. The varieties such as BPT 5204, Swarnadhan, Gangavati Sona and Purple rice were identified as highly susceptible; while CH-45, Tetep, Tadukan and IR-64 were moderately resistant. The varieties Tetep, Tadukan and CH-45 produced fewer spots of minute size while Phoghak and Benibogh produced a greater number of smaller size spots. CG and CGIL (~150 wild rice introgression lines of *O. rufipogon* x Samba Mahsuri) and Improved Nellore Mahsuri (~35 lines of NLR34449 x ISM) were artificially screened under field conditions. Six introgression lines out of 150 showed high level of resistance (CGIL-8 and CGIL-33 with 1 score); while 4 CGIL lines (CGIL – 1, 2, 17, 47) recorded score of 2. Eight lines out of 35 Improved Nellore Mahsuri lines screened, showed high level of resistance to brown spot disease.

HRP/CPT/ PATH/25: Investigations on Sheath rot and Stem rot diseases of Rice

A total of 36 *Sclerotiumoryzae* isolates wereobtained from the disease infected samples of Andhra Pradesh, Telangana and Tamil Nadu. Cultivar MTU3626was used as susceptible host. The isolates of *S. oryzae* were grown on autoclaved typha (*Typha angustata*) stem cuttings (soaked in a solution of 2 % sucrose and 1 % peptone) for 10 days. Plant inoculation with individual *S. oryzae* isolates was carried out at the maximum tillering stage (45ADS) by placing of 4–5 pathogen colonized typha stem cuttings inside the hill. Per cent disease index (PDI) was recorded at a regular interval of 7 days based on 0-9 scale. In addition, the rate of disease increase was also calculated. The isolate So15 recorded highest mean per cent disease index (52.78) with maximum AUDPC (1196.9 units and the isolate So31 had the minimum PDI (13.58) with 254.9 units of AUDPC. The isolate (So15) was considered as virulent isolate based on the pathogenicity and disease reaction on MTU3626. The isolate So33 has the highest growth rate compared to the all the isolates tested.

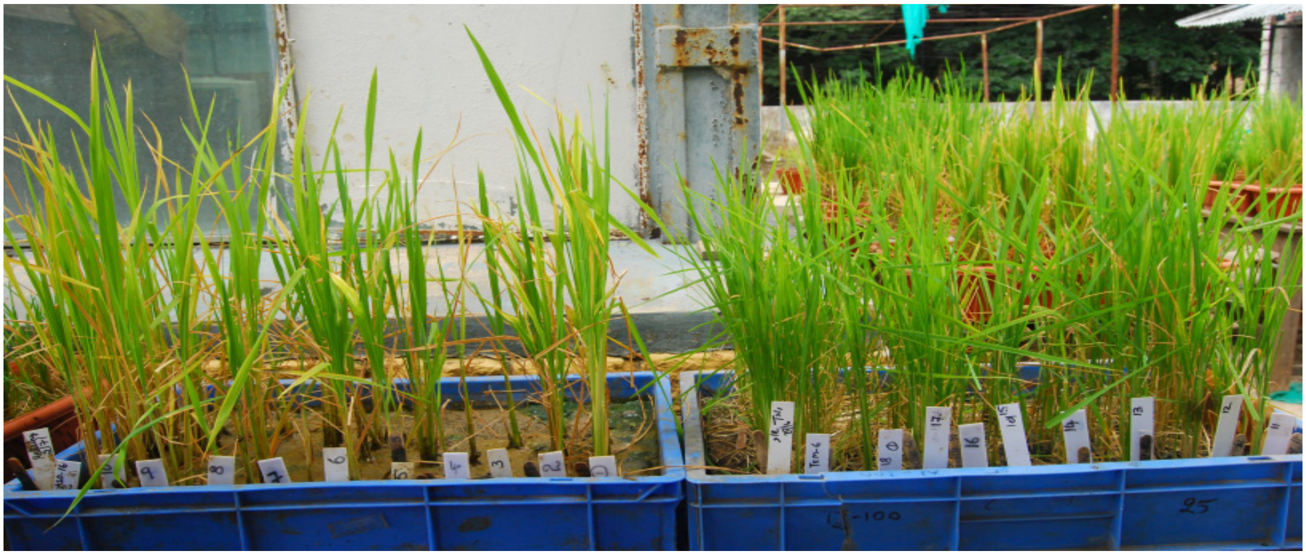
Five different methods of inoculations - Injection, spraying of inoculum, placing of the infected seed between panicle and upper leaf sheath, seed inoculation and soil inoculationwere tested. Placing of the infected seed between panicle and leaf sheath, and injection method produced the disease. The rate of increase of disease per day was more in case of injection method. The effect of major nutrients (N, P, K) and minor nutrients (Zn and Fe) on stem rot disease development was studied in pot culture. Plant inoculation was carried on susceptible cultivar MTU3626 at maximum tillering stage and PDI was recorded based on 0-9 scale. Among all the treatments, T9 (N+P+K+Zn+Fe (Double the recommended dosage of fertilizers (RDF)) recorded minimum PDI and AUDPC (7.72; 129.63 units) and T5 (N+P+Zn+Fe (-K)) recorded maximum PDI (41.36; 894.44 units) when compared to control (46.60; 1015.43 units)

Mineral nutrition on the incidence of stem rot of rice

Treatment	Per cent disease index (PDI)	Epidemic rate (Units d^{-1})	AUDPC (Units^2)
T1. NPK (Recommended dosage of fertilizers (RDF))	12.35	0.03	237.65
T2. NPK (Double the recommended dosage of fertilizers)	13.89	0.04	259.26
T3. P+K+Zn+Fe (-N)	20.99	0.11	432.10
T4. N+K+Zn+Fe (-P)	37.35	0.12	808.02
T5. N+P+Zn+Fe (-K)	41.36	0.10	894.44
T6. N+P+K+ Fe (-Zn)	14.20	0.03	272.22
T7. N+P+K+Zn (-Fe)	14.81	0.05	267.90
T8. N+P+K+Zn+Fe (Recommended dosage of fertilizers (RDF))	9.88	0.02	181.48
T9. N+P+K+Zn+Fe (Double the recommended dosage of fertilizers (RDF))	7.72	0.06	129.63
T10. Control	46.60	0.11	1015.43

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

The bioassay on genome edited and base edited homozygous mutants (18 mutants) developed at CPMB & TNAU, Coimbatore was carried out at IIRR, Hyderabad. The screening was taken up under contained conditions, using non-transgenic ASD16 and TN1 as susceptible and TKM 6 as resistant cultivar. To evaluate virus resistance, 20-day-old seedlings were used for release of two to three viruliferous insects per plant for 8 h to inoculate the virus in healthy mutant and control plants. The disease severity of each plant was scored 30 days post inoculation (dpi). For resistance evaluation, the standard evaluation method of IRRI was adopted. All the screened T_2 homozygous mutants generated from P3 and P4 constructs were either resistant (score 3) or moderately resistant (score 5). Development of tungro-specific symptoms were observed on the plants at 30 days post inoculation. Based on the symptomatic development, the reaction of the mutants and control genotypes varied from 3 to 7 score. All 18 tested mutants were either resistant (score 3) or moderately resistant (score 5). Bioassay of these homozygous mutants confirmed that targeted in-frame modifications in SVLFPNLAGKSYVV residue, specifically in the NL and YV residues are promising in imparting resistance against RTSV. Thus, the developed ASD16 mutants may serve as a suitable source of RTSV resistance and can also be used as a parent to introgress this trait to other *indica* genotypes by crossing.



Screening of ASD 16 - T_2 homozygous deletion mutants for resistance against RTSV - RTD induced symptom development at 30 days after post inoculation.

Details of the RTD score of homozygous deletion mutants in T_2 progeny

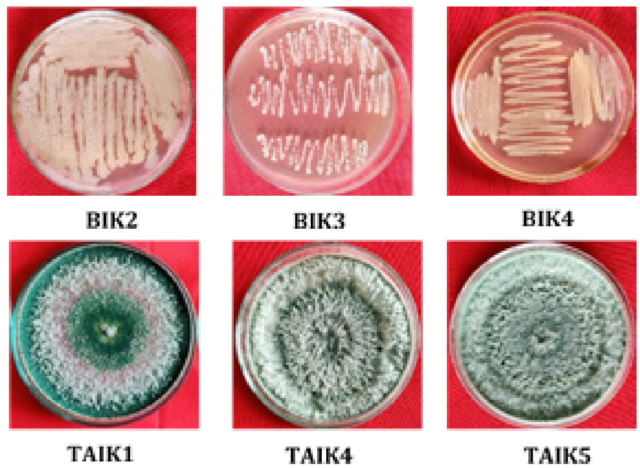
Event ID	RTD score (1 to 9 SES scale)	Event ID	RTD score (1 to 9 SES scale)
YK-ASD16-P3-10-5	3	NS-ASD16-P4-22-2	5
YK-ASD16-P3-12-1	5	NS-ASD16-P4-29-3	3
YK-ASD16-P3-15-2	3	YK-ASD16-P4-33-3	3
YK-ASD16-P3-16-1	5	YK-ASD16-P4-105-1	5
YK-ASD16-P3-17-1	5	YK-ASD16-P5-31-4	7
YK-ASD16-P3-24-1	5	YK-ASD16-P6-67-2	5
YK-ASD16-P3-82-2	5	GR-ASD16-P6-25-2	7
GR-ASD16-P3-46-3	5	ASD16	7
RR-ASD16-P3-3-7	5	TKM 6	5
NS-ASD16-P4-4-2	5	TN 1	7
NS-ASD16-P4-9-2	5		

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

Six native isolates of *Trichoderma* and *Bacillus* having potential for biocontrol and plant growth promoting activities in rice were isolated from different rice growing regions of India. These isolates were screened for their efficiency in both *in vitro* and *in vivo* conditions for about 3 years. The identity of the isolates was confirmed both by morphological and molecular characterization. Three Bacillus spp. - *Bacillus velenzensis* strain BIK2, *Bacillus cabrialesii* strain BIK3 and *Bacillus paralicheniformis* strain BIK4 and *Trichoderma* spp. -*Trichoderma asperellum* strain TAIK1, and *T. asperellum* strain TAIK5 were identified. These promising isolates were subjected for whole genome sequencing using Illumina platform. The data emanated for *Trichoderma asperellum* (TAIK1), *Trichoderma asperellum* (TAIK4), *Trichoderma asperellum* (TAIK5), *Bacillus velezensis* (BIK2), *Bacillus cabrialesii* (BIK3) and *Bacillus paralicheniformis* (BIK4) isolates had an average 100X coverage of 109X, 150X and 116X; 1447X, 905X and 585X respectively. Further studies on annotation of the data obtained in correlation with the lab and field performance of these microbes would enable them to be used in metagenomics studies to compare their performance under natural conditions.

Assembly Statistics of three *Bacillus* and *Trichoderma* isolates

Attributes/ Statistics	*Bacillus velenzensis*	*Bacillus cabrialesii*	*Bacillus paralicheniformis*	*Trichoderma asperellum*	*Trichoderma asperellum*	*Trichoderma asperellum*
Isolate	**BIK2**	**BIK3**	**BIK4**	**TAIK1**	**TAIK4**	**TAIK5**
Contigs	26	28	30	702	473	449
Largest contig	10,78,503	5,75,880	10,56,155	10,48,585	6,24,435	7,25,734
Total Length	39,00,416	41,08,741	44,18,047	3,72,93,549	3,99,77,543	3,60,36,647
N50	10,29,777	3,20,958	6,27,466	2,26,906	2,07,650	1,61,701
N75	4,40,514	1,91,033	2,26,402	1,14,355	1,07,158	87,099
L50	2	5	3	50	64	70
L75	4	10	6	109	132	144
GC%	46.52	44.08	45.47	47	48	49



Culture plates of (A) *Bacillus isolates* (B) *Trichoderma isolates*

TTI : Training, Transfer of Technology and Impact Analysis

TTT/EXT/15: Climate change and Rice Farming: Farmers Perception and Adaptation Strategies

An exploratory study on climate change and rice farming was designed to elicit the farmers' perception and adaptation strategies in Tikkamgarh district of Madhya Pradesh. Information collected through an interview schedule from 250 rice farmers covering 10 villages under the KVK operational jurisdiction where in the climate change challenges are very severe and the mitigation measures were implemented through NICRA project. The upland rice farmers perceived the climate change in terms of increase in temperature (82%), abnormal and erratic rainfall (76%) decrease in total number of rainy days (51%), increased heat wave in summer (48%), depletion of aquifers (33%) and appearance of greater number of new insect pests, disease and weeds (21%). The major adaptation measure practiced by the rice farmers to overcome the climate change were change of rice varieties (45%), planting early maturing varieties (40%), instead of transplanting, adopting direct seeding methods (38%) using drought resistant rice varieties (36%), irrigation management (28%), use of water harvesting schemes (26%) replacing rice cultivation with short duration pulse crops (19%) and selling their labour in government sponsored labour schemes (17%) particularly in the lean season or whenever the crop failed.

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

The project aims to undertake interventions like Seed smart, Technology smart, Water-smart, Nutrient-smart practices, weather-smart, Institutional /market smart activities in the selected villages and study their impact. A blend of traditional extension methods and

ICTs are being deployed to disseminate technologies to farmers. Ecological engineering interventions in the form of marigold plantation on field borders was taken up by selected farmers (23) and they earned an average income of Rs.632/- from sale of flowers (low demand due to pandemic). Demonstrations on high zinc rice variety, DRR Dhan 48 were taken up on farmers' fields (47) as nutrition smart interventions and an average yield of 24 q/acre was recorded. Nutrition information campaign and posters were designed to emphasize upon the importance of zinc in the cognitive development of children. The farmers were motivated to adopt the high zinc rice variety and include it in their daily diets especially families with small children to meet the micronutrient requirements.

The Ladder of Power and Freedom (LoPF) was worked out and women farmers were asked to rank their degree of power (P) and freedom (F) to make decisions to grow crops/varieties on a scale of one to five steps. It was observed that 40% of the women farmers placed their power and freedom to make decisions at step 2 and step 3 indicating that they had only a small amount of P&F (2). At step 3 they had the power and freedom to make some major life decisions (3). The reason attributed was the need for women to get permission from male members of the family for most of the activities.

Ecological engineering interventions on farmers' fields

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

Based on the various case studies and success stories, the Farmer Producer Organisations (FPOs) have been identified as the one of the significant approaches to accelerate the rice technology transfer. Customised intervention matrix comprising of demonstrations on IIRR technologies, Seed Production of IIRR varieties, Need-based Information sharing (through Social media and whiteboards), Rice Check Meeting, exposure visits to IIRR & other FPCs were specifically designed and undertaken. Efforts were made to undertake similar interventions with Yazali FPO (Andhra Pradesh). Profiling of the selected 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. A benchmark survey was conducted among 60 member and non-member farmers to understand and document the existing practices among the farmer members. Based on the need analysis, it was concluded to undertake evidence hub demonstration on IIRR technologies, especially bio-fortified technologies. A database on Farmer Producer Organisations is being maintained and updated.

Documenting the experiences of the FPO stakeholders

Lead Research

TTI/TTT/ECON/3: IPR-Competition interaction in Indian rice seed sector-emerging scenario- implications for enhancing quality seed use

Farmer's seed replacement behaviour was analysed using Heisy and Brennan (1991) analytical model. The key parameters like annual rate of gain in yield through research, annual rate of deterioration in yield of farmer saved seed, base yield, seed to grain price ratio, seed rate per hectare, and minimum acceptable rate of returns were deployed in the optimization model. At the currently prevailing base (average of 5 years 2013-14 to in 2017-18) yield and seed to grain price ratio, under the assumption of annual yield gain of 0.75 percent and 1.6 percent annual decline in yield potential of farmer saved seed, optimal seed replacement time ranged between 3 to 6 years across different states of India. Annual rate of gain in yield needed for optimal replacement time of 3 years ranged between 0.8 to 2.3 per cent across different states of India at seed rate of 50 kg/ha.

District wise rice varietal spread in the state of Andhra Pradesh was undertaken using three seasons data *i.e. kharif* and *rabi* 2019 and *kharif* 2020. Total number of varieties varied between 5 to 18 across 13 districts in 2019 *kharif*, but in *rabi* 2019 it ranged between 1 to12. In 2020 *kharif*, total number of varieties ranged between 4 to 16 across 13 districts. Top variety share in rice area ranged between 26 to 82 percent in 2019 *kharif* while its age ranged between 3-39 years across the districts. In 2019 *rabi* the corresponding values were 21to100 percent and 2 to 41 years across 13 districts of the state. Top variety share in rice area ranged between 30 to 88 percent across districts in 2020 *kharif* and its age ranged between 4-40 years, across the districts. Number of districts in which the top variety age was below 10 years was 2, 6 and 1 in 2019 *kharif*, 2019 *rabi* and 2020 *kharif* respectively.

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

Integrated pest management (IPM) has been accepted as the main strategy for managing pests throughout the world. A study was conducted to estimate the economics and energy efficiency of IPM in rice. The study is based on primary data collected from a sample of 155 SCSP beneficiary farmers (trained in IPM) and 40 farmers (non-beneficiaries). A total of 195 sample rice growing farmers were selected by adopting random sampling technique. Based on the energy equivalents of the inputs and outputs, the energy ratio, energy productivity, specific energy and the net energy were calculated. A comparative energy consumption pattern for IPM and Farmers' practice (FP) was estimated. Equivalent energy inputs for all input and output parameters of rice cultivation were determined from the literature. Equivalent energy inputs for biopesticides were not found to be available in the literature and were calculated for the first time on the assumption that they are inferior chemicals and hence, the energy conversion ratio was taken as 10 MJ/Kg. Results showed that the average grain yield obtained was almost similar in both the systems (4.4 t/ha and 4.6 t/ha for FP and IPM respectively). Adoption of IPM saved total energy inputs by 3324 MJ/ha. The B: C ratio for IPM and FP were 1.99 and 1.69 respectively. IPM method of rice cultivation was energy efficient (8.7) compared to the FP (8.4). The energy productivity is calculated as 0.28 kg/MJ and 0.25 kg/MJ for IPM and FP, respectively. In this study, the specific index for IPM method and FP were 3.62 MJ/kg and 4.05 MJ/kg, respectively implying that each kilogram of paddy produced by IPM method will save approximately 0.43 MJ of energy compared to the Farmers' Practice of rice production. Both the benefit–cost ratio and the energy efficiency in IPM were higher than that of the Farmers' Practice. From the results of the above study, it can be concluded that adoption of IPM in rice cultivation is economical in terms of energy and monetary net returns, in comparison to Farmers' Practice.

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

In 2021, IPM adoption study was undertaken with fifty farmers' fields in five villages in Wanaparthy district of Telangana with IPM components and DRR Dhan 48. The soil analysis of IPM fields were done using the on-farm soil testing kit of ICAR-IIRR. The soils were generally in the range of neutral pH with few exceptions, which were towards alkalinity, for which the recommendation of amending the soil with more of cow dung/ FYM was recommended to the farmers. Nutrient management of IPM fields were in accordance with soil test report. The IPM farmers adopted the following IPM components,

- Application of FYM / fertilizers as per soil test report-based recommendations
- Alleyways i.e. leaving one row after every 10 rows,
- Clipping off leaf tips during transplanting for removing egg masses of stem borer
- Planting of flowering plants on the bunds as Ecological Engineering approach for enhancement of natural enemy population
- Alternate wetting and drying

The effectiveness of spray of oils *viz*., Eucalyptus oil, Lemon grass oil, Citronella oil and Camphor oil, in the management of BPH was demonstrated in the farmers' fields in Venkatapur Village of Srirangapur Mandal. Due to the interventions, the number of sprays ranged from 0 to 1 among the trained IPM. The farmers resorted to one spray of Acephate or Chlorpyriphos for the management of BPH. The respondent farmers obtained higher yield of around 61.93 Q/ha during 2021-22 *kharif* season compared to that of 56.48 Q/ha during the previous 2020-21 *Kharif.*

On-farm soil test being done in Eraldinne village

Farmers practicing on-farm soil test in Nagasanipalle village

On-farm soil test being done in Nagasanipalle village

On-farm Soil test report along with recommendations given to farmers

Training of farmers in IPM and distribution of IPM inputs

Ecological Engineering approaches followed by farmers in Venkatapur village

TTT/CP/CA/4. Wireless Sensor Networks integrating with rice DSS model for real time advisories

Wireless weather sensors, **DS18B20** for recording temperature, **DHT22** for temperature and humidity and **weather meter kit** for wind speed and direction and rainfall along with Raspberry PI 4, solar panel and controller were fabricated for Mini weather station. Python programs were developed to publish the data collected from sensors in Google Sheets. This excel sheet was used as input file to Rice DSS for crop management advisories.

Mini weather station fabricated with Wireless weather sensors (DHT22, DS18B20 and weather meter kit)

Long term soil fertility experimental data of AICRIP, Maruteru for 7 years was used for estimating nutrient requirement using Quantitative evaluation of the fertility of tropical soils (QUEFTS) model. The treatments of single-nutrient omission plots such as +PK (N omitted), +NK (P omitted) and +NP (K omitted) were selected for computation of Accumulated (*a*) and diluted (*d*) coefficients. Internal efficiencies (IE) of N, P and K were derived and by eliminating upper and lower 2.5 percentiles of nutrient IE values *a* and *d* values were computed as *a*N=46, *a*P=124, *a*K= 35 and *d*N=98, *d*P=251, *d*K=58. Nutrient requirement at yield target of 6 t/ha was estimated. Estimated of N, P, K uptake values were 98, 32, 118 kg/ha respectively. Further these models will be integrated with Rice DSS for generating advisories on Rice crop management.

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

Statistical machine learning based genomic prediction models for genomic selection in SNP RDP rice data set has been developed. The data set has been divided into training and testing data set in the ration of 90:10. Along with the classical regression and Bayesian models, machine learning models like artificial neural network (ANN) and support vector regressions (SVR) are employed for genomic prediction in the reported period. The machine learning based models involves optimization of hyper parameters which intern leads to accuracy of genomic selection. During the reported period, the genetic algorithm is used to optimize the weights of feed forward neural network in backpropagation algorithm and also to optimize the hyper parameters of support vector machines. The developed models outperformed the classical ANN and SVR in simulated data sets. The genomic prediction models were implemented in three environments phenotypic data namely N0, N50, N

Recommended. The results reveal that ANN model has outperformed over classical regression, Bayesian, Random Forest and SVR models in both training and testing data sets. The ANN model has yielded lowest RMSE and highest correlation between actual values and GEBV's.

Along with the genomic selection models, two stage space time autoregressive moving average models for forecasting spatiotemporal rice yield data of A.P., India. The weather-based integer valued generalized autoregressive heteroscedastic and artificial intelligence models were developed to model and forecast the rice gall midge population using AICRIP light trap data sets. The artificial neural network intervention models were developed to assess the impact of policies or intervention in time series data.

Institutional Activities

Technologies Assessed and Transferred

Human Resource Development

Extension Activities

Intellectual Property Management and Revenue generation

Awards and Recognitions

Patents/Copy rights/Mobile Applications

Deputations/Linkages and Collaborations

RTI Activities

Significant Events

Personnel

Publications

Appendices

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

DRR Dhan 53

In collaboration with plant pathology, a high-yielding, fine-grain type rice variety possessing durable bacterial blight resistance, named DRR Dhan 53. It has broad-spectrum bacterial blight resistance and > 10 % higher yield as compared to Samba Mahsuri and Improved Samba Mahsuri and possessing the bacterial blight resistance genes, *Xa21, xa13, xa5* and *Xa33.* It has been released through CVRC.

DRR Dhan 54 [IET 25653 (RP 5943-421-16-1-1-B)]:

DRR Dhan 54 (IET 25653) was identified as the top-ranking entry on overall basis in multiple zones with an average yield of 5-5.5 kg/ha under aerobic conditions in multi-location testing of All India Coordinated Rice Improvement Project (AICRIP), indicating its wider adaptability and yield stability. DRR Dhan 54 was released for aerobic system of cultivation in water limiting areas of Zone II (Haryana), III (Odisha, Bihar and Jharkand), VI (Gujarat) and VII (Telangana). It is non-lodging with strong and sturdy culm, long panicles and seed to seed duration of 115-120 days. DRR Dhan 54 has multiple pest and disease resistance for major insect pests and diseases such as leaf blast, neck blast, gallmidge and rice thrips and moderate resistance to plant hoppers and stem borer and desirable grain quality traits in terms of high HRR% (65.3%), intermediate AC% (22.58%) and soft gel consistency.

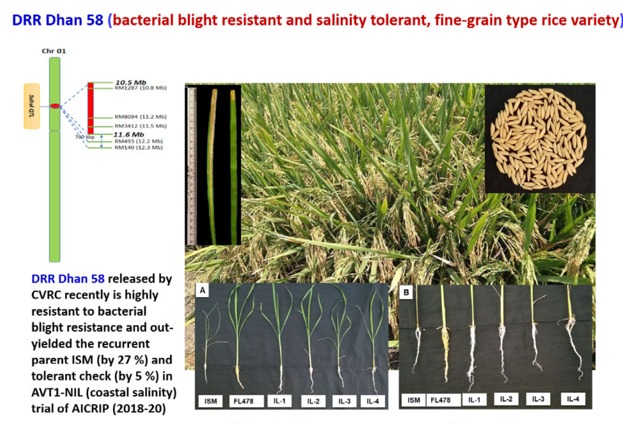
DRR Dhan54

DRR Dhan 56 (IET 26803):

An early duration variety with long slender grains was developed from the cross between Huang-Hua-Zhan*2/Phalguna as a part of Green Super Rice (GSR) for the Resource-Poor of Africa and Asia- Phase III' a collaborative project between ICAR-Indian Institute of Rice Research, Hyderabad and International Rice Research Institute, Philippines. This variety is tall erect, highly vigorous, non-lodging, non-shattering and dark green in colour. The plant comes to flowering within 89 days, plants are 102 cm tall and it produces good biomass and has long panicles. It has high head rice recovery (64.1%) and desirable intermediate amylose content (23.15%). It is resistant to leaf blast and false smut, moderately resistant to Bacterial leaf blight and tolerant to stem borer. The variety has been released for cultivation in irrigated conditions of Punjab and Haryana.

DRR Dhan 58

DRR Dhan 58, a high-yielding, fine-grain, highly tolerant variety to salinity and resistant to bacterial blight was developed. The new variety yields ~12 % more than Samba Mahsuri and Improved Samba Mahsuri in salinity-prone areas. DRR Dhan 58 has the major QTL associated with salinity tolerance and also the bacterial blight resistance genes, *Xa21, xa13* and *xa5.*



DRR Dhan 59

DRR Dhan 59, a high-yielding, long-slender grain type variety in the genetic background of Akshayadhan, resistant to bacterial blight was developed.

DRR Dhan 59 (IET27280): A high-yielding, bacterial blight resistant variety
(NIL of Akshyadhan possessing *Xa33*)

DRR Dhan 60 (IET 28061)

DRR Dhan 60 (RP 5970-2-6-19-16-24-1, IET 28061), A high-yielding, low soil phosphorous (P) tolerant, bacterial blight resistant and fine-grain type rice variety. It is a MAS derived low soil phosphorous (P) tolerant, bacterial blight resistant, high yielding and fine-grain type rice culture developed in the genetic background of a very popular bacterial blight resistant rice variety, Improved Samba Mahsuri by using Swarna as donor for *Pup 1* QTL. It is possessing three major bacterial blight resistance genes, *Xa21+xa13+xa5* and the major QTL/gene associated with low soil phosphorous tolerance, *Pup1* and has seed to seed maturity of 125-130 days and gives a maximum yield of 5.19 t/ ha (under 60 kg/ha of P) and 4.8 t/ ha (under 40 kg/ha of P). Since, IET 28061 has tolerance to low soil P conditions, therefore it has potential to make inroads to low-input rainfed areas of Eastern part of the country and will offer a good alternate to the farmers and will help the farmers not only by way of reduced cost of cultivation but also by fetching good prices in market.

DRR Dhan 60 (bacterial blight resistant and low soil P tolerant, fine-grain type rice variety)

DRR DHAN 60

DRR Dhan 62 (RP 6286-Bio Patho 5-156-24-7; IET 28804), a high-yielding, durable blast and bacterial blight resistant, fine-grain type rice variety was released by CVRC, 2021 for commercial cultivation

DRR Dhan 63 (IET 26383)

DRR Dhan 63 (IET 26383) is a high yielding biofortified rice variety possessing high Zn (24.2 ppm) in polished grains as against 16-17 ppm existing in popular rice varieties. It is a semi-dwarf medium duration variety (127 to 130 days) possessing short bold grains. This variety was released and notified by the Central Sub-Committee on Crop Standard Notification and Release of Varieties for Agricultural Crops Govt. of India vide gazette notification number S.O.8 (E) dt 24th December, 2021 for commercial cultivation in irrigated areas of Uttar Pradesh & Odisha (Zone III) and Kerala (Zone VII). In AICRIP trials of biofortification conducted during 2016-2018, it recorded an average grain yield of 5t/ha which is 18.5% and 9.1% higher than the national yield checks *ie.,* IR64 & BPT-5204 respectively while displayed average Zinc content of 24.2 ppm in polished grains which is 11.5% and 14.2% higher than national yield checks, IR64 & BPT-5204 respectively. It has excellent grain and cooking quality characteristics *i.e.,* high milling recovery (70%), high head rice recovery (59.3 %), intermediate amylose (24.5%), intermediate ASV (4), soft GC (23 mm) with very occasionally chalky.

