50 AICRIP
GOLDEN JUBILEE 1965-2015

वार्षिक प्रतिवेदन
Annual Report
2014-2015

भाकृअनुप
ICAR

भारतीय चावल अनुसंधान संस्थान

भाचाअनुसं
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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 period 2014-15 which is the Golden Jubilee year and the first one of my eventful tenure as Project Director (A) and as part of the celebrations several monthly events are planned to commemorate the 50 golden years of this Institute. IIRR during the year under report, coordinated multidisciplinary multilocation rice production technologies under All India Coordinated Rice Improvement Project (AICRIP) and pursued lead research projects in trust areas of irrigated rice. Besides, specific objective oriented research network projects were organised and exchange of germplasm, breedng lines and information was facilitated.

The arrival of south-west monsoon was slightly delayed with 88% of its long period average. Withstanding the two severe cyclones *Hudud* and *Nilofer,* we could achieve a near record rice production of 103.04 million tones. The progress of research during the period of report is quite encouraging with 54 varieties including 3 hybrids being released for cultivation. The breeder seed production was also satisfactory with 776 tonnes seed of 217 varieties being produced and distributed. It is also heartening to note that the Institute is going to lead the Consortia Research Platform on 'Biofortification in selected crops for nutritional security' with a total budget of Rs. 130 crores during the XII Plan period. Several proven rice production technologies were demonstrated through 431 FLDs covering 17 states.

This year 31 scientists participated in national and international seminars and symposia and steps taken to strengthen the existing research facilities and ongoing programmes. On the research front, significant breakthroughs were achieved in identifying resistant genetic stocks, QTLs, candidate genes, high yielding lines, promising lines under low phosphorous, pyramided basmati lines resistant to bacterial blight and lines with low glycemic index.

The year is also significant in that the institute was conferred with CSIR Award for S & T Innovations for Rural Development (CAIRD) and several individual awards at national and international level for their commendable contributions to rice research. The highlights of the coordinated efforts and comprehensive results of lead research and brief institutional activities undertaken for effective management are presented in this annual report.

Hyderabad
11th May 2015

V Ravindra Babu
Project Director (A)

CONTENTS

कार्यकारी सारांश

Executive summary

अखिल भारतीय समन्वित चावल सुधार कार्यक्रम

केंद्रीये उपसमिति (फसल मानक और अधिसूचना) ने 51 किश्मे और एक संकर को जारी करने के लिए अनुमोदित किया। राज्यवर किश्म पहचान और विज्ञप्ति समिति ने एक संकर और 40 किश्मे के सी आर धान 701 और 40 किश्मे बिहार के लिए ,छत्तीसगढ़ (5),कर्नाटक(1),पंजाब(1),ओड़ीशा(9),तमिल नाडु(3)।त्रिपुरा (9) उत्तर प्रदेश (7) और पश्चिम बंगाल (4) के लिए जारी किए गए। इन किश्मों को विभिन्न पारिस्थितिकी के लिए जारी किए गए। जैसे सिंचित पारिस्थितिकी के लिए; एरोबिक और वर्षा आधारित अपलैंड के लिए; उथले और वर्षा आधारित तथा पहाड़ी और गहरे पानी पारिस्थितिकी के लिए।

फसल सुधार

- वर्ष 2014 में तेतालीस किसमे परीक्षणों , एक स्क्रीनिंग नर्सरी और 6 संकर चावल परीक्षणों का आयोजन किया गया जिसमे 910 प्रयोगों को 126 स्थानों पर जिसमे 27 राज्यों और 2 केंद्र शाहित प्रदेशों सहित देश के सभी 5 क्षेत्रों को शामिल किया गया। इसके अलावा 9 इंजर नर्सरी,530किश्मों को 60स्थानों पर परीक्षण के लिए शामिल किया गया। .
- 30 उत्कृष्ट किश्मे और तीन संकर लाइनों की पहचान विभिन्न पारिस्थितिकी के लिए की गई।
- 6 संकर चावल परीक्षण जैसे आईएचआरटी E, आईएचआरटी ME, आईएचआरटी M, आईएचआरटी MS, एमएलटी(नॉन एमएस) और एमएलटी(एमएस) जिसमे 132 संकर परीक्षण देश के 25-35 अलग-अलग केन्द्रों पर आयोजित की गई जिसमे 18 को उत्कृष्ट संकर के रूप में पहचान की गई है ।
- तीन संकर और 14 उत्कृष्ट किशम की पहचान किस्म पहचान समिति ने जारी करने की सिफारिश की ।
- 51 उत्कृष्ट और एक संकर किशमों की पहचान किस्म पहचान समिति ने विभिन्न राज्यों में जारी करने की सिफारिश की ।
- 530 अभिजात वर्ग लाइनों को आईएनजीएर नर्सरी में परीक्षण की गई जिसमे 55 उत्कृष्ट लाइनों की पहचान की गई।
- डैक आवेदोनों के अनुसार चावल की 217 किस्मों और 8 संकर के पैतृक लाइनों की" प्रजनक बीज उत्पादन का आयोजन 43 क्षेत्रों में किया गया। 433 टन के लक्ष्य के मुकाबले प्रजनक बीज के 775 टन का कुल उत्पादन किया गया।

सस्य विज्ञान

- 274 प्रयोगों के परिणाम में जो की 55 स्थानों पर की गई, 14 जीनोप्रकारों समूहों ने जैसे आईईटी 22952, आईईटी 22957(ईएच-सिंचित), आईईटी 22976(एमएच-सिंचित), आईईटी 23422(ई-रोपण), आईईटी 23189(एरोबिक), आईईटी 22649 (एएसजी) से संबंधित का अपनी नत्रजन उपयोग क्षमता के लिए परीक्षण किया गया और ३१ आशाजनक संवर्धों की पहचान की गयी।
- वर्षाधारित उपरीली पारिस्थितिकी प्रणाली में चावल + उरद/ क्लस्टर सेम / हॉर्स ग्राम (3:2 या 4:2 बदलने की श्रृंखला) ने उपज को बढाने में और लाभ में उत्कृष्ट पाया गया। 75% आरडीएफ़ या 75%आरडीएफ़ +जविक खाद या 100% आरडीएफ़ +20किलोग्राम गंधक/हे पोषक अनुसूची के लगाने में अनाज और मृदा स्वास्थ्य को बढाने में आशाजनक पाया गया।
- वर्षाधारित उपरीली पारिस्थितिकी प्रणाली में पोषक अनुसूची जविक खाद (5 t FYM/2 t वरमी कोंपोस्ट) और 75% पोषक अनुसूची के लगाने में अनाज उपज को बढाने में और मृदा स्वास्थ्य को बढाने में आशाजनक पाया गया।
- वायुजीवी धान के लिए जल्दीबुवाई और 25-35 कि0ग्रा0 बीजदर तथा उपउक्त किस्मों और संकर जैसे DRRH 3 और PAC 837को आशाजनक पाया गया। धान की बोआई की अवस्था में पेंदीमेथलीन(30ईसी)@1.00केजी एआई /हे (बुआई के 3-4 दिन उपरांत) और बीसप्यरिबक्सोडिउम (10%एससी) @35 ग्राम ए आइ के प्रयोग द्वारा व्यापक रूप में अपतृण नियंत्रण में उत्तम परिणाम दर्ज किये गये।
- बोआई की पारंपरिक विधि में अनाज उपज (43) की तुलना में चावल सघनीकरण प्रणाली (श्री) में इनाज उपज (47) के कारण उच्च उपज सूचक मूल्यों की पहचान की गयी। कृषिजोपजाति की तुलना में फसल की स्थापना प्रणाली का स्थान महत्वपूर्ण पाया गया।

मृदा विज्ञान

- 26 साल के लंबे समय के आरबीएस पोषक तत्व प्रबंधन परीक्षणों में 100%आरडीएफ़ +5टन एफ़वाईएम में तीन जगह (मांडया, मारुटेरू और टीटाबर) पर सबसे बेहतर प्रमाण प्राप्त हुआ। एफ़वाईएम अकेले के उपचार के वजह से मांडया में दूसरे साल भी आरडीएफ़ की तूलना में 16% उपज लाभ पाया गया।
- उपज गैप आकलन अध्ययन में प्रचलित अनुमोदित उर्वरक मात्रा और कृषकों के द्वारा व्यवहार में लायी जाने वाली उर्वरक पद्धतियों की तुलना में स्थान विशिष्ट पोषक प्रबंध (55%) आरडीएफ़ पर और (67%) कृषकों के द्वारा खाद व्यवहार पर श्रेष्ठतर पाया गया।
- जीनोटाइप भिन्नता लवणता सहिष्णुता के लिए देखा गया जिसमे 24 किस्मों की तूलना में सीएसआर23,टीटीबी-

Executive summary

404,आइ र 64,यू स 312 और पूजा किस्मों ने (1.87ट/हे) अधिक उपज दर्ज की जिप्सम के नहीं प्रयोग पर। 100% जिप्सम के प्रयोग पर डीआरआरएच-2,सीएसआर-23 और डीआरआरएच-3 ने अधिक उपज दर्ज की।

- वायुजीवी धान प्रणाली में उपज हानि के बिना जल उत्पादकता (कि.ग्रा.धान/उपयोग किया गया मि.मी. जल) 3.9 से 4.8 कि.ग्रा. अनाज तक पाया गया और सिंचाई 75% संचित पटल वाष्पणप (CPE) को इष्टतम पाया गया। प्रतिबंधित आपूर्ति के द्वारा क्रमशः लगभग 12-21 प्रतिशत सिंचित जल की बचत होगी।

- एक अध्ययन में चावल की उत्पादकता और पोषक तत्व उपयोग दक्षता का आकलन फसल कैलेंडर के बदलाव के कारण देखा गया। अनाज पैदावार के पांच स्थानों पर आंकड़े जल्दी रोपण का इष्टतम तारीख पर रोपण पर उच्च अनाज की पैदावार (11 % डीआरआर 40%जीएचटी,,26%केआरके,4%के एच यू और 13%पीडीयू) में दर्ज की गई।

- टिटाबार (असम) और रांची (झारखंड) की निचली धान पारिस्थितिकी में आम्लीय मृदाओं के लिए धान जीनोप्रकार के परीक्षणों से चूने के प्रयोग के रूप में जीनोप्रकार की विविधता पायी गयी। मोण्कोंपू में (सहभागी धान, डीआरआरएच-2,एनडीआर-359,) रांची में डीआरआरएच-3,डीआरआरएच-2,,टीटीबी-404 और टिटाबार के लिए डीआरआरएच-3,पूजा और तुलसी को उत्कृष्ट पाया गया।

- स्यटोंकिनिन,जेविक और सूक्ष्म पोषक और स्प्रे के संयुक्त उपयोग में अधिकतम जस्ता(19-36पीपीएम),लोहा (21-244पीपीएम) दाने और स्ट्रॉ में अवशोषित हुई। इनमे (53-80% जस्ता और 59-97%लोहा) स्ट्रॉ में अवशोषित हुआ और सिर्फ (20-47%जस्ता और 3-41% लोहा) दाने में स्थानांतरित हुआ।

- साइट विशिष्ट पोषक तत्व प्रबंधन के माध्यम से चावल की उपज अधिकतमकरण पर अध्ययन के पहले वर्ष में पोषक तत्व विशेषज्ञ सॉफ्टवेर पर आधारित सिफारिशों में (7-12%) अधिक अनाज उत्पादन हुई।

पादप-क्रिया विज्ञान

- प्रकाश ऊष्मीय अनुक्रमण और विकिरण का उपयोग दक्षता के लिए जल्दी और सामान्य बोया स्थितियों के तहत मूल्यांकन में आईईटी 20924, आईईटी 22569, और ललल्ट को तीनों मौषम के लिए उपुक्त पाया गया। आईईटी 23330 को जल्दी और सोमालाय को देर से बुआई के लिए बेहतर पाया गया।

- सूचक पर एक अध्ययन में बोआई के दो विभिन्न तिथियों के कारण पुष्पण में आगुआई, CDD,CNP, जैव पदार्थ और अनाज की उपज में कोई महत्वपूर्ण भिन्नता नहीं पायी गयी।

- 5संकर किस्मों और एक अधिक उपज देने वाली किस्म (बीपीटी 5204) में सिलिकॉन की उच्च खुराक की जरूरत उसके आंतरिक पत्ता में ऊच सिलिकॉन एसिड सामग्री से स्पष्ट है. सिलिकॉन घुलनशील के अनुप्रयोग से सामान्य फसल और मृदा स्वास्थ्य में सुधार पाया गया।

- 8 गर्मी संवेदनशीलता सूचकांक में आईईटी 23216, आईईटी 23770, आईईटी 23223 और आईईटी 23739 उत्कृष्ट लाइनों की पहचान की गई।

- यील्ड स्थिरता सूचकांक और स्थिरता विचरण पर , आईईटी 24674, सहभागीधान, IET24677 और आईईटी 24683 के आधार पर स्थिर और अपलैंड खेती के लिए उपयुक्त थे।

- दोनों प्रयोगशाला और क्षेत्र की स्थिति के तहत अजैव तनाव सहिष्णुता पर आधारित प्रविष्टियों, आईईटी 24100, आईईटी 24104, 82365-बी बी-47-1, एमआरसी -603, आईआर 55178, एसजी-26-120 और आईआर-310-बी बी -67-2 कई स्थानों में बेहतर पाए गए।

कीट विज्ञान

- देश भर में आठ राज्यों, एक केन्द्र शासित प्रदेशों और 29 स्थानों (जून दिसम्बर) पर किए गए पाक्षिक कीट सर्वेक्षण के आधार पर पत्ता हॉपर के फैलने का पता चला।

- मेजबान पत्ता प्रतिरोध के अध्ययन से पता चला कि प्रविष्टियों - सीआर 2711-149, KAUM 179-1, 179-2 KAUM और KAUM 182-1 पत्ता हॉपरके खिलाफ लगातार दूसरे साल भी प्रतिरोध प्रतिक्रिया का पता चला। आईसी 578,133 और COGR 2 पित्त मिड्ज प्रतिरोध के लिए होनहार पाए गए। तीन प्रविष्टियों अर्थात।, CR3006-8-5, आरपी 4918-228 (एस) और JGL 19,618 कई कीट प्रतिरोध के लिए उपयुक्त पाया गया।

- जीन भिन्नता का 2 मूल्यांकन सात गालमिड्ज बायोट्यपेस से पता चला की W1263, ARC6605, अगनी और आईएनआरसी3021 को आशाजनक और 16 जीन भिन्नता का मूल्यांकन में टी 12 (एसीसी 56989), आरपी 2068-18-3-5, राथुहीनथी और पीटीबी 33 के लिए उपयुक्त पाया गया जिनकी क्षति स्कोर ≤5 थी।

- 34 स्थानों पर किए गए कीटनाशक मूल्यांकन परीक्षण से पता चला कि बुप्रोफेजिन @ 35 + 175 जी ऐ/हेक्टेयर उपचार स्टेम बोरर और पत्ती फ़ोल्डर के खिलाफ प्रभावी था। डानोटेफूरोन 40 जी ऐ/ हेक्टेयर तथा इमिडआक्लोपृद +एथ्रीप्रोले @50 जी ऐ/ हेक्टेयर पौधा हॉपर और पत्ती हॉपर के खिलाफ प्रभावी था।

- गालमिड्ज पर विषाक्तता संघटन अध्ययन द्वारा सकोली और पट्टांबी में जी.एम. और जी.एम 11 जीनों के विरुद्ध 50% से अधिक जीव संख्या विषाक्त पायी गयी।

- कीट प्रजातियों और प्राकृतिक दुश्मनों की निगरानी में पता चला की स्टेम बोरर के पांच प्रजातियों 16 स्थानों में और पीले तना छेदक 14 स्थानों में उपस्थिति पायी गई।

- पौधा हॉपर प्रबंधन के लिए 2 पर्यावरण अभियांत्रिकी छह स्थानों पर परीक्षण किए गए।

- नुकसान उपज आकलन परीक्षण (YLET) से स्टेमबोरेर 10% की वृद्धि की वजह से 1.02 ग्राम की अनाज पैदावार प्रति पौधा में कमी का पता चला।

पादप रोग विज्ञान

- 2021 परीक्षण प्रविष्टियों में से भारत भर में पांच अलग स्क्रीनिंग नर्सरी से मूल्यांकन में उत्कृष्ट प्रविष्टियों की संख्या 83 है लीफ़ ब्लास्ट के विरुध, 72 है नेक ब्लास्ट के विरुध, 43 है शेयथ ब्लायट के विरुध, 45है ब्राउन स्पॉट के विरुध, 30 है शेयथ रोट के विरुध, 64 है बकटेरियल ब्लीटे के विरुध और 27 है रिसे तुंगरों के विरुध।

- बैक्टीरियल ब्लाइट रोगज़नक़ और ब्लास्ट की विषाक्तता की निगरानी अध्ययन में पता चला की घगराघाट, मुगद, कर्जत, इम्फाल, अल्मोरा,हजारीबाग में ब्लास्ट की विषाक्तता में मामूली बदलाव और बैक्टीरियल ब्लाइट रोगज़नक़ की विषाक्तता, आइतुरई,मरुटेरू, नवसारी और रायपुर में पाया गया था।

- संयोजन कवकनाशी आईसीएफ-110 (tricycl azole 45% + hexaconazole 10% विंग) @ 1G / एल नेक ब्लास्ट, नोड ब्लास्ट ,शेयथ ब्लायट, ब्राउन स्पॉट,ग्लूमे डिसकलेरेशन के खिलाफ काफी प्रभावी पाया गया था।

- संयोजन कवकनाशी आईसीएफ-110 (tricycl azole 18% + मंकोजेब 62% डबल्यूपी) @ 2.5g / l को शेयथ रोट के विरुध उपयुक्त पाया गया।

- विशेष आईपीएम परीक्षण डेटा से संकेत मिलता है की आईपीएम प्रथाओं के पालन से लीफ़ ब्लास्ट नेक ब्लास्ट शेयथ ब्लायट ब्राउन स्पॉट शेयथ रोट बकटेरियल ब्लीटे बीमारियों की की प्रगति में कमी होती है।

- फाल्स स्मट स्क्रीनिंग परीक्षण से पता चला कि उत्तर से दक्षिण दिशा, बुआई / रोपण में देरी करने से ज्यादा रोग की घटना दर्ज की गई। संकर KRH 2 सभी स्थानों में अतिसंवेदनशील पाये गए। यू स 312 और पीए 6444. Co43, एमटीयू 1075 और बीपीटी 5204 अत्यधिक संवेदनशील पाये गए ।

- उत्पादन उन्मुख सर्वेक्षण भारत के 18 राज्यों में आयोजित किया गया। नेक ब्लास्ट और फाल्स स्मट जैसी बीमारियों पिछले कुछ वर्षों में देश भर में फैला है। बकाने विशेष रूप से बासमती किस्मों पर पंजाब और हरियाणा में एक बड़ी समस्या बन गया है। बकटेरियल ब्लीटे की बढ़ती घटनाओं असम और तमिलनाडु से दर्ज की गई थी। वहाँ हरियाणा में रूट वीविल और केरल में काले बग की गंभीर समस्या पाये गये।

प्रौद्योगिकी स्थानांतरण

- देश के 17 राज्यों और चार धान पारिस्थितिकियों को सम्मिलित करते हुए विभिन्न धान उत्पादन प्रौद्योकियों को मूल्यांकित करने और प्रदर्शित करने के लिए 485 एफ.एल.डी. का आयोजन किया गया।

- 431 एफ.एल.डी. में से 66% सिंचित चावल पारिस्थितिकी तंत्र में आयोजित की गई, 11%वर्षा आधारित ऊपरी भूभाग में, 16% उथले निम्न भूमि में और पहाड़ी पारिस्थितिकी में 3% एफ.एल.डी. का आयोजन किया गया । 4%एफ.एल.डी. का आयोजन समस्याग्रस्त मिट्टी में आयोजित की गई। अधिकांश मामलों में, एफ.एल.डी टेक्नोलॉजी द्वारा उपज फायदे दर्ज की गई।

हिन्दी गतिविधियाँ

- चावल अनुसंधान निदेशालय, राजेन्द्रनगर, हैदराबाद के अधिकारियों व कर्मचारियों के लिए हिन्दी में प्रवीण की कक्षाएं 10 मार्च से 31 मार्च तक चलायी गई।

- निदेशालय के नये नामकरण होने पर संस्थान के लोगो, सभी बोड्र्स,लेखापत्र,बिभागों के परिपत्र, पटल को द्विभाषिये बनाया गया।

- संस्थान की नई नोटेशीट,कम्प्युटर फेरिफेरल्स को द्विभाषिये बनाया गया ।

- 50 वां स्वर्णिम वार्षिक चावल अनुसंधान समूह बैठक के 500 आमंत्रण पत्रो को द्विभाषिये बनाया गया और पूरे देश के सभी सहभागियों को प्रेषित की गई।

- परियोजना निदेशक की सहमति से, चावल अनुसंधान निदेशालय की राजभाषा कार्यान्वयन समिति की नई राजभाषा कार्यान्वयन समिति का गठन किया गया।

- नई राजभाषा कार्यान्वयन समिति की पहली बैठक जनवरी के पहले सप्ताह में हुआ। इसमे एक हिन्दी कार्यशाला और संस्थान के नये कर्मचारियों के लिए प्रवीण, प्रज्ञा की पाठशाला चलाने का निर्णय हुआ।

- चावल अनुसंधान निदेशालय, राजेन्द्रनगर, हैदराबाद के अधिकारियों व कर्मचारियों के लिए हिन्दी कार्यशाला (दिनांक 31-1-2015) का उद्घाटन समारोह का आयोजन 31 जनवरी,2015 को सेमिनार हाल 1 में किया गया, जिसमे श्री जयशंकर प्रसाद तिवारी,सहायक निदेशक, केंद्रीय हिन्दी राजभाषा विभाग, हैदराबाद को इस समारोह का मुख्य अतिथि बनाया गया।

- टंकण,लेखण और पत्राचार बिषय पर एक दिवसीए हिन्दी कार्यशाला चावल अनुसंधान निदेशालय, राजेन्द्रनगर, हैदराबाद के अधिकारियों व कर्मचारियों के लिए दिनांक 31-1-2015 को किया गया।

- हिंदी में त्वरित भाषण प्रतियोगिता निदेशलाय के सभी अधिकारियों व कर्मचरियों के लिए 31.1.2015 को आयोजित किया गया। इसका विधिवत समापन तथा पुरस्कार वितरण समारोह 3.00 से 4.15 अपराह्न,2015 बजे तक निश्चित किया गया था।

- हिन्दी सप्ताह का आयोजन: इस निदेशालय द्वारा 14 सितंबर ,2014 से 21 सितंबर 2014 तक हिन्दी सप्ताह का आयोजन किया गया जिसका उद्घाटन परियोजना निदेशक महोदय ने किया। इस सिलसिले में कई कार्यक्रमों का आयोजन किया गया।

अग्रणी अनुसंधान

फसल सुधार

पौधा प्रजनन

- IET 23420 (RP5333-41-2-3-आईआर 83383-B-B) जो सहभागी धन , क्षेत्रीय चेक और स्थानीय चेक के ऊपर 22.7%, 45.7% और 18.39% की मात्रा में अधिक उपज लाभ दर्ज की गई को क़िस्म पहचान समिति द्वारा बिहार,मध्य प्रदेश और महाराष्ट्र में जारी करने के लिए पहचान की गई।
- IET 23832 (RP5886HP3-IR80463-B39-3) जिनकी पुष्पन 102 दिनों की है और जो IR64 के ऊपर 13.1%, की मात्रा में अधिक उपज लाभ दर्ज की गई और जिसकी पोलिशेड अवस्था में 19.5पीपीएम Zn और 3.85पीपीएम Fe है, को क़िस्म पहचान समिति द्वारा तमिल नाडु, कर्नाटक और आंध्रा प्रदेश में जारी करने के लिए पहचान की गई।
- क्यूटीएल QTLsqKSM1.1, qNa/KSH 1.1 और qSSISFH8.1 को प्रजनन और अनाज भरने के स्तर पर लवणता सहिष्णुता के लिए सांबा महसूरी में पुष्टि किया गया।
- सांबा महसूरी को क्यूटीएल QTLs qSub1+qDty 2.1+ qDty3.1 से जलमग्नता के विरुध , सूखा सहिष्णुता के विरुध सुधार किया गया।
- कम स्फुर की मात्रा के लिए सहिष्णु जीनोटाइप निम्न हैं विकास, स्वर्णा, एनडीआर 359, IR83140-बी-11-बी,IR83142-बी-57-बी, D4098, वंक्सीयन 7777, HHZ 5-SAL10-DT1-DT1, IR83140-बी-36-बी, लुइन 46 और आरटीएस 14।
- 22 लड़कियों जिनमे खून की कमी थी के बीच लोहे फोर्टिफाइड चावल के खिलाने पर, हीमोग्लोबिन स्तर 9.19 g/dL से 10.67 g/dL बढ़ा हुआ पाया गया।
- एमाइलोज और एम्यलोपेक्टिन विश्लेषण पहली बार के लिए गीला प्रयोगशाला विधि का उपयोग कर एकल अनाज के स्तर पर प्रदर्शन किया गया।

संकर चावल

- DRR-85 सफलतापूर्वक एआईसीआरपी परीक्षणों में परीक्षण के तीन साल पूरा कर लिया गया है। यह संकर बीपीटी 5204 अनाज प्रकार की गुणवत्ता और मध्यम अवधि होने के साथ एक उच्च उपज देने वाली संकर है जो तमिलनाडु, महाराष्ट्र और मध्य प्रदेश में खेती के लिए उपयुक्त है।
- 27 उत्कृष्ट जनांद्रव्यों की पहचान उपलब्ध प्रजनन सामग्री से की गयी ।
- 5 नए संकर यथा DRRH-88, DRRH-89, DRRH-90, DRRH-91 और DRRH-92 को अकृप परिक्षण के लिए नमीत किया गया और 2 संकर जैसे DRRH-85 और DRRH-92 को अग्रिम परिक्षण के लिए नामित किया गया।

जैव प्रौद्योगिकी

- चावल में अनाज भरने के साथ जुड़े जीन की पहचान करने के क्रम में 24 चावल जीनोटाइप सूक्रोज ट्रांसपोर्टर जीन OsSUT1-2. की अभिव्यक्ति के विश्लेषण के लिए इस्तेमाल किया गया।
- आठ बीटी ट्रांसजेनिक चावल लाइनों की पहचान IR64से जिसमे Cry1Ac जीन्स हैं येल्लो स्टेम बोरेर प्रतिरोध के लिए की गयी।
- पानी तनाव स्क्रीनिंग के आधार पर समयुग्मक सूखा सहिष्णु (डीटी) ट्रांसजेनिक चावल लाइनों BPT5204की पहचान की गई।
- उपज घटकों के लिए आठ क्लोन जीनों में से यथा अनाज संख्या (Ghd7, Ghd8 और Cytokinin oxidase); अनाज उपज(Dep1 और Dep3); सीधे विकास, अनाज संख्या, अनाज उपज (PROG1); आदर्श पौधा स्थापत्य और उपज (OsSPL14) के लिए मार्केर्स Ghd8, OsSPL14 और PROG1 जीन्स के साथ जुड़ा होना पाया गया है इंडिका , ट्रोपिकल जपोणिका और ओरयज़ा ग्लाबेरिमा में
- डबल्यूए –सी एम एस लाइंस में तीन के एक सेट और 17 रेस्टोरेर्स की क्रोससिंग L X T से की गयी और संकर विकसित की गयी।
- फेनोटिपिंग और आणविक लक्षण वर्णन चावल ट्रांसजेनिक लाइनों की आरएनएआई तकनीक से की गयी।
- गोलाकार चावल तुंग्रों वायरस की एक दक्षिण भारतीय आइसोलेट्स का पूरा जीनोम की पहचान की गयी और NCBI डेटाबेस में जमा किया गया(accession number: KC794785)।

फसल उत्पादन

सस्य विज्ञान

- स्री विधि उपयोगी पायी गयी जिससे की कार्बनिक और अकार्बनिक पोषक तत्व प्रबंधन के द्वारा उच्च कृषि दक्षता दर्ज की गयी।
- संतृप्ति विधि द्वारा पानी की बचत मात्रा 260 mm/ha (32% जल का) है।
- 75% सिफारिश नाइट्रोजन (120 किग्रा / हेक्टेयर) और पोटेशियम की 50% की सिफारिश की खुराक के शीर्ष ड्रेसिंग के अनुप्रयोग से प्रत्यक्ष चावल उत्पादन विधि में पुष्पगुच्छ काल में पौधों का गिरना कम हो गया है।
- जड़ शरीर रचना के अध्ययन में aerenchyma की एसआरआई में एनटीपी से कम गठन का संकेत दिया

Executive summary

- देरी से बुवाई (सितम्बर), गीला चावल की खेती प्रतिरोपित चावल से आशाजनक साबित होता है।

- वायुजीवी धान के लिए 100-125% नत्रजन का प्रयोग + आविर्भाव के पूर्व शाकनाशी का प्रयोग + धान ढैंचा (1:1) + बुआई के 60 दिनों को बाद हाथ से निराई या बुआई के 25-30 दिनों के बाद 2,4 डी-एन.ए. का प्रयोग आशाजनक पाया गया।

मृदा विज्ञान

- नाइट्रोजन की कई उपयोग दक्षता के आधार पर , जीनोटाइप रासी और रवि जल्दी अवधि के समूह $_2$; लंबी अवधि के समूह से डीआरआरएच88, डीआरआरएच85 और आरपी-जैव 4919-363-5 मध्यम से और स्वर्णधन और SACG 4 (जीएसआर) लंबी अवधि समूह से आशाजनक साबित हुये है।

- नाइट्रीकरण निषेधक के आवेदन से जैसे की नीम कोटेड यूरिया और डाइसिनामएड़े ने धान के खेत से N_2O उत्सर्जन यूरिया की तुलना में काफी कम कर दिया है। कुल N_2O-N उत्सर्जन (नीम कोटेड यूरिया और डाइसिनामएड़े) 0.05% के सीमा में पाये गए और 0.06% (अकेले यूरिया) के बनिस्पत। सबसे ऊँचा दर N_2O-N उत्सर्जन का (41%) निषेदक में तब पाये गयी जब यूरिया और डाइसिनामएड़े का प्रयोग किया गया।

- एक नये तकनीक के जाँच में यह पाया गया की मुर्गी खाद और वरमी खाद जिसे 10% और 20% नत्रजन और स्फुर से संबर्धन की गयीऔर धन की खेती में काफी उत्साहजनक पाये गयी जिससे की 30% उपज ऊटपादन का लाभ और नाइट्रोजन टहता स्पूर की कई उपयोग दक्षता में वृधि हुई है।

- मृदा जाँच कीट का विकास और अलग मिट्टी और स्थितियों के लिए इसके प्रयोग किया गया। एक द्विभाषी मृदा जाँच कार्ड का निर्माण और किसानो के बीच में वितरण किया गया।

- सीरशिया मरसेसेनसे बैक्टीरिया जो की चावल की रिज़ोस्फेरे से अलग की गयी है उसमे कई लाभकारी लक्षण पाया गया है। यह विशेषकर मिट्टी पोषक तत्वों को जुटाना और जैव नियंत्रण में लाभदायक है।

पादप फिजियोलॉजी

- 17 (एचआर)मानचित्रण आबादी विकसित किए गए और आठ लाइनों की पहचान की गई। पांच क्षेत्रों में गुणसूत्र 1, 3 और 5 पर छोटी बाल प्रजनन के 3 उम्मीदवार जीन कीपहचान की गई।

- नाइट्रोजन की उपयोग दक्षता के लिए 30 मानचित्रण आबादी विकसित किए गए और 30 जीनोमिक क्षेत्रों की पहचान की गई।

फसल सुरक्षा

कीट विज्ञान

- 1600 के प्रविष्टियों के खिलाफ उनकी प्रतिक्रिया के लिए मूल्यांकन।

- 7 प्रविष्टियों में, IET 22989, IET 23894, IET 21944, IET 23705, IC NO 578151, VPB 231 and VPB 232 दोनों फुदका कीट प्रतिरोधी थे।

- दोनों फुदका कीट की प्रतिस्पर्धी क्षमता पर ग्रीनहाउस अध्ययन में पाया गया की जब दोनों को साथ में जारी की गयी तब भूरा फुदका की उर्वरता कम हो गयी।

- भूरा फुदका, सफेद पीठवाला फुदका के पर्याक्रमण से कुल बालियों की संख्या और अनाज उपज में कमी दर्ज की गयी।

- दो नए जर्मप्लाज्म नामकरण यथा IC 462402 और IC 577036 गालमिड्ज बायो टाइप -1 के लिए प्रतिरोधी के रूप में पहचान की गई ।

- वास्तविक समय सत्यापन अध्ययन से पुष्टि हुई कि NBS-LRR जो Gm4 अभया में और प्रोलिने रिच प्रोटीन 3 Gm8 अगहनि में कंडीडटेस जीन्स के रूप में विधमान हैं। .

- इक बूंद, एक गीला एजेंट का कीटनाशकों की प्रभावकारिता पर और उनके प्रभाव पर $_2$ फील्ड परीक्षण में पाया गया की तना छेदक हानि काफी कम थे rynaxypyr में और इक बूंद के साथ संयोजन में आसिफट उपचार बनिस्पत की जब उन्हे अकेले में उपयोग की गयी हो। .