Field view of DRR dhan 63 (IET 26383)

Genetic stocks

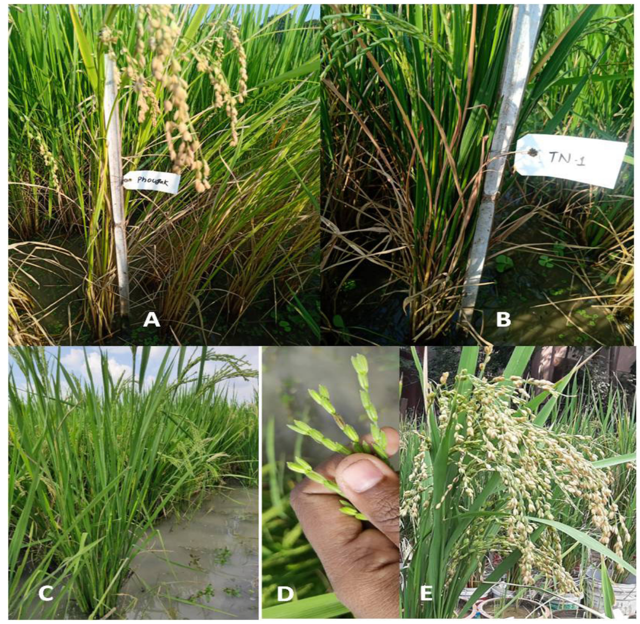
- **RP 5690-20-6-3-2-1 (INGR21176)**- germplasm line was registered as a genetic stock for its dual donor trait possessing resistance to Brown planthopper and White backed planthopper during seedling and reproductive stages of crop growth. The breeding line, RP 5690-20-6-3-2-1 has durable resistance against BPH and WBPH possessing the genes *bph4*, *Bph9*, Bph 17 and *Bph32* genes for BPH resistance; and *wbph9* & *wbph10* genes for WBPH resistance.

RP 5690-20-6-3-2-1 of Rice (INGR21176) during field screening in hotspot areas against planthoppers

- **Wazuhophek (21091; IC0639795 INGR21112)**-North eastern landrace registered as genetic stock with potential valuable features as 'tolerance to sheath blight and low soil P tolerance) (V Prakasam*, Jyothi Badri, RM Sundaram, C Priyanka, GS Laha, MS Prasad, VP Bhadana, Ravindra Kale, Mahadeva Swamy KH, Anila M, Anantha MS and LV Subba Rao) A rice line from NE India, named Wazuhophek has been identified to possess tolerance to low soil phosphorus conditions and also against sheath blight disease and has been registered with ICAR-NBPGR as novel germplasm with ID # 21112. Wazuhophek has been identified to possess novel, non-*Pup1* type tolerance to low soil phosphorus. A major QTL hotspot associated with multiple tolerance-associated traits has been identified on Chr. 8 with the help of SSR markers. Further, Wazuhophek has also been identified to possess a major QTL associated with sheath blight tolerance, located on Chr. 3. These two major QTLs can be transferred to elite, low soil P sensitive and sheath blight susceptible varieties through marker-assisted selection.

Field screening of sheath blight disease during *Kharif*, 2019; A. IR-50-susceptible check; B. Wazuhophek – tolerant land race; TN1-susceptible check and D. Tetep-tolerant check

- **Phougak (D82) (21087; IC0 639794 INGR21093)**-North eastern landrace was registered as novel germplasm with ICAR-NBPGR with ID # 21093. It has potential valuable features such as 'tolerance to sheath blight, resistance to neck blast and resistance to leaf blast.



Inoculated Phougak with least lesions, B. Inoculated TN1-highly susceptible, C. F_1 plant between BPT5204/Phougak, D. Panicle clustering in F_1 plant, E. Clustered panicle in Phougak

Resistance to leaf blast under UBN-2020 in Phougak 2b. Grain

- IET 25443 (INGR21118) : A germplasm line of rice, named RP25443 has been identified to have a higher level of grain zinc and has been registered with ICAR-NBPGR, New Delhi with ID # 21118. It possesses micronutrient Zn – 22.6 ppm and Fe – 3.36 ppm in polished rice grain.

- Breeding lines in the genetic background of Improved Samba Mahsuri and MTU1010 possessing the major bacterial blight resistance genes, *Xa21* + *xa13* + *xa5* and *Xa33*, blast resistance genes, *Pi2* + *Pi54*, low P tolerance QTL, *Pup1* along with yield-enhancing genes, *Gn1a*, *SCM2* and *OsSPL14* have been developed and validated through AICRIP trials 2020. These lines can serve as novel donors for resistance/tolerance.

- Low seed phytate mutants-Nagina 22 EMS mutants showing lesser accumulation of phytic acid.
- CRISPR/Cas gene editing constructs for high yield and disease-resistant traits in rice.
- Eighteen isolates of Rhizoctonia solani ITS region was sequenced and submitted to NCBI- Genbank. Accession numbers were Viz., MZ566497, MZ566473, MZ563462, MZ563372, MZ563000, MZ562955, MZ562893, MZ562887,MZ558753, MZ558749, MZ558724, MZ558549, MZ558547, MZ558529, MZ558502, MZ558500, MZ558498 and MZ558435.
- Field of the world: field locations for rice crop in India. Developed with Agrimetrics, Rothamsted Campus, Harpenden (UK) through DST-ICRISAT project. https://agrimetrics.co.uk/
- The draft genome of YSB was sequenced and predicted to have 46,057 genes with an estimated size of 308 Mb. The existence of complex metabolic mechanisms and genes related to a specific behavior, possible visual, olfactory, and gustatory mechanisms responsible for its evolution as a monophagous pest were determined. The presence of high-immunity-related genes, well-developed RNAi machinery, and diverse effectors provides a means for developing genomic tools for its management. The identified 21,696 SSR markers can be utilized for diversity analysis of populations across the rice-growing regions. The YSB genome assembly has been deposited in the National Center for Biotechnology Information (NCBI) as BioProject PRJNA558851.

HRD

S. No	Name of the Training	Sponsored by/Date	Number of Participants
1.	Certified Farm Advisor Course on Sustainable Rice Production Technology (Virtual mode) 15 days	MANAGE, Hyderabad 27th Jan - 10th Feb 2021	12
2.	3 days training on Rice Production Technology	ATMA, Valsad, Gujarat 10 -12 Feb 2021	22
3.	3 days program on Sustainable Rice Production technology	SCSP-CRIDA, Hyderabad 23-25 Feb 2021	20
4.	3 days training on Rice Production Technology	ATMA, Valsad, Gujarat 03-05 March 2021	22
5.	One day Exposure visit cum Training on Rice Production Technology for Tribal farmers	KVK Bellampalli 04 March 2021	19
6.	3 days program on Sustainable Rice Production Technology	SCSP-CRIDA. Hyderabad, 16-18 Mach 2021	20
7.	3 days program on Sustainable Rice Production Technology	SCSP-CRIDA, Hyderabad 8-10 March 2021	18
8.	One day programme on “Climate resilient technologies, practices, awareness for farmers	28 September 2021	33
9.	One day programme on “Rice Production Technology”	11 November 2021	27
10.	One day Training on Rice Production Technology	ATMA, Ranga Reddy, district	26

Farmers’ training programs

Training program on management of zinc deficiency in rice fields was organized on January 28, 2021 at Deverkonda under the DST-Sponsored project, Technological empowerment of tribal farm women. Chelated zinc was distributed for spray as zinc deficiency was observed in some farmers’ fields in Achamma kunta Tanda and Korra tanda. Eco-entrepreneurship development through vermicompost preparation was promoted among tribal farm women and these units were monitored.

On-campus training on Sustainable Rice Cultivation Practices for rural youth

A one-day on campus training program on Sustainable Rice Cultivation Practices for rural youth undergoing vocational training at Dr. D. Rama Naidu Vignana Jyothi Institute of Rural Development, Tuniki, Andhra Pradesh was organized on November, 20, 2021 at IIRR.

Trainings attended by Scientific Staff

Scientific Staff			
Scientist	**Programme name**	**Organizers**	**Duration**
Dr. Anantha M S	Understanding the implementation of genomic selection in a modern breeding set-up using available genotypic and phenotypic datasets and analyses of pipeline	International Rice Research Institute South Asia Hub, ICRISAT, Hyderabad	28 October 2020 to 27 January 2021
Dr. Anantha M S	Breeding innovations for crop improvement to enhance genetic gains	IRRI South Asia Regional center	20 October 2021-16 November 2021
Dr. Divya Balakrishnan	Creating awareness about Intellectual Property Rights protection for the start-Ups and entrepreneur in Agri horti sectors	College of Horticulture and Forestry, Central Agricultural University (Imphal), Pasighat, Arunachal Pradesh, under Institutional Development Plan of National Agricultural Higher Education	26 - 27 March 2021
Dr.. Divya Balakrishnan Dr. D. Ladhalakshmi	Molecular data analysis through Bioinformatics tools	Department of Molecular Biology and Biotechnology S.V Agricultural College, Tirupati Acharya NG Ranga Agricultural University	01-10 November 2021
Dr. Fiyaz RA	Breeding Innovation for Crop Improvement to Enhance Genetic Gains	IRRI, Philippines ISARC	20 October - 16 November 2021
D Fiyaz RA Dr. Suvarna Rani Chimmili	Sensitization of AICRIP and Modern Breeding Techniques in Rice	Department of Plant Breeding, Crop Improvement, ICAR-IIRR	14 -15 September
Dr. Suvarna Rani Chimmili	Sensitization Programme on Entrepreneurship Development & Start-up Ecosystem	ICAR-National Academy of Agricultural Research Management, Hyderabad	05 - 09 July 2021
Dr. Kalyani M Barbadikar Dr. Suvarna Rani Chimmili	Hands–on training on CRISPR/ CAS9 mediated gene editing in plants	SERB Sponsored Workshop Department of Plant Sciences, University of Hyderabad	03-10 October 2021
Dr. Padmavathi Ch	Hands-on Training on the Use of Advanced Tools in Pest and Disease Predictive Modelling	UAS, Bangalore & ICRISAT, Patancheru, Hyderabad	01-05 March, 2021
Dr. AS Hari Prasad	MDP on Priority setting, Monitoring and Evaluation of agricultural research projects	NAARM, Hyderabad	25-30 October 2021
AS Hari Prasad	International Training Webinar on Hybrid Rice Seed Production & Marketing	CIMMYT Nepal	16 September 2021
Dr. Senguttuvel P	Analysis of multilocation experiments	NAARM, Hyderabad	28th October- 1st November 2021
Dr. Senguttuvel P	Advances in hybrid rice breeding	ATPBR	27-29th September 2021

Scientific Staff			
Dr. Senguttuvel P	International training programme on Hybrid rice seed production and marketing	National Rice Research Program/ Nepal Agricultural Research Council (NRRP/NARC), International Maize and Wheat Improvement Center (CIMMYT), Seed Entrepreneurs Association of Nepal (SEAN)	16-17 September 2021
Dr. Senguttuvel P	National workshop on bridging yield gaps to enhance food grain production: a way forward	TAAS, CGIAR, ICARDA, and IRRI	26 August 2021
Dr. DVK Nageswara Rao	Advances in Web and Mobile Application Development	ICAR-National Academy of Agricultural Research Management, Hyderabad	06-10 December 2021
Dr. Bandeppa	Modern Crop production techniques in Rice - Importance of Data collection and coordination in AICRIP		22-23 October 2021
Dr. Bandeppa	Alternate Cropping Systems for Climate Change and Resource Conservation	ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Udhagamandalam	29 September - 01 October 2021
Dr. Manasa V	Biodiversity and Environmental Laws for Agricultural Integrated Nutrient Management and Nutrient Budgeting through Advanced models to improve Crop Productivity		18 – 22 January 2021
Drs. C N Neeraja and Kalyani M Barbadikar	Training workshop on Genome-Wide Association Studies in Bengal and Assam	University of Aberdeen under the UKRI-GCRF SANH project	07-11 June 2021
Dr. SK Mangrauthia	Biosecurity and Biosafety: Policies, Diagnostics, Phytosanitary Treatments and Issues	ICAR-National Bureau of Plant Genetic Resources (NBPGR)	15- 24 September 2021
Dr. M.S Madhav	Science Administration and Research Management	ASCI	13-24 December 2021
Dr. Kalyani M Barbadikar	Breeding Innovation for Crop Improvement to Enhance Genetic Gains	IRRI South Asia Regional Center	20 October - 16 November 2021
Dr. Kalyani M Barbadikar	Understanding and Filing Intellectual Property Rights	Schollwell Edu Tech	27-28 January 2021
Dr. Santosha Rathod	Transcriptomic Data Analysis	Centre for Agricultural Bioinformatics, ICAR-IASRI, New Delhi	28-30 September 2021
Dr. Santosha Rathod	Training workshop on online training program on Transcriptomic Data Analysis	Centre for Agricultural Bioinformatics, ICAR-IASRI, New Delhi	28-30 October 2021
Dr. Amtul Waris	Creativity in Innovation Management & Research	ESCI, Hyderabad under Women Component DISHA (DST sponsored)	22 - 26 November 2021
Dr. Amtul Waris	Women and Work: Making it Count (certificate course)	Institute of Social Studies Trust organized by Institute of Social Studies Trust, New Delhi	24 September - 10 December 2021
Dr Santosha Rathod	online training program on Transcriptomic Data Analysis	Centre for Agricultural Bioinformatics, ICAR-IASRI, New Delhi	28-30 September, 2021

Scientific Staff			
Dr Santosha Rathod	Analysis of Multi-Location Data	ICAR-NAARM, Hyderabad	October 28-01 November, 2021
Dr GS Laha	Online Training Workshop for Vigilance Officers of ICAR Institutes	ICAR-NAARM, Hyderabad	16-18 August, 2021
Non-Scientific Staff			
Mr. S. Amudhan (ACTO, Entomology	E Governance-Applications in ICAR	IASRI	6-10 Sept, 2021
Mr. S. Amudhan (ACTO, Entomology Mrs. K. Padmaja (STO, Soil Science)	Life skill enhancement and personality development	IARI	16-20 Nov, 2021
Mr. K. Shravan Kumar (TO, Entomology) Y. Roseswar Rao (TO, Pl. Pathology) K. Ramulu (TO, Pl. Physiology)	Appropriate Sampling Techniques Including Sample preparation and preservation for Soil, Water, Plant and Air samples for various Analyses	IARI	2-7 August,2021
Mr.S. Sadanandam Mr. Bharatraju	Training program on repair and maintenance of office buildings		10-12 August 2021
Mr. Bharathraju	GEM Training	Ni-MSME	28-30 July 2021
Mr Navneet Kumar	virtual training on Accrual Accounting	NRRI -Cuttack	22- 26 Nov, 2021
Mr. Ashfaq Ali Mrs. S Hemalatha	GEM Training	Ni-MSME	28-30 July 2021

Intellectual Property Management and Transfer/Commercialization of agricultural technology

Memorandum of Agreement (MOAs) and Memorandum of Understanding (MOUs) signed

- An Agreement signed between Valagro Biosciences Private Limited on 23.09.2021 to carry out the evaluation of the products for field development trials with at otal out lay of Rs.11,20,560/-.
- Memorandum of Understanding (MOU) was signed on 22.10.2021 for licensing ICAR-IIRR developed rice line INGR15002 with M/s Savannah Seeds Pvt Ltd on non-exclusive basis for their research purpose and received Rs.1,50,000/- as licence fee.
- INGR15002 developed in the background of PR114 with resistance to leaf blast and neck blast and found that it carries novel blast resistance genes i.e., Pi68. The DRR-BL-31 line has been registered as INGR15002 by Plant Germplasm Registration Committee (PGRC) of Indian Council of Agricultural Research on April 21, 2015. The unique line (INGR15002) having Pi68 offering the leaf and neck blast resistance was licensed to M/S Ankur seeds, M/S Sriram Bio seeds and M/S Savannah Seeds Pvt Ltd and generated revenue of Rs 4.50 Lakhs
- A MOU was signed on 28.10.2021 between ICAR-IIRR and ITC eChoupal for Evaluation of Farmers Acceptance of New IIRR varieties & technologies for enhancing the rice production.
- MOUs were also signed for academic collaboration with Chaudhary Charan Singh University, a public state university located in Meerut, Uttar Pradesh, India, Malla Reddy University, Hyderabad, Telangana and Yogi Vemana University, Idupulapaya, Andhra Pradesh.
- Material Transfer Agreement (MTA) was signed

on 03.08.2021 between National Institute of Plant Genome Research (NIPGR), New Delhi, ICAR-Indian Institute of Rice Research (IIRR), Hyderabad and ATGC Biotech Pvt Limited in connection with the transfer of material as part of the ongoing DBT project titled “Imparting sheath blight disease tolerance in rice”. The NIPGR, New Delhi will supply the E. coli and ATGC, Hyderabad will formulate the protein from E. coli and ICAR-IIRR institute will evaluate the protein.

- MTA signed on 03.08.2021 between ICAR-Indian Institute of Rice Research (IIRR), Hyderabad and ATGC Biotech Pvt. Limited, Hyderabad in connection with the transfer of Antagonistic fungi and its metabolite for formulation of antagonistic microbes and their secondary metabolites under collaboration work.

Revenue Generation

An amount of Rs. 189 Lakhs was received through testing of varieties and hybrids, contractual services for the evaluation of breeding lines for quality, diseases, insects and also assessing the efficacy of new molecules/chemicals.

Revolving Fund

IIRR is actively involved in production of quality seed in research farms and farmers’ fields and supplying it to Pvt. Seed companies, Govt. seed agencies and also to farmers earning huge revenue. A profit of Rs. 8.01 lakhs was generated for the financial year 2020.

Externally funded projects

Eight new externally funded projects have been sanctioned during 2020 (Appendix 5) with a budget outlay of 311 lakhs. A total of 45 externally funded projects are currently being handled at the Institute (Appendix 6).

Awards & Recognitions

- Dr. R.M. Sundaram was elected and inducted as a Fellow, National Academy of Sciences, India (2021 onward).
- Dr. R.M. Sundaram was elected as President, Society for Advancement of Rice Research, Hyderabad (2021 onward).
- Dr. R.M. Sundaram was nominated as the Outside Expert for Institute Biosafety Committee of M/s JK Seeds by Department of Biotechnology, Govt. of India (2021 onward)
- Dr. R.M. Sundaram was nominated as the member of Institute Management Committee of ICAR-NIASM, Baramati (2021 onward)
- Dr. R.M. Sundaram was elected as a EC member of Hyderabad Regional chapter of Indian Society of Genetics and Plant Breeding (2021 onward).
- Dr. R.M. Sundaram was elected and inducted as a Fellow, National Academy of Agricultural Sciences (2019 onward).
- Dr. R.M. Sundaram was elected as Vice-President, Association of Rice Research Workers, India (2019 onward).
- Dr. R.M. Sundaram was selected as Executive Council Member-Federation of Asian Biotech Associations (2019 onward).
- Dr. R.M. Sundaram was selected as Executive Council Member-Agri Biotech Foundation,

Hyderabad (2019 onward).

- Dr. R.M. Sundaram was selected as Member, Expert Committee of APEDA funded projects operated by International Rice Research Institute, Philippines
- Dr. M.S Madhav is serving as Editor/Academic Editor of PLoS One, BMC Plant Biology and Annals of Genetics
- Dr. M.S Madhav was elected and inducted as a Fellow, Royal Society of Biology (P0143407; UK, London) (2022)
- Dr. P. Revathi, Senior Scientist (Plant Breeding), Hybrid Rice-Crop Improvement Section, IIRR, Hyderabad successfully completed ICAR-Post Doctoral Fellowship (PDF) on 11th October, 2021 under mentorship of Dr A. K. Singh, Director, Division of Genetics, IARI, New Delhi
- Dr. P Revathi was nominated by the Indian Society of Plant Breeders (ISPB) as editorial board member of peer reviewed journal "Electronic Journal of Plant Breeding" (NAAS ratings 5.14) for the year 2021-22
- Dr. Sailaja B served as a Jury member for "Virtual Two-day National Level 24 hours Hackathon (VJ Hackathon) on Victory & Joy in Smart Innovations in the domains: Agriculture, Healthcare and Cyber Security" organized by Department of CSE in collaboration with CSI funded by AICTE under SPICES, VNR VJIET, Hyderabad during 29th -30th October, 2021.
- Dr. Jyothi Badri and Dr. Divya Balakrishnan were selected as invited editors in the Journal Frontiers in Genetics.
- Best Oral presentation Award for the paper "Prakasam V., C Priyanka, K Chakrapani, D. Ladha Lakshmi, G. S. Laha, C. Kannan, D. Krishnaveni, K. Basavaraj, G. S Jesudasu and M. Srinivas Prasad (2021). Oral presentation on Potentiality of new fungicide Mefentrifluconazole 400 g/l SC to curtail sheath blight and grain discoloration of paddy. National e-congress on Plant health and food security: challenges and opportunities, March 25-27, 2021

- Dr. Jyothi Badri received Dr. KS Behera best paper Award on 17th Dec., 2021 during ARRW Diamond Jubilee National Symposium on "GenNext Technologies for Enhanced Productivity, Profitability and Resilience of Rice Farming" from 16-17th Dec 2021 organized by Association of Rice Research Workers (ARRW), Cuttack, Odisha for the paper entitled "Genetic analysis of dormancy and shattering traits in the backcross inbred lines derived from *Oryza sativa* cv. Swarna / *O. nivara* Ac. CR100008" published in Vol. 57 No. 1, 2020 (1-13) of *ORYZA*.
- Dr. R. Mahender Kumar, Principal Scientist, ICAR - IIRR, was awarded Fellow of Indian Society of Agronomy on November 24, 2021.
- Dr. Mangaldeep Tuti, Scientist, ICAR - IIRR was awarded Associate Fellow of Indian Society of Agronomy on November 24, 2021.
- Dr. Santosha Rathod was conferred the Outstanding Achievement Award in the field of Agricultural Statistics and Best Oral Presentation award for Presentation entitled "Modelling and Forecasting of Rice Yield Using Hybrid Spatiotemporal Time Series Approach" during 3rd International Conference (Hybrid Mode) on Food, Agriculture and Innovations during 24-26 December, 2021.

ICAR – IIRR, Hyderabad, Annual Awards for Best Research Paper, 2021

Category	Name of the publication	Authors
Crop Protection	Characterisation of resistance to rice leaf folder, Cnaphalocrocis medinalis, in mutant Samba Mahsuri rice lines" Published in Entomologia Experimentalis et Applicata 02 July 2021.	Sumalatha Javvaji, Uma Maheswari Telugu, Ramana Damarla Bala Venkata, Maganti Sheshu Madhav, Santhosha Rathod, Padmavathi Chintalapati
Social Science	"Two Stage Spatiotemporal Time Series Modeling Approach for Rice Yield Prediction & Advanced Agroecosystem management" Published in Agronomy. 2021; 11(12):2502	Rathod S, Saha A, Patil R, Ondrasek G, Gireesh C, Anantha MS, Rao DVKN, Bandumula N, Senguttuvel P, Swarnaraj AK, Meera SN, Waris A, Jeyakumar P, Parmar B, Muthuraman P, Sundaram RM.
Crop Production	Effect of different cooking methods on loss of iron and zinc micronutrients in fortified and non-fortified rice, Saudi Journal of Biological Sciences, (2021) https://doi.org/10.1016/j.sjbs.2021.02.021.	M. Mohibbe Azam, S. Padmavathi, R. Abdul Fiyaz, Amtul Waris, K.T. Ramya, Chirravuri N. Neeraja
Crop Improvement	PAP 90, a novel rice protein plays a critical role in regulation of D1 protein stability of PSII. Journal of Advanced Research 30 (2021): 197–211.	M. Raghurami Reddy, Satendra K. Mangrauthia, S. Venkata Reddy, P. Manimaran, Poli Yugandharb, P. Naresh Babu, T. Vishnukiran b, D. Subrahmanyam, R.M. Sundaram, S.M. Balachandran

Copy Right

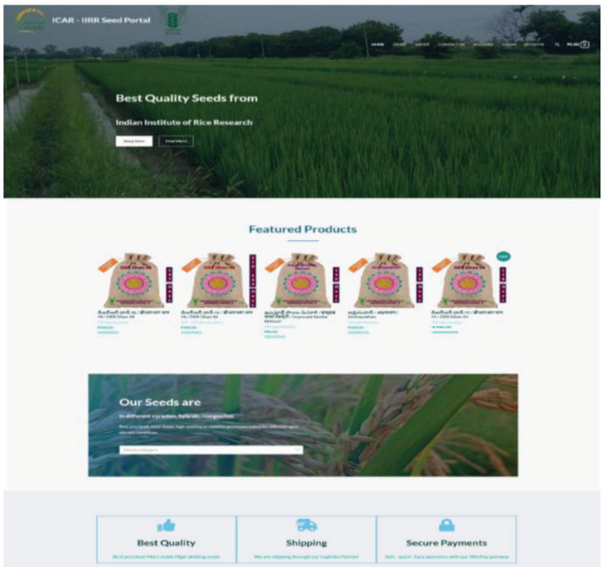
- Copy right (SW-14256/2021) received as a team for the development of IIRR Geoportal on disease distribution maps of blast, bacterial blight, sheath blight and false smut disease.
- IIRR Geoportal- http://www.iirr-geoportal.in (Copyright No. SW-14256/2021)
- A Web based Photothermic Indexing (PTI) Calculator For Rice Genotypes - https://icar-iirr.org/index.php/services/rue-pti-calculator (Copyright No. SW-14313/2021)
- A Mobile App on IIRR Profile in English - https://play.google.com/store/apps/details?id=in.iirrmobapp.hava.myapp5_4_18 (Copy right No. SW-14289/2021)
- Patent filed: Azam MM, Surekha K, Tuti MD, Kumar M, Amtul Waris, and Fiyaz AR. (2021). Method for preparation of stabilizer free silicic acid for foliar application and formulation thereof. Indian Patent Application Number 202141061758 dated 30/12/2021.

Copyrights received during 2021

Portals/Websites/Mobile Apps

- ***IIRR Seed Portal (https://www.iirr-seedportal.in)***

  Seed is the most important basic and critical input required for Rice Production. The responses of all other inputs depend on quality seeds to a large extent. The use of modern improved varieties or hybrids increase yield to still higher level. Many varieties/hybrids have been developed by Indian Institute of Rice Research for rice cultivation suiting to the need of the famers. To facilitate seed procurement online, IIRR seed portal has been developed and hosted at https://www.iirr-seedportal.in).

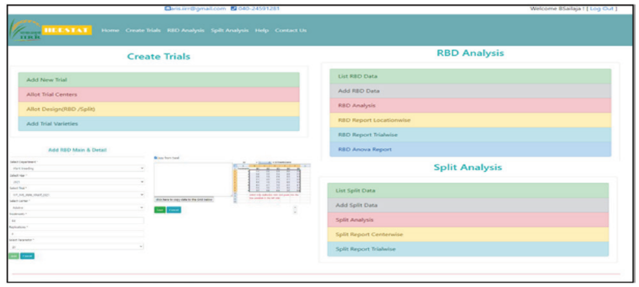


Home page of IIRR Seed Portal

IIRRSTAT (http://14.139.94.107:8084/)

IIRRSTAT – a web based statistical package has been developed to analyse multilocational experimental data of Random Block and Split plot designs and generate reports along with CD, CV and statistical significance in excel format. This software is upgraded version of DRRSTAT developed during 2004 for RBD and SPLIT plot designs. Standalone version i.e DRRSTAT requires MS Access package and need of installation of software. DRRSTAT has been successfully used for AICRIP data analysis for 15 years.

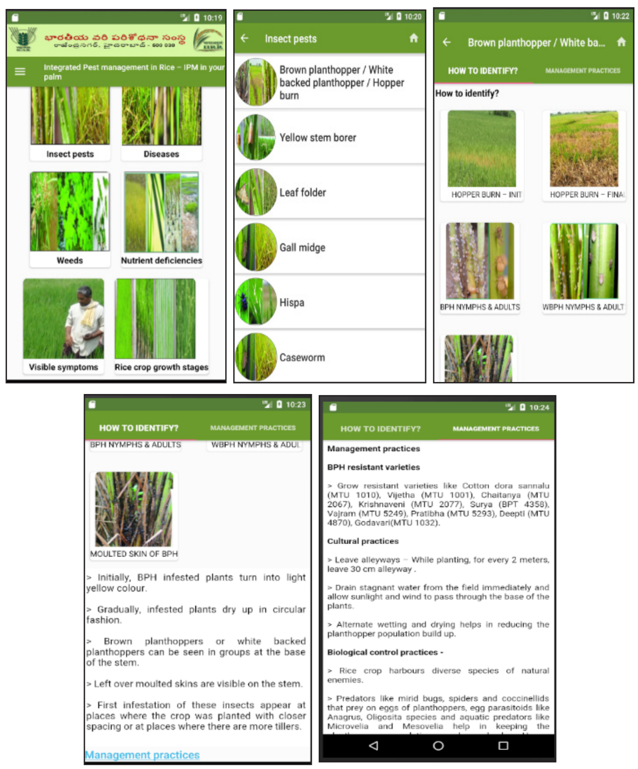
- All the features available in DRRSTAT were covered in IIRRSTAT with new features like copy and paste data from Excel files (Excel Interface) and generate reports to Excel. This is very user friendly and easy data entry than the old version. Users can register in the site and experience the ease of analyzing the experimental data. This package is presently available at the URL http://14.139.94.107:8084/.



Home page and RBD and Split Analysis user interfaces of IIRRSTAT

Rice IPM Mobile App in English Language

Rice IPM app was developed in Telugu language and uploaded in Google play store during 2019. The content of app was translated to English language and app was developed in English for further translation to Hindi and other local languages to reach farmers in different rice growing regions.



Rice IPM Mobile App screens

Deputations

- Dr. Shaik N Meera, Principal Scientist is continuing ain the post of Senior Technical expert on Digital Agriculture and extension system at International Fund for Agriculture development (IFAD) at Cairo, Egypt during 2021.

RTI Activities

- Totally 8 queries and one appeal were received through RTI portal and answers were uploaded within the stipulated time**.** Quarterly and Annually RTI returns were submitted in CIS and RTIMIS portals
- Annual Transparency Audit document (self-appraisal) was prepared
- Frequently asked Questions (FAQs), RTI manuals and transparency audit documents were uploaded in IIRR website at https://icar-iirr.org/index.php/about-iirr/rti

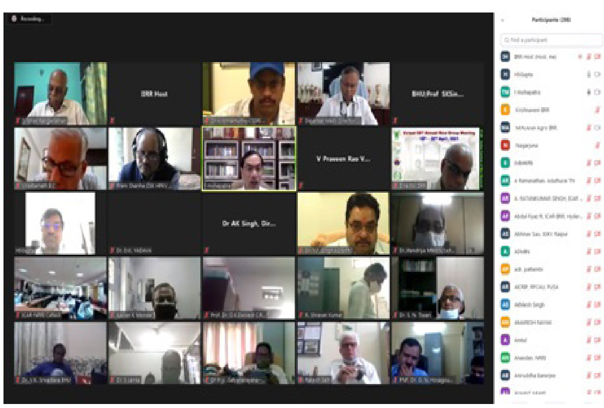
Important Institutional Meetings

Annual Hill Rice Research Group Meeting

The 8th Annual Hill Rice Research Group Meeting was held during 24-25th February 2021 at ICAR-IIRR, Hyderabad in virtual mode under the chairmanship of Dr. T R Sharma, DDG (Crop Science) ICAR. Dr Y P Singh, ADG (FFC) ICAR, Co-chaired the session. After remarks of Dr. D Subrahmanyam, Director (ICAR-IIRR), Dr. AVSR Swamy presented the action taken report of 2019 workshop and results of AICRIP Kharif 2020 of Hill ecology. Various cooperating centers under Hill ecology presented progress made during 2020.

56th Annual Rice Group Meeting (ARGM)

The 56th ARGM was held during 8-15th April 2021 in virtual mode and attended by Dr. Trilochan Mohapatra, Honorable Secretary, DARE and DG, ICAR and other dignitaries. Dr. D. Subrahmanyam, Director (A), ICAR-IIRR welcomed the dignitaries and delegates of AICRIP, QRT, RAC, IRRI and private seed industries. Dr. D. K. Yadava, ADG (Seed) stressed the importance of the AICRIP system in India's rice research. Dr. Y. P. Singh, ADG (FFC) appreciated all the AICRIP cooperators for the excellent conduct of the trials in spite of the COVID pandemic situation. Prof. H. S. Gupta, Retd. Director, ICAR-IARI and Chairman QRT (ICAR-IIRR) cited that 391 varieties including 75 rice hybrids of having the potential in boosting rice production under climate change conditions were released through AICRP during the last eight years. Dr. Trilochan Mohapatra, Honorable Secretary, DARE and DG, ICAR appreciated the efforts in carrying out the AICRIP work despite the pandemic situation. Dr. Y. P. Singh thanked Hon'ble Director General for



his in-depth analysis and discussion. Two technical sessions were organized to present the consolidated results of AICRIP trials conducted during 2020 and to finalize the technical program for 2021.

A special session on the IRRI-ICAR collaborative program was held on 20th April 2021 followed by a presentation on 'Impressions and Recommendations of QRT by Dr. H. S. Gupta.

Expert Committee Meeting on Revisiting AICRIP Guidelines

The first meeting of the expert committee on revisiting some of the AICRIP guidelines for evaluation of entries was held in virtual mode on 28th April 2021 under the chairmanship of Dr. J.P. Tandon, Former ADG (F&FC), ICAR, New Delhi. The members of the committee were Dr. D.K. Yadava, ADG (Seeds), ICAR, New Delhi, Dr. A.K. Singh, Director, ICAR-IARI, New Delhi, Dr. Navtej Singh Bains, Director of Research, PAU, Ludhiana, Dr. R.M. Sundaram, Director, ICAR-IIRR, Hyderabad, Dr. AVSR Swamy, Principal Scientist, ICAR-IIRR, Hyderabad, Dr. Jogi Naidu, Associate. Director, RARS, ANGARU, Maruteru, A.P., Dr. B.C. Viraktamath, former Director, ICAR-IIRR, Hyderabad, Dr. S.R. Das, Retd. Professor, OUAT, Bhubaneswar, Dr. S.K. Pradhan, Principal Scientist, ICAR-NRRI, Cuttack and Dr. A.S. Hariprasad, Principal Scientist, ICAR-IIRR, Hyderabad. An eleven-point agenda was formulated with existing practice and suggested modifications for further discussion in the next meeting.

Varietal Identification Committee Meeting

Varietal Identification Committee (VIC) Meeting in virtual mode was held on 8th June 2020 under the chairmanship of Dr TR Sharma, DDG (Crop Science), ICAR. All the 38 proposals, including 32 varietal entries and 5 hybrid entries were critically examined for their overall, zonal and state yield performance over the years, reaction to biotic/abiotic stresses, performance in agronomic trials and quality features. A total of 26 entries including 23 varietal and 3 hybrid entries were identified and recommended for CVRC and two other hybrids for SVRC release.

87th Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops (CVRC) meeting

The 87th meeting of Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops held through Video Conferencing on 22nd September, 2021 and 18th October, 2021 under the Chairmanship of Dr. T.R. Sharma, Deputy Director General (Crop Sciences), Indian Council of Agricultural Research (ICAR) and Co-Chairman Dr. S.K. Malhotra, Agriculture Commissioner, Govt. of India. The Sub-Committee approved and recommended 26 varieties/hybrids for release and notification through CVRC and notification of 46 state varietal/hybrid releases. Further, Telangana Sona

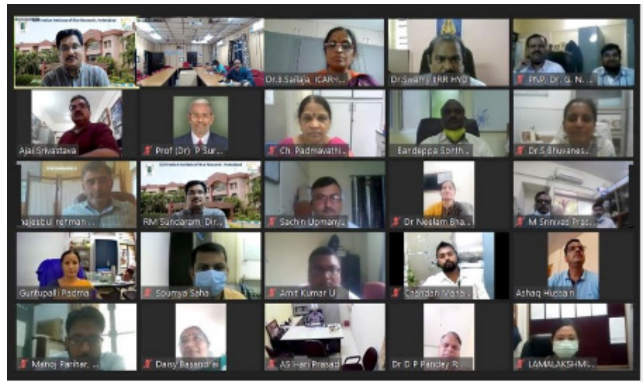
(RNR 15048) was considered for area extension to the state of Karnataka. The same were notified / released and notified through S.O. 8(E). dt 24th Dec, 2021. Of the total 26 varieties/hybrids notified and released through CVRC, six new rice varieties from ICAR-IIRR were released and notified.

Virtual Research Advisory Committee Meeting

The Research Advisory Committee (RAC) Meeting of ICAR-Indian Institute of Rice Research, Hyderabad was held on 26 July, 2021 through virtual mode (Video conferencing) under the Chairmanship of Prof. Akhilesh Tyagi, University of Delhi South Campus, New Delhi. The following RAC members joined the meeting via zoom facility: Dr. Y.P. Singh, ADG (FFC), ICAR, New Delhi; Dr. S. Leena Kumary, Registrar (Retd.), Kerala Agricultural University, Thrissur; Dr. N. Raghuram, Professor, University School of Biotechnology, GGS Indraprastha University, New Delhi; Dr. Mayabini Jena, ICAR Emeritus Scientist, Division of Crop Protection, ICAR-NRRI, Cuttack; Dr. P.C. Rao, Dean (Rctd.), PJTSAU, Hyderabad; Dr. Prem Lata Singh, Head (Retd.), Division of Agricultural Extension, ICAR-IARI, New Delhi; Dr. Dipankar Maiti, Director, ICAR-NRRI, Dr. R.M. Sundaram, Director, IIRR and Dr. M.B.B. Prasad Babu, Member Secretary. The Farmers, Shri. Ramanaiah Chakilam and Shri Bandaru Kushalaiah also participated in the meeting. At the outset, Dr. R.M. Sundaram, Director, IIRR welcomed the RAC team. In the introductory remarks, the chairman and members of the RAC, appreciated the Scientists for their research output despite the Covid-l9 pandemic.

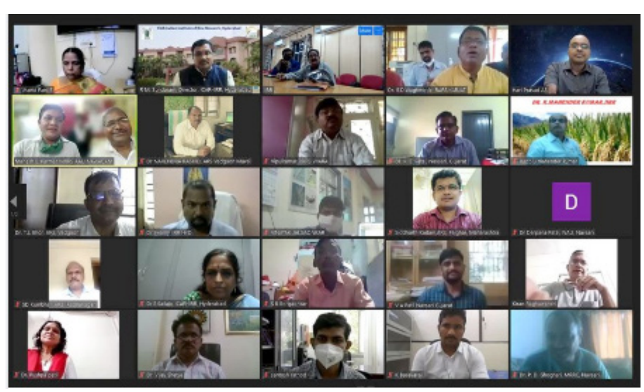
Virtual field monitoring of AICRIP trials

During Kharif 2021 AICRIP monitoring of various zones were conducted by Scientists of ICAR-IIRR and ICAR-NRRI through a series of zone wise virtual field monitoring. AICRIP centres have supported the assessment of entries of trials by nominating monitoring teams from their organizations.



Hills (I)

The first interactive meetings with AICRIP centres were held during 2021 in virtual mode across the zones. The meetings were chaired by Dr. R. M. Sundaram, Director, ICAR-IIRR, Hyderabad and coordinated by Dr. L.V. Subba Rao, PI, AICRIP. Centre wise presentations were made on the status of receipt of trials, trial conduct, self-monitoring, breeding material generated and evaluated, breeder seed production and recent releases from the respective centres. The virtual presentations from the centres were along with a multi-disciplinary monitoring team from ICAR-IIRR participated in the meeting. All the co-operators from different centres of the hill zone presented the progress of AICRIP trials and various issues were deliberated during the course of the meeting.



Western (VI)

Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) Meeting was organised on 23 – 24 Aug, 27-28 Aug and 1st, 2nd, 4th and 6th Sep 2021 (8 days) for the year 2021. The progress and achievements made by all the scientists was discussed in detail along with the future plan of work. New project proposals were presented for approval by the IRC.

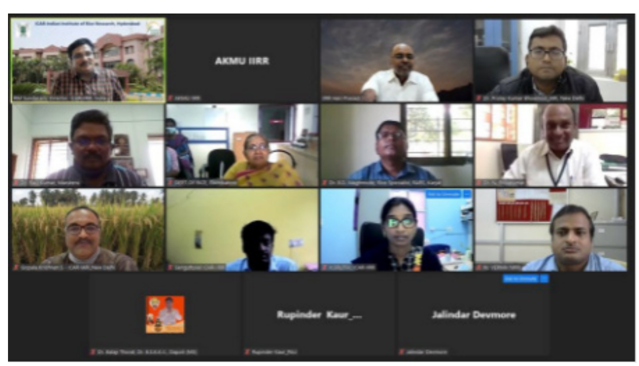
Field IRC for the year 2021 was held on 1st, 2nd and 11th Nov 2021. Dr R M Sundaram, Director and Chairman (IRC) along with all the scientists and technical officers participated in the field IRC. The progress of all the field-based experiments were explained by the respective PIs of the Institute Research Programme. Director appreciated the efforts of all the scientists in effectively conducting the field experiments. Various aspects regarding the ongoing experiments and planning for the next season's experiments were thoroughly discussed.

Virtual Annual Review Meeting of CRP Biofortification

A virtual meeting to review the progress of ICAR-CRP on Biofortification in selected crops for nutritional security was held under the chairmanship of Dr. T R Sharma, DDG (CS) on 30th Nov 2021. Dr. D.K. Yadava, ADG (Seeds) and Dr. R.M. Sundaram, Director, IIRR, Hyderabad & Coordinator, CRP-Biofortification facilitated review meeting followed by the presentations of the status and progress by Dr. C.N. Neeraja (IIRR, Hyderabad), Dr. Sewaram (IIWBR, Karnal), Dr. P.K. Mandal (NRCPB, New Delhi), Dr. Firoz Hossain (IARI, New Delhi), Dr. Hariprasanna K. (IIMR, Hyderabad), Dr. C. Tara Satyavati (PC, AICRP-Pearl millet, Jodhpur), Dr. T E Nagaraja (PC, AICRP-Small millets, Bengaluru), Dr. R Ananthan (NIN, Hyderabad), and Dr. S B N Rao (NIANP, Bengaluru).

ICAR-IIRR held Virtual Review Meeting of CRPHT (Hybrid Rice)

Director, ICAR-IIRR reviewed the progress of work under CRP-Hybrid rice on 29-11-2021. All the nine network centres presented the research highlights/ achievements made during the year.



Director complimented the excellent work towards improving the yield of heterosis in spite of COVID pandemic and related problems. He laid emphasis on the CMS line and maintainer line improvement in a more vigorous and focused way. He also stressed molecular genotyping of all the restorers through fertility restoration (Rf) makers, in addition, to test crosses and combining ability studies.

Other Institutional Activities

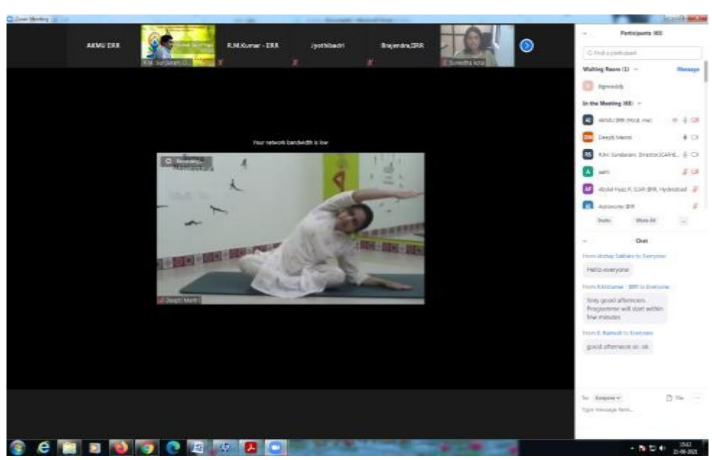
International women's day celebrated

The International Women's Day was celebrated at ICAR-IIRR under the theme "Women Leadership in Agriculture: Entrepreneurship, Equity & Empowerment" in the institute auditorium. The guest speaker, Ms. Manju Latha Kalanidhi, Senior Journalist and founder of the Rice Bucket Challenge, a social initiative to help the needy, deliberated upon the immense role women farmers play in providing food security and acknowledged the role of women scientists of the institute in contributing to rice science. Dr. D. Subrahmanyam, Director (A) of the institute, highlighted the significance of celebrating the International Women's Day and acknowledged the contribution of women scientists, administrative and finance personnel in institutional building.

On the same day, Women's Day was also organised and Best Woman farmers were felicitated in Mutharam, Mudigonda and V.V. Kistapuram villages of Khammam district under SCSP Scheme.

7th International Day of Yoga

ICAR-IIRR organized a Virtual gathering to celebrate the 7th International Day of Yoga on 21 June 2021. More than 65 participants including the permanent staff, AICRIP scientists, and research scholars of the institute attended the function. Dr. R M Sundaram, Director, ICAR-IIRR briefly enlightened the different types of *Yogasanas* and their benefits in life in the present context. Ms Deepti Mantri, Founder, Yogashala, Hyderabad demonstrated several simple Yoga techniques (Sukshma Vyayam) that were helpful for relieving physical and mental strain and stress.



EXTENSION ACTIVITIES

Tribal sub –Plan Activities

Over 2480 tribal farm families of Andhra Pradesh (400), Assam (250) Chhattisgarh (300), Jharkhand (300), Jammu and Kashmir (280) Karnataka (300), Kerala (250), and Telangana (400) 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, 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 9% in Jharkhand and maximum of 22% in Telangana and Andhra Pradesh.



IIRR-SCSP Activities

The biofortified seed, *viz.*, DRR Dhan 48 was provided to 230 beneficiaries of Wanaparthy, Yadadri Bhongir and Medak districts of Telangana. The seed of ICAR-IIRR *viz.*, ISM (383), DRR Dhan 42(132), DRR Dhan 44(22) and DRR Dhan 50(3) was provided to the beneficiary farmers of Telangana and Andhra Pradesh. Drying sheets, sprayers, pheromone traps and lures, herbicide, insecticide, fungicide, green manure seed and storage bins were also provided to the beneficiaries under IIRR-SCSP program. A total of 2,799 demonstrations were organised under ICAR-IIRR-SCSP. These demonstrations were organised in collaboration with SKUAST, Jammu, RARS, Maruteru, ANGRAU, Andhra Pradesh, TNAU, Coimbatore, Tamil Nadu, KVK, Chamarajnagar, Karnataka, KVK, Jammikunta, Telangana, KVK, Gaddipally, Telangana, YFA-KVK, Wanaparthy, Telangana, KVK, Medak, Telangana, KVK, Yagantipalle, Andhra Pradesh and RASS KVK, Andhra Pradesh and RRS, Chinsura, West Bengal. 'Field Day' was organised in Govindapalli village of Kurnool district of Andhra Pradesh on 13th December 2021. Seven off-campus 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 Vermicompost and Water saving technologies.


ICAR-IIRR celebrated 7th Foundation Day

Post relaxation of COVID-19 norms on large gatherings, institute very joyously celebrated the 7th Foundation Day on December 18, 2021 in physical mode. All the IIRR personnel along with Retired IIRR personnel were specially invited and felicitated for their services to the institute. Dr. R M Sundaram, Director, IIRR, Hyderabad shared the key achievements of the institute that highlighted release of 9 varieties by CVRC, Gene identified for phosphorus use efficiency, Improved crop production technologies and efficient tools that were developed and distributed to farmers through effectively conducted capacity building and outreach programmes, training programme last year. The Foundation Day, SVS Shastry memorial lecture on Rice Improvement: New Breeding Technologies was delivered in virtual mode by the DDG (Crop Science), ICAR, Dr. T R Sharma a well-known Plant Molecular Biologist. He dwelled on the challenges facing rice production in the country in terms of growing population, reduced resources of land, water, labour and other resources. Dr. Praveen Rao Velchala, VC, PJTSAU, Guest of Honor for the program highlighted the concern of water shortage in India and about poor water use efficiency in rice. Dr. Himanshu Pathak, Director, ICAR-National Institute of Abiotic Stress Management, Baramati, the special guest of the program emphasized on nitrogen use efficiency in rice and suggested to re-orient the AICRP on rice on this line. On this occasion, best Research Papers under four categories *viz*. Crop Improvement, Crop Protection, Crop Production and Social Sciences were awarded to the selected scientists.

World Soil Day 2021 celebration

ICAR-IIRR organised World soil day on 5th of December, 2021 at Rudraram village, Shabad mandal, Ranga Reddy District of Telangana. A team of eight scientists comprising Soil Science, Agronomy, Plant Breeding, Entomology and Pathology, village sarpanch and more than 50 rice farmers were participated in the programme. Soil scientists of ICAR-IIRR were delivered talks on importance of soil day and its theme of the year (*Halt soil salinization, boost soil productivity*); highlighted the importance of soil health, primary and micro nutrient management, saline soil management, vermicompost preparation

Scientist and Farmers Gathering

Demonstration of LCC

and straw management. Other subject scientists were explained about newly released varieties for pest and disease resistance, high Zn content, short duration and pest and disease management etc. Soil samples brought by the farmers were analysed by rapid soil health testing kit and the soil health cards were generated on the spot and they were distributed to the farmers with proper guidelines on the fertiliser input management. Posters on soil sampling, saline soil management, compost preparation using straw, images of pest and diseases were displayed. Use of leaf colour chart (LCC) on urea economy was explained and distributed to the farmers for their benefit.

ICAR-IIRR organized official language implementation

भारतीय चावल अनुसंधान संस्थान, हैदराबाद में 2021 के दौरान राजभाषा कार्यान्वयन गतिविधियां चेतना मास समारोह

भाकृअनुप - भारतीय चावल अनुसंधान संस्थान, हैदराबाद में 14 सितंबर से 13 अक्तूबर, 2021 के दौरान हिंदी चेतना मास समारोह का आयोजन किया गया। उक्त चेतना मास के अंतर्गत हिंदी में कुल 11 विभिन्न प्रतियोगिताओं (अनुवाद, प्रश्नमंच, अंत्याक्षरी आदि) का आयोजन किया गया। जिनमें वैज्ञानिक, तकनीकी, प्रशासनिक तथा अनुसंधान सहायक, शोध छात्रों आदि ने बड़े-ही उत्साह एवं उमंग के साथ भाग लिया। इसके अलावा उक्त माह के दौरान हिंदी में हस्ताक्षर अभियान भी चलाया गया।

अक्तूबर 27, 2021 को हिंदी चेतना मास के दौरान आयोजित विभिन्न प्रतियोगिता के विजेताओं को पुरस्कार एवं प्रमाण-पत्र वितरण समारोह का आयोजन किया गया। समारोह का शुभारंभ भारतीय कृषि अनुसंधान परिषद् गान से हुआ। सर्वप्रथम डॉ. महेश कुमार, वरिष्ठ तकनीकी अधिकारी (राजभाषा), भाकृअनुप-भारतीय कदन्न अनुसंधान संस्थान एवं राजभाषा प्रभारी, भारतीय चावल अनुसंधान संस्थान, हैदराबाद ने समारोह में उपस्थित लोगों का स्वागत किया। तत्पश्चात उन्होंने पिछले वर्ष के दौरान संस्थान में संपन्न राजभाषा कार्यान्वयन संबंधी कार्यों पर वार्षिक प्रतिवेदन एवं हिंदी चेतना मास समारोह के दौरान आयोजित कार्यक्रमों पर प्रतिवेदन प्रस्तुत किया। उन्होंने उक्त समारोह को सफल बनाने के लिए संस्थान में कार्यरत सभी अधिकारियों एवं कर्मचारियों के प्रति आभार व्यक्त किया ।

इस अवसर पर डॉ. आर एम सुंदरम, निदेशक, भारतीय चावल अनुसंधान संस्थान ने हिंदी चेतना मास के दौरान आयोजित प्रतियोगिताओं के विजेताओं को नकद पुरस्कार तथा प्रमाण-पत्र एवं प्रतियोगिता के अन्य सहभागियों को कलम व सहभागिता प्रमाण-पत्र प्रदान किए। इसके अलावा उन्होंने प्रतियोगिताओं के आयोजकों/निर्णायकों को प्रमाण-पत्र व स्मृति चिह्न भी प्रदान किए। डॉ. सुंदरम ने अपने संबोधन में बताया कि राजभाषा हिंदी में कार्य करना केवल हमारा संवैधानिक दायित्व ही नहीं, बल्कि हमारा नैतिक दायित्व भी है, चूंकि समूचे देश को इसने एकता के सूत्र में बांधे रखा है तथा कदम-कदम पर हमारी सामासिक संस्कृति को सुरक्षित रखने में सहयोग प्रदान कर रही है। इन्हीं विशेषताओं के चलते हिंदी को राजभाषा का दर्जा प्रदान किया गया। इसके अलावा उन्होंने कहा कि हमारा संस्थान कृषि से संबंधित है अतः हमारा दायित्व तो और भी बढ़ जाता है, क्योंकि जब तक किसान हमारे शोध कार्यों से परिचित नहीं होते, तब तक उनका पूरा उपयोग कठिन होगा। अतः किसानों तक हमारी बात पहुंचाने हेतु भारतीय भाषाएं, विशेषकर हिंदी ही हमें सहायता प्रदान कर सकती है।

अंत में श्रीमती वनिता, प्रवर श्रेणी लिपिक के द्वारा धन्यवाद ज्ञापन, तत्पश्चात सामूहिक रूप से राष्ट्रगान के बाद समारोह का समापन हुआ। संस्थान में संपन्न पूरे हिंदी चेतना मास समारोह के कार्यक्रमों का संचालन एवं समन्वय डॉ. आर एम सुंदरम, निदेशक, भाचाअनुसं के दिशा-निर्देश में डॉ. महेश कुमार, श्री बी विद्यानाथ, सहायक प्रशासनिक अधिकारी तथा श्रीमती वनिता के द्वारा किया गया।

ICAR- IIRR organized Swachh Bharat from 2nd to 31st October 2021

Constitution day

ICAR-IIRR celebrated CONSTITUTION DAY - SAMVIDHAN DIVAS on 26.11.2021 to commemorate the adoption of the Constitution of India for the promotion of Constitution values among citizens. The Director, Dr. R. M. Sundaram lead the Mass PREAMBLE reading along with all the IIRR staff.

ICAR - IIRR is organized Vigilance Awareness Week during October 26 - November 1, 2021

Poshan Vatika Mahaabhiyan program on September 17, 2021

On the occasion of Curtain Raiser On "International Year of Millets 2023", Poshan Vatika Mahaabhiyan program was organized in tribal village of Ranga Reddy district of Telangana. About 50 farmers and 74 school girls attended the program on September 17, 2021 in which mini kits of ten different vegetables were distributed to set up kitchen garden for ensuring dietary diversity and nutritional security of families. The seeds of Nutritious rice varieties (DRRDHAN 48, Imporved Samba Mahsuri) were distributed to farmers for overcoming malnutrition and managing diabetes with low GI variety.

Food and Nutrition for Farmers

ICAR-Indian Institute of Rice Research celebrated "Food and Nutrition for Farmers" on August 26, 2021 at Manchal Village, Ranga Reddy District, Telangana Under the "Azadi Ka Amrit Mahotsav" celebrations, A comprehensive program highlighting the stupendous growth in rice production since Independence and the role of ICAR-IIRR rice varieties in food and nutritional security of farmers was organized.

Farmers Interaction Meet & Exposure visit to ICAR-IIRR on 28th September, 2021

Interaction meet of farmers with Honourable, Prime Minister of India (virtual) and exposure visit to ICAR-IIRR was organisecl on September 28th 2021 for farmers from adopted villages of Ranga Reddy District, Telangana. A farmer-scientist interaction was organized and seeds of Improved Samba Mahsuri variety were distributed to farmers for demonstrations.

Campaign on Waste to Wealth

Special National Swachta Campaign on Waste to Wealth was organized on October 12, 2021 in adopted village of the institute (Rudraram village of Shabad Mandal, Chevella, Telangana) along with training program on vermicompost preparation. Director emphasized the significance of observing the month of October as the Swachta Month and motivated the farmers to keep the farm free of waste for a healthy crop growth.

Azadi ka Amrut Mahotsav: Talks and Webinars organized by the Institute

S. No.	Speaker	Title	Organised by	Date
1	Dr P Soman, Vice President & Chief Agronomist, Jain Irrigation systems ltd.	Rice cultivation with drip irrigation and fertigation	ICAR-Indian Institute of Rice Research and Society for advancement of Rice Research	24th June, 2021 Time:11.00 AM
2	Dr. G. Markandeya Chairman & Managing Director ATGC Biotech Pvt Ltd	Semiochemicals as Crop Protection tools: Future of insect sex pheromones in row crops	ICAR-Indian Institute of Rice Research and Society for advancement of Rice Research	30-08-2021
3	Dr. S. Pazhanivelan Professor & Head RS & GIS, TNAU	Rice area mapping and Yield estimation assimilating Remote Sensing products with crop growth models	ICAR-Indian Institute of Rice Research and Society for advancement of Rice Research	07-09-2021

4	Dr Arvind Kumar Deputy Director General – Research Regional Director- Asia ICRISAT, Patancheru, India	Breeding for drought tolerance in rice: Gains made and prospects for the future	ICAR-Indian Institute of Rice Research and Society for advancement of Rice Research	30.10.2021
5	Dr. A.K. Shasany Director, NIPB New Delhi	Aroma Biology and livelihood security	ICAR-Indian Institute of Rice Research and National Academy of Agricultural Sciences, Hyderabad Chapter	1^{st} November, 2021
6	Dr. Ananthan, Scientist D, NIN	Nutritional perspectives of Rice	ICAR-Indian Institute of Rice Research and National Academy of Agricultural Sciences, Hyderabad Chapter	26^{th} November

Distinguished Visitors

Dr. M.P. Pandey, Eminent Rice Researcher (Former Director, ICAR-NRRI, Cuttack: Former Vice-Chancellor, IGKV, Raipur and Former Vice-Chancellor, BAU, Ranchi) visited the institute and interacted with scientists in the Biotechnology section on 20.10.2021.

Dr. Ajit Shasany, Director, ICAR-NIPB interacted with scientists of ICAR-IIRR on 1st Nov. 2021

Mr. Ronald Verdonk, Career Minister-Counsellor for Agricultural Affairs (USDA) and **Dr. Santosh Kumar Singh**, Senior Agricultural Specialist of US Embassy, New Delhi visited our Institute on 15th November 2021 at 4.30 PM and interacting with senior research staff to understand the agricultural production situation in South India, the ongoing research activities in rice and future collaboration with IIRR.