- चार वाणिज्यिक योगों और दो बोतनिकल्स अर्क का खेत की स्थिति के तहत मूल्यांकन किया गया जिसमे मल्टीनीम 300 ppm, नीम बन 300 ppm को काफी उपयोगी पायी गयी स्टेम बोरर और पत्ता मोड़क कीटों पर।

- पर्यावरण इंजीनियरिंग फूल वाले पौधों के साथ में पाया गया की मेड़ पर एक सीमा के रूप में गेंदे के रोपण से Oligosita सपा द्वारा हॉपर अंडे की परजीवी बढ़ जाती है।

- आईआईसीटी, हैदराबाद और CPCRI कासरगोड के साथ आध्यन में, गुलाबी स्टेम बोरर का सेक्स फेरोमोन के घटक की पहचान Sesamia inferens की अक असीटेट अणु के रूप में पहचान की गयी है।

- मिट्टी निमेटोड आबादी के विश्लेषण से पता चलता है की परजीवी नेमाटोड की संख्या एसआरआई भूखंडों में कम था।

पौध सुरक्षा

- 6962 प्रविष्टियों में, जिनमे निल्स,रिल्स भिन्नता, प्रजनन सामग्री, अंतर्गमन लाइनों और IRBN प्रविष्टियों

शामिल हैं ,803 प्रविष्टियों में झोंका के प्रति प्रतिरोधिता है। नौ अंतर्गमन लाइनों यथा PAU # 547, 549, 550, 695, 747, 848, 1061, 1077 and 1195 Xoo इसोलाटेस के खिलाफ व्यापक प्रतिरोध पाया गया है ।

- छह बक्क्क्रोस्स जन्मजात लाइनों (बिल) का परीक्षण 120 में से यथा , BILs # 4B, 5B, 6B, 24B, 25B और 84B राइस तुंगरो वाइरस के खिलाफ प्रतिरोधिता दर्शायी।
- नश्तरिकरन की कई विधियों की जाँच में, सुई नश्तरिकरन जब बूटिंग चरण हो और फिर सापेक्ष आर्द्रता 80-90% तथा 24 ^{0}C पर पौधों को सात दिन तक रखने से स्मट बाल्स का निर्माण होता है।
- कई बार के स्क्रीनिंग पर यह पाया गया की , 2 मुटाण्ट प्रविष्टि, 14 अंतर्गमन लाइनों, 2 संब्रहन्त लाइंस, 1 B लाइन और 7 ट्रोपिकल जपोनिका शेयथ ब्लाट पर बडा प्रभावी पाया गया।
- 260 Xoo इसोलाटेस के फेनो टिपिंग को भारत के विभिन्न चावल उत्पादक क्षेत्रों से एकत्र की है और 22 पेथोटाइप्स में उन्हें वर्गीकृत. किया।
- आरटीवी के प्रभाव प्रतिरोधी किस्म विरक्रामरया और टीकेएम 6, मामूली प्रतिरोधी किस्म आईआर 20 और IR67406-6-3-2-3 के पौधे की ऊंचाई पर प्रमुख नहीं था टीएन1 जैसे अतिसंवेदनशील किस्मों की तुलना में।
- आंध्र प्रदेश के नलगोंडा जिले में सर्वेक्षण से पाया गया की फालस स्मट चावल किस्म बीपीटी 5204 प्रभावित क्षेत्र में गंभीर रूप से प्रभावित था ।

प्रौद्योगिकी स्थानांतरण

- बोरो क्षेत्रों में स्थायी चावल उत्पादन पर अध्ययन में पाया गया की बोरो पारिस्थितिकी के लिए अनुकूल कोई चावल किस्में उपलब्ध नहीं है ।
- किसानों ने डीएसआर के फायदे रोपण के लिए श्रम कम है, सिंचाई के पानी के कम उपयोग, जुताई में समय कम और ऊर्जा की कम खपत होती है।
- तेलंगाना में, सभी अलग श्रेणियों के उत्तरदाताओं में आईसीटी उपकरणों से सूचना मिलने की प्रतिशत ओडिशा की तुलना में अधिक पाया गया।
- राइस चेक कार्यक्रम ओडिशा (पुरी और कोरापुट), तेलंगाना (नलगोंडा), तमिलनाडु (तिरुवल्लुर) में संचालित की जा रही है।

All India Coordinated Rice Improvement Programme (AICRIP)

Fifty one varieties and three hybrids were released during 2014-15 by Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCCSN & RV) and State Varietal Release Committee (SVRC). Central Sub Committee on Crop Standards, Notification and Release of Varieties released 11 varieties and two hybrids(HRI 174 and HRI 178). The State Varietal Release Committees released one hybrid, CR Dhan 701 and 40 varieties for Bihar (1), Chhattisgarh (5), Karnataka (1), Punjab (1), Odisha (9), Tamil Nadu (3), Tripura (9), Uttar Pradesh (7), and West Bengal (4). These high yielding varieties (HVYs) were released for cultivation in different ecology *viz*., upland, irrigated, aerobic, basmati areas, shallow low land, aromatic short grain, semi deep and deep water, saline and alkaline. Many of these varieties are resistant/moderately resistant to biotic stresses.

Crop Improvement

- ✧ During the year 2014, 43 varietal trials, one screening nursery and six hybrid rice trials were conducted in 910 experiments at 126 locations in 27 states and two Union Territories in the country. In addition, nine INGER nurseries involving 530 entries were tested at 60 centers.
- ✧ Thirty varietal entries and three hybrids were identified as promising for different states and ecologies.
- ✧ Six hybrid trials were conducted *viz*., IHRT E, IHRT ME, IHRT M, IHRT MS, MLT (non MS) and MLT (MS) in which, 132 hybrids were tested in 25 – 35 locations representing different agro-climatic regions of the country. 18 hybrids were found to be promising.
- ✧ The Varietal Identification Committee identified three hybrids and 14 varietal entries for release in different states.
- ✧ Of the 530 entries evaluated in INGER observation nurseries, 55 were found to be promising based on phenotypic acceptability and yield for further multilocation testing.
- ✧ Breeder seed production of rice varieties and parental lines of hybrids as per DAC indents was organized at 43 centers across the country, involving 217 varieties and parental lines of eight hybrids. A total production of 7757.42 quintals of breeder seed was achieved against the target of 4328.42 quintals.

Agronomy

- ✧ The results of 274 experiments conducted at 55 locations and evaluation of elite genotypes (15 groups) indicated the superior NUE cultivars *viz*., IET 22952, IET 22957 (EH-irrigated), IET 22976 (MH-irrigated), IET 23422 (E-Transplanted), IET 23189 (AR**),** IET 22649 (ASG) were found promising at 50% RDN as they had lesser reduction in yield over 100% RDN.
- ✧ In Rainfed regions, intercropping of rice + black gram/cluster bean/horse gram (3: 2 or 4: 2 replacement series) resulted in higher rice equivalent yields and gross returns. Depending on the initial fertilizer status, 75% RDF of rice or 75% RDF of rice + organic manure or 100% RDF of rice + 20 kg Sulphur /ha are required to achieve higher yields of rice either as sole crop or rice + intercrops.
- ✧ In aerobic rice, early sowing coupled with a seed rate of 25-35 kg/ha is optimum for realizing higher yields of aerobic rice with selection of suitable promising hybrids DRRH3 and PAC 837 or high yielding varieties using, 100-125 % of RDN (N in three splits). Application of pendimethalin (30EC) @ 1.00 kg a.i. /ha at 3-4 DAS bispyribacsodium (10%SC)@35 g.a.i. /ha at 2-4 leaf stage of weeds was observed to be effective.
- ✧ In SRI method, superiority of SRI method (4.55 t/ha) over Direct seeding followed by SRI principles (4.21 t/ha) on normal transplanting was demonstrated and application of 150% RDF followed by 100% RDF as inorganic or conjuncture use of 50% organic + 50% inorganic was found promising.
- ✧ In direct seeded rice under puddled condition, hybrids recorded superior performance over HYVs. The method of sowing and cultivars was observed to be location specific. Drum seeding or seed drilling on puddled soil were equally productive as that of conventional transplanting.

Irrigation schedules of saturation or alternate wetting and drying were equally effective as that of conventional flooding system.

- The grain yield loss due to weeds was upto 67.1%, when weedy condition was up to 60 days, indicating the necessity of maintaining weed free condition during critical period of crop weed competition. Application of pre-emergence herbicide followed by two applications of post-emergence herbicide for 2nd and 3rd flush of weeds was on par with need based hand weeding.
- In Rice Based Cropping Systems, application of RDF + split application of N (4.99 t/ha) followed by Azotobactor + PSB + Brown manuring with 50% RDF and Azotobactor + PSB + Residue mulch + 75% RDF found promising indicating the substitution of 25-50% RDF with organic manures.

Soil Science

- In the 26th year of study on long term soil fertility management in RBCS, the results indicated the superiority of conjunctive use of 100% RDF + 5t FYM/ha over all other treatments at all the three locations (Mandya, Maruteru and Titabar) and FYM alone increased grain yield significantly by 16% over RDF at Mandya for the second consecutive year.
- In the yield gap assessment trial conducted in farmers' fields, results at Mandya revealed that SNM was superior to the currently recommended blanket fertilizer dose (by 55%) and farmers' fertilizer practice (by 67%) with corresponding improvement in crop nutrition and nutrient use efficiency.
- Genotypic differences were observed in tolerance to sodicity, with CSR 23,TTB-404, IR 64, US 312 and Pooja recording highest yields (1.87-2.10 t/ha) among the 24 genotypes evaluated without gypsum application while DRRH-2, CSR-23 and DRRH-3 were the best performers with 100% gypsum application.
- Irrigation equivalent to 75% of CPE appeared to be optimum for aerobic rice system based on water productivity at Mandya saving about 8% irrigation water over 150% CPE. At Kanpur 100% CPE and 75% CPE resulted in a saving of 16 and 23% but with an associated yield penalty of 12% and 21%, respectively over 150% CPE.
- In the study conducted to assess rice productivity and nutrient use efficiency due to changing crop calendar, the grain yield data indicated that early planting recorded higher grain yields over optimum date of planting at five locations (by 11% at DRR, 40% at GHT, 26% at KRK, 4% at KHU and 13% at PDU).
- The highest yielding genotypes after liming amendment were Sahbhagidhan, DRRH – 2, NDR – 359 at Moncompu, DRRH-3, and TTB-404, DRRH-2 at Ranchi and Tulasi, DRRH-3, Pooja at Titabar.
- Combined use of organics, micronutrients and cytokinin spray resulted in maximum Zn (19-36 ppm in grain) and Fe (21-244 ppm in grain) concentration and uptake in both grain and straw with major portion of the absorbed micronutrients remaining in straw (53-80% of Zn and 59-97% of Fe) and only 20-47% of Zn and 3-41% of Fe was translocated to the grain.
- In the first year of study on yield maximization of rice through site specific nutrient management, the recommendations based on nutrient expert tool resulted in significantly higher (7- 12%) grain yields at five out of 18 locations.

Plant Physiology

- Based on Photothermic indexing and radiation use efficiency IET 20924, IET 22569 and Lalat in all 3 seasons and IET 23300 for early and Somaly for late sown situations were observed to be promising across locations.
- Five Hybrids and one high yielding variety (BPT-5204) were taken up for the study to understand the role of silicon in rice plant. The results indicated that silicon solubilizer application improved soil health and biotic stress tolerance.
- Based on eight different types of heat tolerance (HT) indices, IET 23216, IET 23770, IET 23223 and IET 23739 were observed to be promising.
- Based on YSi and Stability variance, IET 24674, Shabhagidhan, IET24677 and IET 24683 were stable and suitable for upland cultivation.
- Based on multiple abiotic stress tolerance under both lab and field conditions the entries, IET 24100, IET 24104, 82365-B-B-47-1, MRC -603, IR-

55178, SG-26-120 and IR-310-B-B-67-2 were found superior across the locations.

Entomology

- Pest surveys undertaken at 29 locations (June-December) on fortnightly basis revealed outbreak of planthoppers in eight States and one UT representing 11 locations.
- Host plant resistance studies revealed that four entries - CR 2711-149, KAUM 179-1, KAUM 179-2 and KAUM 182-1 showed consistent resistance reaction against planthoppers during second year of testing. IC 578133 and COGR 2 were found promising for gall midge. Three entries viz., CR3006-8-5, RP 4918-228(S) and JGL 19618 were found promising for multiple pest resistance.
- Evaluation of gene differentials against seven identified biotypes of gall midge revealed W1263, ARC6605, Aganni and INRC3021 as promising while in case of planthoppers, among the 16 differentials tested , T 12 (ACC 56989), RP 2068-18-3-5, Rathu Heenati and PTB 33 were promising with a damage score ≤5.
- Insecticide evaluation trial carried at 34 locations revealed that flubendiamide+ buprofezin treatment @ 35+175 g a.i./ha was effective against stem borer and leaf folder, while dinotefuran @ 40 g a.i./ha followed by imidacloprid+ ethiprole @ 50 g a.i./ha were effective against planthoppers and leafhoppers. Results in Pesticide compatibility trial showed that there was no adverse impact on the efficacy of either dinotefuran @ 40 g a.i./ha or rynaxypyr 30 g a.i./ha when applied with either carbendazim+ mancozeb or validamycin, as tank mix in the field.
- Effect of Planting Dates on insect Pest incidence (EPDP) trial revealed that white ear damage was high in early planting as well as late planting. Gall midge damage was found high at Sakoli during normal as well as late planting. Planthoppers incidence was found high only at Gangavathi in normal planting. Insect Pest Incidence in Selective Mechanization for Enhancing Productivity and Profitability of Rice Cultivation Trial (PISMT), showed that at Gangavathi, significantly low population of planthoppers was recorded in plots planted with drum seeder method.
- Monitoring of Pest species and Natural Enemies (MPNE) revealed the presence of five species of stem borer distributed over 16 locations with yellow stem borer (YSB) being dominant in 14 locations. Among the parasitoids, *Tetrastichus schoenobii* was the dominant egg parasitoid. Ecological Engineering for planthopper Management (EEPM) trial carried out at 6 locations indicated that a combination of one or more interventions such as growing of flowering plants on bunds, organic manuring, alleyways, spacing and water management increased natural enemy numbers and egg parasitisation of hoppers in EE plots as compared to farmers practice.
- Yield Loss Estimation Trial (YLET) revealed that every 10% increase in white ears due to stem borer resulted in 1.02 g reduction in grain yield.
- Integrated Pest Management special (IPMs) trial conducted in farmers' fields through participatory approach revealed that location specific IPM interventions resulted in higher yields and favourable benefit cost ratios.
- Light trap data received from 29 centres revealed yellow stem borer and planthoppers as most widespread pests.

Plant Pathology

- Of 2021 entries in five different screening nurseries, the number of promising entries were 83 for leaf blast, 72 for neck blast, 43 for sheath blight, 45 for brown spot, 30 for sheath rot, 64 for bacterial blight and 27 for rice tungro virus.
- Monitoring of field virulences of blast and bacterial blight pathogen revealed that there was minor shift in virulence of blast pathogen at Gaghraghat, Mugad, Karjat, Imphal, Almora Hazaribagh and bacterial blight pathogen at Aduthurai, Maruteru, Navsari and Raipur.
- The data of disease observation nursery revealed that delayed sowing/planting increased the incidence of leaf blast, neck blast, brown spot, sheath rot, false smut and bacterial leaf blight
- The combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) was found significantly effective @ 1g/l against neck blast, node blast, sheath blight, brown spot, glume discolouration and leaf scald.
- The combination product i.e. Merger (tricyclazole

18%+ mancozeb 62% WP) 2.5 g/l was found effective against sheath rot.

- The data on special IPM trial indicated that adoption of IPM practices reduced the progress of disease severity of leaf blast, neck blast, sheath blight, sheath rot, brown spot and bacterial leaf blight compared to farmers' practices.
- The trial on false smut screening revealed that with some exceptions, it appears that as from north to south direction, delay in sowing/ planting results in comparatively higher disease incidence. Among the hybrids tested, KRH 2 is highly susceptible across the locations followed by US 312 and PA 6444. Among the varieties, Co43, MTU 1075 and BPT 5204 were susceptible across the locations.
- Production oriented survey was conducted in 18 states of India during 2014. The diseases like neck blast and false smut have spread throughout the country in the last few years. Bakanae has become a major problem in Punjab and Haryana especially on Basmati varieties. Increasing incidences of bacterial leaf streak was recorded from Assam and Tamil Nadu. Similarly, there was moderate incidence of root weevil in Haryana and moderate to severe incidence of black bug in Kerala.

Transfer of Technology

- A cafeteria of rice technologies were demonstrated in 459 hectare area covering 17 states and four major rice ecosystems of the country.
- Out of 431 FLDs reported, 66% were conducted in irrigated rice ecosystem; and 11% in rainfed uplands. 16% of FLDs were organized in shallow lowlands and 3% in hill ecologies. 4% of the FLDs were conducted in problem soils. In majority of the cases, the yield advantages recorded by the FLD technologies were significant.

Lead Research

Crop Improvement

Plant Breeding

- IET 23420 (RP5333-41-2-3-IR83383-B-B) with 85 days of flowering duration and yield advantage of 22.7, 45.7 and 18.39% over Sahbhagidhan, regional and local checks, identified for release in the states of Bihar, Madhya Pradesh and Maharashtra.
- IET 23832 (RP5886-HP3-IR80463-B39-3) with 102 days flowering duration with 13.1 % yield advantage over IR64, 19.5ppm Zn and 3.85ppm Fe content in polished rice was identified for release in the states of Tamil Nadu, Karnataka and Andhra Pradesh as high zinc line.
- Rice plants were redesigned with high number of grains per panicle, moderate tillers, robust plant and high yield potential.
- The QTLs *qKSM*$_{1.1,}$ *qNa/KSH* $_{1.1}$ and *qSSISFH*$_{8.1}$ for salinity tolerance at reproductive and grain filling stage were validated in background of Samba Mahsuri
- Samba Mahsuri was improved with the QTLs *qSub1+qDty2.1+ qDty3.1* for submergence and drought tolerance.
- About 215 single plant selections were made at F_5 generation for boro areas with cold tolerance at seedling stage and heat tolerance at grain filling.
- The genotypes *viz.,* Vikas, Swarna, NDR 359, IR83140-B-11-B, IR83142-B-57-B, D4098, Wanxian 7777, HHZ 5-SAL10-DT1-DT1, IR83140-B-36-B, Luyin 46 and RTS 14 identified as low P tolerant.
- Nine hundred and sixty five single plant selections were made from 1500 F_5 progenies of 10 crosses evaluated as two-rows progenies under suboptimal level of soil phosphorus.
- IET 24332 (RP 5445-102-23-3-2) from the cross RP bio 226/CR 15 MR 1523 and IET 24395 (RP 5865-300-4-1-1-1-2-3) from cross MTU 1075/MTU 1010 showed more than 5% yield advantage over the best check and promoted to advanced trial.
- IET 24620 (RP 4926-215-175-90-60-45-19), IET 24615 (RP 4926-341-128-101-31-13), IET 24617 (RP 4926-215-111-74-21-12) and IET 24625 (RP 4926-401-86-72-50-28) developed from Swarna/RAU 3041, were promoted to second year of testing in AVT1 ASG of AICRIP trial based on their yield superiority over best checks on overall and regional means.
- Selections from crosses RP 5237 (Vasumati/IET

18004), RP 5238 (Vasumati/IET 19492) and RP 5268 (Pusa 1121/IET 18990) in F_5 generation were found promising for high kernel length of more than 20mm.

- Amylose and amylopectin analysis was performed at single grain level using wet laboratory method for the first time. Presence of chalky area affects the proportion of amylopectin but not amylose. Amylose content varied with environment indicating the need to cultivate and collect the material for quality analysis where the entry is supposed to be released.
- Based on three years of testing for sheath blight disease, six genotypes *viz.*, SM 801, Ngnololasha, Wazuhophek, Gumdhan and Phougak and RP 2068-18-3-5 have been identified as tolerant donor for sheath blight.
- On feeding of iron fortified rice among 22 anemic girls, the haemoglobin level was increased from 9.19 g/dL to 10.67 g/dL.

Hybrid Rice

- DRRH-85 has successfully completed three years of testing in AICRIP trials (IHRT-MS). It is a higher yielding hybrid with MS grain type having BPT 5204 type grain quality and medium duration suitable for cultivation in Tamil Nadu, Maharashtra and Madhya Pradesh.
- Twenty seven promising genotypes were identified and fifty crosses were affected among the promising lines.
- Of the 300 test crosses evaluated, 25 promising test crosses were identified for further evaluation.
- Five new restorer lines *viz.*, AR19-42, AR19-18, AR7-65, AR7-75 and AR19-21 were developed by pedigree method utilizing KMR-3R restorer line with MTU1010 and Shabhagidhan.
- The improved restorer RP 5933-1-19-R-2 derived from the cross Swarna X IBL57 with the yield potential of 6.5 t/ha with short bold grain and 50% flowering of 105 days which performed well under SRI.

Biotechnology

- In order to identify the genes associated with grain filling in rice (*Oryza sativa* L.), 24 rice genotypes were used for expression analysis of sucrose transporter gene *OsSUT1-2*. Increased expression of *OsSUT1-2* (>4 fold) was observed in >85% grain filling in spikelets on primary and secondary branches of upper portion and primary branches of lower portion of the panicle, suggesting important role of this gene in grain filling.
- In a study to identify Single Nucleotide Polymorphism (SNP) haplotypes in starch synthesizing genes, ten genes involved in starch biosynthesis pathway and candidate gene of qGT-6 (large effect QTL identified for Gelatinization Temperature) were selected. KASP (Kompetitive Allele Specific PCR) SNP assays were designed and standardized for these genes.
- To understand the grain yield heterosis, a set of nine and six hybrids possessing positive and negative standard heterosis for grain yield and per day productivity, respectively were identified based on test crosses. A total of 10 EST-SSR markers, four SSR markers targeting $(GATA)_n$ motifs and 12 hypervariable genomic SSR markers showed association with grain yield heterosis.
- WA352/ORF126 was identified as putative candidate for the trait of WA-CMS. A co-dominant functional marker targeting a 20-bp deletion in WA352/ORF126 was developed and validated in a set of WA-CMS and maintainer lines.
- Promising transgenic lines of IR 64 possessing Cry1AC (Bt) and BPT 5204 possessing DREB1A are ready for biosafety trials.
- RNA interference (RNAi) strategy was adopted to attain tungro virus resistance. Molecular and phenotypic characterization of primary transgenic lines developed using RNAi-RTSV coat protein construct was done. Southern positive transgenic lines showed high level of tungro virus resistance.

Crop Production

Agronomy

- Agronomic efficiency of the nutrients applied was higher in SRI method and conjunctive use of the fertilisers (organic and inorganic) was promising.
- Saturation of soil and alternate wetting and

drying method of irrigation was found promising for both the methods (SRI and NTP). The total amount of water saved per ha is to the tune of 2605 m^3. The percent water saving was higher in SRI (32%) over NTP (28%).

- Root anatomy studies indicated lesser formation of aerenchyma in SRI than NTP
- The study of seed priming on performance of aerobic rice showed that seed priming can enhance the seedling vigor and seedling growth which in-turn improves the weed suppressing ability of rice, and consequently reducing the risks of poor stand establishment and crop losses due to weeds.
- Results of Integrated nutrient management in aerobic rice showed that a fertilizer schedule of 75% RDN/ha, 75% RDP and 100% RDK along with Azospirillum+PSB application @ 5 kg/ha each, to be the best schedule with saving of 25% of N and P.
- Among the 36 rice genotypes, IR83142-B-57B, SAGC-05, Huanghuazhan, YJ 20, P-35, HUA564, HUA565, Huanghuuazhan, Zhunghuai, Weed Tolerant Rice1, Luyin46 and D4098 exhibited best performance for second season under aerobic field conditions.

Soil Science

- The genotypes Rasa and Ravi from early; DRRH88, DRRH 85 and RP-Bio-4919-363-5 from medium and Swarnadhan and SACG 4 (GSR) from long duration group were most promising and ranked top for both soil and applied N utilization and responsiveness based on the several NUE indices.
- Field studies on the impact of three nitrification inhibitors on nitrous oxide recorded the highest inhibition of total N2O emission (45%) from plots treated with urea + Dicyandiamide (DCD) followed by Neem Coated Urea (NCU) (27%) and Karanjin + urea (20%).
- Soil health kit was validated for different soils. The conditions and methods of assay are being remodeled based on feedbacks. Soil health cards were being issued based on tested parameters for several stakeholders using soil health kit.
- Exopolysaccharide fructan produced by *Gluconacetobacter diazotrophicus* possesses antioxidant capabilities useful for scavenging hydrogen peroxide, hydroxyl radicals and the free radicals with the antioxidant potential increasing with increasing concentration (1%, 5% and 10%) of the exopolysaccharide.
- Seed priming with exopolysaccharide fructan increased both germination and vigour index of rice with 1% concentration resulting in better improvement in germination and vigour parameters. Seed priming was observed to reduce the electrolyte leakage from seedlings indicative of the membrane stabilizing potential of the fructan

Plant Physiology

- Seventeen (HR) mapping populations were developed and eight promising lines were identified. Five regions on chromosome 1, 3 and 5 for spikelet fertility were also identified along with 3 candidate genes.
- In NUE Experiments, 30 mapping populations were developed and 30 genomic regions were identified to be associated with NUE using association mapping.
- Twenty lines for Nitrogen use efficiency were found to promising and four candidate genes using expression analysis (WFA, NR, AT, PAL) were identified for NUE.
- The maximum rate of photosynthesis was recorded in tropical japonica group as (19.44 µ mol CO_2 $m^{-2}s^{-1}$) followed by popular varieties (18.51 µ mol CO_2 $m^{-2}s^{-1}$) and land races (18.40 µ mol CO_2 $m^{-2}s^{-1}$. Stomatal conductance (gs) differed significantly ($P<0.05$) amongst the genotypes highest values of stomatal conductance was recorded in the popular varieties like IR 64 as (0.56 mol [H_2O] $m^{-2}s^{-1}$), followed by MTU 1001 as (0.54 mol [H_2O] $m^{-2}s^{-1}$) and in Krishna Hamsa as (0.53 mol [H_2O] $m^{-2}s^{-1}$). These entries are statistically at par with each other.
- In indica land races and germplasm lines, the grain quality traits were desirable with slender long grains and show relative tolerance to major biotic stresses, while the tropical japonica lines despite their high yielding capacity and other desirable traits, they are found to be susceptible

to biotic stresses. Data collected on various physiological attributes reveal that the rate of photosynthesis was higher in tropical japonica lines and new generation hybrids

Crop Protection

Entomology

- Out of 1600 entries evaluated for their reaction against planthoppers, two entries were resistant and 33 were moderately resistant to WBPH. Against BPH, six entries were resistant while 18 entries were found moderately resistant. Two entries were resistant to both BPH and WBPH.
- Single plant selections of RP5588 and RP5587 evaluated for yellow stem borer damage revealed high dead heart damage but low white ear damage suggesting that recovery resistance could be one of the mechanisms for stem borer tolerance. Against gall midge, five entries were confirmed for their resistance to gall midge biotype 1.
- Field phenotyping of 204 RILs of TN1/ W1263 for confirmation of reaction to rice leaf folder, revealed that the frequency of leaf area damaged was observed to be a normally distributed curve with values between 98 and 1560 mm. The leaf area fed on TN 1 was double the area fed on W 1263. Data on leaf width indicated a normal distribution with minimum value of 1.0 cm in W1263 and maximum value of 1.5 cm in TN1.
- A field trial on evaluation of bioefficacy of newer insecticides showed that BCS CL 73507 SC 200 @ 60 g a.i. /ha showed significantly low white ear incidence and highest yield compared to recommended bifenthrin and rynaxypyr treatments.
- Egg parasitisation of hoppers was significantly higher in ecological engineering plots with a border of Gaillardia. Keplan Meyer survival analysis of the parasitoid *Gonatocerus* sp. when offered food revealed significant impact on the longevity of the parasitoid.
- Field evaluation of essential oils against major insect pests of rice revealed that oregano, citronella, and lemongrass oils at 5% are moderately effective against yellow stem borer at vegetative stage while, lavender, oregano and cedar wood oils were effective at reproductive stage.
- Laboratory evaluation of response to yellow stem borer (YSB) female moths against essential oils using EAG showed strong repellency to eucalyptus and rosemary oils.
- Electroantennogram (EAG) studies carried out to measure the neurophysiological responses of pink stem borer to 20 synthetic green leaf volatiles revealed a higher response for (Z)-3-hexen-1-ol (-1.31mV) followed by linalool (-0.43mV), indicating that these compounds could play an important role in locating the host-plant.
- Among the three entomopathogenic nematodes evaluated for their biological control, maximum reduction of BPH was observed with *Steinernema glaseri* followed by *Metarhabditis amsactae* isolate Drr-Ma2. DNA sequence of *M. amsactae* isolates Drr-Ma1 & Drr-Ma2 showed 98% similarity with the DNA sequence of ITS regions of *Metarhabditis amsactae*.
- Total nematode abundance was more in SRI compared to the normal transplanted system. However, relative abundance of plant parasitic nematodes in SRI plots was lower than that of the normal transplanted system.

Plant Pathology

- Seven thousand nine hundred and twenty seven lines were screened under artificial inoculation in uniform blast nursery. Fifteen hundred twenty two were resistant. The blast resistant genes like *Pi1*, *Pi2* and *Pi54* were introgressed into elite cultivar Samba Mahsuri
- Pyramiding of *Xa21* and *Xa38* in background of Samba Mahsuri and APMS6B is being carried out and lines are at BC_4F_1 (Samba Mahsuri) and BC_3F_1 (APMS6B).
- At Nalgonda district of Telangana and Ramanathapuram district of Tamil Nadu, false smut disease was recorded between 12% to 45% with maximum of 48 (number) smut balls per panicle during December 2014 and January 2015 respectively.
- Artificial inoculation of *U. virens* during early stage of booting produced maximum no. of smut ball under glass house condition.

- Genotyping and phenotyping of 392 *Xoo* strains have been completed and they have been categorized into 22 pathotypes
- Isolated 21 strains of bacterial leaf streak pathogen from Tamil Nadu, AP and Assam and confirmed them using multiplex (4 markers system) PCR.
- The combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) 1.0g/l effectively reduced the blast.
- Out of 1919 entries screened, 203 entries found to be resistant to tungro.
- Out of twenty weed host species belonging to *Graminaceae* and *Cyperaceae* evaluated for off-season survival of tungro, weed hosts *viz.*, *Paspalumdilatum* and *Paspalum hydrophilum* expressed typical symptoms of the rice tungro disease.

Transfer of Technology

- The study on sustainable rice production practices in Boro areas revealed that there are no rice varieties ideally suited to boro growing ecologies. Diversity in growing situations and farmers' needs warrant the development of need-based and ecology-specific Boro rice varieties.
- Farmers reported the advantages of DSR as reduced labour for planting, reduced time and energy for tillage and reduction in use of irrigation water. Farm women reported that they were relieved from the drudgery of transplanting in bent positions in wet puddle fields and were happy to carry out only weeding in DSR fields. A matrix ranking activity was undertaken to analyse the drudgery perceived by farm women in the rice cultivation activities. Transplanting was ranked as most drudgery prone followed by carrying head load, harvesting and weeding.
- RiceCheck was piloted in Odisha (Puri and Koraput), Telangana (Nalgonda), Tamil Nadu (Tiruvayur). In Telangana, the per cent respondents receiving information from different ICT tools in all categories was found to be higher compared to that of Odisha. In both these provinces, impact of knowledge interventions was found to be significant when blended with field demonstrations.
- There is a significant correlation between the extension professionals and farmers about the perceived and actual benefits accrued by the ICTs.
- A SWOT analysis of hybrid rice seed production technology revealed that the major weakness were less price being offered by the companies, lack of legal safe guard mechanism and drudgery in additional operations like rouging and supplementary pollination.
- The cases of Farmers Producer Organisations of Tamil Nadu is being documented and majority of farmers are aware of various partnership activities including contract farming processes and were willing to form groups for seed production, enter contract farming with written agreement.
- The preliminary observations on IPR competitive interactions indicate that the private sector participation in rice seed research is increasing compared to public sector.

Introduction

Genesis

Mandate

Organization

Infrastructure

Budget Allocation

Significant Achievements

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.

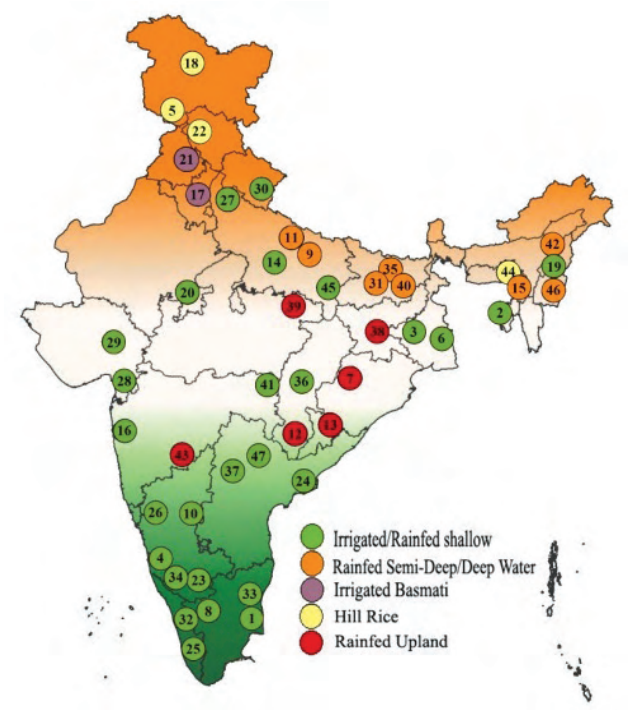
In 1965, AICRIP was started with 22 centers (19 main and 3 testing centers) with 7 zonal centers and 12 regional centers. During fifth five year plan (1974-79) the main and sub centers were classified single cropped (24) and double cropped (21) centers. Excepting Pondicherry and Varanasi which were fully funded by the ICAR, the rest of the centers were financed on a 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 centers were sanctioned raising the total to 53. There were a total of 61 centres including 8 subject related special centers. In the VII plan period (1985-89) the number of centers was reduced to 50 (18 main and 32 sub centers. During the eighth plan (1992-97) there were 51 approved centers of which six centres were withdrawn and and Karnal centre was merged with Kaul in the IX plan period (1997-2002). The total number of centers during X plan (2002-2007) increased to 46 with the approval of Kanpur and Nagina centers and to 47 during XI plan (2007-2012) with addition of Navsari in southern Gujarat in western India. The Directorate has evolved into an efficient and successful program of partnership in rice research bringing together more than 300 rice researchers from 47 funded and over 100 voluntary research centers. In the 12th plan, Indian Council of Agricultural Research (ICAR) has upgraded the DRR to Indian Institute of Rice Research (IIRR).

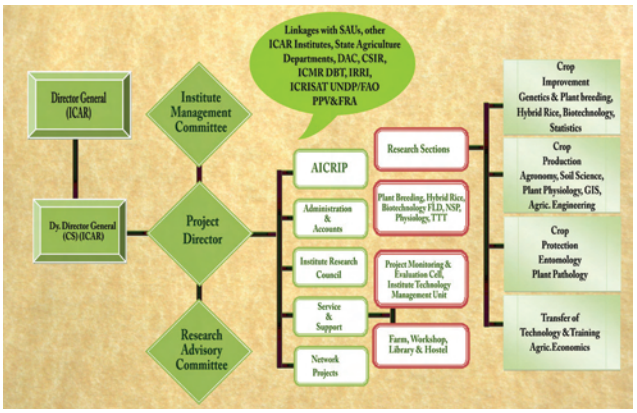
The Mandate

- To organize, coordinate and monitor multi-location testing at national level to identify appropriate varietal and management technologies for all the rice ecosystems.
- To conduct basic, strategic, applied and anticipatory research in the major thrust areas of irrigated rice aimed at enhancement of production, productivity and profitability while preserving environmental quality.
- To initiate, organize, coordinate and monitor research networks relating to problems of national and regional importance.
- To serve as major centre for exchange of research material and information.
- To accelerate the pace of technology transfer through development and adoption of innovative extension training models, self learning modules, organizing formal training courses, frontline demonstrations, exhibitions, farmers' day etc.
- To develop linkages with national, international and private organizations for collaborative research programmes.
- To provide consultancy services and undertake contractual research.

The Organisation

DRR is an important constituent institute of ICAR under direct supervision of the Deputy Director General for Crop Sciences. The detailed organizational setup of the Directorate is provided in its organogram. For fulfilling its mandate effectively, DRR 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 47 funded (see figure & appendix 6) and more than 105 voluntary centers 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).

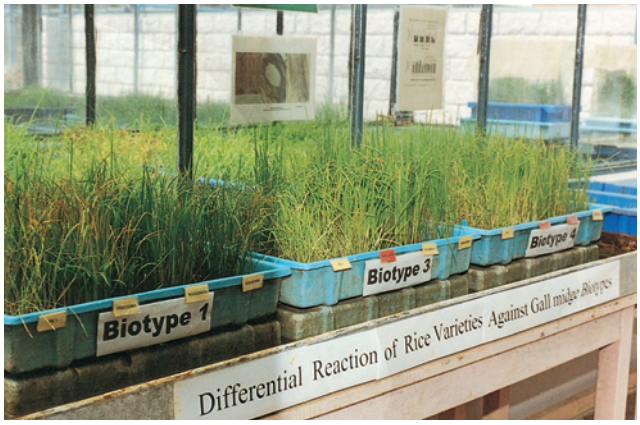




Infrastructure

The Institute is equipped with state of the art facilities with fully equipped laboratories for all the sections, centrally air cooled greenhouses for screening germplasm for resistance against pests and diseases, net-houses, growth chambers, screening nursery beds, containment transgenic poly-houses and heat tunnels. Field facilities include a 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, godowns and limited cold storage facilities.

A centrally air conditioned auditorium with 350 seating capacity, seminar halls, guest house, hostel facilities and a canteen for imparting training and to disseminate information using latest multi-media and ICT tools. The Central library of the institute is a 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.



The Staff

Cadre	Sanctioned	Filled	Vacant
Scientific	71	54	17
Technical	53	40	13
Administrative	32	28	4
Supporting	17	15	2
Total	173	137	36

Statement Showing the Budget Allocation during VI to XI Plan Periods *(Rupees in lakhs)*

Item	VI Plan	VII Plan	VIII Plan	IX Plan	X Plan	XI Plan
IIRR(DRR) Head Qtr.	120.20	200.00	614.19	1247.66	1144.76	1938.00
AICRIP Centres	239.85	346.90	141.10	1762.13	3163.69	4995.00
TOTAL	360.05	365.90	1755.29	3009.79	4206.45	6933.00

Research Achievements

Several distinct technological innovations have been made in terms of new varieties and technologies developed by the AICRIP since the release of the first rice variety Jaya in 1968. Till date 24,900 elite lines developed by different cooperating centres were tested in multi-location trials across the country under the umbrella of All India Coordinated Rice Improvement Programme (AICRIP) at funded, voluntary centres and in partnership with private sector for hybrid rice. AICRIP was instrumental in testing and release of 1088 varieties including 72 hybrids till 2014. Among these 130 varieties and 44 hybrids were released through Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCS & NRV) while the State Variety Release Committees released 886 varieties and 28 hybrids. Of these varieties, 503 are for irrigated areas, 133 for rainfed uplands, 194 for rainfed low lands, 44 for semi deep and 18 for deep water situation, 51 for high altitudes, 42 for saline and alkaline areas, 10 for aerobic, 19 for boro and 74 aromatic long and short grain varieties were released. Having realized the scope and potential of quality rices for export, special thrust was given for genetic enhancement of quality rices in the country which lead to the release of 30 export quality basmati and short grain rice varieties. Many of these varieties posses tolerance / resistance to major pest and diseases.

Rigorous screening of advanced breeding lines through National Screening Nurseries *viz.*, NSN-1, NSN-2, NSN for hills and National hybrid Screening Nursery (NHSN), under both artificial and natural pest infestation regimes at hot spot locations under AICRIP has led to release of varieties resistant to major insect pests. In the last decade, about 180 entries have been identified as promising donors for resistance to multiple insect pests and more than 80 multiple disease resistant lines.

The Breeder Seed Production (BSP) activity in rice began with 66 varieties in 1995 and the number of varieties has steadily increased to 234 by 2012 while the production of breeder seed rose from 1332 quintals in 1995 to 7770 quintals in 2014, which is more than fivefold increase of pure seed to be converted to foundation and certified seed. The notable achievements of 50 golden years of rice research are enlisted below:

- ✧ The first MAS derived product "Improved Samba Mahsuri" was developed by DRR which possesses 3 BB resistant genes *xa*5, *xa*13, X*a*21 conferring resistance which is going to have an immense impact in the years to come. The area under this variety has gone up to 90,000 hectares.
- ✧ Development of first medium slender hybrid "DRRH3" which is similar to Samba Mahsuri with 25-30% higher yield has already proven its merit by being most sought after hybrid.
- ✧ IIRR has been recognized as one of the best DUS centers for maintaining a large reference collection of 629 varieties and for promotion of registration of rice varieties at the Foundation Day Programme of PPV&FRA, New Delhi on 11.11.2010.
- ✧ On IIRR initiative, 71 extant, notified varieties of rice were IPR enabled with PPV&FRA granting registration certificates.
- ✧ A DNA based rapid and reliable assay for

assessment of purity of seed-lots of rice hybrids and CMS lines was developed which is cost effective and time saving.

- Molecular markers for the major fer tility restorer genes *Rf3* and *Rf4* heve been developed and used in hybrid rice programme and for targeted improvement of elite restorer and maintainer lines for disease resistance.
- Identified superior alleles of blast resistance genes *Pi54, Pita and Pib* from germplasm collections which widened the spectrum of resistance and helped to establish suitable gene deployment strategies.
- Novel resistant genes *Xa33* (for BB), *Gm3 & Gm8* (for gall midge) are fine mapped.
- Functional markers have been developed for major blast resistance gene *Pi54* and the major QTL controlling grain length, *Gs3*, for aroma (*BADEX 7-5*).
- High Zn lines: IETs 23825, 22624, 23830, 23824, 23833, 23834, 23831, 23829, 23832.
- Important genes associated with insect metabolism have been identified from yellow stem borer. Presently, RNAi based strategy is being designed targeting these key genes for effective resistance in rice.
- Several candidate genes associated with yield, quality and nutrition have been identified and the outcome of transgenic research is visible with 3Bt transgenic rice events with *Cry1A* showing resistance to stem borer and 3 independent events with *DREB1A* gene in Samba Mahsuri background shor tlisted for Bio-Safety Research Level (BRL-1) testing.
- DRR has developed a rapid and reliable assay for assessment of purity of seed-lots of rice hybrids and CMS lines. The DNA marker-based assay is cost effective (saves 30-50% of cost) as the whole assay can be completed within a time period of 1-2 days as compared to the conventional morphology based Grow-out test which takes a full growing season and involves lot of cost in terms of seed-storage.
- Direct seeding of rice (DSR) is considered as one of the potential alternatives to transplanted rice to overcome problems regarding water and labour.
- Adoption of SRI at proper locations with suitable genotypes has a scope for area increase, enormous saving on seed and 36% saving on water, additional yield of 1.0 to 1.5 t/ha which will add 4-6 million tonnes to our food basket.
- Modification of leaf colour chart (LCC) by IIRR under SSNM and distribution of 2-3 lakhs of LCC to farming community has significantly reduced N application and recorded 5-16% higher yields over RDF.

- Suitable package for aerobic rice system which reduced the water requirement by 30-40% over continuous flooding was developed and several suitable rice-based cropping systems (RBCS) and organic farming for sustaining rice productivity were recommended.
- Seed priming by soaking paddy seed in water and shade drying for 2 1/2 to 3 hours, and repeating the cycle for 5-6 times before sowing improve germination, seedling vigor and establishment in direct sown rice.
- Application of Sulphur 30-45 kg/ha to *kharif* rice in deficient soils for rice-blackgram; Application of Sulphur 30 kg/ha to *kharif* rice and 30 kg/ha to rabi sunflower in rice-sunflower cropping systems is recommended for higher productivity, rice equivalent yields and economic returns.
- Regular supply of Zinc sulphate @ 50 kg/ha once in 3 seasons for normal soils and 100 kg initially for sodic soils is recommended for sustaining rice production in intensively cultivated rice soils.

- An efficient 8 row drum seeder has been designed and developed. the drum seeder technique not only saves on cost of labour but also enhances yield.
- Organic farming systems requires 4-8 crop cycles to stabilize productivity and improvement of physical, fer tility and biological proper ties of soil.
- A number of donors like Velluthacheera, Banglei, Aganni, ADR 52, Pandi, Chennellu etc. with proven multiple resistance to gall midge, BPH and WBPH have been identified. Utilizing these donors, multiple resistant varieties were developed.
- Studies on variation in insect pest population have identified seven distinct gall midge populations in the country while no variation in BPH population was noted.
- Effective insecticides identified are granular formulations of carbofuran, phorate, diazinon, mephospholan, quinalphos, MIPC, chlorantriniprole and spray formulations of phosalone, chlorpyriphos, monocrotophos, carbosulfan, carbaryl, ethofenprox, car tap hydrochloride, fipronil, imidacloprid, buprofezin and pymetrozyne.
- Pheromone mediated monitoring (8 traps with 5 mg impregnated lures per hectare) as well as mass trapping (20 traps per hectare) of yellow stem borer was developed as a practical, cost effective and environmental friendly option for the farmers.
- Planting of one row of Pusa Basmati 1 (PB1), an aromatic cultivar highly susceptible to yellow stem borer, for every 9 rows of any main crop reduced stem borer damage considerably giving additional income from PB1 crop.
- Utilizing some of the resistant donors, several disease resistant varieties have been developed like Swarnadhan, Rasi, Sasyasree, Kasturi, VLK Dhan 39, Himalaya, Sujatha, Co43 for blast, Nidhi, Vikramarya for rice tungro virus.
- A national facility of AICRIP MIS was developed and successfully hosted at the URL http://www.aicrip-intranet. in and links are available with IIRR.
- New products like Rice Riche Pain Relieving Gel, Rice Riche Moisturizing Lotion, Rice Riche Cream for Dry and Cracked heel and Rice based face scrub which keeps skin smooth, soft and moist are developed.
- Transfer of rice production technology is being successfully carried out through Transfer of technology and training (TTT) centre of IIRR by organizing as many as 242 training programmes during the last 25 years catering to the farmers and extension functionaries.
- DRR coordinates the Rice frontline demonstration which is organized every year all over the country demonstrating suitable elite cultivars and appropriate crop management technologies in farmers' fields in association with SAU's and state department of agriculture. Since 1990 to 2000, about 16404 FLDs of 1 acre each have been conducted benefitting rice 33100 farmers. From 2001-02 to 2013-14, about 12150 FLDs of 1 hectare each have been conducted benefitting 30200 rice farmers.
- Rice Knowledge Management Portal (www.rkmp.co.in) is the largest repository of knowledge on any single crop (rice) across the globe. With 16000 pages of knowledge, 18 platforms, more than 50 videos, 6000 minutes of audio, "user specific" platforms like Service domain, Data repository, Diagnostic tools, E-Learning platforms etc, this is one-stop solution for the rice related information.

Research Achievements-AICRIP

All India Coordinated Rice Improvement Project (AICRIP)

Crop Improvement

New Varieties and Hybrids released.

Fifty one varieties and three hybrids were released during 2014-15 by Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCCSN & RV) and State Varietal release Committee (SVRC). Central Sub Committee on Crop Standards, Notification and Release of Varieties released 11 varieties and two hybrids (HRI 174 and HRI 178). The State Varietal Release Committees released one hydrid, CR Dhan 701 and 40 varieties for Bihar (1), Chhattisgarh (5), Karnataka (1), Punjab (1), Odisha (9), Tamil Nadu (3), Tripura (9), Uttar Pradesh (7), and West Bengal (4). These high yielding varieties (HVYs) were released for cultivation in different ecology *viz.*, upland, irrigated, aerobic, basmati areas, shallow low land, aromatic short grain, semi deep and deep water, saline and alkaline. Many of these varieties are resistant/moderately resistant to biotic stresses.


DRR Dhan 43

Varieties released by Central and State variety release committee during 2014-15

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco system	Grain type	Yield (kg/ha)	Reaction to pests/diseases
Central releases									
1	RNR 2354	21260	RNR 2354	RNR-M7/ RNR 19994	105	ASG	SS	6750	MR- Bl.
2	Pusa 1592	22289	Pusa 1592-06-5-2	Pusa Sugandh 5*2 / Pusa 1460	97	Bas	ELS	4730	R-BLB
3	Dhiren	20760	BNKR-1	IR 42/Patnai 23	112	SLW	SB	5250	MR- LBl, NBl, BS, ShR, LF
4	DRR Dhan 42 (IR 64 *Drt 1*)	22836	RP 5208-3 -IR 87707-445-B-B-B	Aday Sel/*3 IR 64	88	IRME	LS	4098	MR-LBl.
5	Indira Aerobic -1	21686	R 1570-2649-1-1546-1	Swarna/ IR 42253	88	Aerob	MS	4250	R-NBl,. ShR, MR-LBl, ShBl, BS, RTD
6	DRR Dhan 44	22081	RP 5127-9-3-IR93376-B-B-130	IR 71700-247-1-1-2/ IR03L120	88	IRE	LS	4903	MR-Bl, ShR, BS, NBl, BPH, SB, LF
7	DRR Dhan 43	22080	RP 5124-11-6-2-IR 83876-B-F_3 Bulk	IR03L03/ IRRI148	88	IRE	LB	6001	R-Bl, MR-BB, NBl, BS, ShR, BLB, BPH, WBPH.
8	PR 124	22767	PAU 3832-79-4-3-1	PR 116// PAU 3075/ PR 106-P3	105	IRE	LS	7609	R-BLB
9	Pant Dhan 24	22096	UPR 3425-11-1-1	Mahamaya/ Gayabyeo	101	IRME	LS	5453	MR-BS, LBl, ShR, GMB1, SB

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco system	Grain type	Yield (kg/ ha)	Reaction to pests/diseases
10	Ajit	22066	C1446-5-18-17-2-MLD 2	CN 540 / IR 50	79	IRE	MS	5032	
11	DRR Dhan 41	22729	RP5311(PR 26703-3B-PJ7)	Nekken1 / BPIRI 10	91	AEROB	LS	3225	T-Nematode, GLH,LF
State Releases									
Bihar									
12	Sabour Shree	18878	RAU 724-48-33	Haryana Basmati/ Mahsuri	108	IRM	MS	6000	
Chhattisgarh									
13	Tarunbhog selection 1	17559	Tested in AICRIP trial as Tarunbhog	Pure line selection	118	IR	SB	4076	MR-Bl
14	Vishnubhog selection-1	-	Vishnubhog	Pure line selection	116	IR	SB	4224	-
15	Badshahbhog Selection-1	17563	Tested in AICRIP trial as Badshahbhog	Pure line selection	105	IR	MS	2933	MR-BS, ShR
16	Chhattisgarh Zinc Rice 1 (CGZR 1)	23824	R- RHZ-2 (R 1033-968-2-1)	Poornima / Annada (Pedigree selection)	85	RUP /IRME/ Aerobic	LB	3787	MR-LBl, NBl, ShBl
17	Dubraj selection 1	-	Used as a check variety in AICRIP trials as Dubraj	Pure line selection	116	IR	MS	3723	MR- LBl, ShR, BLB
Karnataka									
18	Gangavati Sona	20594	GGV-05-01	Selection from MTU 1076	105	IRM	MS	6500	MR-BPH, NBl,
Punjab									
19	PR 123	23774	PAU 3842-59-7-1-1	PR116///PR108/ IRRI76//PR106 P2	113	IRME	LS	7333	-
Odisha									
20	CR Dhan 101 (Ankit)	21627	CR 2702	IR78875/ IR 78877	80	RUP	MS	3980	MR- LBl, NBl, ShBl, BS, SB, LF, GLH
21	CR Dhan 203 (Sachala)	21920	CR2717-10-IR84899-B-185	IR 78877/ IRRI 132	80	Aerob	LS	4050	MR- LBl, ShR, BS, SB, LF
22	CR Dhan 206 (Gopinath)	22731	CR2996-1-14-29-3-1	Brahmanakhi/ NDR 9930077	85	Aerob	SB	3950	MR- LBl, ShR, BS, SB, LF
23	CR Dhan 307 (Madhumani)	20925	CR2599	Dandi/ Naveen//Dandi	105	IRM	SB	4800	MR- LBl, ShR, BS, SB, LF

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco system	Grain type	Yield (kg/ ha)	Reaction to pests/diseases
24	CR Dhan 408 (Chakaakhi)	20265	CR491-1590-330-2-1	CR 149-5010-228/ T 1242	135	RSL	LB	4800	MR- LBl, NBl, BS, BLB.ShR, SB, LF, WBPH
25	CR Dhan 701 (Hybrid)	20852	CRHR32	CRMS 31A/ CRL-22 R	112	RSL	MS	6000	MR- BS, ShBl, RTD, GLH
26	Ashutosh	21341	OR 2331-14	OR 1301-32/ IR 52561	125	SDW	SB	3969	MR-NBl, ShBl,BS, LF
27	Gobinda	21009	OR 2324-8	OR 1206-26-2/IR 57313	103	IRM	MS	4005	MR-ShBl, BLB, GMB1
28	Hasanta	21477	OR 2328-5	OR 1206-26-2/OR 1534-129	120	RSL	SB	3911	MR-LF, WBPH
29	Gita	20878	OR 1734-1-1	Subhadra / NDR 1006	78	IRE	SB	3850	-
Tamil Nadu									
30	CR 1009 Sub 1	-	-	-	125	NIL RSL	SB	5759	MR- BS, Bl, BPH, WBPH
31	TKM 13	22565	TM 07275	WGL 32100/ Swarna	100	IRME	MS	5938	MR- LF, SB, Bl, GLH, RTD, BS, ShR.
32	MDU 6	23994	ACM 01010	MDU 5/ ACM 96136	83	IRE	LS	6118	MR-LF, SB, GLH, WBPH.
Tripura									
33	Tripura Khara Dhan 1	22837	RP 5208-4-IR 87707-446-B-B-B	Aday Sel/*3 IR 64	88	IRE	LS	5224	R -BL, Mr-BLB
34	Tripura Khara Dhan 2	22835	RP 5208-2-IR 87707-182-B-B-B	Aday Sel/*3 IR 64	88	IRE	LS	5224	R -BL, Mr-BLB
35	Tripura Haku-chuk 1		TRC 2013-4 (IR 83928-B-B-56-4)	IR 78877-208-B-1-2/ IR 74371-54-1-1	68	RL	LS	5044	MR - BL, BLB, BS, ShR
36	Tripura Haku-chuk 2		TRC 2013-5(IR 82589-B-B-138-2)	IRRI 132/ IR 74371-54-1-1	66	RUP	LS	5450	MR - BL, BLB, BS, ShR
37	Tripura Aus Dhan	24732	TRC 2013-12 (IR 83928-B-B-42-4)	IR 78877-208-B-1-2/ IR 74371-54-1-1	65	IRE	LS	5714	MR - BL, BLB, BS, ShR
38	Tripura Jala Dhan-1	22167	TRC 2008-1	TRC 229-F-41/ Jaya	118	SDW	LS	4906	MR –BL,ShR
39	Tripura Chi-kan Dhan	22112	TRC 2008-4	C 53/ IR 28224-3-2-3-2	106	IRME	LS	6230	MR –BL,ShR
40	Tripura Sarat Dhan	22113	TRC 2008-5	IR 72870-120-1-2-2/ IR 72870-19-2-2-3	98	IRME	LS	5900	MR-BL,BS,ShR

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco system	Grain type	Yield (kg/ha)	Reaction to pests/diseases
41	Tripura Nirogi Dhan	22580	TRC 2008-6	IR 24594-204-1-2-3-2-6-2/ IR 28222-9-2-2-2-2	95	IRME	SB	6124	MR-BL,BS,FS
Uttar Pradesh									
42	Shiats Dhan-1	20928	AAIR 2	Selection from AAIR 1-03	100	IRM	MS	4287	MR- BL, BS, ShBl
43	Shiats Dhan-2	22576	AAIR 203	IR 73008-138-22-2-2/ IR 65610-24-3-6-3-2-3	105	IRME	LS	5065	MR- ShBl, BS,
44	Shiats Dhan-3	22522	AAIR 205	IR 02N 141/ IR 6805-7-1-2/IR 72890-81-3-2-2	108	IRM	LS	4834	MR- BS, ShBl
45	Shiats Dhan-4	23676	AAIR 208	IR 68068-99-1-3-3/IR 79903-121-21-2	102	IRM	MS	4126	MR- Bl, BS, BLB
46	Shiats Dhan-5	23723	AAIR101	IR 73008-2-2/IR 65610-10-24	93	IRME	LS	4934	MR- Bl, BS, BLB
47	Narendra Lahar	22203	NDR 370135	IR 68068-99-1-3-3-3/ Janak//IRRI 105	105	IRM	LS	5750	R- SB, LF, MR- Bl, ShBl, BLB.
48	Narendra Parag	21835	NDR 6330	Pure line selection from Vishnu Parag	118	ASG	SB	3750	MR- ShBl, BLB, Bl, LF, SB
West Bengal									
49	Rajdeep	17713	CN 1039-9	Sabita/ IR 57540-8	126	SDW	LB	5250	-
50	Gosaba 5	23403	Chinsurah Nona 1	IR 4630-22-2-5-1-3/Non-abokra	110	IRSA	SB	4200	-
51	Sampriti	21987	CN 1317-557-56-BNKR-42-2-3 (BKNR 3)	Vikramarya / Mahsuri	124	RSL	LB	4750	MR- LBl, , NBl, BS, ShR, ShBl, RTD, BLB, GLH
52	Dhruba	20761	CN 1340-76-1-BNKR 23-7-2 (BKNR 2)	IR 42 / Patnai 23	117	RSL	SB	5250	MR- LBl, NBl, BS, LF

Coordinated varietal testing

During 2014, 43 varietal trials, one screening nursery and six hybrid rice trials were conducted in 910 experiments at 120 locations (46 funded, 80 voluntary centers) in 27 states and two Union Territories in all the five regions of the country. Hybrid rice experiment was also conducted by 14 private seed companies. Fifty trials were constituted with 1085 entries including 182 checks and 132 experimental hybrids. In addition, 12 INGER nurseries involving 530 entries were tested at 60 centers. After three years of testing in AICRIP trials, three hybrids and 30 elite breeding lines from 21 centers were found promising for various ecosystem like direct seeded upland condition, transplanted irrigated condition, rainfed shallow lowland, semi deep and deep water, alkaline, inland and coastal salinity soils, upland hilly areas and aerobic situations. (Appendix 1) and the Promising hybrids identified based on overall mean yield advantage over the checks in hybrid trials are given in Appendix 2.

INGER Observational Nurseries

INGER nurseries are the important source of improved genetic resources developed in different countries for utilization in the breeding programme. During 2014, nine INGER Observational Nurseries with 530 elite rice lines were evaluated at 60 different locations. The superior lines were identified in different trials based on yield, resistance/tolerance to biotic stresses, maturity duration and overall phenotypic acceptability.

List of promising entries in different nurseries:

1. **International Irrigated Rice Observational Nurseries (IIRON)**

   Module-1:BP 10622F-BB8-15-BB8, BR 6902-14-4-2-5 and CT 18148-6-9-5-1-3-4-MMP,

   Module -2: CIHERANG, CT 19558- 2-44-5-4-M-1-M, IR 04A21 and IR 06A177

2. **International Rainfed Lowland Rice Observational Nursery (IRLON):** IR 09L226, IR 11L236, IR 12L178, IR 12L186 and IR 12L197

3. **International Upland Rice Observational Nursery (IURON):** IR 12L104, IR 12L110, IR 12L339, IR 12L342 and IR 12L346

4. **International Temperate Rice Observational Nursery (IRTON):** Dasanbyeo, IR 12K250, IR 12K269, IR 50 and IR10K150

5. **Green Super Rice (GSR): GSR-IRLL**: HHZ 10-DT7-Y1, HHZ 17-Y16-Y3-SAL1, HHZ 17-Y16-Y3-Y2, HHZ 25-DT9-Y1-Y1, GSR-RFLL and HHZ 12-Y4-Y1-DT1

6. **International Rice Soil Stress Tolerance Nurseries (IRSSTN):**

   Module 1-CSR-90IR-2, IR12T127, IR12T146 and IR12T198,

7. **International Rice Blast Nursery (IRBN**): IRBLZ5-CA[CO], IRBL 9-W/RL, B4069G-NG-12, HHZ 8-SAL6-SAL3-Y2, and IRRI 151

8. **International Rice Bacterial Blight Nursery (IRBBN):** IR-BB21, IR-BB51, IR-BB53, IR-BB58, IR-BB60, IR-BB65

9. **International Rice Brown Plant Hopper Nursery (IRBPHN**): IR 10F203, IR 10A155, TME80518, Pokkali and IR 10N269

National Seed Project and Breeder Seed Production

Breeder seed production (BSP) of 217 rice varieties and parental lines of 8 rice hybrids was organized at 43 centers across the country as per the DAC indents. A total production of 7757.42 quintals of breeder seed

was achieved against the target of 4328.42 quintals, thus marking 79% more than the indented quantity. At DRR center, 11 varieties and A,B and R lines of DRRH-3 were included in breeder seed production with a total production of 160.82 quintals against the target of 87.30 quintals (Appendix 3).

Crop Production

Agronomy

The Coordinated Agronomy Programme organized 274 experiments conducted at 55 locations during *rabi* and *kharif* seasons of 2014. Elite genotypes (65 AVT-2 cultures) belonging to 15 groups *viz.*, early hill (irrigated), medium hill (irrigated), upland hill (direct seeded), very early (direct seeded), early, mid early, medium, late, aromatic short grain, IHRT medium slender, inland saline and coastal saline in transplanted and aerobic (direct seeded), NILs and Deep Water situation were evaluated for their response to graded levels of nitrogen (NVT). In addition to these, eleven trials on cultural management, three on weed management and two trials on rice based cropping systems were also conducted. Among these trials, 3 trials were conducted in collaboration with Soil Science, Entomology, Pathology and Agricultural Engineering departments. Overall, the receipt of the data was 87 per cent. Results obtained from these trials are summarized here under.

Evaluation of intercropping system with different nutrient management practices in rainfed upland rice

The results revealed that, intercropping of rice + black gram/cluster bean/horse gram (3:2 or 4:2 replacement series) resulted in higher rice equivalent yields and gross returns. Among the nutrient management practices, depending on the initial fertilizer status, 75% RDF of rice or 75% RDF of rice + organic manure or 100% RDF of rice + 20 kg Sulphur /ha are required to achieve higher yields of rice either as sole crop or rice + intercrops in rainfed situation.

Technology for aerobic rice.

Identified varieties and suitable date of sowing in different locations. At majority of the locations, early sowing (5th June – 3rd July) showed higher productivity. Among the test cultivars, Hybrids at four locations showed superior performance; high yielding varieties and hybrids at three locations, showed superior performance. By manipulating these two factors higher productivity of aerobic rice can be attained with reduced water requirements. A seed rate of 25-35 kg/ha is optimum for realizing higher yields of aerobic rice with selection of suitable promising hybrids or high yielding varieties. Hybrid DRRH-3 performed well at three locations followed by PAC 837.

Depending on the initial fertility status, nitrogen dose of 100-125 % of local recommendation can be adopted. Among the nitrogen schedules, three split applications with 1/3 as basal or at 10 – 12 days after rice emergence is required to achieve higher grain yields.

The treatment consisting of application of pendimethalin (30EC) @ 1.00 kg a.i./ha at 3-4 DAS fb bispyribacsodium (10%SC)@35 g.a.i./ha at 15-20 Days after sowing was proved as effective as need based hand weeding at most of the locations.

Technology for system of rice intensification

The evaluation of crop establishment methods along with different nutrient combinations over thirteen locations clearly indicated superiority of SRI method (4.55 t/ha) over Direct Seeded followed by SRI principles (4.21 t/ha) on normal transplanting and application of 150% RDF followed by 100% RDF as inorganic or conjuncture use of organic + inorganic (50 + 50%) found promising. The percent grain yield increase was to the tune of 9-12% in SRI over DSR and Transplanted flooded rice system.

SM SRI system showed better performance at seven locations with reduced cost of cultivation and found remunerative followed by Drum seeder dibbling + SRI principles with lower cost of cultivation.

Technology for direct seeded rice

The results revealed that, hybrids recorded superior performance over high yielding varieties in all the test locations. The method of sowing and cultivars are location specific. Hence standardization of method and selection of cultivars has to be done accordingly.

The performance of drum seeding or seed drilling on puddled soil or line sowing in unpuddled soil, which are equally productive as that of conventional transplanting.

The irrigation schedules of saturation or alternate wetting and drying were equally effective and recorded similar grain yields as that of conventional flooding system. Nitrogen scheduling with either two or three splits including basal application was found necessary depending on the local requirement.

Yield maximization of rice through site specific nutrient management

The recommendations based on nutrient expert (NE) tool resulted in significantly higher grain yields (by 7-12%) over RDF at six locations and with a marginal yield increase at five other locations. Nutrients uptake followed the same trend as that of grain yield. The nutrient omission plots (2.4-5.3, 2.6-6.1 and 2.7-6.7 t/ha in –N, -P and -K plots respectively) and absolute control (1.9-4.7 t/ha) recorded lower values of grain yields as well as soil available nutrients compared to other treatments.

Weed management trials

Application of pre-emergence herbicide (Pretilachlor with safener @ 0.75 kg a.i./ha, or butachlor @ 1-1.5 kg a.i./ha or oxadiargyl @ 0.09 kg a.i/ha or ethoxyslfuron @ 0.01 – 0.03 kg a.i./ha) followed by two applications of post-emergence herbicide (Bispyribac sodium @ 250 ml/ha at 2-3 leaf stage of weeds or chlorimuron + metsulfuron methyl @ 20 gm/ha at 25 DAT) for 2nd and 3rd flush of weeds was significantly superior and on par with two hand weeding treatment.

The results of 11 locations indicated, Direct wet seeding of rice under puddle conditions recorded superior performance over direct dry seeding. The grain yield loss due to weeds ranged from 17.7% to 67.1% when weedy condition was up to 60 days, indicating the weed intensity in direct sown rice either dry or wet and the necessity of maintaining weed free condition during critical period of crop weed competition. The yield loss was minimum when weeds were allowed only up to 15 DAS, at all the locations. Irrespective of the test location, maintaining weed free condition during cropping season is required to minimize yield losses and increase productivity.

Climate resilient management practices in rice and rice based cropping systems

The results revealed that application of RDF + split application of N (4.99 t/ha) followed by T_5 – Azotobactor + PSB + Brown Manuring with 50% RDF and T_4 – Azotobactor + PSB + Residue mulch + 75% RDF found promising indicating the substitution of 25-50% RDF with organic manures.

Irrespective of location, reduced tillage resulted in yield penalty (4.7 to 81.3%) at five out of 8 locations as compared to conventional tillage with the exception of Gangavathi, Raipur and Pantnagar. Among the rice cultivars used, hybrids have out yielded the high yielding variety (HYV) at all the locations except at Raipur and Pantnagar where the differences in yield between hybrid and HYV were insignificant.

Soil Science

Long term soil fertility management in rice-based cropping systems

The results of 26th year indicated the consistent superiority of conjunctive use of 100% recommended dose of fertilizers (RDF) + 5t FYM/ha over all other treatments at all the three locations (Mandya, Maruteru and Titabar) and FYM alone increased grain yield significantly by 16% over RDF at Mandya for the second consecutive year. Soil fertility status at the end of *kharif* -2014 indicated an improvement in soil organic carbon content and available nutrient status when organic manures were applied as supplementary dose or substituted for 50% RDF or when added alone compared to inorganic fertilization.

Yield gap assessment and bridging the gap through site specific integrated nutrient management in rice in farmers' fields

Assessing the variability in nutrient supply, its relationship with rice yields at current recommended and farmers' fertilizer practices, strong to moderate correlation between yields and NK and P uptake respectively was recorded under recommended fertilizer practices. SSNM was superior (6.89 t/ha) to the currently recommended blanket fertilizer dose (4.45 t/ha) and farmers' fertilizer practice (4.13 t/ha) at Mandya with corresponding improvement in crop nutrition and nutrient use efficiency.

Management of sodic and acid soils

Gypsum application in conjunction with NPK fertilization improved grain yields by 47-104% over non amended control while among the 24 genotypes

evaluated, CSR 23, TTB-404, IR 64, US 312 and Pooja were observed to tolerate the sodicity of soils of Kanpur better with highest yields ranging from 1.87 to 2.10 t/ha without gypsum application.

Nutrient and water requirement for aerobic rice cultivation

The NPK requirement at Kanpur (Indo-Gangetic Plains) and Mandya (Cauvery Command) was estimated to be 25.0, 5.8 and 25.0 kg and 13.5, 4.6 and 8.1 kg per tonne of grain production, respectively. Productivity of water (kg grain/ha mm water used) ranged from 2.3-2.4 and 5.2-7.0 kg grain/ha mm water at Kanpur and Mandya, respectively. Irrigation equivalent to 75% of CPE appeared to be optimum for aerobic rice system.

Nutrient use efficiency and soil productivity in early and late sown rice

Early planting recorded higher grain yields over optimum date of planting at five locations (by 11% at DRR, 40% at GHT, 26% at KRK, 4% at KHU and 13% at PDU). Nutrient uptake and nutrient use efficiency were also higher under early planting. Nutrient management practices did not show greater influence on grain yields, nutrient uptake and use efficiency in most of the locations.

Screening of rice genotypes for acid soils and related nutritional constraints

The highest yielding genotype at Moncompu was Sahbhagidhan (9.36 t/ha) under recommended N+ double PK fertilization. At Ranchi, DRRH-3 (7.67 t/ha), TTB 404 (7.08 t/ha) and DRRH-2 (6.74 t/ha) were the highest yielding genotypes at recommended NPK + lime application. Under un limed conditions, the genotypes 27P52, Sahbhagidhan and MAS 946 at Moncompu, DRRH-3 ,TTB 404 and DRRH-2 at Ranchi and Lalat, Aghonibora and Profulla at Titabar were found promising.