Personnel & Staff

Scientific Staff

Name	Designation
Dr. R.M. Sundaram	*Director (appointed on 27th April, 2021*
Plant Breeding	
Dr. L.V. Subba Rao	*Principal Scientist*
Dr. AVSR Swamy	*Principal Scientist*
Dr. S.V. Sai Prasad	*Principal Scientist (Transferred from IARI, New Delhi on 25th Sep., 2021)*
Dr. G. Padmavathi	*Principal Scientist*
Dr. J. Aravind Kumar	*Principal Scientist*
Dr. Gireesh. C	*Senior Scientist*
Dr. Suneetha Kota	*Senior Scientist*
Dr. Jyoth Badri	*Senior Scientist*
Dr. M.S. Anantha	*Senior Scientist*
Dr. R. Abdul Fiyaz	*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. R.M. Sundaram	*Principal Scientist*
Dr. M Seshu Madhav	*Principal Scientist*
Dr. S.K. Mangrauthia	*Senior Scientist*
Dr. Kalyani Kulkarni	*Scientist*
Agronomy	
Dr. R. Mahendra Kumar	*Principal Scientist*
Dr. B. Sreedevi	*Principal Scientist*
Dr. Mangaldeep Tuti	*Senior Scientist*
Mr. S. Saha	*Scientist (Transferred to ICAR-NRRI, Cuttack on 11th October, 2021)*
Dr. Aarti Singh	*Scientist*
Dr. S. Vijaya Kumar	*Scientist (Transferred from ICAR-NRRI, Cuttack on 8th October, 2021)*

Name	Designation
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*
Mr. R. Gobinath	*Scientist*
Ms. V. Manasa	*Scientist*
Physiology & Biochemistry	
Dr. D. Subrahmanyam	*Principal Scientist*
Dr. P. Raghuveer Rao	*Principal Scientist*
Dr. D. Sanjeeva Rao	*Scientist*
Dr. Akshay Sakhare	*Scientist (Transferred from IARI, New Delhi on 28th January, 2021)*
Agril. Engineering	
Dr. Vidhan Singh	*Principal Scientist*
Agril. Chemicals	
Dr. M.M. Azam	*Principal Scientist*
Computer Applications	
Dr. B. Sailaja	*Principal Scientist*
Entomology	
Dr. B. Jhansi Rani	*Principal Scientist*
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*
Mr. 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	*Scientist*
Dr. K. Basavaraj	*Scientist*

Name	Designation
Mr. 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. Jeya Kumar	Principal Scientist
Dr. Lakshmi Prasanna	Senior Scientist
Dr. B. Nirmala	Senior Scientist
Dr. S. Arun Kumar	Senior Scientist
Dr. Santosha Rathod	Scientist
Dr. Divya Balakrishnan	Scientist
Emeritus Scientist	
Dr. P. Ananda Kumar	Emeritus 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	Senior Technical Officer
K. Padmaja	Senior Technical Officer (Transferred from CTRI, Rajahmundry on 1st Sep., 2021
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
P Chandrakanth	Senior Technical Assistant
A Venkataiah	Technical Officer (Superannuated on 30th Nov., 2021)
Tupakula Venkaiah	Technical Officer
C. Muralidhar Reddy	Technical Officer
K Janardhan	Technical Officer (Driver)
T. Narender Prasad	Technical Officer
Bidyasagar Mandal	Senior Technical Assistant (Transferred to ICAR-NRRI, Cuttack)
K.H. Devadas	Senior Technical Assistant
Koteswara Rao Potla	Senior Technical Assistant
K. Narasimha	Senior Technical Assistant (Driver)
M. Chandrakumar	Senior Technician
S. Vijay Kumar	Senior Technician
A Ramesh	Senior Technician (Driver)
D. Srinivasa Rao	Technician (Transferred from CTRI, Rajahmundry on 17th Aug., 2021
V Srinivas	Technician
R. Sathemaiah	Technician
S. Yadaiah	Technician

Administrative Staff

Sathish B.	Senior Administrative Officer (Superannuated on 30th April, 2021)
K. Srinivasa Rao	Finance & Accounts Officer
K. Kousalya	Asst. Administrative Officer
Sudha Nair	Asst. Administrative Officer
R. Udaya Kumar	Private Secretary
Aparna Das	Private Secretary
Uppalapati Rama	Assistant
P. Lakshmi	Assistant
B. Vidyanath	Assistant
T.D. Pushpalatha	Assistant (Superannuated on 31st Oct., 2021)
K. Sudhavalli Tayaru	Assistant
Shaik Ahmed Hussain	Assistant
S. Hemalatha	Personal Assistant
Sandiri Rama Murthy	Personal Assistant
Bommakanti Ramesh	Personal Secretary
Vanitha	UDC (Upper Division Clerk)
Bharath Raju	UDC (Upper Division Clerk)
G. Satyanarayana	UDC (Upper Division Clerk)
K. Mallikarjunudu	UDC (Upper Division Clerk)
Kota Jashwanth	LDC (Lower Division Clerk)
S. Rekha Rani	LDC (Lower Division Clerk)
Ashfaq Ali	Stenographer Gr, III
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	Skilled Supporting Staff (SSS)

Casual Labour regularised to Skilled Support staff on 14th Sep., 2021

S. No.	Name
1.	Smt. V. Sukrutha
2.	Sri. B. Swamy
3.	Smt. G. Sivamma
4.	Smt. G. Vajramani
5.	Sri. I. Bikashpathi
6.	Smt. B. Balamma
7.	Sri. G. Sailu
8.	Smt. B. Sugunamma
9.	Smt. V. Pentamma
10.	Smt. R. Kistamma
11.	Smt. D. Buchamma
12.	Smt. Ch. Swaroopa
13.	Smt. K. Durgamma
14.	Sri. M. Ramesh
15.	Smt. P. Bharthamma
16.	Smt. A. Sathamma
17.	Smt. K. Yadamma
18.	Smt. B. Sakkubai
19.	Smt. V. Chandramma

S. No.	Name
20.	Smt. P. Pushpa
21.	Smt. B. Saroja
22.	Smt. K. Manamma
23.	Sri. G. Venkatesh
24.	Smt. M. Govindamma
25.	Smt. R. Amrutha
26.	Smt. D. Padmamma
27.	Smt. M. Anjamma
28.	Smt. D. Laxmamma
29.	Smt. M. Narasamma
30.	Smt. M. Laxmamma
31.	Smt. R. Parvathamma
32.	Smt. D. Kalavathi
33.	Smt. K. Laxmi
34.	Smt. D. Balamani
35.	Smt. S. Pochamma
36.	Sri. M. Yadaiah
37.	Smt. R. Channamma
38.	Smt. M. Laxmi

Publications

Papers in research Journals (National / International)

Ajay, B.C., Ramya, K.T., Fiyaz, R.A., Govindaraj, G., Bera, S.K., Kumar, N., Gangadhar, K., Kona, P., Singh, G.P. and Radhakrishnan, T., 2021. R-AMMI-LM: Linear-fit Robust-AMMI model to analyze genotype-by environment interactions. *Indian J. Genet*, *81*(1), pp.87-92. https://krishi.icar.gov.in/jspui/ handle/123456789/46386.

Amanullah, Ilyas, M., Nabi, H., Khalid, S., Ahmad, M., Muhammad, A., Ullah, S., Ali, I., Fahad, S., Adnan, M. and Elshikh, M.S., 2021. Integrated Foliar Nutrients Application Improve Wheat (*Triticumaestivum* L.) Productivity under Calcareous Soils in Drylands. *Communications in Soil Science and Plant Analysis*, *52*(21), pp.2748-2766. http://krishi.icar.gov.in/jspui/handle/123456789/71220

Amtul Waris, Neeraja, C.N., Azam, M.M. and Jangaiah, B., 2021. Sensory evaluation and consumer acceptability of zinc biofortified rice by farm women in Telangana, India. *Journal of Cereal Research*, 13(2): 188-196. http://krishi.icar.gov.in/jspui/handle/123456789/71219

Anusha, G., Rao, D.S., Jaldhani, V., Beulah, P., Neeraja, C.N., Gireesh, C., Anantha, M.S., Suneetha, K., Santhosha, R., Prasad, A.S. and Sundaram, R.M., 2021. Grain Fe and Zn content, heterosis, combining ability and its association with grain yield in irrigated and aerobic rice. *Scientific reports*, *11*(1), pp.1-12.http://krishi.icar.gov.in/jspui/handle/123456789/52554

Azam, M.M., Padmavathi, S., Fiyaz, R.A., Amtul Waris, Ramya, K.T. and Neeraja, C.N., 2021. Effect of different cooking methods on loss of iron and zinc micronutrients in fortified and non-fortified rice. *Saudi Journal of Biological Sciences*, *28*(5), pp. 2886-2894. http://krishi.icar.gov.in/jspui/handle/123456789/71221.

Bagudam, R., Eswari, K.B., Badri, J., Devi, G.L., JaiVidhya, L.R.K., Bhavani, P., Swathi, G., Bharath, M., Rao, P.R., Kumar, J.A. and Fiyaz, R.A., 2021. Morphological and molecular characterization of new plant type core set for yield and culm strength traits in rice (*Oryza sativa* L.). *Journal of Plant Biochemistry and Biotechnology*, *30*(2): 233-242. http://krishi.icar.gov.in/jspui/handle/123456789/71034.

Balija, V., Bangale, U., Ponnuvel, S., Barbadikar, K.M., Madamshetty, S.P., Durbha, S.R., Yadla, H. and Maganti, S.M., 2021. Improvement of Upland Rice Variety by Pyramiding Drought Tolerance QTL with Two Major Blast Resistance Genes for Sustainable Rice Production. *Rice Science*, *28*(5), pp.493-500. http://krishi.icar.gov.in/jspui/handle/123456789/71177.

Basavaraj, P.S., Gireesh, C., Bharamappanavara, M., Manoj, C.A., VG, I.L., Ajitha, V., Senguttuvel, P., Sundaram, R.M. and Anantha, M.S., 2021. Stress tolerance indices for the identification of low phosphorus tolerant introgression lines derived from *Oryza rufipogon* Griff. *Plant Genetic Resources*, *19*(4), pp.328-338. http://krishi.icar.gov.in/jspui/handle/123456789/71178.

Beerelli, K., Balakrishnan, D. and Neelamraju, S., 2021. Comparison of Genetic Variability and Trait Association for Yield Contributing Traits among F2 Populations Generated from Wild Introgression Lines of Rice. *Agricultural Research*, pp.1-7. http://krishi.icar.gov.in/jspui/handle/123456789/71179.

Bhargava, K., Shivani, D., Pushpavalli, S.N.C.V.L., Sundaram, R.M., Beulah, P. and Senguttuvel, P., 2021. Genetic variability, correlation and path coefficient analysis in segregating population of rice. *Electronic Journal of Plant Breeding*, *12*(2), 549-555. http://krishi.icar.gov.in/jspui/handle/123456789/71180.

Bhogireddy, S., Mangrauthia, S.K., Kumar, R., Pandey, A.K., Singh, S., Jain, A., Budak, H., Varshney, R.K. and Kudapa, H., 2021. Regulatory non-coding RNAs: a new frontier in regulation of plant biology. *Functional & integrative genomics*, *21*(3), pp.313-330. http://krishi.icar.gov.in/jspui/handle/123456789/71181.

Chakraborti, M., Kumar, A., Verma, R.L., KR, R.R., Patra, B.C., Balakrishnan, D., Sarkar, S., Mandal, N.P., Kar, M.K., Meher, J. and Sundaram, R.M., Rice breeding in India: eight decades of journey towards enhancing the genetic gain for yield, nutritional quality, and commodity value. *ORYZA-An International Journal of Rice*, *58*(1 SPL), pp.69-88. http://krishi.icar.gov.in/jspui/handle/123456789/71222.

Chimmili, S. R., Kumar, C. R. A., Subashini, G., Raveendran, M., Robin, S., Padmavathi, G., Kumar, J. A., Jyothi, B., Divya, B., Sruthi, K. and Rao, L. V. S. (2021) "Assessment of Antioxidant Potential of Lutein, a Retinol Equivalent Carotenoid in Medicinal Landrace of Rice 'Kavuni'", *Journal of Pharmaceutical Research International*, 32(38), pp. 39-46. doi: 10.9734/jpri/2020/v32i3831011.

Chitikela, G., Admala, M., Ramalingareddy, V.K., Bandumula, N., Ondrasek, G., Sundaram, R.M. and Rathod, S., 2021. Artificial-Intelligence-Based Time-Series Intervention Models to Assess the Impact of the COVID-19 Pandemic on Tomato Supply and Prices in Hyderabad, India. *Agronomy*, *11*(9), p.1878. http://krishi.icar.gov.in/jspui/handle/123456789/71257.

De Silva, N. P. S., V. G. Shankar, D. Balakrishnan, B. Kavitha, Y. V. Rao, P. Prashanthi, N. Sarla, SNCVL. Pushpavalli and Srinivasa Chary, D. 2021. Path Coefficient Analysis using Rils of *Oryza nivara* in Swarna Background. *Int.J.Curr.Microbiol.App.Sci.* 10(2): 86-94. http://krishi.icar.gov.in/jspui/handle/123456789/71259.

Deepika, K., Lavuri, K., Rathod, S., Yeshala, C.M., Jukanti, A.K., Reddy, S.N., LV, S.R. and Badri, J., 2021. Multivariate analysis of geographically diverse rice germplasm for genetic improvement of yield, dormancy and shattering-related traits. *Plant Genetic Resources: Characterization and Utilization*, *19*(2), pp.144-152. http://krishi.icar.gov.in/jspui/handle/123456789/71260.

Divya, M., Rajeswari, B., Rao, P.R., Maheswari, T. and Kannan, C. 2021. Morphological and molecular characterization of *Xanthomonas oryzae Pv. Oryzae* (Ishiyama), the leaf blight pathogen of rice (*Oryza sativa*L). *The Journal of Research PJTSAU* 49(3): 1-123 http://krishi.icar.gov.in/jspui/handle/123456789/71261.

Gireesh, C., Sundaram, R.M., Anantha, S.M., Pandey, M.K., Madhav, M.S., Rathod, S., Yathish, K.R., Senguttuvel, P., Kalyani, B.M., Ranjith, E. and Venkata Subbarao, L., 2021. Nested Association Mapping (NAM) Populations: Present Status and Future Prospects in the Genomics Era. *Critical Reviews in Plant Sciences*, *40*(1), pp.49-67 http://krishi.icar.gov.in/jspui/handle/123456789/71262.

Gobinath, R., Datta, S. P., Singh, R.D., Datta, S. C. and Manasa, V. (2021). Synthesis and characterization of ZnO nanoparticles- comparison of acetate (precursor) based methods. Inorganic and Nano-metal Chemistry, doi:10.1080/24701556.2021.1891099.

Ishwarya Lakshmi, V.G., Sreedhar, M., Lakshmi, V.J., Gireesh, C. and Vanisri, S.R.S., 2021. Parental polymorphism survey using genome-wide SSR markers for brown planthopper resistance in rice. *The Pharma Innovation Journal* 10(6): 622-628. http://krishi.icar.gov.in/jspui/handle/123456789/71263.

Ishwarya Lakshmi, V.G., Sreedhar, M., Lakshmi, V.J., Gireesh, C., Rathod, S. and Vanisri, S., 2021. Phenotypic screening and Single marker analysis for Brown planthopper resistance in rice (*Oryza sativa* L.). Journal of Research, PJTSAU 49(1 &2):1-9. http://krishi.icar.gov.in/jspui/handle/123456789/71264.

Ishwarya Lakshmi, V.G., Sreedhar, M., Lakshmi, V.J., Gireesh, C., Rathod, S. and Vanisri, S., 2021. Molecular diversity assessment of rice genotypes for brown planthopper resistance using microsatellite markers. *Electronic Journal of Plant Breeding*, *12*(2), pp.499-506.

Jadhav, S., Balakrishnan, D., Shankar, V.G., Beerelli, K., Chandu, G. and Neelamraju, S., 2021. Genetic diversity analysis and population structure in a rice germplasm collection of different maturity groups. *Journal of Plant Biochemistry and Biotechnology*, pp.1-9. http://krishi.icar.gov.in/jspui/handle/123456789/71265.

Jaldhani, V., Rao, D.S., Beulah, P., Srikanth, B., Rao, P.R., Subrahmanyam, D., Sudhakar, P., Satya, A.K., Neeraja, C.N. and Senguttuvel, P., Assessment of Heat-tolerance Potential in QTL Introgressed Lines of Hybrid Rice Restorer, KMR-3R through PS-II Efficiency, International Journal of Environment and Climate Change 11(11): 258-266. http://krishi.icar.gov.in/jspui/handle/123456789/71266.

Janaki Ramayya, P., Vinukonda, V.P., Singh, U.M., Alam, S., Venkateshwarlu, C., Vipparla, A.K., Dixit, S., Yadav, S., Abbai, R., Badri, J. and PhaniPadmakumari, A., 2021. Marker-assisted forward and backcross breeding for improvement of elite Indian rice variety Naveen for multiple biotic and abiotic stress tolerance. *Plos one*, *16*(9), p.e0256721. http://krishi.icar.gov.in/jspui/handle/123456789/71267.

Javvaji, S., Maheswari Telugu, U., DamarlaBalaVenkata, R., SheshuMadhav, M., Rathod, S. and Chintalapati, P., 2021. Characterization of resistance to rice leaf folder, Cnaphalocrocismedinalis, in mutant Samba Mahsuri rice lines. *EntomologiaExperimentalisetApplicata*, *169*(9), pp.859-875. http://krishi.icar.gov.in/jspui/handle/123456789/71268.

Kale, R.R., Anila, M., MahadevaSwamy, H.K., Bhadana, V.P., Durga Rani, C.V., Senguttuvel, P., Subrahmanyam, D., Hajira, S.K., Rekha, G., Ayyappadass, M. and Laxmiprasanna, B., 2021. Morphological and molecular screening of rice germplasm lines for low soil P tolerance. *Journal of Plant Biochemistry and Biotechnology*, *30*(2), pp.275-286. http://krishi.icar.gov.in/jspui/handle/123456789/71275.

Kale, R.R., Durga Rani, C.V., Anila, M., MahadevaSwamy, H.K., Bhadana, V.P., Senguttuvel, P., Subrahmanyam, D., AyyappaDass, M., Swapnil, K., Anantha, M.S. and Punniakotti, E., 2021. Novel major QTLs associated with low soil phosphorus tolerance identified from the Indian rice landrace, Wazuhophek. *PloS one*, *16*(7), p.e0254526. http://krishi.icar.gov.in/jspui/handle/123456789/52597.

Kannan C., Mishra, D., Miriyala, A., Vellaichamy, P., Kurubar, B., Gompa, J., Madamsetty, S.P. and Raman, M.S., 2021. Native isolates of Trichoderma as bio-suppressants against sheath blight and stem rot pathogens of rice. *Egyptian Journal of Biological Pest Control*, *31*(1), pp.1-10. http://krishi.icar.gov.in/jspui/handle/123456789/71279.

Kattupalli, D., Barbadikar, K.M., Balija, V., Ballichatla, S., Padmakumari, A.P., Saxena, S., Gaikwad, K., Yerram, S., Kokku, P. and Madhav, M.S., 2021. The draft genome of yellow stem borer, an agriculturally important pest, provides molecular insights into its biology, development and specificity towards rice for infestation. *Insects*, *12*(6), p.563. http://krishi.icar.gov.in/jspui/handle/123456789/47548.

Koyyati, R., Latha, P.C., Sandupatla, R., Laxman, V. and Merugu, R., 2021. Evaluation of anti-bacterial and rice seed germination potential of green and chemically synthesized ZnO nanoparticles. *Materials Today: Proceedings*, *44*, pp.2611-2616. http://krishi.icar.gov.in/jspui/handle/123456789/52853.

Krishnamurthy, S.L., Sharma, P.C., Sharma, D.K., Singh, Y.P., Mishra, V.K., Burman, D., Maji, B., Mandal, S., Sarangi, S.K., Gautam, R.K. and Singh, P.K., Manohara K.K., Marandi B.C. Chattopadhyay K, Padmavathi G., Vanve P. B. Patil K. D. Thirumeni S. Verma O. P. Khan A .H. Tiwari S. Geetha S. Gill R. Yadav V. K. Roy B. Prakash M. Anandan A. Bonifacio J. Ismail A. M., Singh R. K. 2021. Additive main effects and multiplicative interaction analyses of yield performance in rice genotypes for general and specific adaptation to salt stress in locations in India. *Euphytica*, *217*(2), pp.1-15. http://krishi.icar.gov.in/jspui/handle/123456789/49643.

Kulkarni, S.R., Balachandran, S.M., Ulaganathan, K., Balakrishnan, D., Prasad, A.S., Rekha, G., Kousik, M.B.V.N., Hajira, S.K., Kale, R.R., Aleena, D. and Anila, M., 2021. Mapping novel QTLs for yield related traits from a popular rice hybrid KRH-2 derived doubled haploid (DH) population. *3 Biotech*, *11*(12), pp.1-20. http://krishi.icar.gov.in/jspui/handle/123456789/71138.

Kumar, N., Chhokar, R.S., Meena, R.P., Kharub, A.S., Gill, S.C., Tripathi, S.C., Gupta, O.P., Mangrauthia, S.K., Sundaram, R.M., Sawant, C.P. and Gupta, A.,2021. Challenges and opportunities in productivity and sustainability of rice cultivation system: a critical review in Indian perspective. *Cereal research communications*, pp.1-29. http://krishi.icar.gov.in/jspui/handle/123456789/71139.

Kumar, S., Tripathi, S., Singh, S.P., Prasad, A., Akter, F., Syed, M.A., Badri, J., Das, S.P., Bhattarai, R., Natividad, M.A. and Quintana, M., Venkateshwarlu C, Anitha R, Yadav S, Singh S K, Swain P, Anandan A, Yadaw R B, Mandal N P, Verulkar S B, Arvind Kumar and Henry A. 2021. Rice breeding for yield under drought has selected for longer flag leaves and lower stomatal density. *Journal of experimental botany*, *72*(13), pp.4981-4992. https://doi.org/10.1093/jxb/erab160. http://krishi.icar.gov.in/jspui/handle/123456789/71146.

Kunta, M., Shivani, D., Jabeen, F., Chaithanya, K., Chiranjeevi, M., Rao, L.V.S, Sundaram, R.M. and Fiyaz, RA. 2021. Multivariate analysis and character association for agro-morphological traits in elite rice germplasm. Journal of Cereal Research 13(3): 270-278. http://doi.org/10.25174/2582-2675/2022/113997.

Laha, G.S., Sundaram, R.M., Rao, L.S., Prasad, M.S., Fiyaz, R.A., Senguttuvel, P., Badri, J., Ladhalakshmi, D., Yugander, A., Masood, S.H. and Dilip, T. 2021. DRR Dhan 53 (RP-6113-Patho-BB9; IET 27294)-a high yielding, bacterial blight resistant, fine grain type rice variety. *Journal of Rice Research*, *14*(1), p.75. http://krishi.icar.gov.in/jspui/handle/123456789/71147.

Lakshmi Prasanna P.A. 2021. Agricultural Trade and Environment nexus- a case study of rice exports from India. *Journal of Rice Research* 14(1): 53-74. http://krishi.icar.gov.in/jspui/handle/123456789/71148.

Lakshmi Prasanna, P.A., Rao, L.V.S., Prasad, A.S.H., Amtul Waris, Meera, S.N., Nirmala, B., Swarnaraj, A.K. and Symaladevi, D.P., 2021. Impact of Intellectual property rights protection for plant varieties on rice varietal development and biodiversity in India. *Journal of Cereal Research 13 (1): 49-61. http://doi. org/10.25174/2582-2675/2021, 106446.* http://krishi.icar.gov.in/jspui/handle/123456789/71149.

Lavanya, K., Chiranjeevi, M., Surender, R., Yadav, P.A.S., Fiyaz, A.R., Sudhakar, P., Satya, A.K. and Rao, L.S., 2021. Characterization of rice traditional varieties (*Oryza sativa* L.) based on DUS descriptors. *The Pharma Innovation Journal*, 10(2): 132-143. http://krishi.icar.gov.in/jspui/handle/123456789/71150.

Lee, D.Y., Jeon, J., Kim, K.T., Cheong, K., Song, H., Choi, G., Ko, J., Opiyo, S.O., Correll, J.C., Zuo, S. and Madhav, S., 2021. Comparative genome analyses of four rice-infecting *Rhizoctonia solani* isolates reveal extensive enrichment of homogalacturonan modification genes. *BMC genomics*, *22*(1), pp.1-15. http://krishi.icar.gov.in/jspui/handle/123456789/71151.

Mahboob, M., Chavan S.N., Nazir N., Mustaqim M., Jahan R., Tahseen Q. (2021). Description of a new and two known species of the insect-associated genus *Oigolaimella Paramonov*, 1952 (Nematoda: Diplogastridae) with a note on the biology, biogeography and relationship with congeners. *Zoologischer Anzeiger*, 295: 163-190.

Mangrauthia, S.K., Ramesh, S.V., Sahana, N. and Praveen, S., 2021. Rhythm of a life within life: role of viral suppressors in hijacking the host cell. *Journal of Plant Biochemistry and Biotechnology*, *30*(4), pp.636-639. http://krishi.icar.gov.in/jspui/handle/123456789/71152.

Moin, M., Saha, A., Bakshi, A., Madhav, M.S. and Kirti, P.B., 2021. Constitutive expression of Ribosomal Protein L6 modulates salt tolerance in rice transgenic plants. *Gene*, *789*, p.145670. http://krishi.icar.gov.in/jspui/handle/123456789/71158.

Moin, M., Saha, A., Bakshi, A., MS, M. and PB, K., 2021. Study on Transcriptional Responses and Identification of Ribosomal Protein Genes for Potential Resistance against Brown Planthopper and Gall Midge Pests in Rice. *Current Genomics*, *22*(2), pp.98-110. http://krishi.icar.gov.in/jspui/handle/123456789/71159.

Moring, A., Hooda, S., Raghuram, N., Adhya, T.K., Ahmad, A., Bandyopadhyay, S.K., Barsby, T., Beig, G., Bentley, A., Bhatia, A. and Dragosits, U., 2021. Nitrogen challenges and opportunities for agricultural and environmental science in India. *Frontiers in Sustainable Food Systems*, *5*, p.505347. http://krishi.icar.gov.in/jspui/handle/123456789/71286.

Nayaka, G.V., Reddy, G.P. and Kumar, R.M., 2021. Dry matter production and partitioning in different plant parts of rice cultivars under irrigation regimes and systems of cultivation. *Indian Journal of Agricultural*

Research, *55*(3), pp.347-352. http://krishi.icar.gov.in/jspui/handle/123456789/71288.

Nayaka, G.V., Reddy, G.P. and Kumar, R.M., 2021. Productivity and economics of rice cultivars under different irrigation regimes and systems of cultivation. *Oryza*, 58(4): 540-554. http://krishi.icar.gov.in/jspui/handle/123456789/71290.

Neeraja, C.N., Barbadikar, K.M., Krishnakanth, T., Bej, S., Rao, I.S., Srikanth, B., Rao, D.S., Subrahmanyam, D., Rao, P.R. and Voleti, S.R., 2021. Down regulation of transcripts involved in selective metabolic pathways as an acclimation strategy in nitrogen use efficient genotypes of rice under low nitrogen. *3 Biotech*, *11*(2), pp.1-15. http://krishi.icar.gov.in/jspui/handle/123456789/57462.

Neeraja, C.N., Barbadikar, K.M., Mangrauthia, S.K., Rao, P.R., Subrahmanayam, D. and Sundaram, R.M., 2021. Genes for NUE in rice: a way forward for molecular breeding and genome editing. *Plant Physiology Reports*, *26*(4), pp.587-599. http://krishi.icar.gov.in/jspui/handle/123456789/71291.

Nirmala, B., Tuti, M.D., Mahender Kumar, R., Amtul Waris, Muthuraman, P., Parmar, B. and Vidhan Singh, T., 2021. Integrated assessment of system of rice intensification vs. conventional method of transplanting for economic benefit, energy efficiency and lower global warming potential in India. *Agroecology and Sustainable Food Systems*, *45*(5), pp.745-766. http://krishi.icar.gov.in/jspui/handle/123456789/71292.

Padbhushan, R., Sharma, S., Kumar, U., Rana, D.S., Kohli, A., Kaviraj, M., Parmar, B., Kumar, R., Annapurna, K., Sinha, A.K. and Gupta, V.V., 2021. Meta-Analysis Approach to Measure the Effect of Integrated Nutrient Management on Crop Performance, Microbial Activity, and Carbon Stocks in Indian Soils. *Frontiers in Environmental Science*, p.396. http://krishi.icar.gov.in/jspui/handle/123456789/71157.

Poli, Y., Nallamothu, V., Hao, A., Goud, M.D., Wang, X., Desiraju, S., Mangrauthia, S.K. and Jain, A., 2021. NH787 EMS mutant of rice variety Nagina22 exhibits higher phosphate use efficiency. *Scientific reports*, *11*(1), pp.1-18.http://krishi.icar.gov.in/jspui/handle/123456789/71156

Potupureddi, G., Balija, V., Ballichatla, S., CG, G., Awalellu, K., Lekkala, S., Jallipalli, K., MG, G., Mohammad, E., Arutla, S. and Burka, R., 2021. Mutation resource of Samba Mahsuri revealed the presence of high extent of variations among key traits for rice improvement. *PloS one*, *16*(10), p.e0258816. http://krishi.icar.gov.in/jspui/handle/123456789/71155.

Prakasam, V., Ladhalakshmi, D., Laha, G.S., Krishnaveni, D., Kannan, C. and Prasad, M.S., 2021. New combination fungicide mancozeb 68%+ hexaconazole 4% WG against blast and sheath blight disease in rice. *Indian Journal of Plant Protection* 49 (2): 137-142.