Studies on partitioning of zinc and iron and prospects for enrichment in rice

Use of micronutrients in combination with recommended NPK, organic manure and cytokinin spray yielded significantly superior to control and at par with the other nutrient treatments at most of the test locations. The combined use of organics, micronutrients and cytokinin spray recorded maximum Zn (19-36 ppm in grain) and Fe (21-244 ppm in grain) concentration and uptake in both grain and straw. Major portion of the absorbed micronutrients remained in straw (53-80% of Zn and 59-97% of Fe) and only 20-47% of Zn and 3-41% of Fe was translocated to the grain) at all the Centres.

Sustaining soil and crop productivity under different rice production systems

Maximum rice productivity in transplanted rice (TPR) indicated its superiority over direct seeded rice (DSR, by 18-32%) and aerobic rice (AR, by 28-74%) at all the three centers (IIRR, Mandya, Puducherry). Among the nutrient combination treatments, RDF+50% organics gave significantly higher grain yield at DRR, Mandya and Puducherry while RDF alone recorded maximum grain yield at Kanpur. Though DSR and AR recorded comparatively low yield and nutrient uptake than Z transplanted rice, the nutrient use efficiency was better in case of DSR and AR.

Yield maximization of rice through site specific nutrient management

In the first year of study on yield maximization of rice through site specific nutrient management using computer based decision tool for nutrient recommendations, developed by International Plant Nutrition Institute (IPNI) at 18 locations, the recommendations based on nutrient expert (NE) tool resulted in significantly higher grain yields (by 7-12%) over RDF at five locations and with a marginal yield increase at five other locations. Nutrients uptake followed the same trend as that of grain yield. The nutrient omission plots (2.4-5.3, 2.6-6.1 and 2.7-6.7 t/ha in –N, -P and –K plots, respectively) and absolute control (1.9-4.7 t/ha) recorded lower values of grain yields as well as soil available nutrients compared to other treatments. Further evaluation of Nutrient expert is needed to fine tune the decision support tool for nutrient recommendations in Rice

Plant Physiology

Photothermic indexing, radiation use efficiency of genotypes:

This trial was conducted at 9 geographical locations with an objective to find the elasticity of the sowing time in relation to changing weather situation at a

particular location and also across the country. Critical cumulative degree days, cumulative nyctoperiods duration wise were determined earlier and the radiation use efficiency of rice genotypes in the past five years were used to assess the performance of these genotypes. Based on the analysis IET 20924 and Lalat in all three dates of planting, IET 23300 for early, PHY1 and IET 22580 for late sowing situations could be used for further developing climate resilient rice genotypes.

Influence of silicon solubilizers on stress tolerance in rice genotypes.

This year Five Hybrids and one high yielding variety (BPT-5204) were taken up for the study to understand the role of silicon in rice plant. Six centers had two treatments with imidazole (T1) and silixol spray (T2) while three centers had control along with T1 and T2. In conclusion it was observed that application of silicon solubulizers and silixol influence was non-significant on yield. However, there was lesser incidence of pest and disease in silixol and Imidazole applied plots

Screening for high temperature tolerance in rice genotypes

In order to simultaneously select genotypes with higher yield and stability of performance across locations under elevated temperature conditions, a parametric model for simultaneous selection in yield and stability "shukla's stability variance and kang's" statistic was performed. Based on the YS_i values genotypes IET22116, IET23216, IET23223, IET23735, IET23739, IET23743, IET23758, IET23770, IET24097, IET24117, IET24122 and Sasyasree can be selected as they produced relatively higher yield under heat stress condition . These genotypes have a higher yield and a lower variation. According to the ANOVA, the interaction is significant

Screening of elite rice cultures for drought tolerance:

Drought resistance/tolerance is a complex trait and successful improvement in this trait depends primarily on selection of parents, selection of screening criteria and effective phenotyping protocols. "Shukla's stability variance and Kang's" statistic was performed to analyse the cultures. According to the YS_i value IET 22747, Sahbhagidhan, IET 23337, IET 23355, IET 24672, IET 24673, IET 24674, IET 24675, IET 24677, IET 24678, IET 24679, IET 24680, IET 24683, IET 24688, IET 24689, IET 24690, IET 24691, IET 24693, IET 24694, IET 24064 and IET 22747 show better performance. However, the *Stability variance* (σ_i^2) was non-significant in case of IET 24674, Sahbhagidhan, IET 24677, IET 24683 indicating that these genotypes are stable across the locations and may be selected for upland cultivation.

Physiological characterization of selected genotypes for multiple abiotic stress tolerance

The experimental lines were subjected to artificially created abiotic stress at different locations independently and their field performance under irrigated situation. Water stress (1% and 2% mannitol), NaCl stress (200mM Eq to -1.26MPa water potential) and submergence (15 -25 cm water depth) stress. It is concluded that, the genotypes with superior physiological characters at germination, seedling stage and field performance are IET 24100, IET 24104, 82365-B-B-47-1, MRC -603, IR-55178, SG-26-120 and IR-310-B-B-67-2.

Crop Protection

Entomology

All India Coordinated Entomology Programme 2014 comprised of 357 experiments conducted under seven major themes at 41 locations in 22 states and one Union territory. Significant findings of these studies carried out during *Kharif* 2014, are given below.

Pest survey report

Pest surveys undertaken at 29 locations (June-December) on fortnightly basis revealed outbreaks of BPH from eight States and one UT representing 11 locations viz., Nellore, Ragolu (AP), Titabar (Assam), Pusa (Bihar), Jagdalpur (Chhattisgarh), Gangavathi, Mandya (Karnataka), Pattambi (Kerala), Karaikal (Puducherry), Rajendranagar and Warangal (Telangana), during October-November 2014.

Host plant resistance studies

Host plant resistance studies comprised of six screening experiments involved evaluation of 1493 entries including 1229 pre-breeding lines & varieties, 131 hybrids, 58 germplasm accessions and 122 checks

against 14 insect pests in 208 valid tests (54 greenhouse reactions +154 field reactions). Of the 51 entries found promising against various insect pests 15 entries were under retesting. Four entries-CR 2711-149, KAUM 179-1, KAUM 179-2 and KAUM 182-1 showed consistent resistance reaction against planthoppers. Three entries viz., CR3006-8-5, RP 4918-228(S) and JGL 19618 were found promising for multiple pest resistance. National Screening Nurseries included four nurseries viz., NSN1 with 254 AVT entries evaluated at 20 locations, NSN2 with 652 IVT cultures screened at 12 locations, NSN-Hills with 112 entries at 8 locations and NHSN with 150 entries evaluated at 20 locations. Based on overall reaction, 8 entries each in NSN 1, 11 entries in NSN2, four entries each in NSN hills and NHSN were found promising.

Insect biotype studies

Under Gall Midge Biotype Trial (GMBT), evaluation of gene differentials against seven identified biotypes and two populations of gall midge revealed W1263, ARC6605, Aganni and INRC3021 as promising. Gall Midge Population Monitoring trial (GMPM) involving monitoring of virulence pattern of gall midge populations with three differentials along with Purple variety at Sakoli revealed that the population was avirulent on W 1263(Gm1) but virulent on Abhaya(Gm4) and RP 2068-18-3-5(gm3). Planthopper Special Screening trial (PHSS) with evaluation of 16 differentials across 10 locations in standard seed box screening test against brown planthopper revealed that two differentials viz., T 12 (ACC 56989) with bph7 gene and RP 2068-18-3-5 with unidentified genes were promising with a damage score of ≤5. Rathu Heenati with Bph3+Bph17 genes and PTB 33 with bph2+Bph3+unknown factors were promising with a damage score of <5.

Chemical control studies

Insecticide evaluation trial carried at 34 locations revealed that flubendiamide+buprofezin treatment @ 35+175 g a.i./ha performed well against stem borer and leaf folder. Dinotefuran @ 40 g a.i./ha followed by imidacloprid+ethiprole @ 50 g a.i./ha were effective against planthoppers and leafhoppers. Pesticide compatibility trial revealed that there was no adverse impact on the efficacy of rynaxypyr @ 30 g a.i./ha and dinotefuran @ 40 g a.i./ha when applied with either carbendazim+mancozeb or validamycin or vice versa confirming the compatibility of the chemicals when used as tank mix in the field.

Ecological studies

Effect of Planting Dates on insect Pest incidence (EPDP) trial conducted at 19 locations revealed high white ear damage in early planting at Raipur alone (39.36%) and in late planting at Nawagam (35.4%), Faizabad (34.14%), Pusa (22.36%) and Raipur (20.09%). Gall midge damage was high at Sakoli during normal (14.88% SS) and late planting (12.79% SS). Leaf folder damage was low in all the plantings at 15 locations. Planthoppers incidence was found high at Gangavathi in normal planting (28.21 BPH/hill & 26.02 WBPH/hill). Insect Pest Incidence in Selective Mechanization for Enhancing Productivity and Profitability of Rice Cultivation Trial (PISMT) was carried out at 5 locations. At Gangavathi, significantly low population of BPH (9.35–23.8/hill) and WBPH (9.3– 23.9/hill) was recorded in Drum seeding treatment.

Biocontrol and biodiversity studies

Monitoring of Pest species and Natural Enemies (MPNE) revealed the presence of five species of stem borer with YSB being dominant in 14 locations. The egg mass parasitisation ranged from 8.00-98.96% while the egg parasitisation varied between 11.66 and 64.21%. In case of planthoppers, two locations viz., Aduthurai and Mandya reported only population of BPH, while only WBPH was observed in Nawagam and New Delhi. Anagrus, Oligosita and Gonatocerus were the parasitoids reported on hopper eggs. Ecological Engineering for Planthopper Management (EEPM) was taken up in 6 locations with a combination of interventions such as organic manuring, alleyways, spacing management, water management and growing of flowering plants on bunds. These interventions increased the predator populations and egg parasitisation of hoppers across the locations but the trends were not discernible in their impact on the reduction of hopper population.

Integrated pest management studies

Yield Loss Estimation Trial (YLET) was conducted at 5 and 3 locations for stem borer and leaffolder respectively. Pooled analysis of per cent white ears vs natural logarithm of grain yield revealed a significant regression ($R2 = 0.5160$; $P \leq 0.0001$; $n = 591$). Every 10% increase in white ears resulted in 1.02 g reduction in grain yield. Integrated Pest Management special

(IPMs) trial conducted at 12 locations during *Kharif* 2014 revealed, insect pest incidence exceeded ETL and found high in farmers practices at four locations. Adoption of IPM practices reduced the incidence of BPH at Maruteru (21.7/hill), DRR (24.6/hill), Gangavathi (6.8/hill) and Aduthurai (3.4/hill) as against 23.4, 36.7, 35 and 11.2 BPH/hill, respectively in Farmer practices. In general, adoption of IPM practices reduced area under disease progress curve (AUDPC) of major diseases like leaf blast, sheath blight, bacterial blight and brown spot at four locations. Weed population and weed biomass recorded at eight locations were considerably reduced in IPM implemented plots. Grain yield was significantly high in IPM plots resulting in high B:C ratio.

Population dynamics of major insect pests assessed through light trap catches

Light trap data received from 29 centres during the year 2014 revealed yellow stem borer as most widespread at 26 centres with highest peak catch (3038 females + 76 males) occurring during 1st standard week (SW) at Aduthurai. Brown planthoppers were reported from 22 centres, with maximum peak population (50675 insects/week) occurring during 16th SW at Maruteru. WBPH was present at 18 centres with the highest population of 21638 insects/week occurring during 45th week at Gangavathi. Gall midge was reported from 12 centres. While leaf folder continued to be widely distributed (26 centres). Green leafhoppers were reported from 25 centres with the highest peak catch of 9670 insects per week during 50th week at Aduthurai centre. This year efforts were initiated to evaluate a new fine trap model of light trap at 12 locations. Results indicated that catches of yellow stem borer and leaf folder were higher in the new trap at five locations.

Plant Pathology

Host plant resistance studies comprised of 5 national screening nurseries including 2021 entries of advanced breeding lines, new rice hybrids and germplasm accessions evaluated for their reactions against major rice diseases at various locations. The promising entries identified against each disease are given in the table.

Disease	Promising entries in Various Screening Nurseries (NSN1, NSN2, NSNH, NHSN, DSN, GSN)
Leaf blast	Entry nos. 146 (IET 23448), 169 (IET 22876), 45 (IET 23268), 147 (IET 23471), 182 (IET 23951), 168 (IET 23982) and 172 (IET 24074) in NSN-1. 547 (IET 24788), 551 (IET 24743), 352 (IET 24676), 367 (IET 24690), 189 (IET 24316), and 493 (IET 24660) in NSN-2. 63 (IET 23539), 79 (IET 22984), 32 (IET 24192) and 89 (IET 23528) in NSN-H. 32 (IET 24815), 9 (IET24796) and 36 (IET 24818) in DSN. 37 (VL31870), 31 (VL31674), 72 (IET 21751) and 18 (VL8083) IC Nos. 86025, 85716, 67633 and 462136 in GSN.
Neck blast	Entry nos. 1 (IET 23088), 9 (IET 23645) and 3 (IET 23642) in NSN1; 132 (IET 24484),112 (IET 24469), and 432 (IET 24394) in NSN2; 48 (IET24227), 50 (IET 24229) and 56 (IET 23546) in NSN-H; 36 (IET 24818), 108 (IET 24882), 1(IET 24789) and 71 (IET 24850) in NHSN; 40 (KAUM112-10-6-7), 112 (RP-Patho-23), 38 (KAUM 109-1-2-1), 98 (RP Patho-9) and 22 (VL8654) in DSN.
Sheath blight	None of the entries were found resistant. Two entries (IET# 24217 & 24219) were showed field tolerance at test locations in NSN-H.
Brown spot	Entry nos. 202 (IET 24569), 5 (IET 23652) and 108 (IET 23834) in NSN1; 556 (IET 24748), 31 (IET 24254), 471 and 395(IET 24701) in NSN2; 63 (IET 23539), 32 (IET 24192) and 27 (IET 24187) in NSNH; 24806 (SPH-56), IET 24819 (PAN-831) and IET 24812 (JRH-64) in NHSN; 28 (VL31289), 38 (KAUM 109-1-2-1), 106 (RP Patho-17) and 101(RPPatho-12) in DSN.
Sheath rot	Entry nos. 9 (IET 23645), 82 (IET 23603) and 5 (IET 23652) in NSN 1; 9 (IET 24301), 295 (IET 24430), 72 (IET 24294), 280 (IET 23837), 345 (CSR 10) and 444 (IET 24405) in NSN 2; 63 (IET 23539) and 65 (IET 22976) in NSN-H; 110(IET 24884), 7 (IET 24784), 26 (IET 24809) and 25 (IET 24808)in NHSN and 64 (IET 23149), 87 (IET 21267), 64 (IET 22603), 184(T -30 -58), 11(CB09154) and 97 (RP Patho-8)in DSN
Bacterial leaf blight	IET Nos. 23268, 23957, 23758, 23224, 22878, 24566, 24565, 23596 and 24573 in NSN-1; IET Nos. 24555, 24261, 24440, 24438, 24269, 24495, 23930, 24356, 24333 and 24586 in NSN-2; IET Nos. 24222, 22967, 23524, 24198 and 24213 in NSN-Hills; IET Nos. 24888, 24891, 24846, 24843, 24850, 24892 and 24890 in NHSN and RPDN-178, RPDN-180, RPDN-161,RPDN-188, IET 22494, IET 23147, IET 22241, RPDN-165, IET 23149, RPDN -174 and RPDN-202 in DSN; IC nos. 70869 and 85713 in GSN.

Disease	Promising entries in Various Screening Nurseries (NSN1, NSN2, NSNH, NHSN, DSN, GSN)
Rice tungro disease	Entry Nos. 138 (IET 23467), 173 (IET 23984), 148 (IET 23455), 208 (IET 23804) in NSN 1; 92 (IET 24449), 520 (IET 23814) and 30 (IET 24253) in NSN 2; 48 (IET 24227) in NSN-H; 84 (NDR-359), 12 (IET 24798) and 39 (IET 24821) in NHSN and 64 (IET 22603) 45 (KAUM180-2) and 57 (IET21423) in DSN; IC Nos. 85720, 85754, 86035, 86091 and 462121 in GSN.
Multiple disease resistance (a minimum of 2 diseases)	IET Nos. 22986, 22989, 23052, 23088, 23224, 23268, 23275, 23591, 23596, 23601, 23642, 23645, 23652, 24142, 23758, 23804, 24006 & 23666 in NSN-1; IET Nos. 23738, 23934, 24269, 24301, 24449, 24495 and 24518 in NSN-2; IET Nos. 23539, 24192, 24220, 23528, 23548, 24229, 24188 & 24198 in NSN-H; IET: 24818, 24795, 24879, 24814, 24797, 24809, 24808, 24887, 24794, 24846, 24850, 24849 and 24156 in NHSN and CB 09154, CB 11161, CB 12532, CB 12532, IET 21267, IET 21347, IET 21751, IET 21852, IET 22164, IET 22603, IET 22985, IET 23147, IET 23149, KAUM 109-1-2-1, RP Patho-12, RP Patho-8, RPDN-117, RPDN-161, RPDN-175, RPDN-180, RPDN-189, RPDN-198, RPDN-202, RP-Patho-23 & T-30-58 in DSN; IC Nos.8571 and 248014 in GSN.

Field monitoring of virulence of *Pyricularia grisea (Blast)*

At 22 locations this trial was conducted. At most of the locations Tetep, Tadukan and Raminad str-3 were resistant. IR64 had recorded susceptible reaction at Imphal, Almora and Hazaribagh. The susceptible checks like HR 12 and Co-39 recorded the disease as expected except at few locations Gaghraghat, Mugad and Karjat. The resistant checks like IR 64 and Rasi reacted differently at Imphal, Almora and Hazaribagh. Hence there is a shift in the pathogen population.

Field monitoring of virulence of *Xanthomonas oryzae* pv. *oryzae* (Bacterial Leaf Blight).

The trial was conducted at 24 different hot spot locations across the country with 22 entries. BB resistance gene *xa13* was found susceptible in 14 locations while *Xa21* was found susceptible in 12 locations. Isolates from Aduthurai, Maruteru, Raipur, Gerua, Kaul, New Delhi and Pantnagar were able to produce susceptible reaction on IRBB 55 having the combination of xa13 and Xa21. Interestingly, IRBB 53 having the combination of xa5 and xa13 showed susceptibility at only five places indicating major shift of pathogen virulence profile.

Disease observation nursery

The trial was conducted at 10 locations. Terminal disease severity of each disease varied according to the location, variety and date of sowing. At Maruteru early sown crop was severely affected by neck blast and in all the three dates of sown crops sheath blight disease incidence was very high. Across the locations, delayed sowing/planting increased the disease development of all diseases. The disease progress was high in the early sown crop for Sheath blight.

Evaluation of new fungicides for location specific fungicides

The combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) was found significantly effective @ 1g/l against neck blast, node blast, sheath blight, brown spot, glume discolouration and leaf scald. The combination product *i.e.* Merger (tricyclazole 18%+ mancozeb 62% WP) 2.5 g/l found effective against sheath rot.

Evaluation of fungicides against false smut

Application of trifloxystrobin 25% + tebuconazole 50% (Nativo 75WG @ 0.4g/l) or propiconazole 25 EC (Tilt or Result @ 1ml/l) either at 50 % or 100% panicle emergence stage was effective and both the chemicals were on par in their performance in reducing the disease.

Integrated disease management

Trial was conducted at 12 locations. With respect to leaf blast and neck blast, cultivars *viz.*, Arize 6129 at Malan, Jehlum at Kudwani and KRH4 at Mandya were performed well along with fungicide application. Similarly at Rewa, JRH 8 performed well against leaf blast. With respect to sheath blight, at Pattambi, Aathira along with spray of hexaconazole (Contaf 5EC) @ 2 ml/l; at Mandya, KRH 4 along with one spray of fungicide; at Faizabad, RH 9020 with two sprays of fungicide and at Maruteru 29 P38 with three spray of fungicide recorded low disease severity and high grain yield. Susceptible variety Swarna recorded

less disease severity of leaf blast and sheath blight and high grain yield when the crop was sprayed with Validamycin @ 2ml/l at Chiplima. In case of bacterial leaf blight management cultivars *viz.,* CoRH 4 at Karaikal and Arize 6444 at Pusa were recorded with high grain yield when nitrogen was applied in split doses (80kg and 120kg) along with required level of potassium and phosphate fertilizers.

Special screening trial on IPM practices

The trial was proposed at 12 locations. Following of IPM practices such as application of balanced dose of fertilizers and application of need based plant protection measures helped to reduce the disease severity of sheath blight at Ludhiana, leaf blast and bacterial leaf blight at Gangavathi; intensity of leaf blast and bacterial leaf blight at Chinsurah both in *Kharif* and *Boro* seasons and disease severity of leaf blat, neck blast, sheath blight, sheath rot, brown spot and bacterial leaf blight diseases at Sakoli.

Screening trial on false smut (Special Trial)

The trial was conducted at 11 locations. Ten entries (varieties/hybrids) were sown at 15 days interval and disease incidence was recorded. Among the hybrids tested, KHH 2 is highly susceptible across the locations followed by US 312 and PA 6444. Among the varieties Co43, MTU 1075 and BPT 5204 were susceptible across the locations.

Production oriented survey

Production oriented survey was conducted in 18 states of India during 2014 *Kharif* season *viz.,* Assam, Bihar, Chhattishgarh, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Puducherry, Punjab, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal. For the country as a whole, the rainfall for the season (June to September) was 88% of its long period average. However, at the end of the season there were two severe cyclonic storms HUDHUD (over bay of Bengal) and Niofar (Over Arabian sea) resulting in damage to crops and human life. Analysis of POS data revealed that a large number of rice hybrids are being grown in different states like Maharashtra, Madhya Pradesh, Jharkhand, Uttar Pradesh, Haryana, parts of Gujarat and Himachal Pradesh. Diseases like leaf blast, neck blast, brown spot, sheath blight, sheath rot, false smut and bacterial blight and insect pests like stem borer, leaf folder and brown plant hopper were wide spread throughout India. The diseases like neck blast and false smut have spread throughout the country in last few years. Bakanae has become a major problem in Punjab and Haryana especially on basmati varieties. False smut was recorded in severe intensities in many areas in Bihar, Tamil Nadu and parts of Uttar Pradesh. Increasing incidences of bacterial leaf streak was recorded from Assam and Tamil Nadu. Similarly, there was moderate incidence of root weevil in Haryana and moderate to severe incidence of black bug in Kerala. In general, the main problems faced by the farmers were shortage of labour and irrigation water, non-availability of inputs in time and good quality seeds of HYVs.

Transfer of Technology

A cafeteria of rice technologies were demonstrated in 459 hectare area covering 17 states and four major rice ecosystems of the country. Out of 431 FLDs reported, about 67% were conducted in irrigated rice ecosystem; whereas about 11% of FLDs were conducted in rainfed uplands. More than 16% of FLDs were organized in shallow lowlands and 3% in hill ecologies. About 4% of the FLDs were conducted in problem soils.

The mean yield advantage was the highest in Rainfed uplands (59% mean yield advantage). Similarly in case of irrigated ecologies (21%), Hill ecologies (31%), Shallow lowlands (16%) and problem soils (28%), yield gaps (particularly Yield gap-II) could be effectively addressed, if proper extension strategies are deployed for large scale adoption of these technologies. Irrigated ecosystems have recorded mean yield of 5.27 t/ha where as in Shallow lowlands FLD technologies have recorded an average yield of 4.80 t/ha followed by 3.67 t/ha in rainfed uplands. In total 35 promising technologies have been identified from 17 states.

Research Achievements-Lead

GEY - Genetic enhancement of yield and stress tolerance

GEQ - Genetic enhancement of quality for domestic and export purpose

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

NPP - ICAR National professor project

GEY - Genetic Enhancement of Yield and Stress Tolerance

GEY/CI/BR/12

Redesigning the indica rice plant type by introgressing the traits for higher yield potential and disease and pest resistance from tropical japonica and wild rices (T. Ram)

IET 23420 (RP5333-41-2-3-IR83383-B-B) with 85 days of flowering duration and yield advantage of 22.7%, over best check Sahbhagi Dhan, was identified for release in the Bihar, Madhya Pradesh and Maharashtra during 2014-15.

Of the 32 FGR lines (Future Generation Rice) evaluated with Jaya, NDR359, Swarna, IR64 and Dhanrasi, the FGR 910024-8, 910021-20, 910022-16, 910024-8, 910021-19 and 0620636 showed 15-24% yield advantage over the best check. In F_6 generation, 119 lines were evaluated in augmented design with six checks. Sixteen lines derived from Swarna/*O. longistaminata* and 162 lines from IR64/*O. glaberrima* were screened against yellow stem borer and 53 lines were selected as tolerant. One hundred and forty four lines in BC_3F_7 generation derived from Swarna/*O. longistaminata* and Swarna/*O. rufipogon* were screened for blast resistance and 27 lines from Swarna/O. longistaminata showed resistance reaction indicating introgression of blast resistance genes from *O. longistaminata.* Twenty three advanced lines of cross between IR 64/*O. glaberrima* were screened for bacterial blight resistance with Xoo isolate DX020, 11 were resistant, nine were moderate resistant. The molecular analysis indicated that the resistance genes present in these lines were different from *Xa21, xa13, xa5* and *Xa33*.

The land races Dangar, Kalamkati, Mikhudeb, AUS257 and Binuhangin were identified as donor for drought tolerance on the basis of leaf rolling, leaf tip drying and yield. In addtion, IR 92527-6-2-1-2 and IR 92546-7-1-1-3, were found promising with more than 2.0 t/ha yield compared to checks yield of less than 1.0t/ha under severe drought conditions.

The efforts were made to improve Sampada variety under Grand Challenge Programme "Development of biotic stress resistance in rice through marker assisted breeding" with two genes each of gallmidge (*Gm1* & *Gm8*), BB (*Xa21* & *Xa33*), blast (*Pi2* & *Pi* ^{kh}) and BPH (*Bph20* & *Bph21*). Marker positive plants in BC_2F_4 generations for the genes *Xa21+Pikh+Xa33*, *Xa21+Gm4* and *Bph 18* identified.

Fig. RP5333-41-2-3-IR83383-B-B

In the project on "Marker Assisted Breeding of Abiotic Stress Tolerant Rice Varieties with Major QTLs for Drought, Submergence and Salt Tolerance" 66 BC_3F_3 plants were found positive for three QTLs (*qDTY2.1, qDTY3.1* and *qSub1*. To validate the QTLs ($qKSM_{1.1,}$ $qNa/KSH_{1.1}$ and $qSSISFH_{8.1}$) for salinity tolerance from CSR27 in background of BPT5204, 240 populations in BC_1F_7 generation screened in field conditions with Ece 8.7 – 9.0 dSm^{-1}, 41 lines showed resistance having all three QTLs. Six lines with these QTLs were evaluated in AICRIP and yielded 1-9% higher than the standard salinity tolerant checks CSR10, CSR23 and CST7-1 indicating that these QTLs are effective against salinity stress at reproductive stage.

GEY/CI/BR/9

Breeding Varieties for Boro areas (L.V. Subba Rao)

As many as 215 single plant selections were made at F_5 generation based on cold tolerance at seedling stage and heat tolerance (>80% spikelet fertility) at

reproductive and grain filling stage. The selection criterion considered were high tiller number, long panicles, complete exsertion of panicle and phenotypic acceptability. Fifty one single plant selections were made from F_2 generation of 12 crosses. The same set of F_2 materials were also sent to Pusa, Karimganj, Titabar and Chinsurah for screening to cold and heat tolerance during rabi 2014.

GEY/CI/BR/16

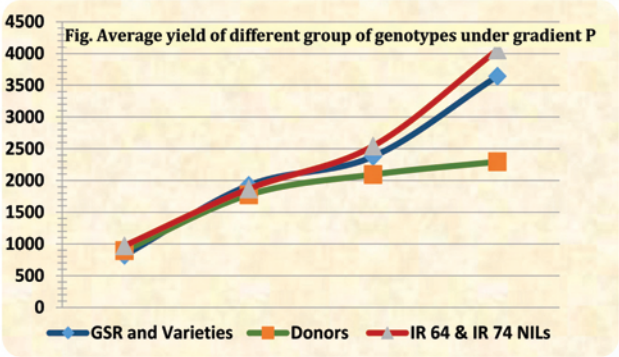
Breeding high yielding rice varieties for resistance to plant hoppers (G. Padmavathi)

Of the 65 lines derived from 13 crosses in F_8 generation screened for BPH resistance, three lines were found resistant and four lines showed moderate resistance under hopper-burn situation. Five resistant lines having yield superiority over local checks were evaluated in AICRIP trial. IET 24332 (RP 5445-102-23-3-2) from the cross RP bio 226/CR 15 MR 1523 and IET 24395 (RP 5865-300-4-1-1-1-2-3), from cross MTU 1075/MTU 1010 showed more than 5% yield advantage over the best check, hence promoted to advanced trial.

GEY/CI/BR/14

Breeding rice for enhanced phosphorous use efficiency (V.P. Bhadana)

Eighty eight genotypes consisting 41 Green Super Rice entries, 17 popular varieties and elite lines, four N22 mutants, 11 Pup1 NILs in the background of IR 64 and IR74 including recurrent parents and 15 Pup donors were screened under graded level of phosphorus (0, 20, 40, and 60 kg/ha) during *Kharif* 2014. In general, tolerant genotypes delayed flowering under low P and possessed more than five productive tillers while sensitive genotypes failed to complete their life cycle. Under 0-P situation, the Pup1 NILs have recorded highest yield (970 kg/ha) followed by donors (895 kg/ha), GSR entries and varieties (821 kg/ha). As P level increases, the NILs responded to phosphorous application with higher yield followed by GSR entries, varieties and donors. Among the varieties, GSR entries and donors, Vikas, Swarna, NDR 359, IR 83140-B-11-B, IR 83142-B-57-B, D 4098, Wanxian 7777, HHZ 5-SAL10-DT1-DT1, IR 83140-B-36-B, Luyin 46 and RTS 14 performed well under low P and identified as a potential donor for improving P use efficiency.



Nine hundred and sixty five single plant selections were made from 1500 F_5 progenies of 10 crosses evaluated under suboptimal level of soil phosphorus. Three hundred and sixty one lines in F_5 generation selected from four different bulk populations were evaluated under 0-P and normal condition, of which 136 plants were selected. In addition, four crosses were advanced to F_5 generation following single seed descent selections to develop RILs population for mapping novel source of low P tolerance.

GEY/CI/BR/19

Screening of germplasm and identification of gene(s) for developing resistance to sheath blight disease in rice (Jyothi Badri)

Thirty six genotypes selected as tolerant for sheath blight in previous screening were again evaluated along with checks Tetep, Teqing and Jasmine 85 (tolerant) and IR 50, Swarna and BPT 5204 (susceptible) under artificial infection in field and glasshouse, the result indicated SM-801, Ngonolasha, Wazuho phek, Gumdhan, BG-380-2, RP-2068-18-3-5, Tetep, Phougak, Thangmoi and Teqing were moderately resistant with 21-30% RLH. The RLH% ranged from 22% (Phougak) to 89.52% (Swarna). Jasmine 85 is reported as moderately resistant for sheath blight, showed susceptible reaction.

Based on three years of testing, six genotypes such as SM 801 (N 22 mutant), Ngnololasha, Wazuhophek, Gumdhan and Phougak and RP 2068-18-3-5 have been identified as tolerance to sheath blight. The moderately resistant genotypes were crossed with

Swarna, Samba Mahsuri, MTU 1010 and Improved Samba Mahsuri to study genetics. The SSR markers reported from moderately tolerant genotypes Tetep, Teqing, Jasmine 85, Pecos, Benam, ARC 10531 and WSS 2 were used to study allelic variations at the locus in the newly identified tolerant genotypes and land races.

GEY/CI/HY-7

Exploitation of inter sub-specific heterosis in rice (*Oryza sativa L.*). (Dr. AS Hari Prasad)

DRRH-85 has successfully completed three years of testing in AICRIP trials (IHRT-MS). It is a higher yielding hybrid with MS grain type having BPT 5204 type grain quality and medium duration suitable for cultivation in Tamil Nadu, Maharashtra and Madhya Pradesh. It is a very good replacement for a popular variety BPT 5204. It has shown yield superiority over the checks on overall mean and in the Southern region.

DRRH 85

Twenty seven promising genotypes were identified from the available breeding materials and fifty crosses were attempted between the promising lines. Around 400 test crosses, 200 paired crosses and 15 varietal crosses were made and 25 promising test crosses were identified for further evaluation. Three hundred eighty single plant selections were made from the breeding materials in various segregating generations

GEY/CI/HY-8.

Development of Parental lines and hybrids with tolerance to salinity and suitability to aerobic situations. (P. Senguttuvel)

Three aerobic hybrids were nominated in aerobic trials (IR 58025A/L2182, IR68897A/SV-315-080R, IR58025A/AYT21) and one hybrid in CSTVT trial (IR79156A/50-13) of AICRIP 2014. New hybrid combinations are identified and included in seed production (Rabi 2015) for IHRT/salinity trails (APMS6A/SL-12-12R).

The DR714-2R restorer is selected for qDTY 12.1 (yield under drought) & Pup1 and APMS 6B (I) for Pup1 and Saltol 1 introgression. The restorer and maintainer lines were phenotyped under drought, low 'P' and salinity conditions. Backcrosses are being attempted with qDTY12.1 positive F1s with DR714-2R and BC_1F_1 positives with APMS 6B recurrent parents.

AR19-42

Fig. Average yield of different group of genotypes under gradient P

Total 421 high yielding F_8 generations lines derived from 21 cross combination are screened for grain yield & its contributing traits under direct seeded and irrigated conditions and also screened for blast, 170 found tolerant and included in 3 row pedigree (*Rabi* 2015). 2 row pedigrees of 200 F_8, 280 F_5 and 210 F_3 generation lines for aerobic & salinity stress was also being evaluated. 30 new F_1s generated utilizing QTL donors for drought, salinity, P use efficiency, and other stresses with parental lines and being evaluated in Rabi 2015 for further generations.

Five new restorer lines *viz.*, AR19-42, AR19-18, AR7-65, AR7-75 and AR19-21 are developed by pedigree method utilizing KMR-3R restorer line with MTU1010 & Shabhagidhan and are included in station trail to study the combining ability and heterosis with four different CMS lines.

GEY/C1/HY/6

Genetic improvement of maintainers and development of CMS lines (K.B. Kemparaju)

774 entries were grown for effecting F1's in source nursery. Of which, 600 crosses were successful

and grown in test cross nursery for its evaluation. Among them nine maintainers and twenty restorers were identified. In the identified ones, promising maintainers include CRR 575-38-1-1, RP 4993-55-14-3-5-1 and CR 3818-1-1-1-1-2. Around 100 paired crosses for APMS-6A/B and 50 for IR 68897A/B were made. Identified 50 high stigma exsertion entries from segregating breeding material.

Cross Combination	Generation
APMS 6A X ORJ -1130	BC_1 Generation
IR 68897A X ORJ - 1130	BC_1 Generation
APMS 6A X NDR 2109-9-1	BC_2 Generation
Pusa 5A X NDR 2109-9-1	BC_2 Generation
Pusa 5A X R-RH2B1-5	BC_3 Generation

GEY/CP/PP/12

Physiological approaches for Ideotype breeding in rice (P. Raghuveer Rao)

The project is being implemented from 2012. The major objective of the project is to study and understand various ideotype concepts available in the literature and evaluate them for suitability to Indian conditions to increase the yield potential of the rice crop. Genotypes drawn from diverse genetic background like tropical japonicas, indica germplasm and land races, wild-rice introgressed lines developed at IIRR under different breeding/biotechnology programmes, popular and promising restorers from hybrid rice section along with popular HYVs and second generation hybrids representing various ideotype models including New Plant Type (NTP) proposed by G.S. Khush in the background of tropical japonicas, second generation NPTs and Green Super Rice (GSR) developed at IRRI were evaluated in this study for identifying suitable donors. The study so far revealed that tropical japonica lines have thick dark leaves with erect upper leaves and horizontal lower leaves with deep root system and strong culms and have high productivity. In indica land races and germplasm lines it was found that the grain quality traits were desirable with slender long grains. It was also found that despite its high yielding capacity and other desirable traits, the tropical japonica lines are found to be susceptible to biotic stresses whereas the indica land races and germplasm lines show relative tolerance to major biotic stresses. Data collected on various physiological attributes reveal that the rate of photosynthesis was higher in tropical japonica lines and new generation hybrids. Based on this information different donors are identified to propose a NPT model suitable for irrigated ecosystem.

Variation in Photosynthetic efficiency [µmol $(CO_2)m^{-2}s^{-1}$] in different groups of rice

Group	Mean	Range	df	MSS	F	ProbF
AVT-1-ME (16)	23.74	26.92 - 21.70	14	5.17	4.128	0.0047***
Hybrids (8)	21.27	25.53 - 14.71	6	25.64	4.573	0.032**
Germplasm/Landraces (24)	13.97	25.5 - 6.90	22	43.24	40.244	1.44E-13***
Introgressed lines(10)	14.74	19.1 - 9.72	8	16.94	15.239	0.00019***
Tropical Japonica (20)	23.60	32.43 - 13.03	18	65.62	6.2262	8.4E-05***
Released Varieties (30)	16.49	27.44 - 10.75	28	44.21	20.205	6.5E-11***

** (P<0.01); *** (P<0.005)

After 5 days of re- watering

GEQ – Genetic enhancement of quality for domestic and export purpose

GEQ/CI/BR/8

Enhancing nutritional quality of rice through biofortification (V.Ravindra Babu)

One hundred fifty single plants in F_6 generation of four crosses, and 50 lines in F8 generation of nine crosses were selected with high zinc and iron contents in polished rice. One hundred thirty five high yielding varieties and 48 germplasm accessions from Liberia were screened for zinc and iron contents in brown, the results indicated that zinc and iron in brown rice varied from 8 to 35 ppm and 7 to 19 ppm , respectively. Thirty six promising lines from HarvestPlus materials were screened for zinc and iron contents which ranged from 8.5 to 14.8 ppm iron and 14.5 to 29.8 ppm zinc in brown rice. Seventy nine landraces from North East were evaluated for yield, iron and zinc content. BPT5204/Chittimuthyalu RIL mapping population is being characterized with SSR and candidate gene based markers, 677 primers have been designed targeting seven genes families associated with zinc metabolism in rice.

IET 23832 ((RP 5886-HP 3-IR80463-B39-3), a Zinc line developed from the cross IR 73707-45-3-2-3/ IR 77080-B-34-3 is a mid early duration culture (~130 days) with long slender grains. It recorded an average of 18.18 ppm Zinc content in polished grains which is higher than the checks viz., Kalanamak (16.43 ppm) and Chittimuthyalu (16.71 ppm). It is found promising for the states of Karnataka, Tamil Nadu and Andhra Pradesh with high yield potential.

GEQ/CI/BR/20

Development of Value Added Rice Based Products for different uses (M. M. Azam)

After 72 hrs of soaking and germination of seeds of Sampada variety, the time required for cooking was reduced from 25 min to 18 min, water uptake ratio was increased from 149.2 to 261.5, volume expansion ratio decreased from 5.32 to 4.35 and length expansion ratio increased from 1.051 to 1.152. Anti-oxidant capacity of germinated brown rice (GBR) was measured in terms of DPPH radical scavenging activity. Antioxidant activity of simple BR, 24-hours GBR, 48-hours GBR and 72-hours GBR were 104.8%, 111.29%, 159.68% and 170.97%, respectively and higher than the polished rice. While over BR, the antioxidant activity of 24-hours GBR, 48-hours GBR and 72-hours GBR are higher by 3.15%, 26.77% and 32.28%, respectively.

Sensory evaluation of polished rice obtained from iron fortified paddy was studied in traditional plain rice and pulihora recipes with normal rice sample of variety Sampada by 15 semi-trained panel members using 7 point hedonic rating score card. The results indicate that there was no difference in the sensory parameters like colour, taste and over all acceptability in normal and iron fortified rice samples. Effect of newly developed iron fortified rice on hemoglobin level was studied in 22 anemic girls in the age group 17 - 22 yrs. Fortified rice was given thrice a week for two months. The result indicated that hemoglobin level was increased from the initial value of 9.19 g/dL to 10.27 in the first month and to 10.67 g/dL in the second month. However in placebo group, the increase in hemoglobin was not observed.

Protocol was developed for preparation of Rice Bran oil (RBO) spread which looks like a gel that can be used as a substitute of butter, margarine and vegetable ghee in bakery products. In addition, method for extraction of rice bran protein was standardized and suitable rice protein rich shampoo composition was formulated for maintaining healthy hair. Two health care products rice moisturizer and pain relieving gel were produced in bulk (23.0 kg, 24.0 kg, respectively) for commercial sale.

GEQ/CI/BR/13

Genetic enhancement of aromatic short and medium grain rices (G.S. Varaprasad)

IET 24620 (RP 4926-215-175-90-60-45-19), IET 24615 (RP 4926-341-128-101-31-13), IET 24617 (RP 4926-215-111-74-21-12) and IET 24625 (RP 4926-401-86-72-50-28) developed from Swarna/RAU 3041, were promoted to second year of testing in AVT1 ASG of AICRIP trial based on their yield superiority over best checks on overall and regional means.

Two hundred and fourty three single plant selections were made from F_2 populations derived from seven crosses *viz.*, Swarna/Dubraj, Sona/Malysia Swarna/Sonachoor, Swarna/RAU 3041, Swarna/KB 13//Swarna/Dubraj, Sona/Kanikabhog, Swarna/Malaysia//Shiklaphool, and Rasi/Sonachoor. In addition, 1250 F_3 progenies from 25 crosses were evaluated and 713 single plant selections were made. Fifty entries in F_5 generation of Swarna/RAU 3041 were evaluated in station trial and five entries were identified as promising for multilocation testing in AICRIP trials.

GEQ/CI/BR/21

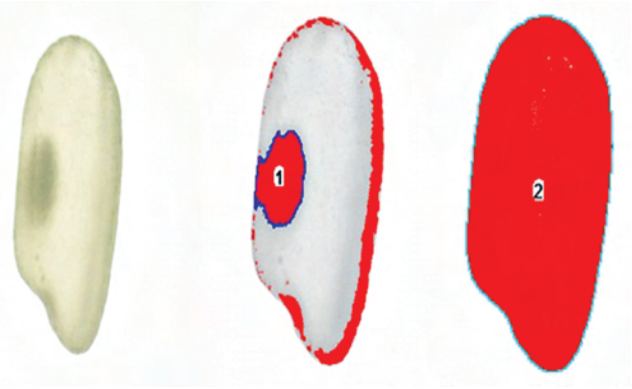
Breeding for quality improvement of rice through conventional and molecular approaches (Suneetha Kota)

Of the 1930 entries from 28 crosses evaluated in two row pedigree nursery, 82 entries with more than 20mm kernel length after cooking were selected. In addition, 760 single plant selections were made from 17 crosses. Single panicle from 100 F_2 plants of IET 18033/IET 18004 and Vasumati/IET 18004 were randomly collected for developing RIL population to map quality traits.

GEQ/CI/BR/18

Investigation into starch properties and chalkiness on rice cooking quality (D. Sanjeeva rao)

Amylose and amylopectin content was analysed in single fully chalky and translucent grain of rice varieties along with bulk seeds. The results indicated significant positive correlation (0.76) of amylose content between single and bulk seeds. The variations in amylose content was marginal in translucent and chalky grains while it was significant in the case of amylopectin using non-interference method (Williard, 1965), while the widely followed Juliano (1971) method produces higher amylose values due to interference of amylopectin. This study concludes that the presence of chalky area affects the proportion of amylopectin but not amylose.



Quantification of chalky area in single rice grain by image analysis.

ABR - Application of Biotechnology tools for Rice improvement

ABR/CI/BT9

Improvement of rice against biotic and abiotic stresses through transgenic approach (S.M. Balachandran)

Several homozygous lines of Bt (Cry1Ac) transgenic rice of IR64 were screened for YSB resistance. Based on the yield performance and stringent whole plant bioassay in transgenic glass house, about 10 consistently stable lines were identified. Confined field trial at IIRR Research Farm will be conducted before promoting to BRL-1 trials (Fig.3).

Fig. 3: IR64-Bt transgenic rice plants evaluated against YSB Biosafety screen house.

Three independent transgenic events in the background of BPT 5204 were developed with DREB1A gene. Event selection trial (EST) in real time conditions in biosafety screen house also confirmed very high level of drought tolerance among the best events. Identified around 25 lines which are highly tolerant to drought both at vegetative and reproductive stages. Select lines are being promoted to Biosafety Research Level-1 (BRL-1) trials (Fig.4).

NT Control Transgenic BD33-24 lines of Rasi and Vandana

ABR/CI/BT/6:

Identification of genes for grain filling in rice (*Oryza sativa L.*) (C.N. Neeraja)

Based on three seasons and two locations experiments, 24 genotypes were selected with differential grain filling across the panicle. Out of two genes reported to be associated with extra heavy panicle *viz.*, sucrose transporter and ADP-glucose pyrophosphorylase (AGPase), expression of sucrose transporter (OsSUT1-2) appears to be associated with total grain filling of 80%. Across panicle, the enhanced expression of OsSUT1-2 was associated with >85% grain filling in spikelets on primary and secondary branches of upper portion and primary branches of lower portion of the panicle (Fig.). The expression of OsSUT1-2 was relatively poor in spikelets on secondary branches of the lower portion of the panicle.

Fig.: Real time expression analysis of OsSUT1-2 in panicles of 24 genotypes

ABR/CI/BT10

Genomic studies on grain yield heterosis and WA-CMS trait in rice (R.M. Sundaram)

Grain yield heterosis: Through test crosses, a set of nine rice hybrids (APMS6A/612-1, IR58025A/1009, PMS10A/612-1, CRMS32A/KMR 3R, PMS10A/EPLT109, PMS10A/ KMR 3R, CRMS31A/BCW 56,CRMS32A/BCW 5 and IR68897A/1096) possessing positive standard heterosis for grain yield and per-day productivity and six hybrids (IR58025A/EPLT109, CRMS31A/ SC5-2-2-1, APMS6A/Salivahana, PMS17A/611-1, PMS17A/BCW56) possessing negative standard heterosis for grain yield and per-day productivity were identified. A set of several EST and genomic SSR markers were tested among these hybrids and other such hybrids possessing positive or negative heterosis for their capacity to predict heterosis. Interestingly, 10 EST-SSR markers (*viz.*, RMES2-1, RMES3-2, RMES5-1, RMES6-1, RMES8-1, RMES9-2, RMES10-1, RM151, RM168 and RM169), four SSR markers targeting $(GATA)_n$ motifs located in promoter region of genes (*viz.*, jGATA009, jGATA058, jGATA12 and jGATA225) and 12 hypervariable genomic SSR markers (*viz.*, HRM12469, HRM20866, HRM11570, HRM16006, HRM24217, HRM23595, HRM24383, HRM18770, HRM25754, HRM16606, HRM6740 and HRM HRM13131) were identified to be highly informative and useful for prediction of heterosis.

Wild Abortive-Cytoplasmic Male Sterility (WA-CMS) trait: An extensive literature survey was carried out in rice and other crops to list the genes or genomic regions, which are associated with respiration and CMS trait and a set of putative candidate genes were identified (WA-352, ORF126, ORFB, ORF 79, ATP6 & UPSTREAM REGIONS OF ATP6, COX11, upstream regions of Nad5 and NADH complex). These genetic regions were analyzed for polymorphism in the coding and upstream sequences using the reference mitochondrial genome sequences of *Indica*, *Japonica*, *O. rufipogon,* WA-CMS and Maintainer. *In-silico* sequence analysis revealed the polymorphism between WA-CMS and normal mitochondria with respect to WA352 and ORF126, indicating that they are putative candidate genes for WA-CMS trait. It was also noticed that the ORFs for WA352 and ORF126 overlap and both refer to the same candidate gene. Further, a robust co-dominant functional marker based a 20-bp Indel polymorphism in WA-352/ORF126 has been developed (Fig. 2).

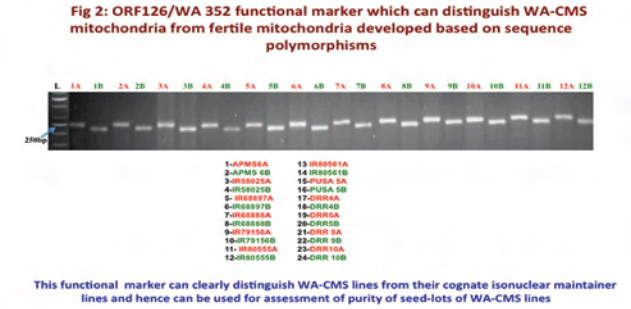


Fig.2: A PCR-based marker targeting an Indel polymorphism in WA352/ORF126 clearly distinguish all WA-CMS lines and their maintainers

ABR/CI/BT 11

Identification of SNP haplotypes in starch synthesizing genes and their association to the various quality characters (M Sheshu Madhav)

Ten gens involved in starch biosynthetic genes and candidate gene of qGT-6 (large effect QTL identified for Gelatinization Temperature) were targeted for identification of SNPs. The list of SNP from these genes is given below (**Table 1**). For these SNP's KASP (Kompetitive Allele Specific PCR) SNP assays were designed. KASP assays were standardized using LC-96 RT PCR.

ABR/CPT/PATH/16

Suppression of Rice tungro virus through RNA interference (Satendra K Mangrauthia)

T1 plants of 10 putative RNAi transgenic lines developed using coat protein gene of Rice tungro spherical virus were characterized at molecular level. Out of three putative transgenic lines (10 plants) used for Southern hybridization analysis, two transgenic lines namely SKM-411 and SKM-447 were found to be Southern positive (**Fig. 5**). High quality DNA was extracted for Southern analysis and restriction was done with BamH1 restriction enzyme. The BamH1

Table 1: The list of SNPs identified from gens involved in starch biosynthesis & candidate gene of *qGT-6*

S.No	Gene/ Gen Bank No.	Chr	RAP Locus	SNP from start codon/Type
1	Granule-bound starch synthase I (GBSS I) FJ235761–FJ235787	66	Os06g0133000	2321-A/C, 2810-T/C
2	ADP-glucose pyrophosphorylase large subunit (ADPase-L)FJ235694–FJ235711	1	Os01g0633100	41-A/T; 1137-G/A;
3	ADP-glucose pyrophosphorylase small subunit (ADPase-S) FJ235712–FJ235727	8	Os08g0345800	5281-A/G, 2929-C/A
4	Putative 1,4-alpha-glucan branching enzyme (BE) FJ235747–FJ23576	6	Os06g0367100	-203-A/G; -185-A/G
5	Branching enzyme-3 precursor (BE3) FJ235728–FJ235746	2		63-C/G
6	Putative isoamylase-type starch debranching enzyme (SDE)FJ235804–FJ235836	9	Os09g0469400	6860-G/A; 6600-A/C
7	Putative GIGANTEA (GI) FJ235788–FJ235803	1	Os01g0182600	734-G/T; 327-A/G
8	Putative starch synthase DULL1 (SSdu1) FJ235837–FJ235854	8	Os08g0191500	2233-T/C; 2311-A/G
9	starch synthase IIa (SSIIa)	6		4198 G/A
10	Sucrose synthase	6		4797380 A/G; 4798303 G/A

digested DNA was transferred to nylon membrane. DNA hybridization was performed using non-radioactive fluorescent probe synthesized using coat protein gene. Also 6 PCR positive transgenic lines (SKM-312, SKM-332, SKM-394, SKM-406,SKM-422, and SKM-467) were included for further analysis. These lines were advance to T2 generation. More than 200 plants were grown at T2 stage. These plants represented 2 Southern positive and 2 PCR positive lines. At T2 stage, 200 plants were tested by PCR for the presence of transgene using gene specific primers. PCR positive plats were used for phenotyping. The phenotyping was done along with susceptible (TN1) and tolerant (Vikramarya and Nidhi) cultivars of rice. Standard AICRIP method was used for screening the plant for tungro virus resistance. All PCR and Southern positive plants were resistant to tungro virus (Fig. 6).

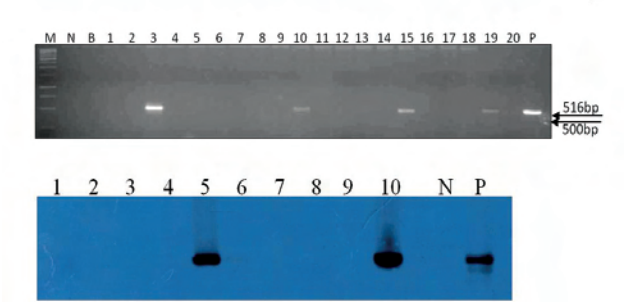


Fig.5: PCR Southern hybridization analysis of RNAi plants (T1)

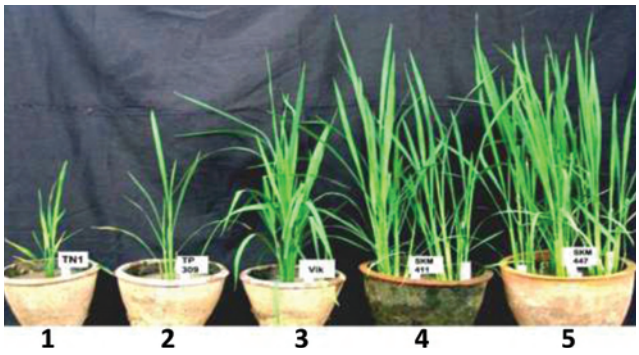


Fig. 6: Phenotyping of RNAi transgenic lines (T2), 1- TN1 (susceptible cultivar), 2- Taipei 309 (non transformed control), 3- Vikramarya (vector resistant cultivar), 4 &5- RNAi transgenic lines in the background of Taipei 309.

ABR/CI/HY/9

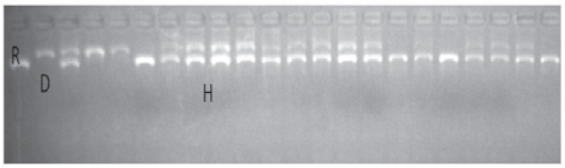
Molecular breeding for Parental Line Improvement in Hybrid Rice (Dr . P. Revathi)

RPHR-1096, DRR 9B were crossed with donors of BLB, blast and BPH resistance and F_1s were back crossed with recurrent parents, these crosses are in BC_1F_4 stage of evaluation.

Fig : DRR 9B with blast resistance gene Pi2 in blast screening nursery

The restorer line RP 5935-1500 derived from the cross RPHR 1096/ Improved Samba Mahsuri (RP bio 226) was subjected to phenotypic and molecular screening for the selection of homozygous resistance lines.

Fig 1- Molecular Screening for *Xa21 in BC1F2 population of RPHR 1096 X RP Bio 226*



R- RPHR 1096, D- RP Bio 226, H- Heterozygous

The improved restorer RP 5933-1-19-R-2 derived from the cross Swarna X IBL57 with the yield potential of 6.5 t/ha with short bold grain and 50% flowering of 105 days which performed well under SRI condition was nominated for AICRIP IVT-Medium trial *Kharif* 2015.

RP5933-1-19-R-2

ABR/CI/BR/11

Mapping quantitative trait loci (QTLs) for yield and related traits using backcross inbred lines (BILs) from elite x wild crosses of rice (*Oryza sativa* L.) (Divya Balakrishnan)

104 BILs derived from cross Swarna x *Oryza nivara* (IRGC81848) and 90 BILs derived from cross Swarna x *Oryza nivara* (IRGC81832) and 118 backcross inbred lines (BILs) derived from cross KMR3 x *O. rufipogon* were screened at *Kharif* 2014 along with recurrent parents for yield and related traits at DRR farm. The data obtained from three seasons was analyzed and compared with high yielding checks; introgression lines 166s, 14s and 148s were selected as best lines with most of the desirable yield traits compared with checks. Stability analysis was conducted using the data on single plant yield from different seasons and locations using AMMI analysis (SAS) and GGE biplot and 14S was identified as the most stable genotype across the locations and seasons followed by 166s and 248s (DRR Dhan40).

Among the BILs 166s has highest photosynthetic rate PN, stomatal conductance, concentration of pigments, chlorophyll a, chlorophyll b and carotenoids. Significant variation was observed in mean PN between checks and BILs in both the seasons. Among, BILs mean PN ranged from 148S (22.17) to 70S (15.37). 166s and derived lines performed better in case of

vigour compared to checks. BILs outperformed popular checks in case of vigour.

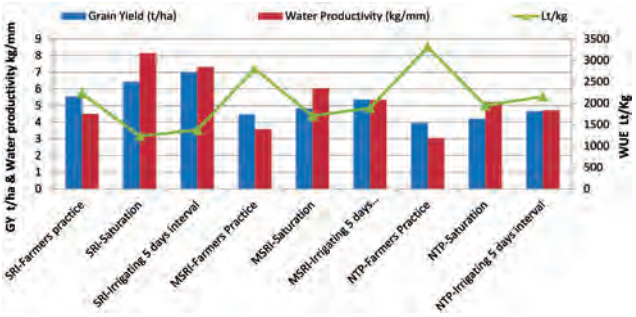
BILs were surveyed for reported genes/ QTLs for yield traits and also using universal core genetic map for rice (Orjuela *et al,* 2010) and the genotypic data was analyzed using Graphical Genotypes software (GGT 2.0) (Van Berloo, 2008). The BILs were genotyped using previously reported markers linked to photosynthetic traits and seedling vigour for haplotype analysis.

RUE – Enhancing Resource and Input Use Efficiency

RUE/CP/AG/10

System of Rice intensification (SRI) - Potential and Sustainability (R. Mahender Kumar)

A total of 69 cultivars (21and 46 cultivars which included high Yielding varieties, hybrids and few elite cultures in both *kharif* and rabi seasons) were evaluated for their yield potential in SRI vs. NTP. Irrespective of the season, all the cultivars were promising under SRI method with a yield increase of 20% over NTP. The inputs were also reduced to the extent of 80% in seed rate, 25% in fertilizer usage and 20-25% in water saving there by enhanced the input use efficiency and total factor productivity in SRI method. Among the cultivars, the performance of hybrids was promising over high yielding varieties and scented & elite cultures.



The promising cultivars *viz.,* Akshayadhan, RP Bio-226, Sampada, Rasi, DhanRasi, Shanthi; Hybrids *viz.,* PA 6444, DRRH3, KRH-2, US 312 and US 314; and Elite cultures *viz.,* Jarava, BK-39-179, TRG-1365,BK-4943 and TRG-12.3 were found promising in terms of better grain yield response in SRI over NTP and identified for SRI cultivation.

Long term trial to assess the nutrient management and sustainable rice production revealed that, grain yield in SRI was significantly higher over NTP (37% in rabi 2012-13, 21% in *kharif* 2013 and 32% in rabi 2013-14). There was a difference in the yield gains in *kharif* and rabi seasons. The nutrient use efficiency and Agronomic efficiency were higher in SRI method over NTP. Among the nutrient combinations, use of integrated organic and inorganic nutrient management found promising over organic or inorganic alone and trend was clear and significant year after year.

There was an increase in Glucosidase activity in SRI method. SRI method supported higher glucosidase activity (91.24 µg p.nitrophenol released g^{-1}soil h^{-1}) compared to NTP (51.18 µg p.nitrophenol released g^{-1}soil h^{-1}).

The farmers field trials (30 NO's) conducted during rabi with water tube (perforated water tube) method to assess the water saving potential for SRI over NTP in different soil conditions also indicated the saving of water to the tune of 28%. The percent water saving varied from soil type and management condition.

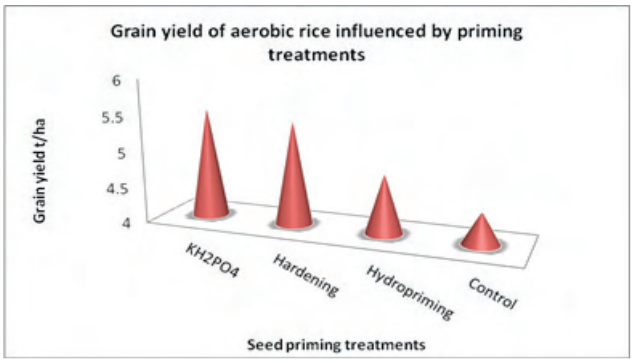
RUE/CP/AG/13

Agro techniques for improving the productivity of aerobic rice (B. Sreedevi)

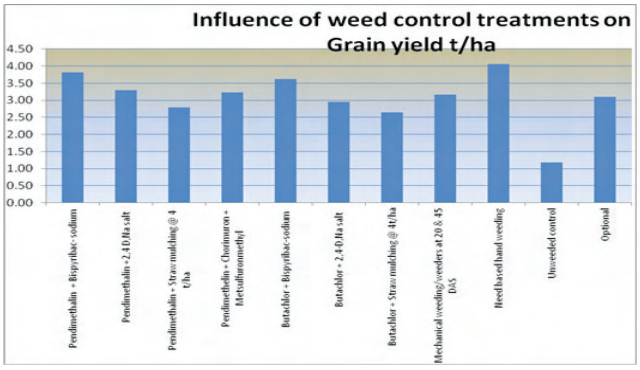
Integrated nutrient management in aerobic rice : The experiment was laid out in split plot design with three replications. The experiment was carried out using one Hybrid (PAC 837) one High Yielding Variety (IR64) with 75 and 100% recommended N, P and K along with biofertilizers (Azospirillum+Phosphorus) Solubilizing Bacteria(PSB)+rooting micorrhiza), The PSB solubilization rate was higher in PSB, Azo+PSB treatments in bulk as well as rhizosphere soils. The

azospirillum population was higher in Azo, Azo+ PSB treated plots and contributed to N nutrition. Results of grain yields showed fertilizer schedule of 75% RDN/ha, 75% RDP and 100% RDK along with Azospirillum+PSB application @ 5 kh/ha each, found to be the best schedule with saving of 25% of N and P requirement.

Influence of seed priming on performance of aerobic rice :



The experiment was conducted during *kharif* 2014 for second consecutive season in Split plot design with four replicates comprising four seed invigoration techniques: (a) Priming with Potassium Dihydrogen Phosphate 4% (b) hardening (soaking seeds in water for 3 hours and re-drying in shade for 3 hours back to initial moisture content and cycle was repeated 4 times (c) hydropriming (soaking seeds in water for 48 h and redrying to original moisture content), (d) unprimed seed (control), and two cultivars *viz.*,PA6444, and weed free and (b) weedy. This study showed that seed priming can enhance the seedling vigor and seedling growth which in-turn improves the weed suppressing ability of rice, and consequently reducing the risks of poor stand establishment and crop losses due to weeds.



Comparative performance of Cultural, Mechanical and Chemical weed control practices in aerobic rice The experiment was conducted in Randomized Block Design with three replications, with different Integrated weed management practices (Pendimethalin (30EC) @1.0 kg a.i/ha (within3-4 DAS) + Bispyribac sodium (10%SC) @ 35 g a.i / ha (15-20DAS), Pendimethalin (30EC) @ 1.0 kg a.i / ha (within3-4 DAS)+ 2,4 D, Na-salt (80WP) @ 0.06 kg a.i /ha (20-25 DAS), Pendimethalin (30EC) @ 1.0 kg. a.i /ha (within3-4 DAS)+ straw mulching @ 4 t/ ha, Pendimethalin (30EC) @ 1.0 kg a.i /ha (within3-4 DAS)+ (Chorimuron + Metsulfuronmethyl) (20 WP) @ 40 g. a.i/ha (25-30DAS), Butachlor (50 EC) @ 1.5 kg a.i /ha (3-4 DAS) + Bispyribac sodium (10% SC) @ 35 g a.i/ha (15-20 DAS), Butachlor (50 EC) @1.5 kg a.i/ ha (3-4 DAS) + 2,4-D, Na-salt (80 WP) @ 0.06 kg a.i/ ha (20-25 DAS), Butachlor (50 EC) @1.5 kg a.i /ha (3-4 DAS)+ straw mulching @4 t/ha (25-30 DAS), Butachlor (50 EC) @ 1.5 kg a.i/ha (3-4 DAS) + (Chorimuron + Metsulfuronmethyl) (20 WP) @ 40 g a.i/ha (25-30 DAS), Mechanical weeding at 20 and 45 DAS, Need based hand weeding and compared with Unweeded control. The study identified mechanical weeding, sequential herbicide application as alternatives to manual weeding. Pendimethalin @ 1 kg a.i./ha 3-4 DAS) fb Bispyribacsodium 35 g at 2-4 leaf stage of weeds or chlorimuron + Metsulfuronmethyl 40 g a.i./ha at 25-30 DAS) in reducing weed menace and thus help in realizing higher grain yields that are comparable to or closer to need based hand weeding.

Evaluation of advanced lines of high yielding varieties and hybrids under aerobic cultivation In *kharif* 2014, screening of weed suppressive advanced lines (Early and mid-early duration). and hybrids *viz.*, Among the 36 test entries of HYV s , IR83142-B-57B,SAGC-05, Huanghuazhan, YJ 20, P-35, HUA564, HUA565,Huanghuuazhan, Zhunghuai, Weed Tolerant Rice1, Luyin46 and D4098 exhibited best performance for second season under aerobic field conditions. Variety Sabita, IR64 were taken up as checks. Among the tested IET entries 23449, 23471 and 23463 exhibited better performance under 100% Recommended Nitrogen Dose.

SSP- Sustaining Rice System Productivity

SSP/CP/SS/11

Assessment of genotypic variability and improving nitrogen use efficiency in irrigated rice (K. Surekha)

This field experiment was initiated in 2010-11 and was continued during *kharif* and *rabi* seasons of 2014 with 2 N levels (@ N-0 and N-100 kg/ha) as main treatments and 15 genotypes as sub treatments in a split plot design with 3 replications to evaluate the N use efficiency and to identify efficient rice genotypes for their responsiveness and use of soil and applied N. In another experiment, 36 Green super rice (GSR) entries from IRRI were evaluated for their NUE at the same N levels. As a third part, some selected varieties (10) were evaluated at graded levels of N (0, 50, 75 and 100 kg N/ha) to select best genotypes that yield similarly at maximum and reduced N doses. Based on the several NUE indices, the genotypes Rasi and Ravi from early; DRRH88, DRRH 85 and RP-Bio-4919-363-5 from medium and Swarnadhan and SACG 4 (GSR) from long duration group were most promising and ranked top for both soil and applied N utilization and responsiveness.

Among the GSR lines, the entries *viz.*, IR 83141-B-32-B, P35, IR 83142-B-21-B, HUA 564, HUANGHUAZHAN, IR 83142-B-60-B and weed tolerant Rice 1 occupied the top 5 positions in most of the NUE indices and can be better utilized in N limiting environments.

Table : Top five GSR lines showing better NUE indices

Rank	Grain yield (t/ha)		PFP	AE	PE	N requirement (kg/t)	
	N0	N100				N 0	N100
1	IR 83141-B-32-B	IR 83141-B-32-B	IR 83141-B-32-B	P35	Akshayad-han	HUA 564	IR 64
2	IR 83142-B-60-B	IR 83142-B-60-B	IR 83142-B-60-B	HUANG-HUAZHAN	IR 83141-B-18-B	6527	Akshayadhan
3	HHZ 5-SAL 10-DT 1-DT 1	P35	P35	IR 83141-B-32-B	HHZ 5-SAL 10-DT 2-DT 1	WEED TOLERANT RICE 1	HHZ 17-DT 6-SAL 3-DT 1
4	SACG 4	IR 83140-B-36-B	IR 83140-B-36-B	HUA 564	HUANG-HUAZHAN	HUANG-HUAZHAN	IR 83142-B-21-B
5	IR 83142-B-21-B	WEED TOLER-ANT RICE 1	WEED TOLERANT RICE 1	IR 83142-B-60-B	P35	P35	TME80518

SSP/CP/SS/14

Heavy metal assessment in soils, grains and water samples of rice growing areas (Brajendra)

The research work on heavy metals like cadmium, arsenic and mercury in soils and water of rice growing areas which was initiated during 2014, envisages to study the effect on heavy metals on rice genotypes, in addition to developing comprehensive database on heavy metals in representative rice growing areas and to come out with suitable strategies to eradicate such toxicities in soils and water bodies. Soil and water samples were collected from different mandals of Mahboobnagar, Nalgonda and Warangal districts. The samples were analysed for Pb,Cd,As and Hg, Except in some mandals of Nalgonda district, remaining mandal soils and water samples reported below than the FAO and BIS recommended heavy metals ratings for safer limits.