Prathi, N.B., Durga Rani, C.V., Balachandran, S.M., Prakasam, V., Chandra Mohan, Y., Nagalakshmi, S., Srivastava, S.K., Sundaram, R.M. and Mangrauthia, S.K., 2021. Genome-Wide Expression Profiling of Small RNAs in Indian Strain of *Rhizoctonia solani* AG1-1A Reveals Differential Regulation of mil RNAs during Pathogenesis and Crosstalk of Gene Regulation. *Journal of Fungi*, *7*(7), p.561. http://krishi.icar.gov.in/jspui/handle/123456789/52598.

Ram T., Jyothi B., Subba Rao L.V., Revathi P., Fiyaz A. R., Sreedevi B., Prasad, M.S., Laha G.S., Jhansi Lakshmi V., Mahender Kumar R. and Nirmala B. 2021. DRR Dhan 54 [IET 25653 (RP 5943-421-16-1-1-B)]. *Journal of Rice Research*, 14(1): 77-78.

Rao, D. V.K. N, Surekha, K. and Aruna L. 2021. Rice crop response to site variability in a multi-locational trial: A call for site specific management. *Oryza* 58(4): 506-516.

Rao, D.V.K., 2021. Highly informative point sources of data: soil health cards for interpolated soil maps. *Current Science*, *120*(10), pp.1554-1555. http://krishi.icar.gov.in/jspui/handle/123456789/47415.

Rao, D.V.K., 2021. Soil has a volume: Volumetric versus gravimetric expression of soil nutrient contents in understanding soil-plant interrelationships. Academia Letters, Article 1736. https://doi.org/10.20935/AL1736http://krishi.icar.gov.in/jspui/handle/123456789/71154.

Rao, D.V.K., Surekha, K. and Manjusha, P.G.S., 2021. Delta yield reflects better site-specific crop response in multi-locational trial. *Current Science*, *120*(8), pp.1291-1292. http://krishi.icar.gov.in/jspui/handle/123456789/71153.

Rathod, R., Soundharya, B., Shahana, F., Lakshmi, D.V., Naik, P.J., Swathi, Y., Swapna, N., Subba Rao, L.V. and Venkataiah, M., 2021. Studies on Genetic Parameters in Breeding Lines of Aerobic Rice. *Environment and Ecology*, *39*(3), pp.605-612. http://krishi.icar.gov.in/jspui/handle/123456789/71168.

Rathod, R., Suman, K., Madhubabu, P., Subbarao, L.V., Eswari, K.B., Chary, D.S. and Neeraja, C.N., 2021. Identification of genomic regions associated with grain zinc concentration in RILs derived from popular cultivar MTU1010 and BR2655 of rice. *Indian Journal of Genetics and Plant breeding*, *81*(04), pp.44-53. http://krishi.icar.gov.in/jspui/handle/123456789/71169.

Rathod, S., Saha, A., Patil, R., Ondrasek, G., Gireesh, C., Anantha, M.S., Rao, D.V.K.N., Bandumula, N., Senguttuvel, P., Swarnaraj, A.K. and Meera, S.N., 2021. Two-Stage Spatiotemporal Time Series Modelling Approach for Rice Yield Prediction & Advanced Agroecosystem Management. *Agronomy*, *11*(12), p.2502. http://krishi.icar.gov.in/jspui/handle/123456789/71197.

Rathod, S., Yerram, S., Arya, P., Katti, G., Rani, J., Padmakumari, A.P., Somasekhar, N., Padmavathi, C., Ondrasek, G., Amudan, S. and Malathi, S., 2021. Climate-Based Modeling and Prediction of Rice Gall Midge Populations Using Count Time Series and Machine Learning Approaches. *Agronomy*, *12*(1), p.22. http://krishi.icar.gov.in/jspui/handle/123456789/71196.

Reddy, B.N., Lakshmi, V.J., Maheswari, T.U. and Laha, G.S., 2021. Compatibility of Entomopathogenic Fungi with Neonicotinoids for the Management of Brown Plant Hopper of Rice, *Nilaparvata lugens* stal. (Delphacidae: Hemiptera). *Agricultural science digest-a research journal*, *41*(2), pp.324-328. http://krishi.icar.gov.in/jspui/handle/123456789/71198.

Reddy, M.R., Mangrauthia, S.K., Reddy, S.V., Manimaran, P., Yugandhar, P., Babu, P.N., Vishnukiran, T., Subrahmanyam, D., Sundaram, R.M. and Balachandran, S.M., 2021. PAP90, a novel rice protein plays a critical role in regulation of D1 protein stability of PSII. *Journal of Advanced Research*, *30*, pp.197-211. http://krishi.icar.gov.in/jspui/handle/123456789/52827.

Reddy, N.V., Chitra Shanker and Rana D. K. 2021. Record of *Conocephalus longipennis* de Haan (Orthoptera: Tettigonidae) predating on rice leaf folder larvae. *Insect Environment* 24 (3): 381-383.

Reddy, N.V., Chitra Shanker, Kannan, C., and Rana, D.K., Mortality factors of *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Crambidae) in bio-intensive pest management modules of rice. *India Journal of Plant Protection*, *49*(3): 161-165. http://krishi.icar.gov.in/jspui/handle/123456789/71199.

Sadras Bhavana, T.R., Rao, P.R., Naik, B.B. and Raju, C.D., Correlation studies between yield and yield attributes of elite rice genotypes transplanted under different growing environments. The Journal of Research, PJTSAU, 49(1 & 2): 10-16.

Sahu, N., Padmavath,i G., Bentur, J.S. and Divya, D. 2021. Validation of reported candidate genes in planthopper resistance in rice line RP 2068. *International journal of Scientific research*. 10(2): 1-3. http://krishi.icar.gov.in/jspui/handle/123456789/71200.

Saradadevi, G.P., Das, D., Mangrauthia, S.K., Mohapatra, S., Chikkaputtaiah, C., Roorkiwal, M., Solanki, M., Sundaram, R.M., Chirravuri, N.N., Sakhare, A.S. and Kota, S., 2021. Genetic, epigenetic, genomic and microbial approaches to enhance salt tolerance of plants: A comprehensive review. *Biology*, *10*(12), p.1255. https://doi.org/10.3390/biology10121255) http://krishi.icar.gov.in/jspui/handle/123456789/71201.

Sathish Kumar P, Praveen Kumar R, Maddala, S.R.S.C., Sundaram, R.M., Singh, A.K., Singh, K., LV, S.R. and Maganti, S.M., 2021. Development of coreset of aromatic rice (*Oryza sativa* L. Indica) based on molecular and morphological diversity. *Genetic Resources and Crop Evolution*, *68*(2), pp.441-450. http://krishi.icar.gov.in/jspui/handle/123456789/52817.

Satturu, V., Kudapa, H.B., Muthuramalingam, P., Nadimpalli, R.G.V., Vattikuti, J.L., Anjali, C., Satish, L., Ramesh, M. and Mulinti, S., 2021. RNA-Seq based global transcriptome analysis of rice unravels the key players associated with brown planthopper resistance. *International Journal of Biological Macromolecules*, *191*, pp.118-128. http://krishi.icar.gov.in/jspui/handle/123456789/71202.

Senguttuvel, P., Sravanraju, N., Jaldhani, V., Divya, B., Beulah, P., Nagaraju, P., Manasa, Y., Prasad, A.S., Brajendra, P., Gireesh, C. and Anantha, M.S., 2021. Evaluation of genotype by environment interaction and adaptability in lowland irrigated rice hybrids for grain yield under high temperature. *Scientific Reports*, *11*(1), pp.1-13. http://krishi.icar.gov.in/jspui/handle/123456789/57226.

Senguttuvel, P., SubbaRao, L. V., HariPrasad, S., Swamy, A. V. S. R., Gireesh, C., Anantha, M. S., Suneetha Kota, Sundaram, R. M., Madhav, M.S., Nirmala, B., Sruthi, K., Laha, G. S., Sreedevi, B., Brajendra, P., Mahender Kumar, R., Padmavathi, G., Prasad, M. S., Somasekhar, N., Sadath Ali, Koteshwar Rao, P., Nagarjuna, E., Jaldhani, V., Beulah, P., Nagaraju, P. and Manasa, Y. 2021. DRR Dhan 55 (IET 26194) - A high yielding, early maturing aerobic rice variety. *Journal of Rice Research* 14 (1): 79-80.

Shah, P., Magar, N.D. and Barbadikar, K.M., 2021. Current technological interventions and applications of CRISPR/Cas for crop improvement. *Molecular Biology Reports*, pp.1-20. http://krishi.icar.gov.in/jspui/handle/123456789/71203.

Sharath, S., Triveni, S., Nagaraju, Y., Latha, P. C. and Vidyasaga,r B. 2021. The Role of Phyllosphere Bacteria in Improving Cotton Growth and Yield Under Drought Conditions. *Frontiers in Agronomy* 3: 680466. http://krishi.icar.gov.in/jspui/handle/123456789/71204.

Sharma, N., Sinha, V.B., Prem Kumar, N.A., Subrahmanyam, D., Neeraja, C.N., Surekha, K., Jha, A., Parsad, R., Sitaramam, V. and Raghuram, N., 2021. Nitrogen use efficiency phenotype and associated genes: roles of germination, flowering, root/shoot length and biomass. *Frontiers in Plant Science*, *11*, p.2329. http://krishi.icar.gov.in/jspui/handle/123456789/71205.

Shikari, A.B., Najeeb, S., Khan, G., Mohidin, F.A., Shah, A.H., Nehvi, F.A., Wani, S.A., Bhat, N.A., Waza, S.A., Subba Rao, L.V. and Steele, K.A., 2021. KASP™ based markers reveal a population sub-structure in temperate rice (*Oryza sativa* L.) germplasm and local landraces grown in the Kashmir valley, north-western Himalayas. *Genetic Resources and Crop Evolution*, *68*(3), pp.821-834. http://krishi.icar.gov.in/jspui/handle/123456789/71206.

Shivani D, Jabeen F, Chaithanya K, Kousik MBVN, Dilip T, Punniakoti E, Supriya K, Sundaram RM, Aravind Kumar j and Fiyaz RA (2021). Assessment of genetic diversity of rice germplasm using microsatellite markers. *The Pharma Innovation Journal* 10: 1393-1397. http://krishi.icar.gov.in/jspui/handle/123456789/71207.

Shivani, D., Jabeen F., Supriya K., Sundaram R. M., Aravind Kumar J. and Fiyaz R. A. 2021. Genetic Variability, Heritability and Genetic advance for yield and its component traits in germplasm lines of Rice (*Oryza sativa* L.). *The J. Res. PJTSAU*, 49 (1&2): 25-29. http://krishi.icar.gov.in/jspui/handle/123456789/71208.

Shivani, D., Neeraja, C.N., Cheralu, C. and Shankar, V.G., 2021. Multivariate analysis and character association studies for yield and nutritional characters in Swarna and type 3 RIL population of rice (*Oryza sativa* L.). *Journal of Cereal Research*, *13*(2):180-187. http:// doi.org/10.25174/2582-2675/2021/113440. http://krishi.icar.gov.in/jspui/handle/123456789/71209.

Shruthi, K., Siddaraju, R., Naveena, K., Ramanappa, T.M., Gireesh, C., Vishwanath, K. and Nagaraju, K.S., Trait Based Modelling Approach for Selection of Elite Germplasm Accessions in Soybean [*Glycine max* (L). Merrill]. *Legume Research-An International Journal*, *1*, p.6. http://krishi.icar.gov.in/jspui/handle/123456789/71210.

Singh, R.K., Kota, S. and Flowers, T.J., 2021. Salt tolerance in rice: seedling and reproductive stage QTL mapping come of age. *Theoretical and Applied Genetics*, *134*(11), pp.3495-3533. http://krishi.icar.gov.in/jspui/handle/123456789/71211.

Singh, U.M., Dixit, S., Alam, S., Yadav, S., Prasanth, V.V., Singh, A.K., Venkateshwarlu, C., Abbai, R., Vipparla, A.K., Badri, J. and Ram, T., 2021. Marker assisted forward breeding to develop a drought, bacterial leaf blight, and blast resistant rice cultivar. *The Plant Genome*, p.e20170. http://krishi.icar.gov.in/jspui/handle/123456789/71212.

Sinha, P., Kumar, T.D., Hajira, S.K., Ayyappa, D., Aleena, D., Masthani, S.K., Anila, M., Rekha, G., Punniakoti, E., Kousik, M.B.V.N. and Sundaram, R.M., 2021. Identification of novel sources of resistance against bacterial blight disease through intensive screening of wild rice introgression lines. *Indian Journal of Plant Protection* 49: 131-137. http://krishi.icar.gov.in/jspui/handle/123456789/71213.

Srijan, A., Senguttuvel, P., Sundaram R.M., Jaldhani, V., Sudheer Kumar, S., Srinivasa Chary, D., Kuldeep Singh Dangi. 2021. Morphological and Molecular Approaches in Identification of Fertility Restorers Among Aerobic Lines of Rice (*Oryza sativa* L.). Environment and Ecology 39(4). Pp. 974-979. ISSN 0970-0420.

Srinivasan, R., Nayak, D.C., Gobinath, R., Kumar, S.N., Rao, D.V.K.N. and Singh, S.K., 2021. Consequential rice crop response to resultant soil properties in a toposequence in eastern coastal plain of Odisha, India. *Modeling Earth Systems and Environment*, pp.1-16.

Subhashree P, Jhansi Lakshmi V, Sheshu Madhav M, Rajeswari B and Srinivas C 2021. Virulence of rice brown planthopper population from Khammam district of Telangana state against rice genotypes and its morphometrics. *Journal of Research, PJTSAU*. 49(3):16-22. http://krishi.icar.gov.in/jspui/handle/123456789/71214.

Subhashree P., Lakshmi VJ, Madhav M S, Rajeswari B and Srinivas C. 2021. Non-preference mechanism of resistance to brown planthopper, *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) population of Mahabubnagar, Telangana in rice genotypes. *Journal of Experimental zoology. India.* 24(2): 1811-1817. DocID: https://connectjournals.com/ 03895.2021.24.1811 http://krishi.icar.gov.in/jspui/handle/123456789/71215.

Suman, K., Neeraja, C.N., Madhubabu, P., Rathod, S., Bej, S., Jadhav, K.P., Kumar, J.A., Chaitanya, U., Pawar, S.C., Rani, S.H. and Subbarao, L.V., 2021. Identification of Promising RILs for High Grain Zinc Through Genotype× Environment Analysis and Stable Grain Zinc QTL Using SSRs and SNPs in Rice (*Oryza sativa* L.). *Frontiers in plant science*, p.22. http://krishi.icar.gov.in/jspui/handle/123456789/57459.

Sundaram, R.M., Anila, M., Barbadikar, K.M., Mangrauthia,, S.K. Raghuveer Rao, P., Subrahmanyam, D., Voleti, S.R., Surekha, K., Subba Rao, L.V., Neeraja, C.N. and Mahender Kumar, R. (2021). Innovations for tapping genetic potential and agronomic efficiencies of crops: Rice, *Indian Journal of Agronomy* 66 (5th IAC Special issue): S191-S200. http://krishi.icar.gov.in/jspui/handle/123456789/71216.

Surekha K, Gobinath,R. and Manasa, V., 2021. Improving Yield and Nitrogen Use Efficiency Using Polymer Coated Urea in Two Crop Establishment Methods of Rice (*Oryza sativa* L.) Under Vertisol (Typic Pellustert). *International Journal of Plant Production*, *15*(4), pp.679-693.

Surender, R., Lavanya, K., Abdul Fiyaz, C.M., Shiva Prasad, G. and Rao, L.S., 2021. Screening of rice (*O. sativa* L.) genotypes for heat tolerance to develop climate resilient rice genotypes.*The Pharma Innovation Journal*. 10(2): 132-143. http://krishi.icar.gov.in/jspui/handle/123456789/71217.

Thakur, V.J.S., Ponnuswamy, R., Singh, A.K., Shankar, V.G. and Chary, S.D., 2021. Molecular tagging of Rf genes for the fertility restoration of WA-CMS system by bulk segregant analysis in rice. *Indian Journal of Genetics and Plant Breeding*, *81*(01), pp.43-49. http://krishi.icar.gov.in/jspui/handle/123456789/71218.

Yugander, A., Ershad Md., Muthuraman, P., Prakasam, V., Ladhalakshmi, D., Sheshu Madhav, M., Srinivas Prasad, M., Sundaram, R. M. and Laha, G. S. 2021. Understanding the variability of rice bacterial blight pathogen, *Xanthomonas oryzae* pv. *oryzae* in Andhra Pradesh, India. *Journal of Basic Microbiology* DOI: 10.1002/jobm.202100406.

Book Edited

Kumar Anil, O. P. Verma, Ravi Ranjan Kumar, Rashmi Mishra, Lakshmi B and Senguttuvel P. Advances In: Plant Biotechnology. March, 2021. Parmar Publication, Dhanbad-828109, Jharkhand. ISBN: 978-81-927825-3-5.

Ravi Ranjan Kumar, O. P. Verma, Lokesh V, Satyendra,

Publications

Anand Kumar, Vishwa Vijay Thakur and Senguttuvel P. Introductory Plant Biotechnology. March, 2021, Parmar Publication, Dhanbad-828109, Jharkhand ISBN:978-81-927825-2-6.

Shanker A K, Shanker Chitra, Anjali Anand and Maheswari M 2021. Climate Change and Crop Stress: Molecules to Ecosystems, ISBN: 978-0-12-816091-6, Academic Press (Elsevier) Pp 565.

Shanthi Bushan, Sunil Kumar, et al., Senguttuvel P. Method's manual for breeding of open pollinated varieties. Parmar Publication. Mr. Gajendra Parmar, Proprietor, Parmar Publication 854, KG Ashram, Bhuinphod, Govindpur Road, Dhanbad-828109, Jharkhand. ISBN: 978-81-952546-7-4.

Sailabala Dei, Amtul Waris, AK Sinha, Anil Kumar, Pankaj Kumar, Surbhi Jain. 2021. Climate Change and Agriculture. Parmar Publications ISBN-978-81-925875-6-5. pp 197

Books and Book Chapters

Aravind Kumar J, Subba Rao LV, Abdul Fiyaz R, Badri J, Mahesh G, Chiranjeevi M, Chaitanya U, Sanjeeva Rao D, Sundaram RM (2021) Rice Grain Quality Analysis. ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-500030, Telangana State, India, 56 pp. ISBN 978-81-948904-1-6.

Arun MN, Shankara Hebbar S, Bhanu Prakash K, Senthilvel T., Nair A.K, Padmavathi G., Pratima Pandey and Aarti Singh. 2021. Seed Priming – The way forward to mitigate abiotic stress in crops. In: Hasanuzzaman M (ed). Plant Stress Physiology- Perspectives in Agriculture Intech Open. ISBN 978-1-83969-867-5.

Bentur JS, Sundaram RM, Mangrauthia SK and Nair S (2021). Molecular Approaches for Insect Pest Management in Rice. In: Ali J and Wani SH (eds.) Rice Improvement Physiological, Molecular Breeding and Genetic Perspectives. International Rice Research Institute, Los Banos, Philippines. pp 379-424. ISBN 978-3-030-66529-6; ISBN 978-3-030-66530-2 (eBook) (available online at https://doi.org/10.1007/978-3-030-66530-2).

Gobinath, R., Bandeppa, S., Manasa, V., Rajendiran, S., Kiran Kumar, Ranjan Paul and Basavaraj, K. (2021). Nanoparticle-Mediated Adsorption of Pollutants: A Way Forward to Mitigation of Environmental Pollution. In: Microbial Rejuvenation of Polluted Environment, Microorganisms for Sustainability, https://doi.org/10.1007/978-981-15-7455-9_13, Springer Nature Singapore. Pp 317-348.

Jaldhani V, Sanjeeva Rao D, Beulah P, Nagaraju P, Suneetha K, Veronica N, Kondamudi R, Sundaram RM, Madhav MS, Neeraja CN, Raghuveer Rao, P, Subrahmanyam D, Voleti SR and Senguttuvel P (2021). Drought and heat stress combination in a changing climate. In: Shankar A, Shanker C, Anand A, Maheshwari M (Eds.). Climate Change and Crop Stress Molecules to Ecosystems. Academic Press. England pp 33-54. ISBN: 978-0-12-816091-6.

Jaldhani, V., Senguttuvel, P., Srikanth, B., Rao, P. R., Subrahmanyam, D. & Rao, D. S. (2021). Present status and future prospects of drought tolerance in rice. Cereal Grains. Intech Open. doi. 10.5772/intechopen.97461

Kumar M, Sandhya, Pawan Kumar, Akash Gaurav Singh and Aravind Kumar Jukanti (2021) Abiotic Stress Tolerance in Rice: Insight in Climate Change Scenario. In: Integrative Advances in Rice Research (Ed. Ming Huang), pp 1-20, Intech Open Publications. DOI: 10.5772/intechopen.98909.

Laha, G. S., Prakasam, V., Muthuraman, P., Jeyakumar, P. and Brajendra 2021. Climate change and emerging rice disease scenario. In: Climate Change and Disease Dynamics (Eds. Kumar, P., Roy, S., Kumar, A., Gupta, R. N., Tiwari, S., Vengateswari, M. and Prasad, S. A.), Parmar Publications, pp. 1-10.

Neeraja C N., Voleti S.R., Subrahmanyam D., Surekha K., Sonali Bej, Krishnakanth Talapanti and Raghuveer P.R. 2021. Molecular Breeding for Improving Nitrogen Use Efficiency in Rice: Progress and Perspectives. Chapter 12: (Eds) Mohammad Anwar Hossain, Lutful Hassan, Khandakar Md. Ifterkharuddaula, Arvind Kumar, Robert Henry, Molecular Breeding for Rice Abiotic Stress Tolerance and Nutritional Quality (Wiley Online Library) https://doi.org/10.1002/9781119633174.ch12.

Nivetha N, A. K. Lavanya, K. V. Vikram, A. D. Asha, K. S. Sruthi, S. Bandeppa, K. Annapurna and Sangeeta Paul .2021. PGPR-Mediated Regulation of Antioxidants: Prospects for Abiotic Stress Management in Plants. In: Antioxidants in Plant-Microbe Interaction DOI: 10.1007/978-981-16-1350-0_23

Nivetha N, Asha A. D., Bandeppa, Thakur J K, Dukare A.S., Bishwajeet Paul and Sangeeta Paul. 2021. Microbial-Based Nanoparticles as Potential Approach of Insect Pest Management. In: Microbes for Sustainable lnsect Pest Management DOI: 10.1007/978-3-030-67231-7_7

Priyadarshi R, Sinha P, Dasari A, Sundaram RM (2021). Application of "Omics" Technologies in Crop Breeding. In: Kumar A, Kumar R, Shukla P and Patel HK (Eds.). Omics Technologies for Sustainable Agriculture and Global Food Security (Vol II). Springer, Singapore. pp 24-45. Print ISBN: 978-981-16-2955-6 (available online at https://doi.org/10.1007/978-981-16-2956-3_2).

Samadhan Y B, Ritu Vishwa Karma, Shaloo Verma, Hillol Chakdar, G S Bandeppa. 2021. Rhizospheric

Diversity of Cyanobacteria and Their Significance in Tropical Ecosystem In: Plant, Soil and Microbes in Tropical Ecosystems DOI: 10.1007/978-981-16-3364-5_3.

Sanjeeva Rao D, Neeraja CN, Madhu Babu P, Nirmala B, Suman K, Rao LVS, Surekha K, Raghu P, Longvah T, Surendra P, Kumar R, Babu VR and Voleti SR (2021) Zinc Biofortified Rice Varieties: Challenges, Possibilities, and Progress in India. In Mir, R. R., Isobe, S. N., Pandey, M. K., Kumar, A., eds. (2021). Achieving Nutritional Security and Food Safety Through Genomics-Based Breeding of Crops. Lausanne: Frontiers Media SA. pp.129-141doi: 10.3389/978-2-88966-611-9.

Shanker C, Padmavathi Ch, Himabindu P and Repelle N 2021. Molecules to ecosystems -recent trends in chemical ecology for combating biotic stresses in a changing climate In (Eds.) Arun K Shanker, Chitra Shanker, Anjali Anand and Maheshwari M. Climate Change and Crop Stress, 361-410, Academic Press (Elsevier).

Tuti M D, R Mahender Kumar and Brajendra. 2021. Climate Change and Its Impact on Rice Productivity and Quality. V. K. Hebsale Mallappa, M. Shirur (eds.), Climate Change and Resilient Food Systems, Springer.https://doi.org/10.1007/978-981-33-4538-6_6.

Amtul Waris. 2021. Gender Implications for climate smart agriculture in Women & Diversity, eds. N S, Rathore, Lalita Vatta and Ragini Ranawat. International Books & Periodical supply Service, New Delhi 654 pages ISBN:978-93-88892-79-7 Pp 117-125.

Technical Bulletins/ Articles

Amtul Waris and B.Nirmala (2021) Manual on Good Agricultural Practices in Rice cultivation published in local language(telugu) under DST-SEED project. Technical bulletin No. 108/2021. ICAR-IIRR, Hyderabad. PP 44.

Fiyaz A.R, Aravind Kuar J, M Chiranjeevi, U Chaitanya, D Shivani, K Chaitanya, L V Subba Rao, and R M Sundaram (2021). A Compendium of Rice Genetic Stocks Registered in India. ICAR-Indian Institute of Rice Research (ICAR-IIRR), Rajendranagar, Hyderabad-500030, Telangana, India. ICAR-IIRR Publication No. 109/2021.

Jhansi Rani B., N. Balasubramani, P. Muthuraman, Amtul Waris, P. Jeya Kumar, P.A. Lakshmi Prasanna, B. Nirmala and Santosha Rathod (2021) Compendium of Lecture Notes: Training Programme on "Sustainable Rice Production Technology" of Module II: Certified Farm Advisor Program (Rice), 27th January -10th February, 2021, Indian Institute of Rice Research, Rajendranagar, Hyderabad pp. 237

Kumar R M., Mangal Deep Tuti, B. Sreedevi, K. Surekha, D. Subrahmanyam, B. Nirmala, T. Vidhan Singh, Brajendra and R.M. Sundaram. Agro-technologies for enhancing rice productivity, resource conservation and climate resilience - AICRIP experiences. Agro-technologies, 2021, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500030. 53 pp.

Mahender Kumar R., Mangal Deep Tuti, B. Sreedevi, K. Surekha, D. Subrahmanyam, B. Nirmala, T. Vidhan Singh, Brajendra and R.M. Sundaram. Agro-technologies for enhancing rice productivity, resource conservation and climate resilience - AICRIP experiences. Agro-technologies, 2021, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500030.

Nirmala Bandumula (2021) 'Economics of Rice production technologies' in Training Manual on 'Sustainable rice production Technologies-Module II certified Farm Advisor Program' sponsored by MANAGE held during January 27 to February 10, 2021, ICAR-Indian Institute of Rice Research, Hyderabad-500030. P. 218-221.

Sharma J.P., Sarfaraz Ahmed Wani, Nazir A. Bhat, Najeebul Rehman Sofi, Asif B. Shikari, Ashaq Hussain, Gazala H. Khan, L.V. Subba Rao, F.A. Mohiddin, Shabir H. Wani, I.A. Jahangir, M.A. Ganai, G.A. Parray & N.A. Bhat (2021). Rice Landraces of Kashmir Himalayas: A Journey from Conservation to Revival for Livelihood Security, MRCFC, SKUAST-Kashmir, Khudwani, Anantnag, 192102. Pp 44. Book No. AU/DR/BOOKLET/MB/MRCFC/2021/011: DATED:05-10-2021.

Satyavathi, CT and Ambawat, S and Khandelwal, V and Govindaraj, M and Neeraja, CN (2021) Micronutrient Rich Pearl Millet for Nutritionally Secure India. ICAR-All India Coordinated Research Project on Pearl Millet, Jodhpur, India

Popular Articles

Amtul Waris, B.Nirmala and K. Shruthi (2021) Community adharitha vittanotpatti: Mukhya Uddhesyamu mariyu salahalu. *Vyavasayam. PJTSAU.* 7(5).23-24.

Amtul Waris. 2021. Extension Strategies for Skilling of Rural Youth for Paddy Cultivation and Entrepreneurship Development. *Agriculture & Food-E-Newsletter* 3(12) 60-63.

Amtul Waris. 2021. Farm Women's Critical Role in Climate Smart Agriculture and Achieving the Sustainable Development Goals *Agriculture &Food-E-Newsletter* 3(5) 112-116.

Basavaraj K, Jesudasu GS, Prakasam V, Ladhalakshmi D, Gireesh C, Gobinath R, Suvarna Rani and Bandeppa. 2021. Phytoalexins: Defensive Compounds Against Plant Pathogens. *Agricultural science and green energy* 2(1): 54-60.

Chimmili Suvarna Rani and Sruthi K. 2021. RGA – A new

breeding method for rapid advancement of breeding cycle in rice – Do more with less. *Indian Farming*, 71 (4): 19-21.

Gobinath R, Manasa V, Surekha K., Vijayakumar S and Bandeppa. 2021. New age nutrient carriers for rice based cropping systems. *Indian Farming*, 71 (4): 12 -16.

Ishwarya Lakshmi V G, Gireesh C, Basavaraj P S and Anantha M S. Weed competitiveness: an essence for direct seeded and aerobic rice. 2021. *Krishi Science,* 2(2): 19 -22.

Nirmala B., Kumar R. M. and Sriramulu T. 2021. *Vari lo neruga vitte vidhanam* (DSR). *Rythu Nestham*. 17-18.