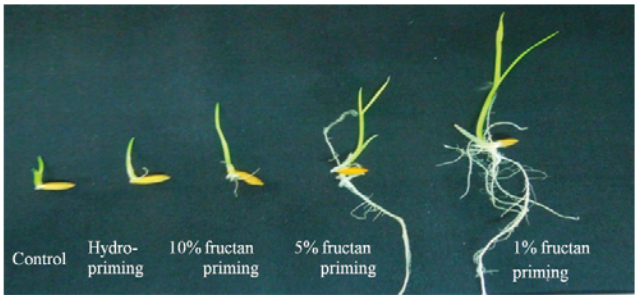
SSP/CP/SS/13

Utilization of plant growth promoting microorganisms for improving nitrogen and water use efficiency in rice (P.C. Latha)

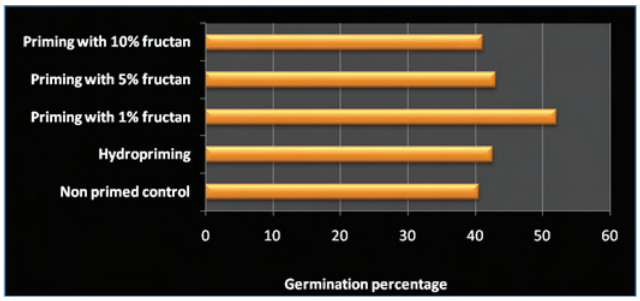
Gluconacetobacter diazotrophicus, an endophytic bacterium secretes levansucrase enzyme, which in addition to allowing the bacterium to utilize sucrose, also results in the production of extracellular levan, a β-(2,6)-linked polyfructan. Exopolysaccharide fructan of *G. diazotrophicus* PAL 5 was extracted and examined for antioxidant activities and evaluated as a seed priming agent for improving rice seed germination and seedling vigour.

Three concentrations of aqueous fructan (1%, 5% and 10% w/v) were tested for antioxidant activities, with fructan (10%) recording highest total antioxidant activity of 85.56%. Highest scavenging activity of 80.83%, 77.46% and 49.25 % for hydroxyl radical, hydrogen peroxide and free radical respectively was also observed with 10% fructan.

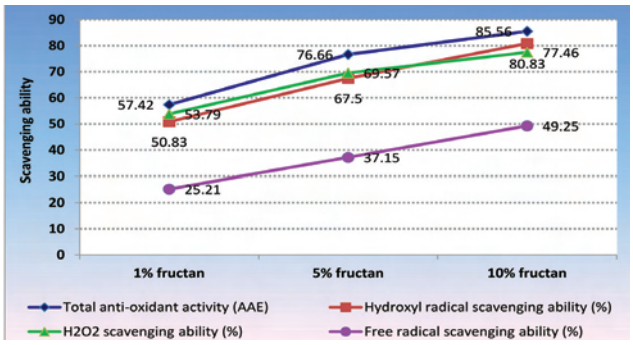
Significant differences in germination percentage, vigour index and membrane stability were observed between fructan primed (1%, 5% and 10%) and nonprimed rice seeds. Priming with 1% fructan exhibited highest germination percentage and vigour index of 52.1% and 186 over untreated control.



Seed priming not only improved germination rate but also enhanced seedling vigor, as indicated by longer roots and shoots observed in priming treatments. Seed priming with fructan enhanced the vigour index ranging from 64-182% in which priming with 1% resulted the highest vigour index of 186. Seedling lengths were increased significantly by nearly all the treatments. Priming with 1% resulted in the highest vigour index of 186. Hydropriming increased vigour index by 42.7%.



Hydropriming of rice seeds showed highest leakage (67.22%) which is followed by non-priming control (46.66%), Priming with 10 %(42.85%) and 5 %(33.33%) fructan. Priming with 1% fructan showed lowest electrolyte leakage (16.31%). Expolysaccharide fructan from *G. diazotrophicus* possesses antioxidant activities and when used as a seed priming agent it can act as a seed invigorator by increasing seed germination and vigor of rice.



CP/ENG/6

Selective mechanization in rice cultivation (T. Vidhan Singh)

Developed riding type of drum seeder by modifying the existing 8 row Chinese transplanter. The newly developed drum seeder was tested during Rabi, 2015. The results have shown that the highest yield was in case of SRI method followed by Drum seeder in case of DRRH3 followed by RP Bio-226. Due to low height of the drum seeder, soil was coming into contact with the drums. This has been modified and will be tested in *Kharif*-2015.

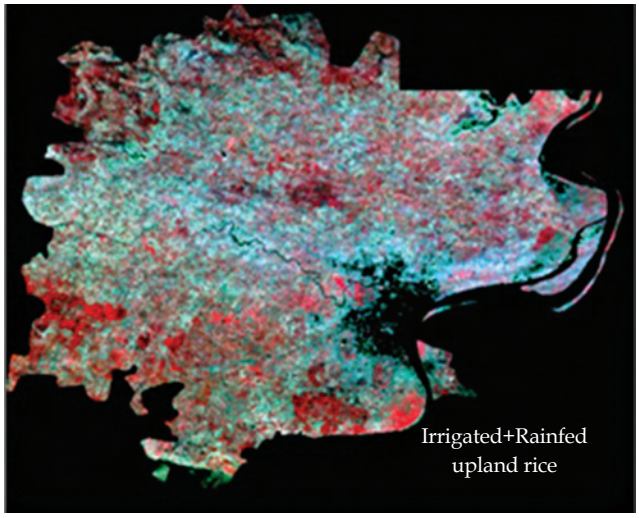
TTI/CP/CA/3

Computer Applications: Delineation of rice growing ecologies by using spatial technologies and crop models (B. Sailaja)

During this year, Oryza2000 and DSSAT models were validated under rain fed ecosystem. Rainfed Upland experiment conducted at BHU, Varanasi during 2012 under Physiology AICRIP Programme was selected for this validation. Sahbhagidhan (105-110 days) and Anjali (96 days) varieties were chosen. Oryza2000 model performed well in irrigated than in rain fed situation. DSSAT model performed well in irrigated and rain fed situations.

In continuation to validation of Oryza2000 and DSSAT models under irrigated ecosystem, this year these two models were validated under rain fed ecosystem. Growth parameters at basic vegetative, photoperiod sensitive, panicle formation and grain filling phases were generated for each variety and used for model evaluation. Grain Yields estimated from these two models were compared with observed values. Predicted values of DSSAT model were closed to observed values compared to ORYZA2000 model under rain fed situation. Oryza2000 model performed well in irrigated ecosystem than rain fed and DSSAT performed well in irrigated and rain fed ecosystems.

IRS P6 LISS3 images of Varanasi and Mirzapur districts of Uttar Pradesh were processed and rice area was identified under irrigated and rainfed upland ecosystems.



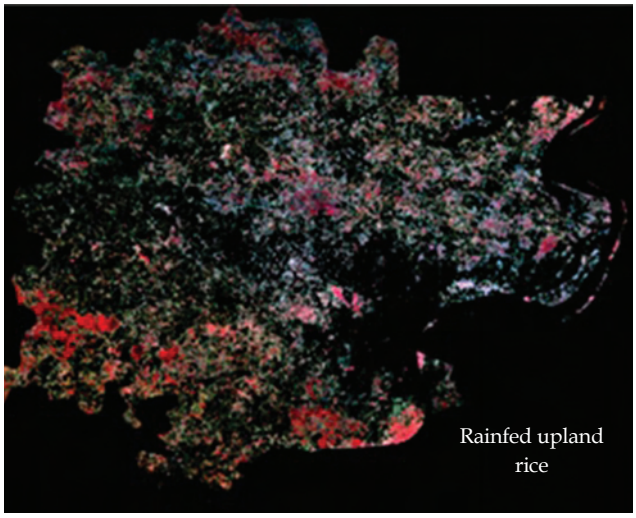


Fig : Classified Rice area under irrigated and rainfed ecosystems in Varanasi district, Uttar Pradesh (red colour pixels represent rice crop)

CCR – Assessing and managing Crop Response to Climate Change

CCR/CP/PP/9

Physiological studies on heat tolerance due to ambient and elevated carbon dioxide in rice) (S.R.Voleti)

Physiological studies on seedlings to high temperature and elevated carbon dioxide under two different soil conditions: Ten sets of Ten genotypes belonging to different duration groups were sown in clay (DRR soil) and light red (CRIDA) and 700 and 500 ppm carbon dioxide concentration in OTCs at CRIDA. During the one month period, the temperature differences between the chamber and ambient was 3-50 C whereas between the two treatment levels i.e.500 ppm and 700 ppm temperature differences were not noticed.

The results indicated that, irrespective of genotypes seedling survival % was at par under both soil conditions however, at 700 ppm CO2 survival % was more under clay soils perhaps due to better water holding capacity. Surprisingly, the seedlings grown under light soils were morphologically more vigorous and uniform when compared to the seedlings grown under heavy (clay) soil. It appears that, plants grown under light soils invested sugars for structural synthesis as evidenced by higher shoot biomass and lower soluble sugars and soil respiration rates. Seedlings under clay soils had higher soluble sugars and relatively higher rates of soil respiration rates with low shoot biomass. Measurements of SPAD values in the seedlings did not differ under both soil types. PA 6201 was found to be highly susceptible followed by KRH-2 and DR714-1-2R lines while the remaining genotypes are moderate in their tolerance to elevated CO2 condition.

Terminal heat stress, hybrids and varieties:

About 20 genotypes have been tested for variation in the phenological and yield attributes under different dates of sowing during *Kharif* season. Under delayed sowing conditions, two weeks delay in mean growth period has been recorded while under early sown conditions, the phenological development was advanced by one week. Among the genotypes, Akshyadhan, Phulguna, Triguna, Tulasi the number of grains produced were lowest under late sown conditions.. Akshaydhan had higher 1000 grain weight than rest of the genotypes under late sown condition. Forty restorer lines, 2 A lines, 4 B lines and 6 released hybrids were evaluated for 18 characters for two consecutive years. Hybrids and parents exhibited higher leaf rolling times (149-139 secs) with lower reduction in leaf area. Spikelet fertility and sterility of these genotypes, and the physiological responses such as membrane stability index, chlorophylls, water relations and photosynthesis studied.It is concluded that, leaf temperature is one of the important selection criteria that could be used to assess for high temperature tolerance.

Long term Objective of Oryza model :

Oryza model was executed with 4-8 years weather data. Sowing dates with 20 days gap starting from Jan to Aug were given as input data and optimum yield among these data sets were observed under potential and nitrogen and water limited environments. Weather parameters of optimum yield data in the above two situations under every year were compared. Based on the observations and weather, the best sowing dates wherein maximum output of yields varied. Reasons, for such wide variations in relation to sowing date and yield is being analyzed further to improve the prediction. Also, the model was executed on 3 years data sets generated under AICRIP ifor early, normal and late sown situation for 3 locations DRR, Maruteru and Titabar to predict temperature and carbon dioxide responses on rice, increased temperatures. An increase of 60C rice yields reduced by 27 to 50% across geographical locations while the increase in rice due to carbon dioxide was 1-3% only, indicating the vulnerability of rice crop.

CCR/CP/PP/11

Evaluation of genotypic variability in leaf photosynthetic efficiency and its associated factors in rice (D. Subrahmanyam)

During *Kharif* -2014, 43 divergent rice genotypes were included in the study. Significant variation in leaf photosynthetic efficiency (PN) was recorded during

kharif 2014 season grand mean of all the genotypes for rate of photosynthesis was (18.68 µ mol CO_2 $m^{-2}s^{-1}$), maximum PN among all the genotypes was recorded in land race variety Bhejaridhan as (23.76 µ mol CO_2 $m^{-2}s^{-1}$), followed by popular varieties, MTU 1010 as (23.42 µ mol CO_2 $m^{-2}s^{-1}$) and IR 64 (22.53 µ mol CO_2 $m^{-2}s^{-1}$). These entries are statistically at par with each other. Where as the PN was lower (> grand mean of all the genotypes) in Sugandha Samba as (10.51 µ mol CO_2 $m^{-2}s^{-1}$), E 2710 as (12.57 µ mol CO_2 $m^{-2}s^{-1}$) and RPHR 517 recorded the rate of photosynthesis as (13.49 µ mol CO_2 $m^{-2}s^{-1}$). These entries are statistically at par with each other. Among all the groups the maximum rate of photosynthesis was recorded in tropical japonica group as (19.44 µ mol CO_2 $m^{-2}s^{-1}$) followed by popular varieties (18.51 µ mol CO_2 $m^{-2}s^{-}1$) and land races (18.40 µ mol CO_2 $m^{-2}s^{-}1$.

Stomatal conductance (gs) differed significantly ($P<0.05$) amongst the genotypes highest values of stomatal conductance was recorded in the popular varieties like IR 64 as (0.56 mol [H_2O] $m^{-2}s^{-1}$), followed by MTU 1001 as (0.54 mol [H_2O] $m^{-2}s^{-1}$) and in Krishna Hamsa as (0.53 mol [H_2O] $m^{-2}s^{-1}$). These entries are statistically at par with each other. While the lower values of stomatal conductance was observed in RPHR 517 as (0.13 mol [H_2O] $m^{-2}s^{-1}$), followed by Germplasm line E 2710 as (0.14 mol [H_2O] $m^{-2}s^{-1}$) and Introgressed line 24 K as (0.15 mol [H_2O] $m^{-2}s^{-1}$). These entries are statistically at par with each other. Among all the groups, the maximum stomatal conductance > grand mean of all the genotypes was recorded only in popular variety group as (0.41mol [H_2O] $m^{-2}s^{-1}$). Significant variation in transpiration rate and intercellular CO_2 concentration was observed amongst the genotypes.

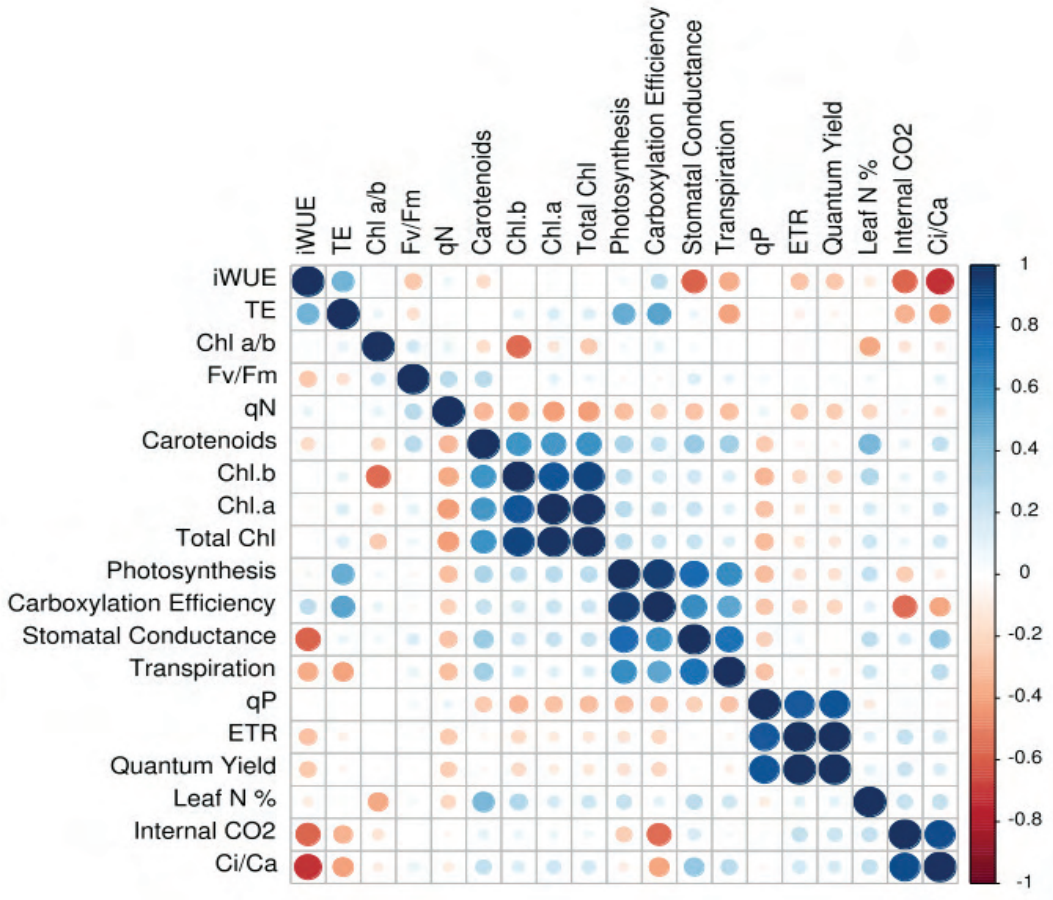


Fig. 1 Relationship between photosynthesis rate and other gas-exchange traits and fluorescence parameters.

Pearson correlation analysis was performed using the mean of all 4 seasons. Correlation coefficients were presented as coloured circles, positive association was shown in blue colour and negative correlation coefficients were presented in red colour. The intensity of colour and size of the circle indicate the value of the coefficient. The colour scale for the correlation coefficient was given on the right side of the plot.

Table 1: Relationship of Physiological traits with leaf photosynthesis, grain yield and total dry matter during *kharif* (2014) season

	Chl a	Chl b	Total Chl	Carotenoids	P_N	TDM	Grain weight (g/hill)
Chl a	1	0.269	0.927**	0.383**	0.512**	0.210	0.342*
Chl b		1	0.610**	0.177	0.203	-0.217	-0.091
Total chlorophyll			1	0.384**	0.500**	0.087	0.246
Carotenoid				1	0.475**	0.080	0.226
P_N					1	0.342*	0.542**
TDM						1	0.852**
Grain weight/hill							1

A strong positive association between photosynthesis rate and stomatal conductance, transpiration rate and carboxylation efficiency was observed (Fig.1 and 2). Strong positive association between PN and gs was reported in the literature for many crops. The photosynthetic rate (PN) and stomatal conductance (gs) of leaves are correlated across diverse environments

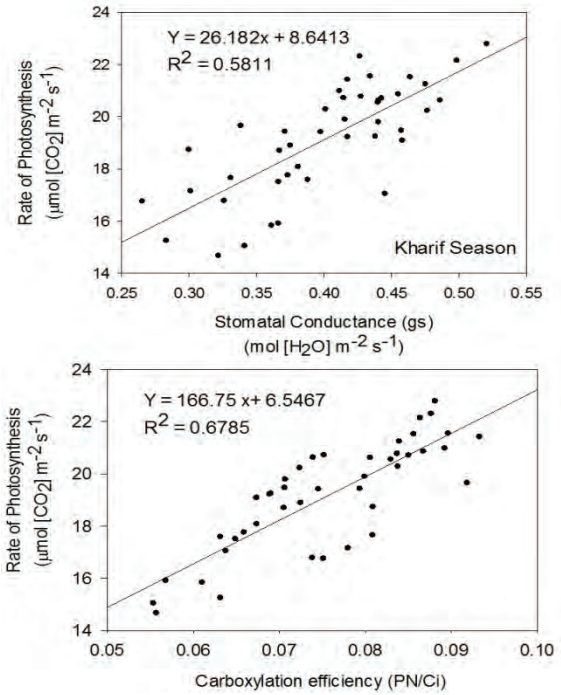


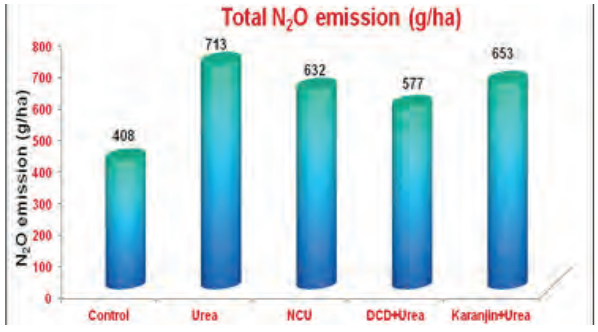
Fig. : Relationship between leaf photosynthetic efficiency (PN) and stomatal conductance(gs) and carboxylation efficiency (PN/Ci).

To understand the relationship between leaf gas-exchange traits and total dry matter accumulation and grain yield simple correlation analysis was performed (Pearson Correlation). Leaf photosynthetic pigments show positive association with PN. Leaf photosynthetic rate was found to be significantly related with TDM recorded at maturity and grain yield in *kharif* season.

CCR/CP/SS/10

Impact of changing temperatures on nitrogen dynamics and use efficiency in rice (M.B.B. Prasad Babu)

The impact of three nitrification inhibitors *viz.*, Dicyandiamide (DCD), Neem Coated Urea (NCU) and Karanjin in addition to prilled urea and unfertilized control on N_2O emissions, nitrogen use efficiency (NUE) and grain yield of rice was studied under RBD with four replications. All the three nitrification inhibitors reduced N_2O emission significantly from the rice field as compared with urea. The N_2O flux during the study period was higher with untreated urea as compared to urea with inhibitors, indicating the inhibitory role of the nitrification inhibitors on N_2O emission. Total N_2O–N emissions were highest with urea (713 g/ha) followed by Karanjin + urea (654 g/ha), NCU (632 g/ha) and DCD + urea (577 g/ha) and were least in control with no nitrogen (409 g/ha). The highest inhibition of total N_2O emission (45%) was recorded from plots treated with urea + DCD followed by NCU (27%) and Karanjin + urea (20%).



Maximum N uptake of 111 kg/ha was recorded with DCD + Urea followed by NCU (95 kg/ha), Karanjin + Urea (87 kg/ha) and untreated Urea (81.61 kg/ha) while it was the lowest (32 kg/ha) in unfertilized Control. Application of N significantly increased grain yield as compared to control where N was not

applied. The highest grain yield of 6.16 t/ha was recorded by the application of DCD + Urea, followed by NCU (5.56 t/ha), Karanjin + Urea (5.42 t/ha) and urea alone (4.83 t/ha). Karanjin + Urea performed at par with NCU in terms of yield (grain and straw) and N uptake. The yield increased by 27, 15 and 12% by the application of DCD, NCU and Karanjin respectively over untreated urea. The nitrogen use efficiency (kg grain/kg N applied) was highest with DCD + Urea (51 kg grain/kg N applied) followed by NCU (46 kg grain/kg N applied) and Karanjin + Urea (45 kg grain/kg N applied).

Effect of nitrification inhibitors on yield (kg/ha) and N uptake (*Kharif* 2014)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	N Uptake (Kg/ha)	NUE (kg grain/kg N applied)
T1 - Control	2740	3188	32	-
T2 - Urea	4831	5225	76	40
T3 - NCU	5558	6075	95	46
T4 - Urea + DCD	6157	6850	111	51
T5 - Urea + Karanjin	5415	5650	87	45
CD (0.05)	420	328	14	-
CV (%)	11	15	12	-
Expt. Mean	4940	5398	80	-

HRI – Host-plant Resistance against Insect Pests and its Management

HRI/CPT/ENT/11

Assessment of host plant resistance to brown planthopper (BPH) and whitebackedplanthopper (WBPH) and their management (V. Jhansi Lakshmi)

Of the 1600 entries consisting of breeding lines evaluated for their reaction against planthoppers *viz.*, WBPH and BPH through mass screening test in the greenhouse, two entries, MO1 and Pokkali were resistant to WBPH with a damage score of <3 and 33 entries *i.e.* IET 22957, IR 64, IET 23417, IET 23984, C 101 LAC (DP 2), IET 23420, IET 24573, TRG 170, TRG 167, CR 2711-149, IET 23837, IET 24408, IET 24424, IET 24663, IET 24658, IET 23853, IET 24639, IET 24641, IET 24655, IET 23844, Jaldidhan 6, IET 23748, IET 24735, IET 23846, IET 24731, IET 24537, IET 24662, IET 24746, IET 24367, IET 24400, IET 24656, IET 24753, IET 24732 were found to be moderately resistant to WBPH. Six entries, PTB 33, RP 4918-228(S), ARPS 2001, ARPS 2002, ARPS 2003 and ARPS 2004 were resistant to BPH with a damage score of <3 and 18 entries RP 2068-18-3-5, IR 64, IET 24575, IET 23429, IET 24425, CST 7-1, IET 24501, IET 24537, IET 24667, IET 24425, IET 24501, VPB-231, KAUM 179-2, CR 2711-149, IET 24537, IET 24667, ARPS 2010 and ARPS 2013 were found moderately resistant with a damage score of 3.1 to 5. The entries, IR 64, IET 24537 and CR 2711-149 were resistant to both BPH and WBPH.

HRI/CPT/ ENT/23

Insect-plant Interactions with Special Reference to Rice Pests–Yellow stem borer and Gall midge (A.P. Padmakumari)

Single plant selections (279 backcross inbred lines - BILs) of RP 5588 (IR 64 X *O. glaberrima*) were raised as three row material in *kharif* 2014 along with checks and were evaluated for yellow stem borer damage at vegetative phase. The mean damage in the population was 42.4 % DH with a maximum of 61.76 % DH in some of the lines. Two BILs with more than 40 % DH recovered completely and showed nil white ear damage as well as good grain filling. Another 10 BILs had 1% white ear damage suggesting that recovery resistance could be one of the mechanisms for stem borer tolerance. Similarly in the case of RP 5587, the mean dead heart damage was 40.8% and six BILs showed less than 1 % white ear damage at harvest.

In the greenhouse evaluations at DRR, involving standard screening technique of releasing adult gall midge on 15-20 day old seedlings grown in trays, the

entries IET 21842, IET 21841, IET 22096, IET 22262 IET 23247 and IET 22155 were confirmed for their resistance to gall midge biotype 1 .

HRI/CPT/ENT/19

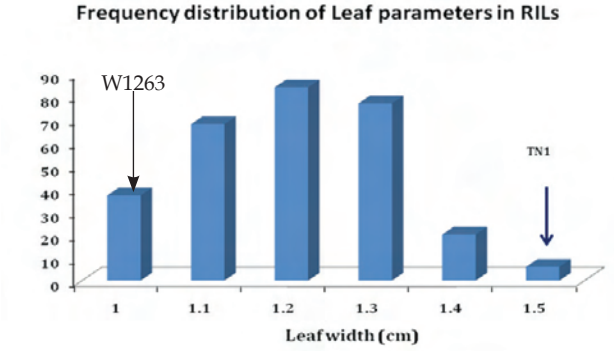
Assessment of host plant resistance to Leaffolder and its management. (Ch. Padmavathi)

Phenotyping of 204 RILs of TN1/ W1263 was done in the field for confirmation of reaction to rice leaf folder, *Cnaphalocrocis medinalis* during *Kharif* 2014.

Special screening method for phenotyping RILs of TN1/ W1263 for resistance to rice leaf folder

Each RIL was grown in a line of 20 and 3 hills were screened in each line. Special method was devised for screening wherein the leaves of the RIL were covered and tied at the bottom. A single 3rd instar larva was released on to the leaves from the top of the bag and allowed to feed for 48 hrs. After 48 hrs, larva was collected and the number of damaged leaves were counted, collected and preserved for the measurement of damaged leaf area. Damaged leaves were scanned with Cannon MF 4320-4350 scanner at colour mode with 300dpi image quality. Leaf area fed was measured by using image software (http://imagej.nih.gov/ij/). Each time, both the parents were also screened along with the RILs.

The data on frequency of leaf area damaged revealed a normal distribution curve with values between 98 and 1560 mm. The leaf area fed in TN 1 was double the area fed in W 1263. Leaf parameters like leaf length and leaf width of second leaf from top were measured in these 204 RILs along with parents. Data on leaf width indicated a normal distribution with minimum value of 1.0 cm in W1263 and maximum value of 1.5 cm in TN1.

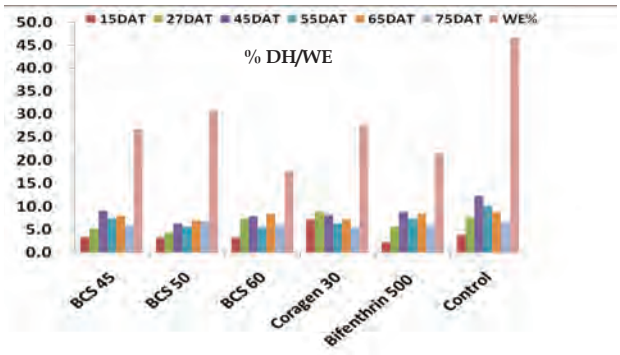


IPM- Integrated Pest Management

IPM/CPT/ENT/3)

Chemical control as a component of rice IPM (G.Katti)

A field trial was carried out to evaluate the effect of bio-efficacy of a newer insecticide BCS CL 73507 SC 200 against stem borer and leaf folder in rice during *kharif* 2014 at DRR Farm, Rajendranagar. The trial included six treatments replicated four times in a randomized block design (RBD). The treatments consisted of BCS CL 73507 SC 200 at three doses *viz.*, 40, 50 and 60 g a.i./ha, rynaxypyr (Coragen 20 SC) @ 30 g a.i./ha, bifenthrin 10 EC @ 500 g a.i./ha and an untreated control treatment without any pesticide application. Two applications were given at 30 and 55 DAT @ 500 litres of spray fluid per ha.



Efficacy of newer insecticide, BCS CL 73507 SC 200 against stem borer in rice

Stem borer incidence ranged from 2.1 to 9.1% DH in insecticide treatments and 3.8 to 12.2% DH in control during 15 to 75 DAT. The white ear incidence varied between 17.5 and 30.6% in insecticide treatments compared to 46.6% in control. BCS CL 73507 SC 200

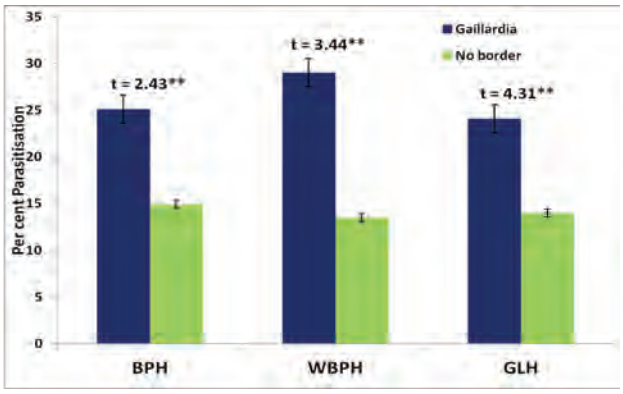
@ 60 g a.i. /ha showed significantly low white ear incidence of 17.5% on par with bifenthrin 10% EC @ 500 g a.i./ha (21.5% WE). BCS CL 73507 SC 200 @ 60 g a.i./ha yielded the highest of 4122 kg/ha on par with BCS CL 73507 SC 200 @ 45 g a.i./ha showing an yield of 3975 kg/ha.

IPM/CPT/ENT/13

Invertebrate biodiversity of irrigated rice ecosystems and its functional significance. (Chitra Shanker)

Ecologically engineering with flowering plants Gaillardia, marigold and sunflower were tested during *kharif* 2014 on GLH, BPH and WBPH egg parasitisation by egg baiting with potted plants exposed to oviposition by the three hoppers. The potted plants were brought back to the laboratory and allowed for parasitoids to develop. The parasitisation was assessed by dissecting out the eggs and by counting the emerging parasitoids. Three parasitoids, *Oligosita* sp., *Anagrus* sp. and *Gonatocerus* sp. were observed with *Oligosita* being predominant on planthoppers and *Gonatocerus* on leafhopper eggs.

The parasitisation was significantly higher in all three hopper eggs with a border of Gaillardia. The parasitisation % of GLH eggs was 14.0 without border and 24.1 with Gaillardia border (df = 138; t = 4.31; P < 0.01), in BPH eggs it was 14.92 and 25.1, respectively without and with border (df = 71; t = 2.43; P = 0.01) while in case of WBPH, the per cent parasitisation was 13.5 without border and 29.0 with Gaillardia border (df = 112; t = 3.44; P < 0.01). Keplan Meyer survival analysis of the parasitoid *Gonatocerus* sp. when offered food revealed that food had significant impact on the longevity of the parasitoid (Log-rank (Mantel-Cox test: Chi square 167.2; df 6; p value- <0.0001****). Olfactometer studies with two way and six way models were carried out on two coccinellids *Micraspis discolor* and *Coccinella transversalis* for their attraction to flowers of Gaillardia. Yellow coloured flowers were more attractive to the adult beetles.



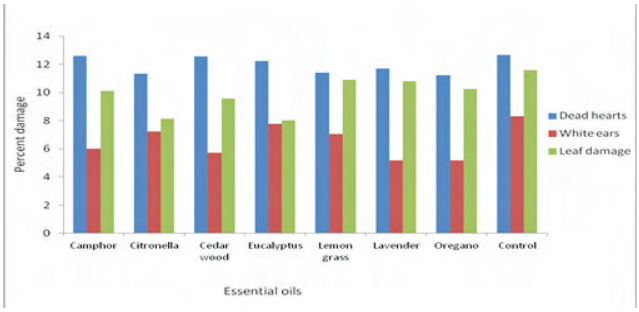
Effect of flowering border on egg parasitisation of hoppers

IPM/CPT/ENT/21

Botanicals for sustainable management of major pests of rice (B. Jhansi Rani)

A field experiment was conducted to evaluate the efficacy of essential oils at 0.5% against key pests in a randomized block design with 3 replications during *Kharif*, 2014. Of Seven essential oils tested oregano, citronella, and lemongrass oils were found to be moderately effective against yellow stem borer, *Scirpophaga incertulas,* showing 11.22-11.42% dead hearts compared to 12.68% in control. In case of white ears, lavender, oregano and cedar wood oils were effective with 5.19-5.73% damage compared to 8.33% in control. Eucalyptus and citronella oils showed efficacy against leaf folder, *Cnaphalocrocis medinalis* with 8.04-8.12% leaf damage as against 11.59% in control .

Response of yellow stem borer (YSB) female moths to various essential oils was tested using EAG in the laboratory. Of the 14 oils evaluated, YSB antennae exhibited strong response to eucalyptus and rosemary oils indicating high repellency with EAG value of > 2.9 (-mV). Moderate reaction (repellency) was recorded in oils like camphor, sweet basil and citronella.

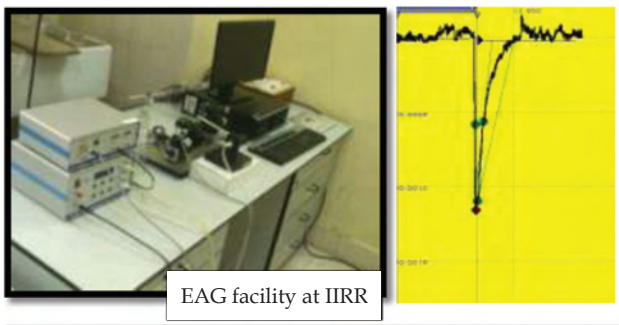


Field efficacy of essential oils against yellow stem borer and leaf folder

IPM/CPT/ENT/20

Semiochemical approaches to manage insect pests of rice with special emphasis on sex pheromones (M. Sampath Kumar)

Electroantennogram (EAG) studies were carried out to measure the electrophysiological responses of pink stem borer (PSB), *Sesamia inferens* (Walker) to 20 synthetic volatiles from rice plants. Female antenna of PSB was excised from the scape level and was mounted on dual electrode using conducting gel. The antennal preparation revealed a good signal-noise ratio to the volatiles tested. The response was higher for (Z)-3-hexen-1-ol (-1.31mV) followed by linalool (-0.43mV) indicating that these compounds could play an important role in locating the host plant. They may also act as synergists in attracting more insects, either male or female in pheromone traps.



EAG facility at IIRR

EAG response of female PSB to (Z)-3-hexen-1-ol compound

IPM/CPT/ENT/22

Investigations on Nematodes of Importance to Rice Cultivation (N. Somasekhar)

Three entomopathogenic nematodes (*Metarhabditis amsactae* isolates Drr-Ma1, *Heterorhabditis indica* and *Steinernema glaseri*) were evaluated for their biological control potential against rice brown planthopper (BPH) in a small scale field experiment. Observations on insect population revealed that the insect population was significantly reduced in nematode treated plots as compared to the untreated control. Maximum reduction (84.11%) in insect population was observed with *Steinernema glaseri* followed by *Metarhabditis amsactae* isolate Drr-Ma2.

Molecular characterization of entomopathogenic nematode isolates Drr-Ma1 & Drr-Ma2 was done based on DNA sequences of ITS regions of ribosomal genes. The DNA sequence of *M. amsactae* isolates Drr-Ma1 & Drr-Ma2 showed 98% similarity with the DNA sequence of ITS regions of *Metarhabditis amsactae* reported earlier. These sequences were submitted to GeneBank (Accession No: KP834432 & KP834433).

Twenty aerobic rice cultures were screened for resistance to rice root-knot nematode *Meloidogyne graminicola*. None of the entries were resistant to the nematode. However, five entries (IET 22729, IET 22737, IET 22716 & IET 22704) were found moderately resistant.

A PCR based method was developed for molecular detection of white-tip nematode *Aphelenchoides besseyi* infection in rice seeds using specific primers targeting rDNA sequences.

Analyses of soil samples collected from rice plants grown at different temperature regimes revealed that root population of rice root nematode was significantly low (270 nematodes/5g root) in plants grown at elevated temperature (4°C above ambient) as compared to those grown at ambient temperature (348/5g root) in rice cultivar Vandana. Further, Observations on nematode population in aerobic rice revealed that the population of plant parasitic nematodes was low in treatments receiving bio fertilizers compared to those receiving only chemical fertilizers. Total nematode abundance was more in SRI system compared to the normal transplanted system although relative abundance of plant parasitic nematodes (0.52) in SRI plots was lower than that of the normal transplanted system (0.64).

HRP - Host-plant Resistance against Pathogens and its Management

HRP/CPT/PATH/15

Assessment of host plant resistance to rice blast disease and its management (M. Srinivas Prasad)

The rice breeding material developed under various institute projects (NILs and RILs) were evaluated against blast disease. A total of seven thousand nine hundred and twenty seven lines were screened under artificial inoculation in uniform blast nursery and found that fifteen hundred twenty two were resistant. Besides the lines six hundred seventy one accessions were also evaluated against blast and observed that six were resistant.

Three blast resistant genes like *Pi-1*, *Pi-2* and *Pi-54* were introgressed individually through marker assisted selection in to the elite parents BPT 5204. The populations were phenotyped with blast pathogen and genotyped with the gene linked markers like RM 224, 1MSM & RM527 and RM206 & Pi-54 MAS. Six lines were nominated in AICRIP i.e RP-Patho-1-2-15, RP-Patho-1-6-5, RP-Patho-3-56-11, RP-Patho 3-73-6, RP-Bio-Patho-2-18-5 and RP-Bio-Patho-2-16-4 in the background of Samba Mahsuri and Improved Samba Mahsuri they contain *Pi-1*, *Pi-54* and *Xa21+Pi-54* genes respectively. Out of six lines three were promoted to AVT-2 NIL; they are IET Nos 24164, 24166 and 24167. There were superior in agronomic performance, grain and cooking quality traits compared to recurrent parent Samba Mahsuri with an added advantage of blast resistance. The improved lines will also be valuable as donors for blast resistance and also useful for pyramiding blast resistance genes rice breeding programmes. In the process of fine mapping of *Pi-1* gene, a new marker namely RM 27386 was identified as linked makers, which can be used in conjunction with RM 224 in MAS programmes. Diverse isolates of blast pathogen from various parts of India were collected and chacrecterized morhphologicaly and genotypically and understood the diversity of the pathogen. Collection of high density population from the hotspot locations are in the progress and their virulence monitoring is being carried out.

Phenotypic evaluation of three gene pyramided lines

Fungicides were tested against blast disease during *Kharif*-2014. Seven fungicidal molecules *viz.* ICF-110 (Tricyclazole 45% + Hexaconazole 10% WG), MERGER (Tricyclazole 18%+ Mancozeb 62% WP), Companion (Mancozeb 63% WP + Carbendazium 12% WP), Tricyclazole 75%WP, Hexaconazole 5%EC, Mancozeb 75%WP and Carbendazium 50%WP were tested at IIRR field. Randomized block design was followed to conduct the experiment. Three replications were maintained for each treatment. The experimental results showed that blast disease incidence was reduced on rice irrespective of fungicide as compare to untreated check (PDI: 88.82). Among the entire treatments Tricyclazole 75%WP (0.6g /liter of water) showed less (47.8) Percent disease index (PDI) than other test molecule, followed by Tricyclazole 18%+ Mancozeb 62% WP (2.5g/ liter of water).

IET-24167

HRP/CPT/PATH/13

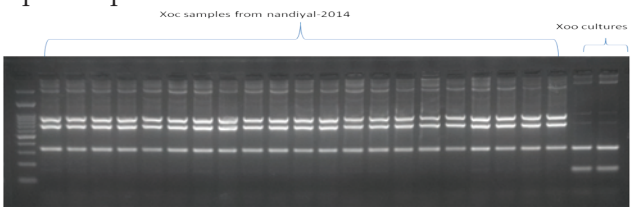
Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice (G. S. Laha)

Host Plant Resistance: Out of Sixty entries received through IRBBN from IRRI, four cultures *viz.,* IR 03N137, IR 05N412, IR 08N136 and IR 09N522 showed a moderate level of resistance. Most of the pyramided lines except IRBB 50 (*Xa4* + *xa5*) and IRBB 61 (*Xa4* + *xa5*+ *Xa7*) showed resistance to the *Xoo* isolates used. Four entries from AICRIP 2012 (IET # 22119, 22226, 22715 and 22766) and one entry from 2013 AICRIP (IET # 22490) showed very high level of resistance with a disease score of 1upon reinoculation. For pyramiding, resistance genes Xa21 and Xa38 in the background of Samba Mahsuri (BC4) and APMS6B (BC3).

Survey of bacterial blight affected areas in coastal Andhra Pradesh: There was a severe outbreak of bacterial blight in East and West Godavari districts of Andhra Pradesh following the severe cyclone "HUDHUD". A survey was conducted in different mandals of these two affected districts during second week of November. The disease incidence in these two districts ranged from 25-80% (with a disease severity score of 9 in the SES scale) on different varieties. The varieties like Prabhat (IET 3626), Samba Mahsuri (BPT 5204) and PL-1100 (minikit) were severely infected. However rice variety Swarna (MTU 7029) showed comparatively less incidence of the disease. Bacterial blight resistant rice variety 'Improved Samba Mahsuri' which was given to about 100 farmers through a CCMB-DRR collaborative program called 'BLIGHT OUT' showed complete resistance to bacterial blight.

Collection and characterization of isolates of *Xanthomonas oryzae* pv. *Oryzae:* During 2014, 105 new Xoo strains have been isolated which includes 8 strains from Kerala, 2 from Odisha and 95 strains from Andhra Pradesh. During 2014, we have pathotyped 140 Xoo isolates and genotyped 392 Xoo isolates. Additionally, we have isolated 21 Xanthomonas oryzae pv. oryzicola (Xoc) (bacterial

leaf streak) cultures during 2014. We also confirmed the Xanthomonas oryzae pv. oryzicola isolates using a multi-marker system (Lang *et al*., 2010) consisted of 4 primer pairs.



Multiplex PCR for distinguishing strains of Xoo and Xoc

Evaluation of some alternate strategies for the management of BLB of rice: We evaluated the antibacterial activity of water extracts of 50 different plant species against BLB. Out of these, 6 plant species showed inhibitory effect against *Xoo* under *in vitro* condition. These include leaf extracts of *Eucalyptus globulus, Datura stramonium* and *Ocimum sanctum*, modified stem extracts of *Allium sativum* and *Curcuma domestica* and extract of flower buds of *Syzygium aromaticum.*

HRP/CPT/PATH/14

Assessment of host plant resistance and Development of Diagnostic tools to rice tungro virus disease (D. Krishnaveni)

Twenty weed host species belonging to Graminaceae and Cyperaceae were tested for host range studies against rice tungro disease. Out of twenty weed host species tested through forced feed inoculation with viruliferous leaf hoppers (*Nephotettix virescens*), thirteen weed species were found positive which includes *viz., Cynodon dactylon, Digitaria sanguinalis, Echinocloa colonum, E. crusgalli, Leptochloa chinensis, Panicum repens, Cyperus rotundus, Fimbrystylis miliaceae, Dinebra aratica, Brachiaria ramosa, Paspalum dilatum, Leersia hexandra*, and *Paspalum hydrophilum.* The virus recovered from the seven virus infected weed host species *viz., E. colonum, E. crusgalli, Panicum repens, C. rotandus, Paspalum dilatum, P. hydrophilum* and *Leersia hexandra.* Weed hosts *viz., Paspalum dilatum* and *Paspalum hydrophilum* expressed typical symptoms of the rice tungro disease.

Symptoms due to tungro infection in weed host *Paspalum dilatatum*

Symptoms due to tungro infection in weed host *Paspalum hydrophilum*

Virus-vector and host relationship of rice tungro disease: Thirty rice genotypes from different places *viz.,* India (9 Nos) , Indonesia (6Nos) , Srilanka (1No), IRRI, Philippines (12 Nos) and Bangladesh (2 Nos) were tested under glasshouse conditions. The results revealed that all rice genotypes expressed typical tungro symptoms except in five rice genotypes *viz.,* Palisithari 601, Utri Merah, Utri Rajapan, ARC 11554 and IR 81366-124-1-2-2 which were found free of foliar symptoms except mild stunting. In case of virus - vector and host relationship of rice tungro disease, the incubation period in the tungro resistant cultivars ranged from 12 to 15 days and recorded a score of 1 or 3 whereas moderately resistant cultivars with incubation period of 11-13 days showed a score of 3 or 5 and susceptible cultivars showed symptoms < 10 days of inoculation with RTD with a disease score of 7 or 9. Resistant rice cultivars, Palisithari 601 and ARC 11554 recorded 1 score for both tungro and green leafhoppers. Rice genotypes showing moderately resistant reaction of IRRI cultures (IR 73546-20-2-2-2, IR 77298-5-6 and IR 81336-39-3-3-3) recorded 3 score with varied levels of resistance to the green leafhoppers. Rice cultivars, Tjempo Kijik, Utri Merah an Utri Rajapan exhibited limited resistance to leaf hoppers but recorded low score against RTD indicating their resistance to the tungro viruses. Whereas moderately resistant genotypes obtained from IRRI (IR 73546-20-2-2-2, IR 77298-5-6 and IR 81336-39-3-3-3) expressed resistant reaction with 3 score with varied levels of resistance to the green leafhoppers. Unlike resistant rice genotypes there was no recovery of symptoms observed on the tungro susceptible genotypes.

HRP/CPT/PATH/17

Epidemiology and management of false smut disease of rice (D. Ladha Lakshmi)

Survey was conducted during December 2014 and January 2015 at Nalgonda district of Telangana and Ramanathapuram district of Tamil Nadu respectively. At Nalgonda, the percentage of infected tillers were recorded as 12.39% at Miryalguda, 25.17% at Kampasagar, 13.83% at Thipuraram, 23.05% at Nanyathanda and 44.37% at Vadhyathanda. At Ramanathapuram district of Tamil Nadu, villages *viz.,* Mayapuram, Sengamadai, Sappaniyenthal, Vallandai and T. Kallupatti of Madurai district were surveyed and the percentage of disease infection was varied from 20.15% to 54.97%. In all the villages, BPT 5204 was grown and the percentage of infected tillers was high compared to Nalgonda district. Smut balls were grouped into different category *viz.,* 1-3, 4-6, 7-9, 10-12, 13-15, 16-20, 21-25, 26-30 and 31-55. Within the category of the smut balls, numbers of filled grains, chaffy grains were counted individually. At Ramanathapuram and Madurai, with few exceptions, the results revealed that the number of filled grains was decreased when number of smut balls was increased. Lowest number of filled grains was recorded when the smut balls were above 20. With respect to percentage of infected grains, 21% of infected grains were recorded when the number of smut balls were in the range of 31-55. Results also revealed that, when the percentage of infected grain increased, the percentage of chaffy grains was also increased invariably. Highest percentage of chaffy grains (59.36%) was recorded when the smut balls were above 30. Similar results were obtained with the samples collected at Nalgonda also.

Details on the average no. of filled grains/panicle, % of grains infected and % of chaffy grains of samples collected at Ramanathapuram and Madurai

Range of smut balls	Maximum No. of Filled grains	Chaffy grains		% of grains infected	% of chaffy grains
		Minimum no. of grains	Maximum no. of grains		
1-3	218	6	90	1.08	19.07
4-6	246	5	85	2.94	19.82
7-9	225	13	84	4.49	25.14
10-12	256	14	94	5.98	27.10
13-15	200	27	158	6.94	34.82
16-20	162	27	161	9.84	40.39
21-25	191	9	160	11.30	44.10
26-30	195	12	175	15.71	42.41
31-55	180	43	152	21.58	59.36

All the data were collected on average of 20-25 plants with same no. of smut ball

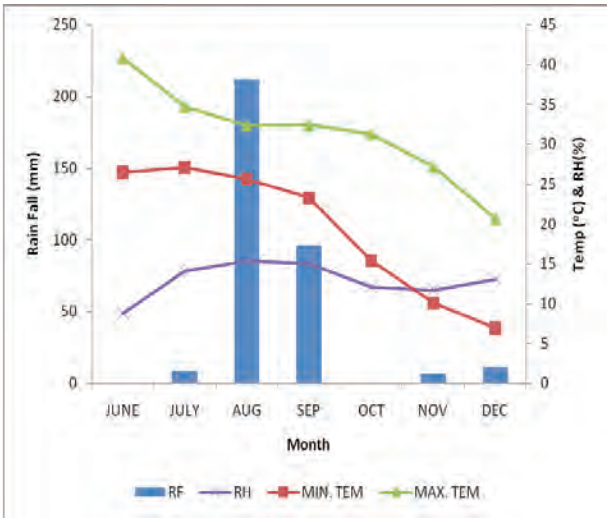


Fig 1: ***Analysis of the effect of weather parameters on false smut incidence***

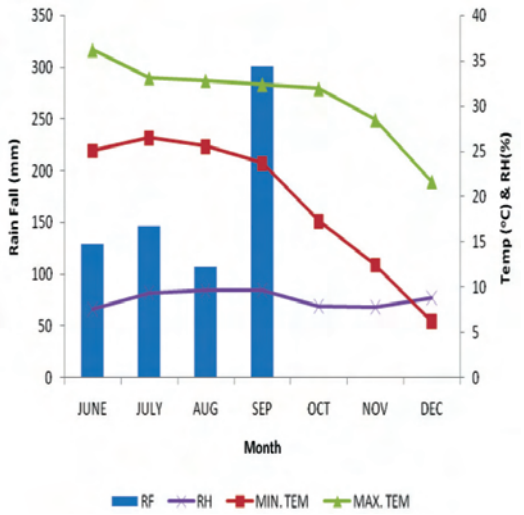


Fig 2: Distribution of rain fall, Temp (Max & Min) during crop season period (June to (June to December, 2012) at Kaul

Weather parameters *viz.*, maximum temperature, minimum temperature, rain fall and relative humidity were collected from June to December of the last two years. Analysis of results revealed that false smut incidence was very high (67%) when the rainfall received during the month of September was also very high (301 mm). During the year 2011, the disease was low (17%) and the amount of rainfall was also low (96 mm) (Figure 1 & Figure 2). From this it was evident that rainfall during the booting stage may play a major role on the occurrence of the disease.

HRP/CPT/PATH/18

Characterization and management of *Rhizoctonia solani* causing sheath blight of rice (V. Prakasam)

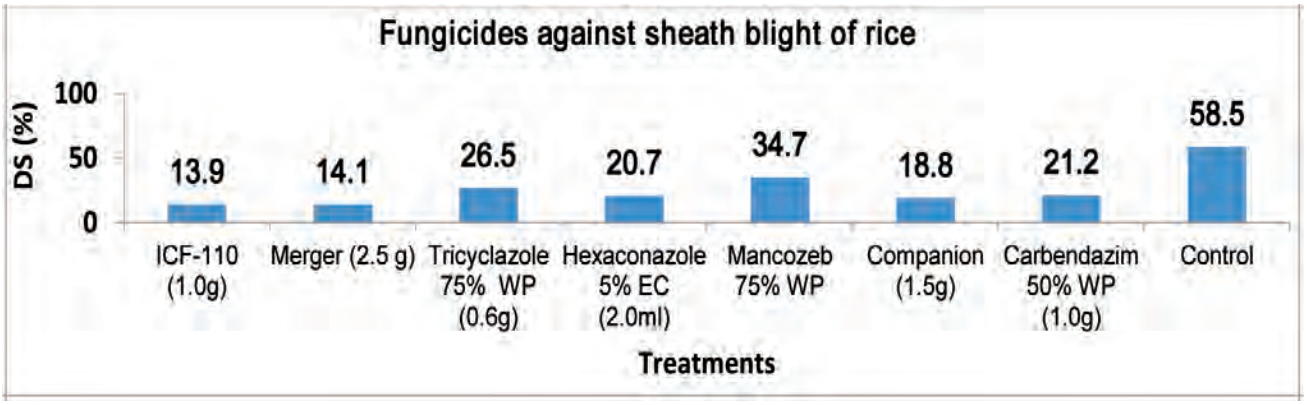
Collection and isolation of *R. solani* isolates from different rice ecosystems: Sheath blight disease samples were collected and isolated the fungus (27 isolates) from Karnataka and Tamil Nadu (Melur, T.Kallupatti, Vedipatti and Tirumangalam blocks of Madurai district). Pure cultures were maintained in the potato dextrose agar (PDA) medium for biological studies and diversity analysis.

Evaluation of new and commercially available fungicides on sheath blight disease: Six fungicidal treatments effectively reduced the disease severity compared to check (DS – 58.5%). The new combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) at 1.0 g/l sprayed plot showed less disease severity (DS:21.4%) when compare to other treatment plots. This was followed by new product MERGER (tricyclazole 18%+ mancozeb 62% WP) 2.5g/l. Grain yield in the experimental plots were recorded and observed that increased grain yield compared to check plot (3469 Kg/ha).

Bio-efficacy of Mancozeb 68%+Hexaconazole 4% WG (ICF-310) against sheath blight of rice: All treatments significantly reduced the disease compare to control. Among all the treatments the combination of mancozeb 68%+hexaconazole 4% WG showed less Percent disease index (PDI) (35.26) than check fungicide hexaconazole 5% EC. The test chemicals did not show any symptoms of phyto-toxicity in test variety TN-1. Grain yield in the experimental plots were recorded and observed that increased grain yield (5552 Kg/ha) in T3 treatment compared to check plot (4172 Kg/ha).

Six different vitamins (thiamine hydrochloride, pyridoxine hydrochloride, nicotinic acid, riboflavin, ascorbic acid and salicylic acid) and its combinations were sprayed on the rice (IR50) to study the induced systemic resistance against sheath blight disease. In this experiment we have observed that all the treatments were showed high disease severity compare to control.

Screening of new combination fungicides against sheath blight



Bio-efficacy of Mancozeb 68%+Hexaconazole 4% WG (ICF-310) against sheath blight of rice:

Treatment	Formulation dosage (per ha)			DS	Yield (Kg/ha)
	g.a.i/ ha	ml/ha	ml / lt. of water		
Mancozeb68%+Hexaconazole 4% WG	680+40	1000	2.0 ml	33.33 (35.26)	4985
Mancozeb68%+Hexaconazole 4% WG	850+50	1250	2.5 ml	33.33 (35.26)	4890
Mancozeb68%+Hexaconazole 4% WG	1020+60	1500	3.0 ml	33.33 (35.26)	5552
Hexaconazole 5% EC	50	1000	2.0 ml	36.11 (36.89)	4640
Mancozeb 75% WP	125	1500	3.0 ml	41.94 (40.33)	4717
Propineb70% WP (T6)	60	2000	4.0 ml	63.8 (53.06)	5322
Mancozeb62%+Tricylazole 18%	775+225	1250	2.5 ml	55.00 (47.87)	4707
Control	--	--	-	77.78 (61.87)	4172
LSD (*P=0.05*)				5.2	-
CV (%)				8.1	18.73

(Figures in parenthesis indicate transformed means; A-Arc sin transformation)

TTI – Training, Transfer of Technology and Impact analysis

TTT/EXT/8

Sustainable Rice production Practices: problems and prospects (P. Muthuraman)

During the year, various sustainable rice practices of boro rice growing regions of Assam are being studied. The study revealed that in the highly concentrated boro areas there are no rice varieties ideally suited to boro growing ecologies. Diversity in growing situations and farmers' needs warrant the development of needs-based and ecology-specific boro rice varieties.

The following distinct plant characteristics are required to fulfill the farmers' expectations *viz.*, 1. High-yielding plant architecture; 2. Semi-tall (swampy situations) and semi-dwarf (irrigated situations) plant heights, with stiff straw and moderate tillering ability, 3. cold-tolerance at the vegetative phase, with early seedling vigour in terms of seedling height (35 to 40 cm) at 40 days of seeding;, 4. Early-maturing (165 days); 5. Grain types, coarse and fine; 6. Seed dormancy; 7. Resistance or tolerance to stem borer and neck blast; 8. Tolerance to iron toxicity (irrigated situations).

Comprehensive management strategies for controlling stem borer must be formulated with particular emphasis on host resistance, biological control and the needs-based use of chemicals. The efficacy of farmers' indigenous technical knowledge should be tested and effective indigenous techniques incorporated into an IPM strategy.

Popularizing the shallow bore well technologies by using bamboo tubes will help the farmers to make efficient water management practices in boro ecosystem.

TTT/EXT/10

Gender dimensions in Rice Sector: An Exploratory study on labor migration and livelihoods (Amtul Waris)

The members' of women SHG's were interviewed for gender analysis in rice cultivation and drudgery faced. Carrying head load of harvested paddy, harvesting and weeding were ranked as more drudgery prone compared to transplanting. The SHG movement had made their lives easier with ready income in their hands which was spent in the following order of importance, home needs, inputs for agriculture, house hold goods, children's education and small pieces of jewellery. Low yields (76%) with high weed infestation (63%) and BPH damage (41%) were the main problems in paddy cultivation as reported by farm women.

A focus group discussion on livelihood options for farm women was conducted with farm labour to understand the seasonality of wage employment in farming. Employment in agriculture as wage work was available for 8-9 months in a year and the month of April was only the lean month. Household activities like fuel wood collection, minor house repair and food preservation formed the major activities.

The farm women's use of agricultural information networks indicated that informal sources (family members, neighbours and group members) formed the major source of information followed by formal (NGO, KVK) and mass media. Farm women's perception of the highest information need was for variety of rice, followed by weed control, fertilizer application, pest and disease management and government schemes.

Farm women's perceptions about Direct Seeded Rice (DSR) indicated that they were relieved from the drudgery of transplanting in bent positions in wet puddle fields. On enquiring whether DSR has adverse effects on their earnings from transplanting rice, they reported that since all the farmers have not shifted to DSR they still get to work in transplanted rice fields. Moreover, they preferred to fore go the wages as they do not want to take up the hard work and drudgery of transplanting. Most of the farmers and farm women also reported that the shift to DSR is imminent as young girls and women are not willing to do transplanting and prefer other non-farm employment options.

TTT/EXT/12

Maximizing the Impact of Rice Technologies through ICT applications (Shaik N. Meera)

During the year 2014-15, a small action research and surveys were conducted in two major rice growing states in India (Telangana and Odisha) involving 80 rice farmers and extension professionals. The study focused on demand analysis for knowledge products and rice technologies, mapping of knowledge and technology sources, delivery channels, ICT tools, impact, factorial contribution of non-negotiable adoption points to farm productivity etc., From the ricecheck experience, 12 categories of information was finalized.

Gap analysis of yield range and adoption of key checks (Telengana – 40 farmers)

Yield range (in t/ha)	Number n=40	%	Range of Key checks
3.1-4.0	9	22.5	3 to 7
4.1-5.0	28	70	8 to 12
Above 5.0	3	7.5	13 to 14

The ICT usage by the farmers in accessing this information was assessed. In case of Telangana, the per cent respondents receiving information from different ICT tools in all these categories (checks) was found to be higher compared to that of Odisha. Further analysis of the components was also done to know the factorial contribution. The farmers (n=37) who recorded an yield below5 t/ha, can be reached with knowledge interventions by providing the knowledge and do how of 9 checks. This may be taken up during the subsequent seasons.

India RiceCheck programme

Various activities were undertaken as part of ICAR-IRRI work plan GRiSP Theme 6. During this year, an innovative participatory extension method (RiceCheck) has been piloted in Telangana, Odisha, Tamil Nadu and Andhra Pradesh.

To explore the integration of RiceCheck program into existing extension set up of the country, the pilot project was implemented involving AICRIP centre (RRTTS, Koraput), SAU (OUAT), an NGO (MSSRF) and KVK (Kampasagar, Nalgonda). In all these activities State Department of Agriculture officials were involved.

Significance in ICAR Context: Last couple years, ICAR has re-invented the concept of 'Farmer First' that aimed to move beyond production and productivity and to recognise the complex, diverse and risk prone realities of majority of the farmers and enhance farmers-scientists contact with multi stake holders participation. While theoretically this concept may sound good, but what is lacking is 'operationalising such concepts' in the field conditions. ICAR needs to develop a series of 'toolkits' such as RiceCheck.

RiceCheck piloted in Odisha (Puri and Koraput), Telangana (Nalgonda), Tamil Nadu (Tiruvayur). A total of 7 groups comprising 20 farmers in each group were involved in the RiceCheck programme. The local extension professionals facilitated the group meetings. The complete track of key checks, practices, adoption of yield contributing factors was undertaken. Recommendation booklets (4) are prepared.

TTT/EXT/9

An Exploratory Study on Partnerships: Impact and Implications for the Rice Sector (S. Arun Kumar)

The cases of contract farming in Basmati rice reveals that the sector has grown ahead of the partnership formation. During the nineties, initial years of growth of basmati rice sector contract farming arrangement were necessary as the export demand was growing. Moreover, the farmers were not aware of appropriate varieties and technical know-how, not accessible to quality seeds, assured procurement and price. The companies like KRBL, Kohinoor, PFL have deployed contract farming to procure quality products from the farmers. Now, the sector is mature with increased production, many buyers and established linkages with millers and farmers fully aware of the technical know-how.

The private sector involvement with KVK in popularizing Direct Seeded Rice in the region has assisted in increasing the area from 500 hectares in 2012-13 to 4355 hectares in 2013-14. The analysis of the results reveals that the majority of farmers (above 80%) are aware of contract farming processes or partnership activities in rice farming. The cases of Farmers Producer Organizations of Tamil Nadu is being documented and majority of farmers are aware of various partnership activities including contract farming processes and were willing to form groups for seed production, enter contract farming with written agreement.

TTT/ECON/1

Yield gaps and constraints in rice production- An econometric analysis (B. Nirmala)

A situation analysis of hybrid rice seed production was carried out in Warangal, Karimnagar and Medak districts of Telangana and Kurnool district of Andhra Pradesh states, from the perspectives of hybrid rice seed producers with a total sample size of 120 farmers by employing the strengths, weakness, opportunities and threats (SWOT) method. Kendall's Coefficient of Concordance (w) was used to test the rank of factors associated with SWOT. The coefficients of concordance for SWOT were 0.6. The results revealed that, income stability, price certainty and timely supply of inputs and technical advices were the major strengths in hybrid rice seed production. The major weaknesses were relatively less price being offered by the companies, lack of legal safe guard mechanism and drudgery in additional operations like rouging and supplementary pollination. From results of the present study it is suggested that there is a need to evolve legal safeguard mechanism to avoid breach of contract between producers and seed companies.

A farm level impact study on System of Rice Intensification (SRI) method of rice cultivation was conducted in Atmakur mandal of Nalgonda district of Telangana. The advantage of SRI method was seen in case of reduction in cost of cultivation, higher yields and early harvesting of the crop. Adoption of SRI method resulted in the saving of Rs.1679 per hectare on seed. A productivity gain of 21.75 % was found in SRI method of rice cultivation over the conventional method.

The impact of chemical weed control with herbicide 'Penoxsulam' was assessed on farmers' fields in Rangareddy district of Telangana. Penoxsulam was tested initially in DRR station trials and further evaluated in AICRIP Agronomy program and recommended for commercial sale. The results revealed that chemical weed control with application of Penoxsulam resulted in timely weed control, drudgery reduction and saving in cost of cultivation by Rs.3075/ per hectare over the manual weeding.

An economic evaluation of mechanized harvesting in rice was conducted in Rangareddy district and found that it resulted in a reduction in cost of cultivation by Rs. 4,250/- ha. Besides, due to the acute labour shortage during the peak operation periods in rice, mechanical harvesting with combine harvester (hired) was perceived as the only coping strategy for labour shortage.

TTT/ECON 3

IPR-Competition interaction in Indian rice seed sector: emerging scenario-implications for enhancing quality seed use. (P.A.Lakshmi Prasanna)

This project attempts to seek answers to the questions (i)What is the effect of Protection of Plant Varieties and Farmers Rights Act (PPVFRA) and Patents Act on rice seed sector structure (both upstream research sector and downstream seed market) and pricing?(ii) What role public sector regulatory and public sector research organizations have to play in Indian rice seed sector in changing IPR and competition interaction context?(iii) What is the appropriate incentive and regulatory policy mix for promoting private sector participation in Indian rice seed sector and at the same time ensuring seed availability to farmers at affordable price?

As at 31 December 2014, in total rice applications received by PPVFRA, farmers applications share constituted 88%, followed by private sector 7%. In the initial year i.e 2007, only 2 applications from farmers were received, but in later years the number increased. In total new rice applications (i.e 217), Private sector share stood at 85%. Out of 3797 rice applications received, only 110 applications pertained to hybrid varieties. Out of this 110 applications, 93% was contributed by Private sector. Total number of companies applied for Protection under PPVFRA for their rice varieties were 38 , out of which 31 companies applied for protection of new varieties and 28 companies applied for protection of their hybrid varieties.

As at 31 December 2014, 715 rice varieties were registered, out of which 71 % were farmers varieties. 70 varieties pertained to private sector as against 139 varieties of public sector. 47 new rice varieties were registered out of which 41 pertained to private sector. 19 companies received registration certificates for their rice varieties, 14 companies received registration certificates for their new varieties and 16 companies received registration for their hybrid varieties.

Thus preliminary observations indicate that private sector participation in rice seed research is increasing compared to public sector. Private industry sector is dominant in new varieties and hybrid varieties. Though farmers are dominant category both in number of applications and varieties registered, will they be effective competitors against private industry? Further probing is needed for answering this question in terms of geographic area/ rice ecosystem suitability and traits of farmers' varieties vis-a-vis varieties of private industry. Similar probing is needed to assess competition of public sector and private industry in upstream rice research sector. This needs to be followed by probing of downstream rice seed sector so as to get insights relevant for policy implications.

ICAR National Professor Project

ICAR-NPP-OXX02332

Development of chromosome segment substitution lines of rice from elite x wild crosses to map QTLs/genes for yield traits (Dr. N. Sarla)

The project was initiated with an objective to develop a set of chromosome segment substitution lines (CSSLs) using elite x wild crosses such that the entire chromosome of the wild accession are represented in the whole set of CSSLs as contig lines. These lines would serve as a national resource to map any trait especially yields related traits. High yielding popular Indian rice varieties of different duration were selected as recurrent parents and wild accessions of Oryza rufipogon and Oryza nivara with high photosynthetic efficiency were used as donors. These parental genotypes were crossed and advanced to back cross generations for CSSL development. Simultaneously a set of 165 SSRs which are equally distributed throughout rice genome were used to identify parental polymorphism and further used in screening of back cross generations to select Introgression Lines with desired chromosome segment size.

Seven popular genotypes (Swarna, MTU1010, Dhanarasi, Rasi, Krishnahamsa Vandana and Varadhan) and O. nivara and O. rufipogon accessions (O. rufipogon (ACC.No. CR 100267) - 18, O. nivara (ACC. No. CR 100008) - 27, O. nivara (ACC. No. CR 100097) -29) were selected for development of CSSLs. 21 crosses (F1s) were made from the above parental combinations using high yielding parents as female and wild donor genotypes as male parent. The F1s of seven crosses were backcrossed to corresponding recurrent parent to produce BC1F1 population. Two selected crosses viz., Swarna x O. rufipogon and MTU1010 x O. rufipogon were advanced to BC2F1 generation. All the parental genotypes were genotyped along with 13 other genotypes including wild, indica, temperate japonica, tropical japonica, basmati and aus type accessions using core set SSR primers (Orjula et al, 2010). Polymorphic markers were identified using this genotypic data. Cluster analysis grouped the 23 rice genotypes in to three clusters at a genetic similarity of 0.26 to 0.75. The genotypic data was analyzed using STRUCTURE and genotypes were grouped into four populations.

Development of CSSLs from Swarna x *O.nivara* BILs

105 Swarna x O.nivara (81848) (S) BC2F8 lines were raised in field during Kharif 2014, 94 were selected for genotyping using 79 SSR markers. Genotypic data of each BIL was subjected to CSSL Finder software and identified a complete set of CSSLs with 51 lines. BILs derived from Swarna x O.nivara (81832) were genotyped to develop CSSLs in the background of Swarna at BC2F8 generation. The genotypic data subjected to CSSL finder; among the 91 BILs, 42 formed complete set of CSSLs.