Ramprakash, T., Padmaja, B., Sreedevi, B. 2021. Weed Management in Changing Climate. *Annadata*. December 2021, 22-24.

Sharma J.P., Sarfaraz Ahmed Wani, Nazir A. Bhat, Najeebul Rehman Sofi, Asif B. Shikari, Ashaq Hussain, Gazala H. Khan, L.V. Subba Rao, F.A. Mohiddin, Shabir H. Wani, I.A. Jahangir, M.A. Ganai, G.A. Parray & N.A. Bhat (2021). Rice Landraces of Kashmir Himalayas: A Journey from Conservation to Revival for Livelihood Security, MRCFC, SKUAST-Kashmir, Khudwani, Anantnag, 192102. Pp 44. Book No. AU/DR/BOOKLET/MB/MRCFC/2021/011: DATED:05-10-2021

Tuti M D, Mahender Kumar R, Sreedevi B, Singh A and Saha S. 2021. Weed management in system of rice intensification. *Indian Farming* 71(4): 65–66.

Vijayakumar, S., Sivashankari, M., Gobinath, R., Saha, S and Prabhu, G. 2021. Alleviating malnutrition through agronomic bio-fortification using value-added fertilizers, *Indian Farming* 71(01): 18–21.

Vijayakumar, S., Subramanian, E., Saravanane, P., Gobinath, R. and Saha, S. 2021. Farm mechanization in rice cultivation: Present status, bottlenecks and potential. *Indian Farming*, 71(01): 04-07.

Abstracts/ Extended Summaries

Akula, Mounika and Nirmala B. 2021. Rice Production in Telangana: Growth, Instability and Decomposition Analysis. ARRW Diamond Jubilee National Symposium - 2021 on GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming. Organized by Association of Rice Research Workers, Cuttack, Odisha. Abstract Book P.80.

Amtul Waris (2021) Rice based food entrepreneurship development of women farmers. ARRW Diamond Jubilee National Symposium on GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming, December 16-17, 2021 Cuttack, Odisha, India pg161.

Athulya, R., Padmakumarim A. P. and Uma Maheswari, T. 2021. Biochemical characterization of Scirpophaga incertulas populations of Telangana State. ARRW Diamond Jubilee National Symposium – 2021 on “GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming” on 16-17. December 2021 pg. 137.

B Srikanth, D Subrahmanyam, CN Neeraja, J Veerendra and S Narender Reddy. 2021. Genotypic variation for nitrogen use efficiency in rice under differential nitrogen levels. International Conference on FCPPB, 2021. October 6-7, 2021.

B Srikanth, D Subrahmanyam, CN Neeraja, J Veerendra and S Narender Reddy. 2021. Influence of graded levels of nitrogen on grain characteristics of different rice genotypes. Global Rice Conference 2021: Deliberations on Advances in Rice Research. September, 24-25, 2021.

Chaitanya, M.S., Anitha, G., and Shanker Chitra. 2021. Abundance and diversity of hemipteran and hymenopteran insects at vegetative stage of rice under different organic rice regimes Abstract no. S1-PP-04, Pg 31, Book of abstracts, Sixth National Conference on Biological Control: Innovative Approaches for Green India, ICAR- NBAIR, Bengaluru 3-5 march 2021.

Dhawande, A., Lakshmi, V. J. and Subba Rao, L.V. 2021. Non-preference mechanism of resistance in rice germplasm accessions to White backed planthopper Sogatella furcifera (Horvath). Extended Summaries 5th International Agronomy Congress November 23-27, 2021, PJTSAU, Hyderabad-500030. Pp. 2057-2058.

Jasmine C, Beulah P, Jaldhani V, Manasa Y, Nagaraju P, Neeraja CN, HariPrasad AS, Sundaram RM, Senguttuvel P. 2021. Genetic diversity for grain Fe and Zn content through molecular and morphological evaluation in hybrid rice parental lines. Global Rice Conference 2021: Deliberations on Advances in Rice Research. September, 24-25, 2021.

Karthika, G., Sandeep, G., Satendra, K.M. Sundaram R.M. and Revathi P. 2021. Development and utilization of wild introgression lines (ILs) using *O. rufipogon* and *O. nivara* accessions for enhancing yield & yield contributing traits in rice. Abstract No. PO 45, International conference on Future Challenges and Prospects in Plant Breeding, 6 - 7, October, 2021. Tamil Nadu Agricultural University, Coimbatore.

Lakshmi Prasanna, P.A (2021) Effects of changes in paddy procurement policy in West Bengal- some preliminary insights. ARRW Diamond Jubilee National Symposium on GenNext technologies for enhancing productivity, profitability and Resilience of Rice Farming Abstracts pp:156.

Manasa, V., Gobinath, R., Surekha, K., Azam M. M., Bandeppa, S. and Aarti Singh. 2021. Effect of Super

Absorbent Polymer on yield and yield components of direct seeded rice in a Vertisol. Presented in 5th International Agronomy Congress, November 23-27, Hyderabad, India

Nirmala, B. 2021. Economics and energy analysis of adoption of IPM in Tamil Nadu. Abstract Book. ARRW Diamond Jubilee National Symposium-2021 on GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming. Organized by Association of Rice Research Workers, Cuttack, Odisha. P.124.

Nirmala, B., Tuti M.D., Kumar R.M. and Muthuraman P. 2021. Comparative assessment of direct seeded rice and conventional method of transplanting for economic benefit and energy efficiency. Extended Summaries: 5th International Agronomy Congress, Organized by Indian Society of Agronomy, November 23-27, 2021, India. p. 90-91.

Prakasam V, Priyanka C, Chakrapani K, Ladha lakshmi D, Laha G S, Kannan C, Krishnaveni D, Basavaraj K, Jesudasu G S and Srinivas Prasad M. 2021. Potentiality of new fungicide Mefentrifluconazole 400 g/l SC to curtail sheath blight and grain discoloration of paddy. National e-congress on Plant health and food security: challenges and opportunities, March 25-27, 2021.

Rao, D.V.K.N., Surekha, K., Aruna, L. and Sundaram, R.M. 2021. Delta (Δ) yield is a better input to understand site-specific response of rice. Abstracts: ARRW Diamond Jubilee National Symposium - GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming, Theme - II: Precision technologies for rice production, 16-17 December 2021, Cuttack, page 117.

Reddy, V. N., Shanker, Chitra, Rana D.K., Anitha G .2021. In-situ conservation of arthropod biodiversity through bio-intensive pest management in rice. Abstract In "National Web Conference on Strategies for Buffering Ecosystems for Sustainable Services in The Era of Intensive Agriculture and Climate Change" ANGRAU, 25-26, March, 2021.

Senguttuvel, P., Beulah. P., Nagaraju P., Manasa Y., Veerender J., Anantha M.S., Gireesh C., Hari Prasad A.S., Sheshu M., and Sundaram R.M. Marker Assisted Pedigree selection for improvement of drought tolerance in restorer line of rice. Extended summaries: ARRW Diamond Jubilee National Symposium 2021 GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming December 16-17, 2021 held at ICAR-NRRI, Cuttack. Abstract- ADJNS/TH-I/LT/33, Pg 32.

Shanker, Chitra. 2021. Habitat Management Strategies for conservation biological control in rice, Lead talk Abstract no. S2-LP-01, Pg 3, Book of abstracts, Sixth National Conference on Biological Control: Innovative Approaches for Green India, ICAR- NBAIR, Bengaluru 3-5 march, 2021.

Somasekhar N., Sivakrishna K. and Kumar R .M. 2021. Damage potential of rice root-knot nematode (Meloidogyne graminicola) as influenced by environmental problems. Extended summaries of 5th International Agronomy Congress. Nov. 23-27, 2021, Hyderabad. Pp. 1350-1351.

Somasekhar, N. 2021. Climate Change: Consequences to Phytonematode Management. Abstracts of National seminar on the "Facets of Innovation and Development of Plant Nematology". Nematological Society of India, New Delhi. October 29-30, 2021. PP 14.

Somasekhar, N., Subba Rao, L. V., Sivakrishna, K. and Chavan, S. N .2021. Screening of rice germplasm for resistance to rice root-knot nematode Meloidogyne graminicola. Abstracts of National seminar on the "Facets of Innovation and Development of Plant Nematology" Nematological Society of India, New Delhi. October 29-30, 2021. Pp. 21.

Surekha, K., Tuti, M. D., Kumar R.M. and Rao, D.V.K.N. 2021. Nutrient Expert® assisted site-specific nutrient management: An alternative precision fertilization technology for rice in India. Oral paper presented in 5th International Agronomy Congress, November 23-27, 2021, Organised by PJTSAU, Hyderabad, India. Extended summaries. Pp 1364-1365.

Thenmozhli, G.S., Aswini, L., Gobinath, R., Rohini Kumari, V. and Krishnaveni, G (2021). Bioleaching of heavy metals using efficient extremophilic actinobcateria isolate form coal mine soil of Tamilnadu. Oral paper presented in The International Conference on Novel paradigms in Biotechnology-Bioengineering interface from concepts to reality –[NPBBI 2021], 10-12, November, 2021, organized by Satyabama University, Chennai. Extended summaries Pp: 106.

Tuti M D, K Surekha, R. Mahender Kumar, V. Manasa, Gobinath R and R. M. Sundaram. 2021. Phosphorus use efficiency of drought tolerant rice varieties grown in low phosphorus soil. Abstract: ARRW Diamond Jubilee National Symposium-2021, December 16-17, 2021, India, p 92.

Tuti M. D., Surekha K, Kumar R. M., Manasa V. and Gobinath R, 2021, Exploring Phosphorus Use Efficiency Potential of Drought Tolerant Rice Varieties Grown In Low Phosphorus Soil. Presented in 5th International Agronomy Congress, November 23-27, Hyderabad, India. 1371-1373.

Umakanth B, Saritha K, Gopalakrishna Murthy K, Jyothi Badri B, Subba Rao L.V. and. Padmavathi G. Marker-assisted introgression of major QTLs, qDTY1.1, qDTY2.1, qDTY2.2 and qDTY3.1 for grain yield under drought stress into the background of DRR Dhan 50. Extended summaries: ARRW Diamond Jubilee National Symposium 2021 GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming December 16-17, 2021 held at ICAR-NRRI, Cuttack. Abstract- ADJNS/TH-I/LT/17, Pp 17.(2nd prize).

Vijayaraghavendra, R., Vijaya Lakshmi, K., Shanker, Chitra, Malathi, S., Jagadeeshwar, R. and Damodar Raju, C H. 2021. Ecological engineering approach for enhancing predators of brown planthopper (BPH), Nilaparvata lugens (Stal.) in rice ecosystem, Abstract No S1-PP-26, Pg 53, Book of abstracts, Sixth National Conference on Biological Control: Innovative Approaches for Green India, ICAR- NBAIR, Bengaluru 3-5 march, 2021.

Yandava, Swaroopa, Rajasri, M., and Padmakumari, A. P. 2021. Survey and abundance of Rice stem borers in northern coastal districts of Andhra Pradesh. ARRW Diamond Jubilee National Symposium – 2021 on "Gen Next Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming" on 16-17 December, 2021 pg. 113.

Participation in Symposia/ Workshops

Scientist	Programme name	Organizers	Duration
Dr. G Padmavathi	National Workshop on Bridging the Yield Gaps to Enhance Food grain Production: A Way Forward	Trust for Advancement of Agricultural Sciences (TAAS), Indian Council of Agricultural Research (ICAR), International Rice Research Institute (IRRI), International Crops Research Institute for Semi-Arid Tropics (ICRISAT), and International Center for Agricultural Research in the Dry Areas (ICARDA)	26 August 2021
Dr. Fiyaz RA Dr. Divya B.	International conference on Future Challenges and Prospects in Plant Breeding	Centre for Plant Breeding and Genetics, TNAU, Coimbatore, Tamil Nadu, India	06 -07 October
Dr. Suvarna Rani Chimmili Dr. Soma Sekher N	National webinar on Microbial Biopesticides: Next Generation Preparedness	DBT-North East Centre for Agricultural Biotechnology (DBT-NECAB) and Department of Plant Pathology, AAU, Jorhat	2 July 2021
Dr. Suvarna Rani Chimmili	World Water Day webinar on Value of Water with reference to Rice Cultivation	ICAR-IIRR, Hyderabad	March 22 2021
Dr. Soma Sekher N	Webinar on Mastering craft of academic writing: a systematic approach	Wiley Publishing Group	August 31 2021
Dr. Soma Sekher N	National webinar on Rice Fallow Management in Eastern India	ICAR Research Complex for Eastern Region, Patna	August 26 2021
Dr. Soma Sekher N	Webinar on Conquering intricacies of citations and references	Wiley Publishing Group	August 24 2021
Dr. Soma Sekher N	National webinar on Artificial Intelligence for Smart Agriculture	ICAR Research Complex for Eastern Region, Patna	July 22 2021
Dr. Soma Sekher N	International webinar on Agroecological Opportunities with System of Rice Intensification (SRI) and System of Crop Intensification (SCI)	The Malaysian Agroecology Society for Sustainable Resource Intensification (SRI-MAS), Malaysia	June 25 2021
Dr. Soma Sekher N	International Webinar on Nematode management	Syngenta & Nematology Education in Sub-Sahara Africa (NEMEDUSSA)	June 9 2021
Dr. Soma Sekher N	National Webinar on Nematodes- a continuing bottleneck in crop production: available technologies and recent advances.	Dept. of Nematology, Rajasthan College of Agriculture, MPUAT, Udaipur	April 4 2021
Drs. R M Sundaram, Senguttuvel P, Rao DVKN, Surekha K., Amtul Waris, Kalyani M Barbadikar	ARRW Diamond Jubilee National Symposium 2021 GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming	NRRI, Cuttack	December 16-17 2021
Dr. Senguttuvel P	Global rice conference	TRRI, Aduthurai	September 24-25, 2021
Dr. Senguttuvel P	Global symposium on salt affected soils	FAO, Rome Italy	20-22 October 2021
Dr. Senguttuvel P	International conference on food, agriculture and innovations	Ranchi, Jharkhand	24-26th December 2021

Scientist	Programme name	Organizers	Duration
Drs. Surekha K, M Tuti, RM Kumar. S Vijayakumar,	5th International Agronomy Congress	PJTSAU, Hyderabad	November 23-27 2021
Dr. Amtul Waris	Delivering for Nutrition (D4N) in South Asia: Implementation Research in the Context of COVID-19'	IFPRI under Poshan	01-02 December 2021
Dr. S Vijayakumar	International Webinar on "Fighting the hunger using smart technology"	IIOPR, Pedavegi, Andhra Pradesh	26 October 2021
Dr. S Vijayakumar	Global Virtual – Summit on Management of Degraded Lands for Restoring Our Earth	International Soil Conservation Organization	April 22, 2021
Dr. S Vijayakumar	National Conference on Integrated Farming Systems: A Tool for Enhancing Income and Nutritional Security	ICAR-Research Complex for Eastern Region, Patna, Bihar	October 5-7, 2021
Dr. S Vijayakumar	International Webinar Conference (Virtual) on "Alternate Cropping Systems for Climate Change and Resource Conservation	ICAR- IIFSR, Modipuram, Meerut	29 September to 01 October 2021

Lectures Delivered

SCIENTIST	Topic	PROGRAMME NAME	ORGANIZERS	Date
Dr. AVSR Swamy	Concepts of speed breeding and its applications in rice improvement	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. AVSR Swamy	Critical considerations in breeding and conducting AICRIP trials for Hill ecologies	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. C. Gireesh	Pre-breeding for widening the genetic base of rice using wild species	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. Divya Balakrishnan	Interspecific Chromosome segment substitution lines (CSSLs) of rice as a valuable plant genetic resource for crop improvement	International Conference on Future Challenges and Prospects in Plant Breeding	Centre for Plant Breeding and Genetics, TNAU, Coimbatore	06 - 07 October
Dr. Divya Balakrishnan	CSSLs development and applications	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. G Padmavathi	Critical considerations in breeding and conducting biofortification trials of AICRIP for different rice ecologies	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. G Padmavathi	Marker-assisted introgression of major QTLs, *Qdty 1.1, Qdty 2.1, Qdty 2.2, and Qdty 3.1* for grain yield under drought stress into the background of DRR Dhan 50 (Awarded 2nd prize)	ARRW Diamond Jubilee National Symposium 2021 GenNext Technologies for Enhancing Productivity, Profitability and Resilience of Rice Farming,	ICAR-NRRI, Cuttack	16-17 December
Dr. G. Padmavathi	Critical considerations in breeding and conducting AICRIP trials for Biofortification	Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September

SCIENTIST	Topic	PROGRAMME NAME	ORGANIZERS	Date
Dr. J. Aravind Kumar	Critical considerations in breeding and conducting AICRIP trials for MS trials & Grain quality considerations in AICRIP	Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. Jyothi Badri	Critical considerations in breeding and conducting AICRIP trials for Irrigated ecology (E, ME, M,L,)	Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. K. Suneetha	Critical considerations in breeding and conducting AICRIP trials for Salinity and alkalinity	Sensitization of AICRIP and Modern Breeding Techniques in Rice	ICAR-IIRR, Hyderabad	14-15 September
Dr. L.V Subba Rao	Five decades of AICRIP: Process, Achievements and future prospects	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-15 September
Dr. MS Anantha	Critical considerations in breeding and conducting AICRIP trials for Nutrient use efficiency	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-15 September
Dr. MS Anantha	Modern breeding techniques in rice (GWAS and GS)	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-15 September
Dr. R. Abdul Fiyaz	Critical considerations in breeding and conducting AICRIP trials for Near Isogenic Lines	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-15 September
Dr. Suvarna Rani Chimmili	Breeding and conducting AICRIP trials on Aromatic Short grain rice	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-15 September
Dr. Suvarna Rani Chimmili	QTL mapping in rice	Training on Sensitization of AICRIP and Modern Breeding Techniques in Rice ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-15 September
Sridhar Y	Mode of Action of Insecticides	Grooming of PG students for future challenges sponsored by organised by ICAR New Delhi (SC-sub plan)	Department of Entomology, G. B. Pant University of Agriculture and Technology, Pant Nagar	19-23 February
Dr. Soma Sekhar N	Climate Change: Consequences to Phytonematode Management Invited (Lead talk)	Facets of Innovation and Development of Plant Nematology	Nematological Society of India, New Delhi	29-30 October
Dr. R.M. Sundaram	Application of biotechnological tools for rice improvement	National Academy of Agricultural Extension Management, Hyderabad		10 February
Dr. R.M. Sundaram	Agri-biotechnology for enhancing farmer's income	Global Bio India Roadshow 2021		25 February

SCIENTIST	Topic	PROGRAMME NAME	ORGANIZERS	Date
Dr. R.M. Sundaram	Multi-trait improvement of Samba Mahsuri variety through molecular breeding	Training on Integration of *in-vitro* based double haploid technology, MAS, transgenic and CRISP-Cas9 in rice improvement	ICAR-NRRI	01 March
Dr. R.M. Sundaram	Developing Climate Change resilient lines of the elite fine-grain type rice variety, Samba Mahsuri, through molecular breeding	Plant Breeding today: New techniques, new skills,	Pune Knowledge Cluster	21 June
Dr. R.M. Sundaram	Molecular breeding for rice improvement		Agri Biotech Foundation, Hyderabad	29 September
Dr. R.M. Sundaram	Application of biotechnological tools for hybrid rice improvement		Advanced Training in Plant Breeding (ATPBR), Maharashtra	29 September
Dr. R.M. Sundaram		International Conference on Future Challenges and prospects of Plant Breeding conducted (Lead lecture)	Tamil Nadu Agricultural University, India	06 October
Dr. R.M. Sundaram	Gene tagging and mapping: Basic concepts	A training program on Breeding Innovation for Crop Improvement to Enhance Genetic Gains	International Rice Research Institute, Philippines	26 October
Dr. R.M. Sundaram	Breeding for disease resistance in rice: Present status and future prospects	Indian Phytopathological society		02 December
Dr. M.S Madhav	Exploring R genes for rice blast disease management	Recent Advances in Molecular Plant-Pathogen Interactions (RAMPPI 2021)	Department of Biotechnology, National Institute of Technology Durgapur	06-10 September
Dr. C N Neeraja	Approaches in Biofortification of crops with nutrients	Agricultural Graduate Students Conference (AGSC)		07 September
Dr. Sundaram RM	Molecular Breeding for multi-trait improvement in rice	5th National Youth Convention on Innovation and Agricultural Reforms for farmer's prosperity jointly	All India Agricultural University Students Association, ICAR and PJTSAU	20-21 February
Dr. Sundaram RM	Molecular breeding for durable biotic stress resistance in rice Plant protection (Lead lecture)	Global Rice Conference conducted by (TRRI),	Tamil Nadu Rice Research Institute Aduthurai, TNAU and IIFPT, Thanjavur	25-25 September
Dr. Sundaram RM	Breeding for nutrient use efficiency in rice	Fifth International Agronomy Congress Agri Innovations to Combat Food and Nutrition Challenges		22-26 November
Dr. P. Ananda Kumar	Biotechnological Approaches for Enhancing Water Use Efficiency in Agriculture including Horticulture (Keynote presentation)	Global Conference on Innovative Approaches for Enhancing Water Productivity in Agriculture including	PJTSAU, Hyderabad	16-19 September

Appendix-1

Promising Entries in Varietal Trials, *Kharif* 2020

S. No.	IET No.	Designation	GT	DFF	Yield (kg/ha)	Trial	Promising for
1	27892	RCPR 58-IR 93827-29-1-1-3	LS	84	5116	AVT 2 – E TP	Promising in Zone-III for Odisha and Bihar
2	26898	HURS 17-7-IR 95768-9-2-1-2	LS	86	5900	AVT 2 – E TP	Promising in Zone-III for Odisha and Bihar
3	27866	HKR 16-1-1R14L521	LS	88	5290	AVT 2 – E TP	Promising in Zone-III for Odisha, Bihar, West Bengal and Zone –V for Maharashtra
4	27914	CRR 807-1	LS	84	5081	AVT 2 – E TP	Promising in Zone-III for Bihar and West Bengal
5	27905	NP 9968	MS	84	4598	AVT 2 – E TP	Promising in Zone-III for Bihar and West Bengal
6	27880	ORJ 1346 (TP 27626)	LB	83	5106	AVT 2 – E TP	Promising in Zone-III for Bihar and West Bengal
7	27332	NPH-X1 (Hybrid)	SB	86	5137	AVT 2 – E TP	Promising in Zone-III for Bihar, West Bengal and Jharkhand
8	27340	US-319 (Hybrid)	LB	87	5394	AVT 2 – E TP	Promising in Zone-III for Jharkhand
9	27329	MP-3050 (Hybrid)	LB	86	5173	AVT 2 – E TP	Promising in Zone-III for Jharkhand
10	27263	CR 4113-3-2-1	LB	103	5155	AVT 2 - IM	Promising in Zone-III for Odisha and Bihar
11	25530	CR 3561-3-2-1-1-1-1	SB	90	5540	AVT 2 - IM	Promising in Zone-III for Odisha and Bihar
12	27387	PHI 18104 (Hybrid)	MS	91 (Z-3) 98 (Z-5)	5947 (Z-3) 5638 (Z-5)	AVT 2 - IM	Promising in Zone-III for Odisha and Zone – V for Chhattisgarh
13	27689	CR 3516-1-1-2-1-1-4	MS	92	5290	AVT 2 - IM	Promising in Zone-III for Odisha
14	27686	MTU 1310 (MTU 2613-25-1-4)	MS	104	6064	AVT 2 - IM	Promising in Zone-VII for Andhra Pradesh and Telangana
15	27705	MTU 2385-187-1-1-1	LB	103	6359	AVT 2 - IM	Promising in Zone-VII for Andhra Pradesh, Telangana & Karnataka
16	27438	MTU 2385-187-1-1-1	MS	104	5681	AVT 1 - MS	Promising in Zone-III for Odisha and Zone –VII Andhra Pradesh, Telangana & Tamil Nadu
17	27951	HURS 18-2-IR 98976-20-1-2-2	LB	80	4839	AVT 1 - AEROB	Promising in Zone-II for Haryana
18	27280	RP 5989-47-15-11-1-126-2-13-11	LB	103 (Z-3)	4613 (Z-3) 5300 (Z-7)	AVT 2 – NIL (IM)	Promising in Akshyadhan growing regions of the country
19	28784	RP 6287-188-45-12-88	MS	110 (Z-3) 97 (Z-5&6) 100 (Z-7)	4316 (Z-3) 4229 (Z-5 &6) 4028 (Z-7)	AVT 1 – NIL (Late)	Promising in Improved Samba Mahsuri growing regions of the country
20	28014	Pusa 1853-12-288	MS	110	4708	AVT 1 – NIL (Late)	Promising in Samba Mahsuri growing regions of the country
21	28801	RP 6298-FG3G-12-5	MS	99	4118	AVT 1 – NIL (Late)	Promising in Improved Samba Mahsuri growing regions of the country
22	28805	RP 6286-Bio Patho 5-156-24-10	MS	107 (Z-3) 100 (Z-5,6) 102 (Z-7)	2691 (Z-3) 3385 (Z-5 &6) 3768 (Z-7)	AVT 1 – NIL (Late)	Promising in Improved Samba Mahsuri growing regions of the country

Appendix-2

Promising hybrids identified in different hybrid rice trials *Kharif* 2020

Name of the Hybrid	IET No.	DFF	Promising in
IHRT-E			
PHI 20101	28959	88	Overall
HRI 207	28950	85	Overall
JKRH 1601	28956	89	Overall
IHRT-ME			
PHI 20102	28979	93	Overall
KAVERI 7317	28972	90	Zone II & V
RRX 809	28982	93	Zone III
IHRT-M			
PHI 20108	29006	95	Overall
S 7004	29001	98	Overall
HRI 204	28997	99	Overall
IHRT-MS			
RALLI 19608	29017	97	Overall
KAVERI 7623	29019	97	Overall
RRX 708	29021	101	Zone III

Appendix-3

Variety wise breeder seed production during *Kharif*, 2020 (as per DAC indent) (Quantity in Quintals)

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
1	Abhishek (IET - 17868)(rr-272-829)	3.22	9.20	5.98	CRURRS, Hazaribagh
2	Ajit	8.50	8.50	0.00	RRS, Chinsurah
3	Amara (MTU-1064)	6.60	51.00	44.40	ANGRAU, Guntur
4	Anjali (IET-16430, RR-347-166)	0.50	9.20	8.70	CRURRS, Hazaribagh
5	Annada	1.50	1.00	-0.50	NRRI-CUTTACK
6	Ashuthosh	2.00	2.00	0.00	OUAT, Bhubaneshwar
7	Athira (PTB-51)	0.50	2.00	1.50	KAU, Pattambi
8	Badshabhog selection-1	16.00	9.30	-6.70	IGKV, Raipur
9	Bahadur sub-1	51.50	28.29	-23.21	RARS, Titabar (AAU, Jorhat)
10	Bamleshwari (IET no.14444, R 738-1-64-2-2)	10.00	11.70	1.70	IGKV, Raipur
11	Basmati-370	10.00	5.00	-5.00	RRS, Kaul
12	Basmati-564	0.10	0.10	0.00	SKUAST, Chatha
13	Bhadra (MO-4)	3.50	0.50	-3.00	RRS, Moncompu
14	Bharani (NLR 30491)	4.00	0.00	-4.00	ANGRAU, Guntur
15	Bhogavati	0.60	5.50	4.90	ARS, Radhanagari

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
16	Bidhan Suruchi (IET 25701)	1.00	0.00	-1.00	RRS, Chinsurah
17	Bina Dhan-10	1.10	1.00	-0.10	ICAR-IIRR, Hyderabad.
18	Bina Dhan-12	0.30	0.30	0.00	ICAR-IIRR, Hyderabad.
19	Bina Dhan-17	25.50	25.00	-0.50	ICAR-IIRR, Hyderabad.
20	Bina Dhan-69	0.10	0.10	0.00	ICAR-IIRR, Hyderabad.
21	Bina Dhan-75	0.10	0.10	0.00	ICAR-IIRR, Hyderabad.
22	Birsa Mati	1.65	2.00	0.35	BAU, Ranchi
23	Birsa Vikas Dhan - 111 (IET 19848) (PY - 84)	1.65	1.70	0.05	BAU, Ranchi
24	Birsa Vikas Dhan - 203	2.10	2.20	0.10	BAU, Ranchi
25	Birsa Vikas Dhan-109	1.65	1.70	0.05	BAU, Ranchi
26	Birsa Vikas Dhan-110	1.65	1.75	0.10	BAU, Ranchi
27	Birsa Vikas Sugandha - 1 (IET 18941)	1.65	2.20	0.55	BAU, Ranchi
28	Bnkr-1 (Dhiren) (IET 20760)	4.25	5.00	0.75	RRS, Chinsurah
29	BPT 5204	43.50	0.00	-43.50	ANGRAU, Guntur
30	BPT-3291 (Sonamasuri)	4.00	0.00	-4.00	ANGRAU, Guntur
31	BR-2655	2.50	6.00	3.50	UAS, Bengaluru
32	C.g. Sughandih Bhog	20.00	20.10	0.10	IGKV, Raipur
33	C.g. Madhuraj Dhan-55	15.30	15.50	0.20	IGKV, Raipur
34	Chandra (IET 23409) (MTU-1153)	26.50	70.00	43.50	ANGRAU, Guntur
35	Chandrahasini (IET - 16800)	10.00	13.50	3.50	IGKV, Raipur
36	Chhattisgarh Dev Bhog	10.00	18.00	8.00	IGKV, Raipur
37	Chhattisgarh Zinc Rice-1	22.20	22.50	0.30	IGKV, Raipur
38	Chhattisgarh Zinc Rice-2	30.00	30.80	0.80	IGKV, Raipur
39	Chinsurah Nona - 2 (Gosaba- 6) (IET -21943)	1.00	1.50	0.50	RRS, Chinsurah
40	Chinsurah Rice (IET 19140) (CNI 383-5-11)	1.60	1.60	0.00	RRS, Chinsurah
41	Ciherang Sub-1	16.00	28.00	12.00	ICAR-IIRR, Hyderabad
42	CN1272-55-105 (IET -19886)	0.50	2.50	2.00	RRS, Chinsurah
43	CNR-2 (IET 20235)	1.50	1.50	0.00	RRS, Chinsurah
44	Co 51	30.80	141.75	110.95	TNAU, Coimbatore
45	Co-43 Sub-1	0.50	0.50	0.00	TNAU, Coimbatore
46	Cottondora Sannalu (MTU-1010)	201.20	2.80	-198.40	ANGRAU, Guntur
47	CR 1018 (Gayatri) IET 8022	1.60	5.00	3.40	NRRI-Cuttack
48	CR Boro Dhan-2 (IET 17612)	0.30	0.50	0.20	NRRI-Cuttack
49	CR Dhan 201 (IET 21924)	1.20	1.00	-0.20	NRRI-Cuttack
50	CR Dhan 202 (IET 21917	2.50	2.50	0.00	NRRI-Cuttack
51	CR Dhan 300 (CR2301-5) (IET 19816)	0.90	0.80	-0.10	NRRI-Cuttack
52	CR Dhan 303 (CR 2649-7) (IET 21589	2.00	2.50	0.50	NRRI-Cuttack
53	CR Dhan 304 (IET 22117)	3.60	5.00	1.40	NRRI-Cuttack
54	CR Dhan 305 (IET 21287)	3.80	4.00	0.20	NRRI-Cuttack
55	CR Dhan 311 (Mukul)	11.10	10.00	-1.10	NRRI-Cuttack
56	CR Dhan 401(Reeta) (IET 19969)	1.50	0.00	-1.50	NRRI-Cuttack

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
57	CR Dhan 500 (IET 20220)	0.30	0.50	0.20	NRRI-Cuttack
58	CR Dhan 505 (IET 21719)	3.10	1.50	-1.60	NRRI-Cuttack
59	CR Dhan 511	0.60	0.80	0.20	NRRI-Cuttack
60	CR Dhan 701 (IET 20852) (CRHR32)	0.10	0.00	-0.10	NRRI-Cuttack
61	CR Dhan 800 (Swarna-Mas)	19.80	27.00	7.20	NRRI-Cuttack
62	CR Dhan 801 (IET-25667)	1.50	4.00	2.50	NRRI-Cuttack
63	CR Dhan 910	0.60	0.00	-0.60	NRRI-Cuttack
64	CR Dhan -10 (IET8312)	1.00	1.00	0.00	NRRI-Cuttack
65	CR Dhan -100	6.35	0.00	-6.35	NRRI-Cuttack
66	CR Dhan -101	12.35	12.00	-0.35	NRRI-Cuttack
67	CR Dhan -203	11.80	10.00	-1.80	NRRI-Cuttack
68	CR Dhan -204 (IET 21692)	3.00	2.50	-0.50	NRRI-Cuttack
69	CR Dhan -207	0.30	1.00	0.70	NRRI-Cuttack
70	CR Dhan -209	1.00	1.00	0.00	NRRI-Cuttack
71	CR Dhan -301	17.50	10.00	-7.50	NRRI-Cuttack
72	CR Dhan -307	9.90	10.00	0.10	NRRI-Cuttack
73	CR Dhan -310	23.40	25.00	1.60	NRRI-Cuttack
74	CR Dhan -405	1.00	1.00	0.00	NRRI-Cuttack
75	CR Dhan -407	0.20	0.00	-0.20	NRRI-Cuttack
76	CR Dhan -409	15.10	10.00	-5.10	NRRI-Cuttack
77	CR Dhan -506	0.30	0.80	0.50	NRRI-Cuttack
78	CR Dhan -508	25.40	20.00	-5.40	NRRI-Cuttack
79	CR Dhan -601	31.45	25.00	-6.45	NRRI-Cuttack
80	CR Dhan -909	30.00	0.00	-30.00	NRRI-Cuttack
81	CR Sugandh Dhan 907 (IET 21044) (CR 2616- 3- 3-3-1)	10.00	0.00	-10.00	NRRI-Cuttack
82	CR Sugandh Dhan 998	0.30	0.00	-0.30	NRRI-Cuttack
83	CR-1009	0.70	0.80	0.10	NRRI-Cuttack
84	CR-1009 Sub-1	23.50	19.00	-4.50	NRRI-Cuttack
85	CSR 30	0.10	7.95	7.85	CSSRI, Karnal
86	CSR 36 (Naina) (IET17340)	8.80	9.00	0.20	CSSRI, Karnal
87	CSR 43	1.00	5.40	4.40	CSSRI, Karnal
88	CSR 46 (CSR 2k-262)	1.50	5.40	3.90	CSSRI, Karnal
89	CSR 52 (CSR 12 b 23)	0.60	2.00	1.40	CSSRI, Karnal
90	CSR 56 (IET 24537)	1.25	4.80	3.55	CSSRI, Karnal
91	CSR 60 (IET 25378)	0.25	5.20	4.95	CSSRI, Karnal
92	Danteshwari (IET 15450, R 302-111)	10.00	18.90	8.90	IGKV, Raipur
93	Dhanarasi	0.20	1.00	0.80	ICAR-IIRR, Hyderabad
94	Dhiren (IET 20760)	3.00	5.00	2.00	RRS, Bankura
95	Dhruba (IET 20761)	3.00	3.20	0.20	RRS, Bankura
96	DRR Dhan 50 (IET 25671) (DRT tolerant)	28.80	7.60	-21.20	ICAR-IIRR, Hyderabad
97	DRR Dhan 45 (IET 23832)	14.80	15.00	0.20	ICAR-IIRR, Hyderabad

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
98	DRR Dhan 39	6.00	2.50	-3.50	ICAR-IIRR, Hyderabad
99	DRR Dhan 41	0.25	0.25	0.00	ICAR-IIRR, Hyderabad
100	DRR Dhan 43	10.65	2.50	-8.15	ICAR-IIRR, Hyderabad
101	DRR Dhan 44	44.40	50.00	5.60	ICAR-IIRR, Hyderabad
102	DRR Dhan 45	0.10	2.00	1.90	ICAR-IIRR, Hyderabad
103	DRR Dhan 46	2.60	2.00	-0.60	ICAR-IIRR, Hyderabad
104	DRR Dhan 48	2.10	3.00	0.90	ICAR-IIRR, Hyderabad
105	DRR Dhan 49	0.10	1.20	1.10	ICAR-IIRR, Hyderabad
106	DRR Dhan 51	4.10	18.00	13.90	ICAR-IIRR, Hyderabad
107	Dubraj Selection-1	20.50	24.00	3.50	IGKV, Raipur
108	Erra Mallelu (WGL-20471)	1.00	30.00	29.00	PJTSAU, Hyderabad
109	Gar-14	0.60	2.25	1.65	GAU, Nawagam
110	Geetanjali (CRM-2007-1) (IET 17276)	1.00	1.00	0.00	NRRI-Cuttack
111	Gitesh	25.00	48.20	23.20	RARS, Titabar (AAU, Jorhat)
112	Giza-14	4.00	8.00	4.00	SKUAST, Chatha
113	GNR-3	0.50	15.00	14.50	GAU, Nawagam
114	Gontra Bidhan-1 (IET 17430)	39.50	41.00	1.50	BCKVV, Nadia
115	Gontra Bindhan-3 (IET 22752)	18.70	36.00	17.30	BCKVV, Nadia
116	Gontra Bindhan-4	0.30	0.00	-0.30	BCKVV, Nadia
117	Gopinath (CR Dhan 206)	3.00	2.50	-0.50	NRRI-Cuttack
118	Govind	2.00	5.46	3.46	GBPUAT, Pantnagar
119	Hasanta	3.00	20.00	17.00	OUAT, Bhubaneshwar
120	Him Palam Dhan-1	5.10	5.25	0.15	CSKHPKVV, Malan
121	HKR 127 (HKR-95-222)	2.70	3.00	0.30	RRS, Kaul
122	HKR 128	0.25	1.00	0.75	RRS, Kaul
123	HKR 47	7.00	5.00	-2.00	RRS, Kaul
124	HKR 48	0.50	1.00	0.50	RRS, Kaul
125	HPR 2143	10.00	10.20	0.20	CSKHPKVV, Malan
126	HPR 1068	5.00	7.18	2.18	CSKHPKVV, Malan
127	HPR 2720	5.00	3.06	-1.94	CSKHPKVV, Malan
128	HUR 1304 (Malviya Dhan 1304)	1.50	10.70	9.20	BHU, Varanasi
129	HUR 1309 (Malviya Sugandh Dhan-1309)	1.50	10.50	9.00	BHU, Varanasi
130	HUR 917	5.00	22.10	17.10	BHU, Varanasi
131	IET 5656	1.30	1.50	0.20	ICAR-IIRR, Hyderabad
132	IGKVR 1 (IET 19569)	0.30	0.00	-0.30	IGKV, Raipur
133	IGKVR 2 (IET 19795)	15.00	16.50	1.50	IGKV, Raipur
134	Improved Pusa Basmati-1 (IET18990) (Pusa 1460-01-32-6-7-67)	1.90	1.90	0.00	ICAR-IARI Regional Station, Karnal
135	Improved Chinnor	10.30	13.85	3.55	JNKVV, Jabalpur
136	Improved Jeera Shankar	10.30	10.32	0.02	JNKVV, Jabalpur
137	Improved Lalat	10.10	0.00	-10.10	OUAT, Bhubaneshwar
138	Improved Samba Mahsuri	1.60	200.00	198.40	ICAR-IIRR, Hyderabad

Appendices

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
139	Indira Aerobic- 1 (R 1570-2649-1-1546-1) (IET 21686)	30.50	47.70	17.20	IGKV, Raipur
140	Indira Barani Dhan-1 (RF-17-38-70) (IET 21205)	22.00	26.70	4.70	IGKV, Raipur
141	Indrayani (IET 12897)	15.40	50.00	34.60	ARS, Vadagaon
142	Inglongkheri	30.00	0.00	-30.00	RARS, Titabar (AAU, Jorhat)
143	Intan	1.50	2.50	1.00	ARS, Mugad
144	IR 36	10.00	15.30	5.30	IGKV, Raipur
145	IR 64	44.00	51.00	7.00	IGKV, Raipur
146	IR-64 DRT-1 (DRR Dhan-42)	115.00	160.00	45.00	ICAR-IIRR, Hyderabad.
147	Jalashri (TTB 202-3)	30.00	0.00	-30.00	RARS, Titabar (AAU, Jorhat)
148	Jaldbi (IET 17153)	2.00	2.00	0.00	IGKV, Raipur
149	Jalkunwari (TTB 202-4)	30.00	0.00	-30.00	RARS, Titabar (AAU, Jorhat)
150	Jammu Basmati-129 (SJR-129-2-2) (IET 24597)	1.10	0.37	-0.73	SKUAST, Chatha
151	Jaya	9.50	4.00	-5.50	ICAR-IIRR, Hyderabad.
152	JGL 11470 (Jagtial Mahsuri)	50.00	56.00	6.00	PJTSAU, Hyderabad
153	JGL 1798	0.50	71.00	70.50	PJTSAU, Hyderabad
154	JGL 18047 (Bathukamma)	73.90	101.00	27.10	PJTSAU, Hyderabad
155	JGL 24423	3.00	153.00	150.00	PJTSAU, Hyderabad
156	JR 767	11.80	12.00	0.20	JNKVV, Jabalpur
157	JR 81	10.90	905.34	894.44	JNKVV, Jabalpur
158	JRB 1	23.00	40.50	17.50	JNKVV, Jabalpur
159	JRH 19	5.00	5.00	0.00	JNKVV, Jabalpur
160	Jyothi	13.40	14.00	0.60	KAU, Pattambi
161	K 39	2.00	2.10	0.10	SKUAT, Khudwani
162	K-448	2.00	2.20	0.20	SKUAT, Khudwani
163	Kalachampa	26.20	96.10	69.90	SSTL, BBSR, Govt of Odisha
164	Kanaklata	25.65	0.00	-25.65	RARS, Titabar (AAU, Jorhat)
165	Karjat-3	2.50	4.95	2.45	RARS, Karjat
166	Karjat-5	0.60	3.60	3.00	RARS, Karjat
167	Karjat-7	1.50	8.10	6.60	RARS, Karjat
168	Karjat-8	1.60	3.78	2.18	RARS, Karjat
169	Karjat-9	0.60	5.40	4.80	RARS, Karjat
170	Khandagiri	3.00	4.00	1.00	OUAT, Bhubaneshwar
171	Khitish (IET 4094)	3.00	3.10	0.10	RRS, Chinsurah
172	KMD-2 (Abhilash)	1.50	2.50	1.00	ARS, Mugad
173	KNM 733	1.50	27.60	26.10	PJTSAU, Hyderabad
174	KNM 118	93.50	152.75	59.25	PJTSAU, Hyderabad
175	Kranti (R 2022)	0.50	2761.29	2760.79	JNKVV, Jabalpur
176	Kunaram Sannalu	0.30	152.75	152.45	PJTSAU, Hyderabad
177	Lalat (IET 9947)	15.50	15.50	0.00	OUAT, Bhubaneshwar
178	Lunasampad (IET 19470)	1.30	0.40	-0.90	NRRI-Cuttack
179	Lunasuwarna (IET 18697)	1.00	0.40	-0.60	NRRI-Cuttack

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
180	Lunisree	0.50	0.00	-0.50	NRRI-Cuttack
181	Mahamaya (IET 10749)	85.00	85.80	0.80	IGKV, Raipur
182	Maheswari (IGRKVR1244)	20.00	20.10	0.10	IGKV, Raipur
183	Mahisagar	0.50	5.50	5.00	GAU, Nawagam
184	Mandakini (OR 2077-4) (IET 17847)	0.50	0.50	0.00	OUAT, Bhubaneshwar
185	Manisha (IET 23770)	0.20	0.25	0.05	RRS, Chinsurah
186	Maruteru Sannalu (MTU-1006, IET 14348)	1.00	0.00	-1.00	ANGRAU, Guntur
187	MO 21 (Pratiksha)	0.75	2.50	1.75	RRS, Moncompu
188	MTU 1001 (Vijetha)	86.20	55.00	-31.20	ANGRAU, Guntur
189	MTU 1075 (IET 18482)	14.00	23.00	9.00	ANGRAU, Guntur
190	MTU 1078	3.00	0.00	-3.00	ANGRAU, Guntur
191	MTU 1140 (Bheema)	8.30	15.00	6.70	ANGRAU, Guntur
192	MTU 1156	87.90	5.80	-82.10	ANGRAU, Guntur
193	MTU 2116	3.00	0.00	-3.00	ANGRAU, Guntur
194	MTU 1061	7.20	25.00	17.80	ANGRAU, Guntur
195	MTU 1081	0.10	0.00	-0.10	ANGRAU, Guntur
196	MTU 1121(Sri Dhruthi)	30.60	40.00	9.40	ANGRAU, Guntur
197	MTU 1155	3.00	0.80	-2.20	ANGRAU, Guntur
198	MTU 1172	1.00	7.20	6.20	ANGRAU, Guntur
199	MTU 1187	0.60	0.00	-0.60	ANGRAU, Guntur
200	MTU 1194	0.60	0.00	-0.60	ANGRAU, Guntur
201	MTU 1210	3.00	1.20	-1.80	ANGRAU, Guntur
202	MTU 3626	1.50	3.00	1.50	ANGRAU, Guntur
203	MTU 7029	119.30	96.00	-23.30	ANGRAU, Guntur
204	Muktashree (IET 21845)	1.00	0.00	-1.00	NDUAT, Faizabad
205	Narendra-8002 (IET 15848)	5.00	0.00	-5.00	NDUAT, Faizabad
206	Naveen (CR-749-20-2) (IET-14461)	5.50	5.00	-0.50	NRRI-Cuttack
207	NDLR-7	60.00	0.00	-60.00	ANGRAU, Guntur
208	NDR 2064 (IET 17475)	0.30	0.00	-0.30	NDUAT, Faizabad
209	NDR 3112	0.60	0.00	-0.60	NDUAT, Faizabad
210	Nellore Mahsuri (NLR 34449)	4.00	0.00	-4.00	ANGRAU, Guntur
211	NLR 34449	4.00	0.00	-4.00	ANGRAU, Guntur
212	NRRI Super Rice	0.20	0.00	-0.20	NRRI-Cuttack
213	Pant Basmati-2	0.10	0.10	0.00	GBPUAT, Pantnagar
214	Pant Dhan-18 (IET 17920) (UPRI 99-1)	1.20	10.74	9.54	GBPUAT, Pantnagar
215	Pant Dhan-24	10.45	42.97	32.52	GBPUAT, Pantnagar
216	Pant Dhan-26	0.30	4.28	3.98	GBPUAT, Pantnagar
217	Pant-4	0.15	9.87	9.72	GBPUAT, Pantnagar
218	Pardhiva (NLR 33892)	5.00	0.00	-5.00	ANGRAU, Guntur
219	Parijat (IET 2684)	1.00	1.00	0.00	OUAT, Bhubaneshwar
220	PAU-201	7.75	0.00	-7.75	PAU, Ludhina

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
221	PB 1638	0.50	0.00	-0.50	ICAR-IARI Regional Station, Karnal
222	PDKV Tilak (SYE-503-78-34-2)	1.50	5.00	3.50	ARS, Sindewahi
223	Phalguni (IET 18720) CRAC 2224-1041)	0.50	1.00	0.50	NRRI-Cuttack
224	Phule Samruddhi (VDN-99-29)	1.00	10.00	9.00	ARS, Vadagaon
225	PKV HMT	30.60	45.00	14.40	ARS, Sindewahi
226	PKV Kisan	1.00	2.00	1.00	ARS, Sindewahi
227	Pooja (IET 12241)	30.20	32.50	2.30	NRRI-Cuttack
228	Poornima (IET-12284, R-281-PP-31-1)	1.50	2.55	1.05	IGKV, Raipur
229	PR 121	28.80	38.00	9.20	PAU, Ludhina
230	PR 122	10.35	16.00	5.65	PAU, Ludhina
231	PR 127	7.00	13.00	6.00	PAU, Ludhina
232	PR 113	0.50	5.00	4.50	PAU, Ludhina
233	PR 114	0.40	4.00	3.60	PAU, Ludhina
234	PR 118	9.40	12.70	3.30	PAU, Ludhina
235	PR 123	0.50	1.00	0.50	PAU, Ludhina
236	PR 124	7.15	14.00	6.85	PAU, Ludhina
237	PR 125	0.40	0.00	-0.40	PAU, Ludhina
238	PR 126	19.60	20.00	0.40	PAU, Ludhina
239	PR 128	8.00	10.00	2.00	PAU, Ludhina
240	PR 129	4.35	6.00	1.65	PAU, Ludhina
241	PR 130	0.60	0.00	-0.60	PAU, Ludhina
242	PR 30	0.60	0.00	-0.60	PAU, Ludhina
243	Prabhat	1.00	0.00	-1.00	ANGRAU, Guntur
244	Pratap -1 (RSK - 1091 - 10 -1-1)	0.10	0.10	0.00	MPUAT, Kota
245	Pratibha	5.00	5.00	0.00	OUAT, Bhubaneshwar
246	Pratikshya (ORS 201-5)(IET 15191)	24.50	27.00	2.50	OUAT, Bhubaneshwar
247	Punjab Basmati 4	0.05	1.00	0.95	PAU, Ludhina
248	Punjab Basmati 5	0.05	1.00	0.95	PAU, Ludhina
249	Pusa 1121 (Pusa Sugandh-4)	110.00	72.00	-38.00	BEDF, New Delhi, IARI, Regional Station, Karnal
250	Pusa 1592	2.18	5.00	2.82	DSST & IARI New Delhi , ICAR-IARI Regional Station, Karnal
251	Pusa 6 (IET 22290) (Pusa 1612-7-6-5)	3.50	4.50	1.00	ICAR-IARI Regional Station, Karnal
252	Pusa Basmati 1637 (IET 24570)	43.40	0.00	-43.40	ICAR-IARI Regional Station, Karnal
253	Pusa Basmati 1728	13.45	0.00	-13.45	ICAR-IARI Regional Station, Karnal
254	Pusa Basmati-1509 (IET 21960) (Pusa 1509-03-3-9-5)	129.00	50.00	-79.00	BEDF, New Delhi , IARI Regional Station, Karnal
255	Pusa Basmati-1609	1.70	1.70	0.00	ICAR-IARI Regional Station, Karnal

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
256	Pusa Basmati-1718 (IET 24565)	82.55	52.00	-30.55	ICAR-IARI Regional Station, Karnal
257	Pusa Basmati-6 (Pusa 1401) (IET 18005)	29.20	29.20	0.00	ICAR-IARI Regional Station, Karnal
258	Pusa sugandh-2 (IET 16310, Pusa-204-1-126)	0.40	0.00	-0.40	DSST & IARI New Delhi
259	Pusa sugandh-3 (IET 16313, Pusa-2504-1-3-1)	20.50	0.00	-20.50	DSST & IARI New Delhi
260	Pusa Sugandh-5 (IET 17021)	124.56	69.50	-55.06	DSST & IARI New Delhi , ICAR-IARI Regional Station, Karnal
261	Pusa-44	0.10	10.00	9.90	ICAR-IARI, Regional Station, Karnal
262	Pusa-6 (IET 22290) (Pusa 1612-7-6-5)	0.60	4.50	3.90	DSST & IARI, New Delhi
263	Pusa Samba 1850	3.00	3.00	0.00	ICAR-IARI, Regional Station, Karnal
264	Puspa (IET 17509)	2.00	2.00	0.00	RRS, Bankura
265	Rajendra Neelam	0.30	45.00	44.70	RAU, Pusa
266	Rajendra Bhagvati	36.50	44.50	8.00	RAU, Pusa
267	Rajendra Kasturi	0.30	6.00	5.70	RAU, Pusa
268	Rajendra Mahsuri-1	54.80	81.00	26.20	RAU, Pusa
269	Rajendra Sweta	20.55	29.00	8.45	RAU, Pusa
270	Rajeswari (IGKVR 1)	45.10	73.50	28.40	IGKV, Raipur
271	Rani Dhan (IET 19148)	8.10	9.10	1.00	OUAT, Bhubaneshwar
272	Ranjeet (IET 12554)	1.50	144.80	143.30	RARS, Titabar (AAU, Jorhat)
273	Ranjit Sub -1	54.80	170.00	115.20	RARS, Titabar (AAU, Jorhat)
274	Rashmi (JR-201)	10.00	10.80	0.80	JNKVV, Jabalpur
275	Rasi (IET 1444)	0.50	0.50	0.00	ICAR-IIRR, Hyderabad.
276	Ratnagiri-7	0.30	4.59	4.29	ARS, Ratanagiri
277	Ratnagiri-9	0.60	6.62	6.02	ARS, Ratanagiri
278	RGL 2537	10.50	0.00	-10.50	ANGRAU, Guntur
279	RNR-1446	0.30	5.00	4.70	PJTSAU, Hyderabad
280	RNR-15048 (Telangana Sona)	103.00	349.80	246.80	PJTSAU, Hyderabad
281	Rongkhang	30.00	0.00	-30.00	RARS, Titabar (AAU, Jorhat)
282	RTN-5	3.00	14.40	11.40	ARS, Ratanagiri
283	RTN-8	0.30	9.00	8.70	ARS, Ratanagiri
284	Sabita (IET-8970)	2.50	3.00	0.50	RRS, Chinsurah
285	Sabour Shree (RAU 724-48-33) (IET 18878)	50.20	173.50	123.30	BAU, Sabour
286	Sahbhagi (Sahbhagi Dhan IET-19576)	76.44	164.00	87.56	CRURRS, Hazaribagh
287	Sakoli-9	0.60	1.00	0.40	ARS, Sakoli
288	Samba Sub-1 (IET 21248)	14.30	4.00	-10.30	NRRI-Cuttack
289	Sampada (IET 19424)	30.90	1.80	-29.10	ICAR-IIRR, Hyderabad.
290	Sampriti (BNKR-b12) (IET-21987)	2.05	2.10	0.05	RRS, Bankura
291	Sarala CR-260-77 (IET-10279)	3.00	5.50	2.50	NRRI-Cuttack
292	Sarjoo-52	0.30	0.00	-0.30	NDUAT, Faizabad

S. No.	Variety	Allocation	Production	Surplus (+/-) Deficit (-)	Producing centre
293	Satyabhama	6.00	5.00	-1.00	NRRI-Cuttack
294	Setha	0.60	5.00	4.40	BAU, Sabour
295	Shatabdi (IET-4786)	28.10	57.70	29.60	RRS, Chinsurah
296	Shiats Dhan -1 (AAIR 2) (IET 20928)	7.10	7.10	0.00	SHUATS, Allahabad
297	Shiats Dhan 2 (AAIR 203)	3.50	3.50	0.00	SHUATS, Allahabad
298	Shiats Dhan 3 (AAIR 205) (IET 22522)	5.00	5.00	0.00	SHUATS, Allahabad
299	Shobhini (RNR-2354) (IET 21260)	2.00	3.00	1.00	PJTSAU, Hyderabad
300	SJR-5(IET-19972)	15.00	0.25	-14.75	SKUAST, Chatha
301	Sreyas	0.60	0.00	-0.60	RRS, Monocompu
302	Sugandh Dhan-908	0.40	0.00	-0.40	NRRI-Cuttack
303	Sugandha Samba (MR-2465)	0.10	3.00	2.90	PJTSAU, Hyderabad
304	Swarana-Sub 1 (CR 2539-1) IET-20266	106.70	75.00	-31.70	NRRI-Cuttack
305	Tarun Bhog Selection-1	10.00	7.50	-2.50	IGKV, Raipur
306	Tellahamsa	2.00	20.00	18.00	PJTSAU, Hyderabad
307	Thanu	2.90	3.00	0.10	UAS, Bengaluru
308	Trombey Chattisgarh Dubraj Mutent-1	10.00	24.00	14.00	IGKV, Raipur
309	Tunga (IET-13901)	4.75	5.00	0.25	UAS, Bengaluru
310	Uma (MO-16)	18.75	16.00	-2.75	RRS, Monocompu
311	Uttar Sona (UBKVR-1) (IET-24171)	1.00	1.00	0.00	RRS, Bankura
312	Vallabh Basmati-24	0.30	11.45	11.15	SVBAUA& T Meerut
313	VarshaDhan (CRLC-899) (IET-16481)	2.50	1.40	-1.10	NRRI-Cuttack
314	VishnuBhog Selection-1	15.00	19.80	4.80	IGKV, Raipur
315	VL Dhan 157 (VL 31611) (IET 22292)	2.50	1.30	-1.20	VIHA, Almora
316	VL Dhan 158	2.30	5.30	3.00	VIHA, Almora
317	VL Dhan 68 (VL 31611) (IET 22283)	8.00	10.50	2.50	VIHA, Almora
318	VL Dhan 85 (IET-16455) (VL-3613)	0.60	0.60	0.00	VIHA, Almora
319	WGL-915	1.50	7.00	5.50	PJTSAU, Hyderabad
320	Zinco Rice MS	51.00	52.20	1.20	IGKV, Raipur

Hybrids

S. No.	Centre Name	Variety	Target	Production	Surplus (+) Deficit (-)
1	BSKVV, Dapoli	Sahayadri 5 (A line)	0.15	0.15	0.00
		Sahayadri 5 (B line)	0.05	0.45	0.40
		Sahayadri 5 (R line)	0.05	0.50	0.45
		Total	**0.25**	**1.10**	**0.85**
2	UAS, Bangalore	KRH 4 (A-line)	0.05	0.55	0.50
		KRH 4 (B-line)	0.02	0.02	0.00
		KRH 4 (R-line)	0.02	1.00	0.98
		Total	**0.09**	**1.57**	**1.48**

S. No.	Centre Name	Variety	Target	Production	Surplus (+) Deficit (-)
3	ICAR-IIRR, Hyderabad	DRRH 2 (A line)	0.10	0.10	0.00
		DRRH 2 (B line)	0.10	0.10	0.00
		DRRH 2 (R line)	0.10	0.10	0.00
		Total	**0.30**	**0.30**	**0.00**
4	ICAR-NRRI, Cuttack	CRMS 32 A	0.18	0.00	-0.18
		CRMS 32 B	0.09	0.00	-0.09
		Total	**0.27**	**0.00**	**-0.27**
Total (B)			**0.91**	**2.97**	**2.06**
Total (A+B)			**4166.11**	**9217.33**	**5051.22**

Appendix-4

List of Institute Projects 2021

Project Code	Project Title	PI	Co-PIs
CROP IMPROVEMENT DIVISION			
Plant Breeding			
GEQ/CI/BR/8	Enhancing nutritional quality of rice through bio-fortification	Dr. L. V Subba Rao	Dr. G Padmavathi, Dr K Surekha, Dr. B Sreedevi,Dr CN Neeraja, Dr. D Sanjeeva Rao, Dr J. Arvind Kumar, Dr. T Longvah (NIN)
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. D Subramanyam Dr RA Fiyaz, Dr. Jyoti Badri, Dr Ch Suvarna Rani
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. L.V. Subba Rao, Dr. G. Padmavathi, Dr. M. Sheshu Madhav, Dr. J. Aravind Kumar, Dr. Jyothi Badri, Dr. Divya Balakrishnan, Dr. M. S. Anantha, Dr. C. Gireesh
GEY/CI/BR/26	Breeding for high yielding water use efficient short duration rice hybrids & varieties.	Dr. AVSR Swamy	Dr. R.M.Sundaram, Dr. M. Seshu Madhav, Dr. R. Mahender Kumar, Dr. P. Senguttuvel, Dr. Jyothi Badri, Dr. R. Abdul Fiyaz, Dr. D. Subrahmanyam
GEY/CI/BR/16	Traditional and molecular approaches for breeding improved rice varieties with resistance to planthoppers	Dr. G. Padmavathi	Dr. C. Gireesh, Dr. V. Jhansi Lakshmi, Dr. M. Sheshu Madhav, Dr. P.V. Satyanarayana-Maruteru, Dr. Nanda Kishore-Maruteru
GEY/CI/BR/22	Prebreeding to explore wild species and land races of rice for bacterial blight resistance and yield enhancing traits.	Dr. C. Gireesh	Dr. MS Anantha, Dr. Divya B, Dr. K. Suneetha, Dr. G. Padmavathi, Dr. P. Senguttvel, Dr. L.V. Subba Rao, Dr. Santosha Rathod, Dr. K. Basavaraj, Dr. M. Tuti, Dr. KB Kemparaju, Dr. RM. Sundaram, Dr. Sheshu Madhav, Dr. GS Laha, Dr. Y. Sridhar,

Project Code	Project Title	PI	Co-PIs
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. Santosh Rathod, Dr. Brajendra, Dr. Akshay S. Sakhare, Dr. Mangal Deep Tuti, Dr. Viswanathan Chinnusamy Dr. Girija Rani, Dr. Krishnamurthy SL, Dr. Manohar K K
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. LV Subba Rao, 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	Breeding high yielding rice cultivars tolerant to low soil phosphorus and nitrogen	Dr. M. S. Anantha	Dr. C Gireesh, Dr. R.M. Sundaram, Dr. R. Abdul Fiyaz, Dr. P. Senguttuvel, Dr. R Mahender Kumar, Dr. K. Surekha, Dr. Brajendra, Dr. Raghuveer Rao, Dr. Aarthi Singh, Dr. Ch. Suvarna Rani
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. L.V. Subba Rao
ABR/ CI/ BR/28	Exploring wild introgression lines and mutants to identify novel genes/ QTLs for yield contributing traits	Dr. Divya Balakrishnan	Dr. N Sarla, Dr. D. Subrahmaniyam, Dr. G Padmavathi, Dr. Jyothi B, Dr. P. Revathi, Dr. C. Gireesh, Dr. Ladha Lakshmi , Dr. B.Kalyani, Dr. Suvarna C
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/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. Sheshu Madhav, Dr. B.Sreedevi, Dr. C Gireesh, Dr. MS Anantha, Dr. G. Padmavathi, Dr. Mahender Kumar, Dr. R Gopinath, Dr. N. Somasekhar, Dr. D. Subrahmanyam
GEY/CI/ HY/12	Development of superior restorers and Identification of new restorer(*Rf*) genes for WA-CMS system in rice by conventional and molecular approaches	Dr. P. Revathi	Dr. Jyothi Badri, Dr. Satendra Kumar Mangrauthia, Dr. Divya balakrishnan, Dr. M. Srinivas Prasad Dr. V. Jhansilakshmi, Dr. K. Sruthi
GEY/CI/ HY/16	Genetic improvement of maintainers for yield and attributing traits with introgression of yield enhancing genes	Dr. K. B. Kemparaju	Dr. AS Hari Prasad, Ms. K Shruti Dr. C Gireesh, Dr. RM Sundaram
GEY/CI/ HY/14	Establishment and validation of heterotic gene pools in hybrid rice	Dr. K. Sruthi	Drs. A.S. Hari Prasad, P. Senguttuvel, P. Revathi, B. Kemparaju and R.M. Sundaram
Biotechnology			
ABR/CI/BT/6	Identification of genes for grain filling in rice (*Oryza sativa* L.)	Dr. CN Neeraja	Drs S.R. Voleti, L.V. Subbarao, M. Sheshu Madhav, S. M. Balachandran, Divya Shyamala Devi, D Sanjeeva Rao, Kalyani S Kulkarni

Project Code	Project Title	PI	Co-PIs
ABR/CI/ BT/10	Genomic studies on grain yield heterosis and WA-CMS trait in rice	Dr. R.M. Sundaram	Dr. S.M. Balachandran, Dr. M.S. Madhav, Dr. A.S. Hariprasad, Dr. P. Revathi, Dr. P. Raghuveer Rao Dr. K. Sruthi
ABR/CI/ BT/16	Exploring the mutant resources for rice improvement	Dr. M. Sheshu Madhav	Dr. R. M. Sundaram, Dr. Kalyani Kulkarni Dr. D. Sanjeeva Rao, Dr. B. Sreedevi, Dr. P. Senguttuvel, Dr. L.V. Subba Rao, Dr. C. Gireesh, Dr. A.P. Padma kumari, Dr. Jhansi Laxmi Dr. Ch. Padmavathi, Dr. Y. Sridhar Dr. G.S. Laha, Dr. M.S. Prasad, Dr. Ladha Lakshmi
ABR/CI/ BT/13	Candidate gene identification for manipulating growth related genes in rice through computational and expression studies	Dr. P.S. Divya	Dr. S.M. Balachandran Dr. D. Subrahmanyam
ABR/CI/ BT/14	Exploring RNAi Technology for Management of Rice Diseases	Dr. S. K. Mangrauthia	Dr. S.M. Balachandran, Dr. G.S. Laha, Dr. D. Krishnaveni, Dr. P. Revathi, Dr. V. Prakasam, Dr. Kalyani Kulkarni
ABR/CI/ BT/15	Molecular and functional characterization of useful root traits in rice	Dr. Kalyani M. Barbadikar	Dr. M. Seshu Madhav, Dr. D. Subrahmanyam, Dr. P. Senguttuvel, Dr. S. M. Balachandran, Dr. Divya P. S.
CROP PRODUCTION DIVISION			
RUE/CP/AG/ 14	Strategic research on enhancing water Use efficiency and productivity in irrigated rice system	Dr. R. Mahender Kumar	Drs. K. Surekha, B.Sreedevi, Soumya Saha, Ch. Padmavthi, M. Srinivas Prasad, V Prakasham, N. Somashekhar, B. Nirmala, Amtul Waris, AVS Swamy, Senguttuvel. P, C. Kannan, Vidhan Singh. T, Y. Sreedhar, Bandeppa, MBB. Prasad Babu, DVK Nageswar Rao, Dr. K. Srinivas (CRIDA) Prof. Saran Sohi, University of Edinburgh,UK, Pranaadhara – A.P
RUE/CP/AG/ 13	Development of Climate smart and economic weed management technologies for changing rice establishment systems	Dr. B. Sreedevi	Drs. Mahender Kumar N.Somasekhar, P. Senguttuvel, Mangal Deep Tuti, C. Kannan, D.V.K. Nageswararao, R. and B. Jhansirani
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	R. Mahender Kumar, B. Sreedevi, Soumya Saha, Aarti Singh, B. Nirmala, T. Vidhan Singh and Bandeppa
SSP/CP/ AG/16	Development of sustainable agro-techniques for direct seeded rice	Dr. Soumya Saha	Drs. Mangal Deep Tuti, Bandeppa, Satish N. Chavan, R. M. Kumar, T. Vidhan Singh
RUE/CP/ AG/17	Comparative study of organic and conservation agriculture for enhanced resource use efficiency, yield and quality of rice	Dr Aarti Singh	Drs. V. Manasa, M.D. Tuti, Anantha M.S., K. Sruthi, Vidhan Singh, Satish Chavan, R.M. Kumar and M.N. Arun
Soil Science			
SSP/CP/ SS/11	Assessment of Genotypic variability in nitrogen use efficiency and improving NUE in irrigated rice	Dr. K. Surekha	Drs. D. V. K. Nageswara Rao, V. Manasa, R. Gobinath, R.M. Kumar C.N. Neeraja, and MM Azam

Project Code	Project Title	PI	Co-PIs
CCR/CP/ SS/17	Studies on emission of green house gases (GHGs) from rice soils and their mitigation	Dr. M.B.B. Prasad Babu	Dr. R. Mahender Kumar, Dr. P.C. Latha and Dr. Brajendra
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	Drs. K. Surekha, R. Mahender Kumar, B. Sridevi, Ch. Padmavati and V. Prakasam
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/15	Microbial population dynamics in different rice establishment method in relation to nutritional availability and acquisition.	Dr. Bandeppa	Dr. P. C. Latha, Dr. K. Surekha, Dr. Mangal Deep Tuti and Dr. Kalyani. M Barbadikar
RUE/CP/ SS/19	Evaluation of ZnO nanoparticles on performance of rice	Dr. Gobinath, R	Dr. Manasa, Dr. Surekha, Dr. PC Latha, Dr. Brajendra, Dr. Soumya Saha
RUE/CP/ SS/20	Efficacy of hydrogel on yield and soil properties of rice	Dr. V. Manasa	Dr. Gobinath, Dr. Surekha Dr. Bandeppa, Dr. Aarti singh Dr. M.M. Azam
Plant Physiology			
CCR/CP/ PP/11	Evaluation of genotypic variability in leaf photosynthetic efficiency and its associated factors in rice	Dr. D Subrahmanyam	Dr. S. R. Voleti Dr. V. P. Bhadana
GEY/CP/PP/	Role of Silicon in inducing abiotic stress tolerance in rice	Dr. P Raghuveer Rao	Dr. D Sanjeeva Rao Dr. Mangaldeep Tuti
GEQ/CI/ BR/26	Investigation into the role of major metabolites on rice grain quality	Dr. D. Sanjeeva Rao	Drs. C. N. Neeraja, D. Subrahmanyam, M. Seshu, Madhav, P. Senguttuvel and Jyothi Badri
Agricultural Engineering			
RUE/CP/ ENG/6	Selective mechanization in rice cultivation	Dr. T Vidhan Singh	Dr. R. Mahender Kumar and Dr. B. Nirmala
Computer Applications			
TTI/CP/CA/4	Wireless Sensor Networks integrating with Rice DSS model for real time advisories	Dr. B Sailaja	Dr. D. Subrahmanyam, Dr. K . Surekha, Dr Ch. Padmavathi, Dr. Santhosh Mithra, (CTCRI, Thiruvananthapura)
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	P.C. Latha, R. Mahendra Kumar, Amtul Waris, T. Vidhan Singh, D. Sanjeeva Rao, R. Abdul Fiyaz, S. R. Voleti, GR Katti, AP Padmakumari, MS Prasad, GS Laha, V. Prakasam, K. Surekha, V. Manasa, Aparna Kuna
CROP PROTECTION			
IPM/CPT/ ENT/21	Botanicals for sustainable management of major pests of rice	Dr. B Jhansi Rani	Dr. Chitra Shankar, Dr. M.M. Azam Dr. M. Srinivasa Prasad

Appendices

Project Code	Project Title	PI	Co-PIs
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
IPM/ CPT/ ENT/22	Investigations on Nematodes of Importance to Rice Cultivation	Dr. N. Soma Sekhar	Drs. S.N. Chavan, P.C. Latha
HRI/ CPT/ ENT/23	Insect-plant interactions with special reference to rice pests – yellow stem borer and gall midge	Dr. A. P. Padmakumari	Dr. Y.Sreedhar, Dr. D Subramanyam, Dr S R Voleti, Dr. K. Suneetha
IPM/ CPT/ ENT/26	Biointensive pest management with emphasis on biological control of rice pests	Dr.Chitra Shanker	Dr. Gururaj Katti, Dr B Jhansi Rani, Dr N Somasekhar and Dr. C Kannan
HRI/CPT/ ENT/27	HPR to rice leaf folder and Semiochemical approaches for the management of insect pests of rice	Dr.Ch Padmavathi	Drs. Y Sridhar, Divya Balakrishnan, MM Azam, G Katti
IPM/CPT/ ENT/24	Bioecology and Management of Emerging Insect and Mite pests of rice	Dr. Y. Sridhar	Drs. V. Jhansilaxmi, A. P. Padma Kumari, Chitra Shanker, Ch. Padmavathi
IPM/CPT/ ENT/25	Development of Entomopathogenic Nematodes (EPN) for Biointensive Integrated Pest Management in Rice	Mr. Satish N. Chavan	Dr. N. Somasekhar, Dr. Gururaj Katti, Dr. A.P. Padmakumari, Dr. C. Kannan.
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. M.S. Madhav, Dr. Divya Balakrishnan, Dr. Basavraj and Dr G Jesudasu
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. Ladha Lakshmi, Dr. R. M. Sundaram, Dr. S. K. Mangrautia
HRP/CPT/ PATH/14	Assessment of host plant resistance and development of diagnostic tools for rice tungro virus disease	Dr.D. Krishnaveni	Dr G.S. Laha, Dr. C. N. Neeraja, Dr. Chitra Shanker, Dr. S.K. Mangrauthia and Dr. D. Ladhalakshmi
HRP/CPT/ PATH/	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 and 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 Ladha lakshmi, Dr Jyothi badri
HRP/CPT/ PATH/24	Survey, 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 and Dr. Divya Balakrishnan
HRP/CPT/ PATH/25	Host plant resistance and Characterization of pathogens of Sheath rot and Stem rot diseases of Rice	Mr. Satyaswara Jasudasu Gompa	Dr. G.S. Laha, Dr. M. Srinivas Prasad, Dr. V. Prakasam, Dr. K. Basavaraj, Dr. D. Ladhalakshmi, Dr D Krishnaveni

Project Code	Project Title	PI	Co-PIs
TRAINING, TRANSFER OF TECHNOLOGY AND IMPACT ANALYSIS			
TTT/EXT/15	Climate change and rice farming: Farmers perception and adaptation strategies	Dr. P. Muthuraman	Drs. Shaik N. Meera, S. Arun Kumar, P. Jeyakumar, Brajendra
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. R.M. Kumar, Dr. B. Sreedevi, Dr. Brajendra, Dr. Jhansi Lakshmi, Dr. Jyothi Badri
TTI/TTT/ EXT/18	Impact Acceleration with Digital Extension Ecosystem for Rice Farmers	Dr. S. N. Meera	Dr. Arun Kumar. S Dr. Santosha Rathod
TTI/TTT/ EXT/13	On-Farm Adoption of IPM Technologies and impact analysis	Dr. P. Jeyakumar	Dr. Ch.Padmavathi, Dr. C.Kannan, Dr. B. Sridevi, Dr. Amtul Waris, Dr. S.Arun Kumar, Dr. Santosh Rathod
TTI/TTT/ ECON/3	IPR - Competition interaction in rice seed sector – Emerging scenario- implications for enhancing quality seed use.	Dr. P. A. Lakshmi Prasanna	Dr. L. V. Subba Rao, Dr. A. S. Hari Prasad, Dr. Amtul Waris, Dr. S. N. Meera, Dr. B. Nirmala, Dr. S. Arun Kumar and Dr. Divya P. Symaladevi
TTT/ ECON/4	Economics, Energy and Sensitivity Analysis of selected Rice production technologies	Dr. B. Nirmala	Drs. P. Muthuraman, Amtul Waris, R. Mahender Kumar, A. S. Hari Prasad, T. Vidhan Singh and P. Senguttuvelu
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. R M Sundaram Dr. C Gireesh, Dr. P Senguttuvel

Appendix-5

Externally funded projects sanctioned during 2021

S. No	Title of project	PI &Co-PI	Funding agency	Project duration	Sanctioned budget
1	Genome engineering of host genes for yellow stem Borer and Brown Plant Hopper resistance using CRISPR/Cas technology''	M. Sheshu Madhav	DBT, Govt. of India	2021-24	35.0
2	Towards product development in rice using mutant traits of agronomic importance	M. Sheshu Madhav	CSIR	2021-24	36.30
3	"IRRI-India Frontiers in Rice Science-New Science- Sub project 1: Resource re-mobilization during grain filling under drought"	Jyothi Badri	IRRI	2021 -22	3.79
4	Molecular tagging of genes related to early seedling vigour using landraces and wild introgression lines to develop climate smart rice varieties	Divya Balakrishnan LV Subbarao	DST SERB	2021-24	36.0

S. No	Title of project	PI &Co-PI	Funding agency	Project duration	Sanctioned budget
5	Harnessing haplotype diversity of genes controlling yield, stress tolerance and resource use efficiency traits in rice for accelerating genetic gains.	Dr. Sheshu Madhav	NASF	2021-24	52.17
6	ICAR-IRRI Development of appropriate machinery systems for rice mechanization	Dr. Vidhaan Singh	IRRI	2021-23	1.50
7	Targeting Pup 1 independent mechanisms for improving low soil phosphorus tolerance and use-efficiency in rice	Dr. Satendra Kumar Dr. Mangrauthia, Dr. MS Anantha, Dr. R M Sundaram	DBT	2021 -24	130.35
8	Evaluation of different bio stimulants (VALAGRO) on crop growth, physiological and biochemical changes, and yield of Rice crop	Dr Mahender Kumar	VALAGRO	2021-23	15.92
					311.03

Appendix-6

Ongoing Externally funded projects in 2021

S. No.	Title of the Project / Schemes	Name of the PI & Co-PI	Funding Agency	Duration	Budget (lakh Rs)
1	CRP- Biofortification in selected crops for nutritional security.	C N Neeraja (PI) K Surekha, Kalyani M Kulkarni, D Sanjeeva Rao, L V Subba Rao, R M Sundaram, Amtul Waris, U Chaitanya	ICAR	2017-25	198.5
2	ICAR-Consortia Research Platform on Molecular Breeding in Crops.	R M Sundaram (PI) LV Subba Rao, R Abdul Fiyaz, C Gireesh, M S Anantha, P Senguttuvel, S M Balachandran, M S Madhav, M S Prasad, G S Laha, A P Padmakumari, V Jhansi Lakshmi	ICAR	2017-25	38.125
3	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 S Bandeppa Kalyani M Barbadikar MBB Prasad Babu	ICAR	2017-25	104.00
4	ICAR-Plant Scheme: "Incentivizing Research in Agriculture". Project: Molecular genetic analysis of resistance/ tolerance to different stresses in rice, wheat, chickpea and mustard including sheath blight complex genomics	R M Sundaram (PI) G S Laha V Prakasam D Ladha Lakshmi Jyothi Badri	ICAR	2017-25	48.01
5	CRP on Agro-biodiversity	L V Subba Rao (PI) C Gireesh, M S Anantha	ICAR	2014-20	4.0 /year
6	Mega Seed Project	L V Subba Rao (PI) AVSR Swamy, R Abdul Fiyaz, U Chaitanya	ICAR	2006- Long term	8.0/year
7	National Seed Project	L V Subba Rao (PI) R Abdul Fiyaz, U Chaitanya	ICAR	1992 – Long term	3.5/year

S. No.	Title of the Project / Schemes	Name of the PI & Co-PI	Funding Agency	Duration	Budget (lakh Rs)
8	CRP on Hybrid Technology (Hybrid Rice)	A S Hari Prasad (PI) P Senguttuvel, P Revathi, K B Kemparaju	ICAR	2015-20	112.89
9	AICRP – Biocontrol	Chitra Shanker (PI)	ICAR	2017-21	4.00
10	Application of Next-Generation Breeding, Genotyping, and Digitalization Approaches for Improving the Genetic Gain in Indian Staple Crops	L V Subba Rao R Abdul Fiyaz P Revathi	ICAR-BMGF	2018-22	18.00
11	Genetic improvement of rice for yield, NUE, WUE, abiotic and biotic stress tolerance through RNA Guided Genome Editing (CRISPR/Cas9/Cpf1)	S K Mangrauthia (PI)	ICAR-NASF	2018-21	83.85
12	Development of climate resilient lines of the bacterial blight resistant and low glycemic index rice variety, Improved Samba Mahsuri	R M Sundaram (PI) G S Laha, L V Subba Rao, S M Balachandran, M S Prasad, M S Madhav, R Abdul Fiyaz, P Senguttuvel	CSIR FTT Scheme	2019-22	31.26
13	DBT sponsored Project on "Marker-assisted introgression of yield enhancing genes to increase yield potential of Indian rice varieties	R M Sundaram (PI) M S Madhav S M Balachandran P Senguttuvel Jyothi Badri	DBT	2016-21	82.504
14	Maintenance, characterization and use of EMS Mutants of Upland Variety Nagina 22 for functional genomics in rice-Phase-II	S K Mangrauthia (PI) S R Voleti Divya Balakrishnan	DBT	2015-21	93.03
15	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, G S Laha, Jhansi lakshmi Satendra K Magrauthia	DBT	2018-21	71.95 lakhs
16	Exploring Chromosome Segment Substitution Lines from inter-specific crosses to decipher the genetics of grain weight and earliness	Divya Balakrishnan (PI)	DBT BioCare	2019-22	43.10
17	Imparting sheath blight resistance in rice (A DBT flagship project)	R M Sundaram (PI) C Kannan, V Prakasam, G S Laha	DBT	2019-22	108
18	Characterization of strong culm Sambha Mahsuri mutants and identification of candidate genes associated with strong culm	M Sheshu Madhav (PI) Kalyani M Barbadikar	DST	2018-21	27.7
19	Mainstreaming rice landraces diversity in varietal development through genome wide association studies: A model for large-scale utilization of gene bank collections of rice" DBT Network project coordinated by IARI and NBPGR	C. N. Neeraja L.V. Subbarao C. Gireesh J. Aravind Kumar D. Ladhalakshmi Anantha M. S R. Abdul Fiyaz	DBT	2020-25	143.35
20	Development of haplotype based near isogenic lines (Haplo-NILs) for enhanced genetic gain in rice	Jyothi Badri, J Aravind Kumar, MS Prasad, Jhansi Lakshmi, AP Padma Kumari, V PRakasam	DBT	2020-22	118.00

S. No.	Title of the Project / Schemes	Name of the PI & Co-PI	Funding Agency	Duration	Budget (lakh Rs)
21	DST-ICRISAT Center of Excellence on Climate Change Research for Plant Protection (CoE-CCRPP): Pest and disease management for climate change adaptation	V Prakasam (PI) M S Prasad, G S Laha, G Katti, Ch Padmavathi, Chitra Shanker, S K Mangrauthia, M S Madhav, D Subrahmanyam P. Muthuraman	DST	2018-23	87.96
22	RNA-seq based mapping of robust root system architecture for identification of candidate genes	Kalyani M Barbadikar (PI)	DST-SERB	2018-21	44.18
23	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 R.M. Sundaram, G.S. Laha, J Aravind Kumar, L.V. Subba Rao and Basavaraj K.	DST-SERB	2020-23	36.96
24	Mapping genomic regions associated with bacterial leaf blight resistance derived from *Oryza glaberrima*	C Gireesh	DST-SERB	2020-23	27.57
25	Advance breeding technologies to speed up genetic gain, create durable resistance to biotic and increase Indian farmers and consumers food and nutritional security	L V Subba Rao (PI) R Abdul Fiyaz	IRRI	2017-22	USD 8900
26	ICAR-IRRI Development of high Zinc rice varieties	L V Subba Rao (PI) C N Neeraja, M S Ananatha	IRRI	2017-22	USD 6000
27	ICAR-IRRI Seed dissemination and production of nucleus & breeder seed of stress tolerant varieties	L V Subba Rao (PI) R Abdul Fiyaz	IRRI	2017-22	USD 7000
28	ICAR- IRRI Collaborative Work Plan (2017-2022) Crop and resource management for irrigated cereal systems	R Mahender Kumar (PI)	IRRI	2017-22	8 lakh
29	IRRI – India Sub project: Insect-Pest and Disease Forecasting and Decision Support Systems in rice	Ch Padmavathi	IRRI		
30	Accelerating Genetic Gain in Rice (AGGRi) Alliance	AVSR Swamy	IRRI	2020-24	37.50
31	Direct Seeded Rice Consortium (DSRC)	Mahender Kumar	IRRI	2020-22	6.50
32	Increasing the Health potential in rice by lowering glycaemic index response in high yielding lines (Low GI Rice)	Aravind Kumar J	IRRI	2020-22	4.50
33	Supporting Rice Sector with Digital Extension Strategies (Rice Doctor)- Increasing productivity of rice-based cropping systems and farmers' income in Odisha	Chitra Shanker D. Krishnaveni Brajendra,	IRRI	2020-21	4.00
34	Global Challenges Research Fund (GCRF) South Asian Nitrogen Hub (SANH)	D Subrahmanyam (PI) C N Neeraja	GCRF-UK	2020-25	92.00
35	Biofortification of rice (Harvest Plus)	G Padmavathi (PI) LV Subba Rao	CIAT, Columbia & IFPRI, USA under HPlus program	2018-22	80.00
36	DUS Tests in Rice	L V Subba Rao (PI) J Aravind Kumar, Jyothi Badri	PPV&FRA	2008 – Long term	13.0

S. No.	Title of the Project / Schemes	Name of the PI & Co-PI	Funding Agency	Duration	Budget (lakh Rs)
37	Identification of heterotic yield QTLs in Swarna X *Oryza* rufipogon introgression lines (ILs) and transferring into parental lines of hybrid rice to enhance the magnitude of heterosis	P Revathi(PI)	SERB	2018-21	33.59
38	Characterization and understanding the genetics of resistance of *Ustilaginoideavirens* and Identification of false smut disease tolerant sources in rice	D Ladha lakshmi (PI)	SERB	2019-22	33.30
39	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	2018-22	17.00
40	Evaluation of Bioefficacy of BCS CL 73507SC 200 against eggs and larvae of yellow stem borer, *Scirpophagaincertulas* (Walker)"	G Katti (PI) A P Padmakumari	Bayer Crop Science India ltd	2019-21	40.76
41	Evaluation of Bio-efficiency of Penoxsulam 2.67% OD in wet direct sown rice	B Sreedevi (PI)	Corteva Agri Sciences	2019-21	7.08 lakhs
42	Evaluation of UAV Application of Adama Insecticides for the Management of Insect Pests of Rice	Y Sridhar	Adama India Pvt. Ltd	2020-22	8.70
43	Evaluation of BAS 560 00 I for bioefficacy against brown planthopper and white backed planthopper and phytotoxicity in Rice	B. Jhansi Rani Dr. Y. Sridhar	BASF India Limited	2020-22	9.80
44	Bio-efficacy of ITK based botanicals against insect pests of rice	B. Jhansi Rani Y. Sridhar	NIF, Gujarat	2020-22	13.30
45	Evaluation of ecoSolv water device and ecoAgra advanced agriculture surfactant on yield and water productivity of irrigated rice	R. Mahender Kumar	ecoSolv technologies	2020-21	7.26

Completion Report of Externally Funded Projects

DBT sponsored project entitled "Marker-assisted introgression of yield enhancing genes to increase yield potential of Indian rice varieties" Dr. R M Sundaram

The yield enhancing genes, *viz., Gn1a, SCM2* and *OsSPL14* were transferred into the genetic background of elite cultivars, Swarna, MTU1010, Aksyadhan, Samba Mahsuri and Improved Samba Mahsuri through marker-assisted backcross breeding. The improved versions of the above-mentioned rice varieties were observed to possess more number of grains per panicle, better panicle branching and stronger culm. A breeding line of in the genetic background of the mega-rice variety, Samba Mahsuri, named RP6294-1096-1101-22-3, possessing the yield enhancing genes *Gm1a, SCM2* and *OsSPL14* has been promoted to final year of testing (i.e. AVT2-IL trials) of AICRIP 2021.

DST-SERB Early Career Project RNA-seq based mapping of robust root system architecture for identification of candidate genes Dr. Kalyani M Barbadikar

The MutMap population was developed using wild type parent BPT 5204 and mutant of BPT 5204, TI 128 having robust root system architecture, early vigor and yield under aerobic condition. On the basis of the root phenotyping (emphasis on root length, root volume) of the F2 mapping population under aerobic conditions for RNA or transcriptome bulk sequencing and irrigated conditions (MutMap- DNA bulk seq), extreme bulks of fifteen lines for each along with parents were sequenced on Illumina high throughput sequencing platforms. The emanating 10 GB data was subjected to the Mut-Map pipeline developed by Yu Sugihara (https://github.com/YuSugihara/MutMap) wherein the mutant bulk was compared with wild type bulk. SNP indexing showed major differences in SNPs and the genes harbouring the SNPs. The SNPs having index near to one viz. GRAS transcription factor, qCTR12-Root development, Ethylene responsive transcription factor, ACT DOMAIN CONTAINING PROTEIN KINASE 6-ACTPK1 and Exp. Protein- Uncharacterized Protein were selected for KASP allelic validation in the same MutMap mapping population and the genotyping corroborated with the grouping of lines as per the root phenotyping. The F2 mapping population was further progressed through inbreeding and are currently in the F6 generation. The lines showing desirable root characters and yield under aerobic field condition are being evaluated for registration as genetic stock on account of its robust root system and ability for adaptation under aerobic condition.

The Mutmap data has been submitted to the NCBI. One junior research fellow, Mr Nakul D Magar was trained for executing the methods and analysis involved and three equipments viz. Centrifuge-5424 R Eppendorf, Electronic weighing balance iGENELab serve, Open Rotary shaker iGENE LABSERVE were procured through this project.

Root phenotyping of the F2 population under aerobic condition maintained in the polyhouse for MutMap QTL-seq analysis

Acknowledgements

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हर कदम, हर डगर
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