Institutional Activities

Technologies assessed and transferred

Licensing

Awards/recognitions Revenue generation

Linkages and collaborations

Significant events

Personnel

Publications

RFD

Technologies Assessed and Transferred

Training and Extension

During the year 2014-15, five training programs were planned, organized and evaluated on various aspects of Rice Production Technologies through which 126 persons were trained. Out of five training programs, one was Model Training Course on 'System of Rice Intensification' sponsored by Directorate of Extension, New Delhi. Two were short courses *viz.*, 'Soil Health Management in Rice and Rice based cropping system' sponsored by ICAR and 'Quality and Nutritional aspects of rice and other crops' organized under CRP on Biofortification. A winter school on 'New Frontiers in Rice Breeding for improving yield, quality and stress tolerance for sustaining future rice production' sponsored by ICAR was organized. A ten days training program on 'Widening of gentic base in Rice through Pre-Breeding for developing Next Generation Varieties and Hybrids' sponsored by ICAR was also organized. For all the training programs information brochures were designed and prepared including background information, course content, training methodology etc. and sent to various State Department of Agriculture, SAUs' and Private sector for nominations. Through these five training programs 126 participants were trained including Scientists, senior level Extension functionaries, Subject Matter Specialists from various Departments of Agriculture and State Agricultural Universities.

S No	Training Title	Training Period/Duration	Sponsor	Number of participants
1	Model Training Course on System of Rice Intensification	July 16-23, 2014 (8 days)	DOE	19
2	ICAR Short Course on Soil Health Management in Rice and Rice based cropping system	August 19-28, 2014 (10 days)	ICAR	28
3	ICAR Winter School on New Frontiers in Rice Breeding for improving yield, quality and stress tolerance for sustaining future rice production	September 10-30, 2014 (21 days)	ICAR	27
4	Short Course on Quality and Nutritional aspects of rice and other crops	January 3-12, 2015 (10 days)	CRP on Biofortification	28
5	Widening of gentic base in Rice through Pre-Breeding for developing Next Generation Varieties and Hybrids	January 19-28, 2015 (10 days)	ICAR	24

Frontline Demonstrations (FLDs)

A cafeteria of rice technologies were demonstrated in 459 hectare area covering 17 states and four major rice ecosystems of the country. FLDs organized during this year have been effective in creating the awareness about the potential of new rice varieties, hybrids and other management technologies. In majority of the cases the yield advantages recorded by the FLD technologies were significant. Out of

431 FLDs reported, about 67% were conducted in irrigated rice ecosystem; whereas about 11% of FLDs were conducted in rainfed uplands. More than 16% of FLDs were organized in shallow lowlands and 3% in hill ecologies. About 4% of the FLDs were conducted in problem soils. There is a scope to increase the number of FLDs in rainfed ecologies.

The analysis of yield advantages obtained in various ecosystems revealed that across the ecosystems, FLD technologies have recorded impressive yield advantages. The mean yield advantage was the highest in Rainfed uplands (59% mean yield advantage). Similarly in case of irrigated ecologies (21%), Hill ecologies (31%), Shallow lowlands (16%) and problem soils (28%), yield gaps (particularly Yield gap-II) could be effectively addressed, if proper extension strategies are deployed for large scale adoption of these technologies.

FLD technologies demonstrated in irrigated ecosystems have recorded mean yield of 5.27 t/ha where as in Shallow lowlands FLD technologies have recorded an average yield of 4.80 t/ha. Average demonstration yields in rainfed uplands was 3.67 t/ha.

Tribal Sub-Plan Activities

Participatory IPM program was conducted in 3 thandas *viz.*, Balajinagar thanda, Badya thanda and Nimya thanda of Damarcherla mandal, Nalgonda district during *kharif* 2014. In these thandas, brown planthopper (BPH) incidence was very high last year and many farmers lost their crop due to the hopper burn. Keeping this in view, effective and economic ways of managing insect pests as well as weeds and diseases in a holistic way was demonstrated in special IPM trial carried out in 25 acres area through farmers participatory approach in each thanda. Continuous monitoring of the pests was done by making regular visits to both IPM and Farmers practice fields in these thandas and suggestions given for the management of pests. Inputs like fertilizers, weedicides, insecticides and fungicides were provided on need basis. Other options like provision of alley ways, leaf colour chart based fertilizer application and monitoring through pheromone traps were also demonstrated. Additionally, around 50 tribal farmers of these 3 thandas also benefitted through the mid-season awareness program and Samagra Sasya Rakshana

Ecosystem	Total FLDs (ha)	Mean FLD Yield (t/ha)	Mean Check Yield (t/ha)	Mean % Yield Advantage
Irrigated	292	5.27	4.43	21.35
Shallow Lowlands	70	4.80	4.15	16.02
Hills	10	4.21	3.31	31.11
Rainfed Upland	44	3.67	2.4	59.72
Problem Soils	15	4.7	3.66	28.03
Total or Mean	431	4.53	3.59	31.246

Dinotsavam (IPM day) wherein IPM pocket books with pictorial presentation (in local language *i.e,* Telugu) and Leaf colour charts were distributed to these farmers. All these farmers were provided exposure to these interventions through visit to these participatory IPM fields and experiential learning interaction with IPM farmers.

In order to overcome the drudgery, the drum seeder were given to the farmers of Nalgonda district for crop establishment. Skill training on use of drum seeder to save labour and water was organized on tribal farmers' field to demonstrate its potential to save drudgery for women and also overcome labour shortage.

'Parthenium Awareness Campaign' for TSP farmers of Achammakunta tanda of Nalgonda district of Telangana under IIRR-Tribal Sub-Plan activities was undertaken to create awareness about the harmful effects of Parthenium.

Two off-campus training programs were conducted for TSP farmers of Kamepally mandal of Khammam

district under Tribal Sub-Plan of National Seed Project activities on 09th September 2014 and Maheshwaram Mandal of Rangareddy district under TSP-Mega Seed activities on 12 Th September 2014. The objective of the training program was to impart knowledge on seed production practices and improved rice production technologies to tribal farmers. A comprehensive blend of interactive lectures on various technical aspects

of seed production and improved rice production technologies were planned under the able guidance of the Project Director. The module on technical guidance for seed production prepared by the Nodal Officer, NSP Seed, was elaborated upon to the farmers during these training programmes.

Knapsack sprayers of 16 ltrs. capacity were distributed to tribal farmers of Repallewada tanda of Khammam district on 13th February 2015. These sprayers were distributed for the mutual use in groups by beneficiary tribal farmers, for need based application of herbicides, fungicides and pesticides in participatory seed production for effective management of weeds, pests and diseases.

Field Day

In order to develop eco-entrepreneurship of tribal women, skill training on setting up a vermicompost unit was organized and ready to install vermi-beds were distributed to tribal farm women.

A Field Day was organized on December 6, 2014 on Farmer's field at Gonekol Village of Dindi, Nalgonda under Head to Head programme of STRASA to showcase the performance and production potential of the demonstrated varieties, IET-22080, IET-22081 and IET-22836.The participating farmers saw the crop stand in the field and were impressed by the yield potential and therefore seeds were provided by the farmers after harvest to the interested farmers for cultivation during rabi.

Women in Agriculture Day

Every year 'Women in Agriculture day' is celebrated on 4th December. To commemorate this occasion DRR celebrated 'Women in Agriculture Day' on December 5, 2014 at a tribal village, Jharpula Tanda in Nalgonda District with the active involvement of the NGO, ARDS, from Deverkonda. On this occasion, a series of activities *viz.*, hands-on-skill training on use of drum seeder for rice planting, setting up a vermicompost unit were taken up. The program was attended by an enthusiastic group of more than hundred tribal farmers and farm women. Farm women appreciated the use of drum seeder as it lessened their drudgery. Dr. Amtul Waris coordinated the conduct of 'Women in Agriculture Day' and Drs.R.Mahender Kumar, K. Surekha, P.A. Lakshmi Prasanna and B. Nirmala were the resource persons.

Farmers Day

DRR has organized Farmers Day on 15th November 2014 to showcase latest varieties, hybrids and technologies developed which would help rice farmers to increase their productivity and profitability. Honourable Union Minister (Labour & Employment) Shri Bandaru Dattatreya was the Chief Guest on this occasion. Shri. Duscharla Satyanarayana (President, Jalasadhana Committee and Telangana Rythu Samithi) participated in the function as Guest of Honour.

The Farmers Day witnessed participation of more than 1000 farmers and farm leaders from Telangana, Andhra Pradesh and other neighbouring states. Several progressive rice farmers who made significant contributions in the rice farming were felicitated by the dignitaries. Apart from DRR, city based agricultural research institutes had put up the stalls for showcasing their technologies for the benefit of the participants. Few private companies also came forward to share latest products that aim at reducing the cost of cultivation and improving the profitability.

Dr. V. Ravindra Babu, Project Director addressed the gathering along with the dignitaries. A scientists-farmers' interaction was conducted after the field visit. Several farmers sought solutions on their field problems from the experts. A seed sale counter was opened to help the farmers to buy and adopt improved rice varieties. Rice related literatures were distributed to the farmers.

Visitors' Services

During the year 2014-15, about 6020 visitors comprising students, extension professionals, scientists, farmers, foreign delegates, policy makers, private input dealers visited DRR and got acquainted with the ongoing activities and achievements of DRR.

Organizing Farmers' Day/ Fairs / Exhibition

1. DRR has organized Farmers Day on 15th November 2014 to showcase latest varieties, hybrids and technologies developed which would help rice farmers to increase their productivity and profitability. The Farmers Day witnessed participation of more than 1500 farmers and farm leaders from Telangana, Andhra Pradesh and other neighbouring states.
2. DRR took active part in the National Workshop cum Exhibition on Popularization and Commercialization of low-cost agri-technologies at NIPHM during 4-6 February 2015.
3. DRR organized Farmers Day at Veerareddy palli village, Kurnool district on Oct.20th 2014;
4. Field day was organised on 16th September 2014 at Agamiyaguda village (Ranga Reddy District)

Intellectual Property Management and Transfer/Commercialization of agricultural technology Scheme

IIRR (DRR) entered MoAs with private seed companies on non- exclusive basis for commercialization, production and marketing of DRR varieties / hybrids. The agreement is valid for 5 years initially and renewable on mutually agreed terms and conditions. During 2014-15, 1 MoA each for DRRH-2 and Improved Samba Mahsuri and 2 MoA for DRRH-3 signed and earned Rs. 16 lakhs**.** More than 100 entries of seed was provided to various institutes and private companies through MTA. Several applications for germplasm registration were screened and certified by ITMU members for soft registration with NBPGR, New Delhi. As an authorized institute, IIRR received several import permit applications which were scrutinized and forwarded to NBPGR for processing.

S. No	Variety / Hybrid	Licensee Name	Licensee Address	Signed Date	Duration (years)
1	DRRH-2	Super Agri Seeds Private Limited	5th Floor, Akash Ganga, Plot no. 144, H.No. 8-3-1503, Srinagar Colony, Hyderabad - 500073	13/05/2014	5
2	DRRH-3	Sansar Agropol Private Limited	Sansar Agropol Private Limited, 64, Surya Nagar, Bhubaneswar - 751003, Odisha	25/10/2014	5
3	DRRH-3	Bioseed Research India	Bioseed Research India, Plot No. 206, Road No. 14, Jubilee Hills, Hyderabad – 500 033	29/12/2014	5
4	Improved Samba Mahsuri	Metahelix Life Sciences Limited	Metahelix Life Sciences Limited, Plot No. 3, KIADB, 4th Phase, Bommasandra, Bangalore – 560 099	01-08-2015	5

Revenue Generation

An amount of Rs. 1,48,86274.00 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

DRR 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. The receipts have generated an amount of Rs. 23, 08,106.00 for the financial year 2014-15.

AICRIP Centres

List of funded AICRIP centres with staff positions during 2014-15 is given in Appendix 4.

Externally Funded Projects

Four externally funded projects have been sanctioned during 2014-15 (Appendix 6) with a budget outlay of 11886 lakhs. A total of 40 externally funded projects are currently being handled at DRR (Appendix 7) with a sanctioned budget of Rs. 38 crores.

Awards and Recognitions

IIRR (DRR) in association with Centre for Cellular & Molecular Biology (CCMB), Hyderabad bagged 'CSIR Award for S&T Innovations for Rural Development (CAIRD) – 2013' for development and deployment of Improved Samba Mahsuri rice variety which is bacterial blight resistant, high yielding and possesses fine-grains. The award carried a cash prize of Rs.10 lakh, a citation and a shield.

Dr. Satendra Kumar Mangrauthia has been selected as Member of National Academy of Sciences, India (NASI), prestigious Science Academy of the country. He will be the member of this academy from 2014.

Dr A S Hari Prasad, Principal Scientist, upon successful completion, has been awarded the Post Graduate Diploma in Technology Management in Agriculture (PGD-TMA 2013), by the University of Hyderabad, in a function held at NAARM, Hyderabad on August 07, 2014.

Dr B. Gangaiah, Principal Scientist (Agronomy), was conferred with Indian Society of Agronomy (ISA) Fellowship. He received the award at ISA Biennial Symposium organized at PAU, Ludhiana on November 18, 2014 in the presence of leading agricultural scientists of the country.

Miss. S. J. S. Rama Devi, Senior Research Fellow, has been chosen for young Rice Scientist award for her doctoral work on "*Identification and mapping of novel blast resistance gene(s) in introgression lines of rice*" The award was presented to her at 4th International Rice Congress 2014, which was held at Bangkok, Thailand during October 2014. She is pursuing her Ph.D, (Dept. of Genetics, Osmania University) under the guidance of Dr. B. C. Viraktamath and Dr. M. Sheshu Madhav.

Drs B. Sailaja, SR. Voleti, D. Subramanyam, M.S. Nahawat and NH. Rao, won the 'GS Sirohi Best Paper Award-2013', for their research paper entitled 'Validation of Oryza2000 model under combined nitrogen and water limited situations' (published in Indian Journal of Plant Physiology, Vol 18:31-40). The award was presented on November 23, 2014 at

the National Conference of Plant Physiology held at OUA&T, Bhubaneswar.

Dr. B. Nirmala, was awarded best paper award for her research paper entitled 'Technology dissemination approaches for bridging rice yield gaps on small farms' presented in 7th National Extension Education Congress held by Society of Extension Education, Agra during November 8-11,2014 at ICAR for NEHR, Umiam, Meghalaya

Dr. Vemuri Ravindra Babu, Project Director (A), IIRR (DRR) was conferred with Innovative Agricultural Scientist 2015 award for his outstanding contribution in rice breeding by development of varieties suitable for saline water irrigation. This award was presented in the biotech fest, an agricultural innovative festival in January 2015 by SKSD Mahila Kalasala (Degree and PG), SVK Education Society, Tanuku, West Godavari district, AP.

Dr. RM Sundaram, Senior Scientist, Biotechnology received Dr. PN Behl Award of IARI for excellence in Crop Sciences from Dr. VL Chopra in a solemn function at Division of Genetics, IARI on 20th Feb. 2015.

Dr. BC Viraktamath, Former project Director, IIRR has been elected as the Fellow of National Academy of Agricultural Sciences with effect from 1st January 2015.

Dr.B. Nirmala, Scientist (Agricultural Economics), received Sri.G.Sriramulu Memorial Gold Medal for securing highest OGPA in PhD in the Faculty of Agriculture from Dr.Daniel Gustafson, DDG (Operations), FAO, during 45th Convocation of ANGRAU held in Tirupati on 4th April, 2015.

Name of the Scientist	Award
Dr V Ravindra Babu	Life time achievement award (SS-DAT)
Dr T Ram	Life time achievement award (AF)
Dr. S. M. Balachandran	Distinguished Scientist award (SSDAT)
Dr. Shaikh N meera	Distinguished Scientist award (SSDAT)
Dr. Maganti Sheshumadhav	Distinguished Scientist award (AF)
Dr. Suneetha Kota	Young Scientist award (SSDAT)
Dr. B. Nirmala	Young Scientist award (SSDAT)
Dr. P. C. Latha	Young Scientist award (SSDAT)
Dr. Divya Balakrishnan	Young Scientist award (SSDAT)
Dr. P. Senguttuvel	Young Scientist award (AF)
Dr. R. Mahender Kumar	Fellowship award (AF)
Dr. L V Subbarao	Fellowship award (AF)
Dr. P Muthuraman	Fellowship award (AF)
Dr. M Azam	Fellowship award (AF)
Dr. Ch. Padmavathi	Fellowship award (SSDAT)
Dr. Satendra K. Mangrauthia	Fellowship award (SSDAT)
Dr. Banugu Sreedevi	Fellowship award (SSDAT)

Deputations

Dr. C. N. Neeraja visited University of Aberdeen, Scotland, UK from 23.10.2013 to May 15.5.2014 under DBT CREST fellowship 2012-2013.

Dr. M. Sheshu Madhav, Senior Scientist Biotechnology was on deputation to IRRI, Philippines to attend the training course on 'SNP data analyses under the Project 8 & 11 of IRRI-ICAR collaborative work plan 2011-16 during May 5-9, 2014.

Dr. R.M. Sundaram, Senior Scientist, Biotechnology was on deputation to Germany to participate in the Sixth Indo-German Frontier of Engineering Symposium, held at Potsdam, Germany during May 22-25, 2014.

Dr. A.S. Hari Prasad, Principal Scientist, participated as an expert consultant in FAO & APSA organized special meeting on "Hybrid Rice Development in Asia: Assessment of Limitations and Potential" during July 2-3, 2014 at Bangkok, Thailand.

Dr. T. Ram, Principal Scientist & Dr. P. Revathi, Scientist participated in 'Integrated Breeding Multi Year Course (IB-MYC)' during 15-26 September, 2014 in Spain.

Dr R M Sundaram, Senior Scientist (Biotechnology), attended a training programme on "Molecular breeding" at IRRI from September. 22, to October 3, 2014.

A team of 10 scientists' *viz.*, Drs V. Ravindra Babu, T. Ram, L. V. Subba Rao, R. Mahender Kumar, K. Surekha, G. Padmavathi, Chitra Shanker, S. N. Meera, P. Revathi and S.K Mangrutia participated in the fourth International Rice Congress (IRC 2014) at Bangkok, Thailand from October 27 to November 1, 2014.

Dr V Ravindra Babu, Project Director (A), DRR visited IRRI, Philippines during November 3-7, 2014 and interacted IRRI scientists on the ongoing research programmes and to establish active collaboration for the rice improvement programme.

Dr. MM Azam, Principal Scientist, Plant Breeding participated in regional workshop on "Water-Energy-Food Nexus" held in Kathmandu during February 10-12, 2015 organized by Fulbright Commission and US Embassy in Nepal.

Significant Events

Research Advisory Committee Meeting:

The third meeting of the Research Advisory Committee was held at DRR from May 2-3, 2014 under the chairmanship of Prof E.A.Siddiq, Former DDG (CS), ICAR & Honorary Professor, ANGRAU. The participating members included Dr T. Mohapatra, Director, CRRI; Dr Ramesh V Sonti, Chief Scientist, CCMB; Dr S.N. Sinha, Ex-Head, IARI Regional Station, Karnal; Dr. R.P. Singh, Former Project Director, Project Directorate on Cropping System Research, Modipuram; Dr R.K. Samanta, Vice Chancellor, BCKVV (WB); and Dr Gururaj Katti, Principal Scientist & Member Secretary, RAC, DRR. At the outset, Dr B.C. Viraktamath, Director, welcomed the Chairman and all the members and presented an overview of DRR research activities and accomplishments covering crop improvement, crop production, crop protection and social sciences sections. Dr G Katti presented the proceedings of RAC-2013 and action taken report. This was followed by detailed presentation of research accomplishments of each dis cipline by respective heads of sections. A Special publication 'Genetic Diversity and Genealogy of Rice Varieties of India' was released by the Chairman, RAC during the meeting.

Institute Research Council Meeting organized

Institute Research Council Meeting (IRC) was organized from May 5-8, 2014 under the chairmanship of Dr. B.C.Viraktamath, Project Director, DRR. All the Scientific Staff of DRR participated in the meeting. At the outset, Dr. V.Jhansi Lakshmi, Principal Scientist,

Entomology and Secretary, IRC welcomed the chairman and all the members of IRC. The chairman in his opening remarks highlighted the importance of IRC and the sequential system of conducting QRT, IMC, ARGM, RAC and IRC before *Kharif* season starts. This was followed by presentation of the work done during 2013-14 by individual scientists of each discipline. Each presentation was thoroughly discussed by the members. Four new projects were approved by the chairman. In his concluding remarks, the chairman emphasized that a) the hybrid rice scientists should focus on product delivery with emphasis on yield enhancement and pest resistance, b) minikit programme should be reintroduced and at least 5000 minikits to be given for new varieties and technologies c) mechanization should be intensively popularized d) comprehensive contingency plan should be prepared due to the predicted El nino effect and monsoon abnormalities. The meeting ended with vote of thanks by Dr. B. Sreedevi, Principal Scientist, Agronomy and Joint Secretary, IRC.

Students Training programme organized

Students of final year, B.Tech. (Agri Engineering) KCAET, Tavanur, KAU, Kerala underwent a training at DRR for one month on "In plant training on farm machinery operations for water management in rice" during 1-30 May, 2014 under the guidance of Dr. T.Vidhan Singh, Principal Scientist (FM&P) and Dr. Mahendra Kumar, Principal Scientist (Agronomy). DRR Scientists interacted with the students in the form of class room lectures on all aspects of rice cultivation. The students were also exposed to practical classes at Water Technology Center of ANGRAU, Hyderabad.

ICAR Foundation day celebrations

DRR celebrated "ICAR Foundation day" on 16th July 2014. Dr.S.M.Virmani, Advisor, Indian Resources Information & Management Technologies Ltd. was the Chief Guest of the celebrations and he delivered a lecture on "Role of basic and strategic research in transforming Indian agriculture". Prof. E. A. Siddiq, Hon. Chair Professor, Institute of Biotechnology and Dr. B. C. Viraktamath, former Project Director, DRR, were the special guests. Dr.K. S. Varaprasad, Director, DOR and Dr R. Kalpana Sastry, Joint Director, NAARM also graced the function.

SRI training programme

A Model Training Course on "Innovative System of Rice Intensification" sponsored by the Directorate of Extension (DOE), New Delhi was organized during July 16-23, 2014. About 19 participants from 12 states attended this training programme. The main objective of this programme is to impart knowledge and skills about SRI techniques for enhancing rice production and to identify field problems associated with SRI method of cultivation. The participants also prepared the location–specific action plan for promotion and adoption of SRI in their respective states.

ICAR sponsored short training course on Soil Health Management

ICAR sponsored short course training programme on Soil Health Management Techniques in Rice and Rice based Cropping Systems was organized during August 19-28, 2014. Twenty five scientists from various SAUs/ICAR institutes, from 11 states

of the country participated in the programme. The participants were trained with latest information and skills on soil quality dynamics and evolving suitable soil health management techniques, through lectures, practical classes followed by discussion, group/ panel discussions, field/laboratory visits and formulation of location specific action plans.

Hindi week celebrated

Directorate Hindi *saptah* celebrated during September 14-20, 2014. In the inaugural function, Dr. V Ravindra Babu, Project Director (A), called on all the scientists and staff of DRR to actively participate in all the functions and try to work and use more and more Hindi as far as possible. An *antakshri* competition was organized on the same day in which almost 40 staff members of DRR took active participation. Many more events like quiz, memory test were organized during the week, with active participation of staff members. Around 30 scientists and staff members were felicitated in the valedictory function and Dr. SR Yadav, Secretary, TOLIC, CRIDA was the chief guest of the function.

Winter School on New frontiers in rice breeding

An ICAR sponsored winter school on "New frontiers in rice breeding for improving yield, quality and stress tolerance for sustaining future production" was organized from September 10-30, 2014. The training programme was envisaged to impart knowledge on recent advances in rice improvement and broadly major areas covered are Rice Breeding Research: Current scenario and future prospects ; Evaluation and utilization of rice genetic resources and pre-breeding; Re-designing of rice plant for future food security; Recent advances in breeding for export quality and nutrition; Application of biotechnological tools for rice improvement; Breeding strategies to develop climate resilient varieties tolerant to biotic and abiotic stresses; Recent advances in heterosis breeding and Use of statistical tools in rice breeding. The winter school was attended by 27 participants from 14 states and one union territory. More than 60 theoretical lectures by 32 resource persons from DRR and 17 guest speakers from public and private sectors and about 18 practical (hands-on) exercises and exposure visits to seed production fields, R&D facilities of public and private seed companies including facilities at DRR and IRRI South Asia Hub were organized.

Training on MIS & FMS

To sensitize the staff about the implementation of MIS & FMS at the institute, modular training for working with different modules was organized, with the help of IBM team, to scientific, administrative and finance staff during August 1-2, 2014.

Swachh Bharat Abhiyan

Respecting nationwide call by our Honorable Prime Minister of India, Narendra Modi, Swachh Bharat Abhiyan was launched at Directorate of Rice Research on October 2nd 2014. The office functioned on that day and all the staff assembled at 9.30 AM. Dr. Ravindra Babu, Project Director (A), DRR briefed about Mahatma Gandhi`s vision of Clean India and the initiative taken by the Prime Minister on Mahatma's birth anniversary for cleaning the country. A cleanliness oath (*Swachhta Shapath*) was taken by all the staff of DRR. Later the staff members voluntarily attended the cleaning of inside and outside the Institute premises.

The activity is being carried out every week to make the institute neat and clean. A Swachh Bharat Abhiyan committee has been constituted to carry out the activities under annual and five year action plan chalked out by ICAR.

Village adoption under Swatch Bharath activities

Survey was conducted in March 2015 and Harshaguda village, Maheshwaram Mandal, Ranga Reddy District was selected for adoption under Swatchh Bharath activities of IIRR for 2015-16 based on the information given by the local Kisan club

Sports Meet-Medals' galore

DRR staff participated in the ICAR Zonal Sports Meet (2014) held at Indian Institute of Horticultural Research, Bengaluru during 13th to 17th October 2014 and won eight medals.

Drs K Surekha & G Padmavathi won the gold medal for Table Tennis Doubles and Dr P Revathi won the gold medal in Women's High jump event. Two silver medals were won for the events - Men's Badminton (Mr. Vijay Kumar, Mr. K Ramulu, Mr. T Vekaiah, Dr Vidhan Singh & Dr Arun Kumar S) and Table Tennis Women Singles (Dr K Surekha), respectively. Mrs U Rama won bronze medal in Discus throw and Dr P Revathi won three bronze medals for the long jump, 100 metres and 200 metres for women. DRR is proud of all these achievers and congratulates them for their excellent performance.

Field Institute Research Council (IRC)

Field IRC meeting was conducted at the DRR Experimental Farm on 25.10.2014 to monitor and review the experiments. Dr P.K. Agarwal, ADG (NFBSFARA), ICAR, critically reviewed the experiments and offered suggestions for further improvement of the research programmes.

Vigilance awareness week

Vigilance Week was observed at this Directorate from October 27 – November 01, 2014. On this occasion, the Project Director (A) administered oath to all the staff on the vigilance awareness. An essay and poster competitions were organized on the occasion and prizes were distributed to the winners.

IMC Meeting

The XVIII Institute Management Committee of DRR was held on 21.11.2014 to discuss and fine tune the requirements of the institute. The meeting was attended by the external experts *viz.*, Dr. Raji Reddy, Director Research, Prof. Jayashankar Telangana State Agricultural University; Dr. B. Dayakar Rao, Principal Scientist, DSR; Shri Athmakuri Brahmaiah, Shri M. Vittal Reddy, Farmers' representatives; Shri D.D. Verma, Comptroller (Finance), NAARM; besides the Project Director (A), and Heads of various sections of DRR.

IBSC Meeting

The 15th Institutional Biosafety Committee (IBSC) Meeting of Directorate of Rice Research was held on December 10, 2014 to review the biosafety aspects of the transgenic research undertaken at the institute. The meeting was attended by the DBT Nominee Prof. P.B. Kirti, Hyderabad Central University, Dr. M. Sujatha, Expert Member & Principal Scientist, DOR and Dr. A. Debnath, Chief Medical Officer, NAARM, besides Dr V Ravindra Babu, Project Director(A) and the other members from DRR. Four new proposals were reviewed and approved by the committee.

ECOBASM-2014

A two day National Conference on Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management (ECOBASM-2014) was organized jointly by the Society for Scientific Development of Agriculture and Technology, ASTHA foundation Meerut, UP and the Society for Advancement of Rice Research (SARR), DRR, Hyderabad during December 13-14th, 2014 at the Directorate. Dr. G S Sindhu, Agricultural Commissioner , Government of India was the chief guest of the inaugural function, Dr. S.K. Patil, VC , IGKVV, Dr. Padmaraju, VC, ANGRAU, Dr. V Ravindra Babu were the guest of honour in the inaugural function. Around 1000 delegates participated in the conference and deliberated on important issues. A number of DRR scientists, bagged several awards in the conference.

Brain Storming Meeting on Hybrid Rice

A brain storming meeting was organized at the Directorate, on December 18, 2014 with private sector representatives to assess the status of hybrid rice technology, strategies to improve and

refine the technology for further expansion in the country, synergizing the public-private partnerships in a much closer, effective and efficient way to make the technology more attractive and profitable to the farming community. Around 50 representatives from private seed companies besides scientists of Crop Improvement Section, DRR participated and took part in the deliberations of the meeting.

Curtain raiser function on launch of IIRR Golden Jubilee Celebrations

On the occasion of completion of 50 years of excellent service to the rice farming community and other stakeholders, IIRR decided to celebrate 2015 as Golden Jubilee Year and planned to organize several programs during the year including Golden Jubilee Annual Rice Workers Group Meeting in April 2015 and Golden Jubilee International Symposium during November 2015. In this context, a curtain-raiser function was organized on January 9, 2015 for launching of the Golden Jubilee Celebrations.

Dr. V. Ravindra Babu, Project Director (A), IIRR highlighted the achievements and the Chief Guest, Dr. Swapan Kumar Datta, DDG (CS) complemented the efforts and contributions of IIRR. The eminent scientists, Dr. S.N. Puri, Dr. J.S. Sandhu, Prof. A. Padmaraju, Prof. A. Praveen Rao, Dr. T. Mohapatra, and Dr. J.K. Ladha, were guests of honour. The directors of the local ICAR institutes also graced the occasion. On the eve of his superannuation from the ICAR service, Dr. S.K. Datta was felicitated overwhelmingly. Five innovative and progressive farmers from Telangana were also felicitated.

2nd Pre-Rice Group Meeting for hill Region

The 2nd Pre-Rice Group Meeting for Hill Region, 2015 was organized at IIRR on 20th February, 2015. Fifteen scientists from 8 states participated in the meeting and Dr. D.V. Seshu former global coordinator of International Network for Genetic Evaluation of Rice, Philippines and founder Scientist member of AICRIP has inaugurated the meeting and chaired the technical session. Dr. V. Ravindra Babu, Project Director (Acting), IIRR highlighted importance of hill ecology.

Open Day Celebrations

The Institute has celebrated "Open Day' on February 28, 2015 and facilitated the visit of 600 young high school students from 12 schools and made them aware of different aspects of rice crop, research facilities available, conducted various competitions *viz.*, elocution, poster presentation, quiz and distributed prizes to the winners.

Hindi Karyashala organized

A one day Hindi Karyashala was organized on 31-1-15 at the Institute in which the Chief Guest Shri Jai Shankar Tiwari apprised the officials about use and applications of Hindi language. The winners of extempore competition were felicitated by the project Director. A two months long Hindi Pragya and praveen classes are being conducted for the staff of IIRR which commenced in the month of February and will conclude on 31st March, 2015. A total of 20 staff members are attending the same.

Registration of Plant Varieties and Farmers Rights (PPV&FRA)

One day Awareness Workshop on "Registration of Plant Varieties and Farmers' Rights (PPV&FRA)" was organized at IIRR, on 18th March, 2015 to create awareness about the functions of PPV&FRA, farmers' Rights, Community recognition awards, registration of farmers varieties etc.

Awareness campaign for judicious use of herbicides

An awareness campaign for judicious use of herbicides was organized in Raavichedu village of Mahbubnagar District of Telangana 23rd January 2015 about the correct method of use of herbicides by knapsack sprayer and penoxsulam herbicide for one time application was distributed.

50th Annual Rice Research Group Meetings, 11 - 15th April, 2015

The inaugural session of the 50th Annual Rice Research Group Meetings cum Golden Jubilee Annual Workshop was held in the auditorium of Indian Institute of Rice Research, Hyderabad on 12.4.2015 at 10 AM. The Chief Guest was Shri Bandaru Dattatreya, Union Minister of Labour & Employement, Govt of India, Chairman Dr. S. Ayyappan, Director General, ICAR & Secretary, DARE and Dr. Robert S.Zeigler, Director Gene ral, IRRI, Dr J.S. Sandhu, Deputy Director General (Crop Science), Dr. M. Mahadevappa, Former Chairman, ASRB were Guest of Honor during the inaugural session.

Six leading centres of SAUs were identified for their prominent role and immense contribution to the AICRIP and the staff of these centres were felicitated. Retired scientists from co-operating centres of AICRIP, Progressive farmers from various states were felicitated for their specific contribution in the generation and adoption of technologies to the progress of Nation.

On the occasion of the Golden Jubilee celebrations former directors of IIRR, 12 retired scientists, 10 technical officers, 4 technical assistants and 5

administrative staff were felicitated. Seventeen farmers hailing from various states were also felicitated at 50 ARGM. Eight Publications were also released and website for SARR & International Rice Symposium-2015 were e- released.

Important Visitors

Dr J S Chauhan, ADG (Seeds), ICAR, New Delhi, visited our institute and Experimental farm on September 20, 2014 and interacted with the scientists about their research activities.

Visit of a team led by Dr.Violeta Village, Golden Rice IRRI, Philippines on August 01, 2014.

A team of five delegates from Ministry of Agriculture, Fiji visited DRR on August 12, 2014 and interacted with Project Director (A) & scientists explained the activities of DRR which included AICRIP testing and lead research programmes.

A team of scientists from Vietnam have visited DRR on September 04, 2014 and interacted with the Project Director (A) about the activities of the institute.

Dr. Swapan Kumar Datta DDG(CS), Dr. J S Sandhu, Agricultural Commissioner, Govt. of India, Dr. S.N. Puri, Ex-Vice Chancellor CAU, Imphal, Manipur, Directors of Local ICAR Institutes, Vice Chancellors of State Agricultural Universities and many dignitaries attended Curtain Raiser Programme-Golden Jubilee Celebrations of IIRR held on 9th January 2015.

Dr. Jahir Ali, Plant Breeder (GSR), IRRI visited IIRR and interacted with scientists associated with "Green Super Rice" Project on 17th February 2015.

Dr. D V Seshu former global coordinator of International network for genetic evaluation of rice, Philippines and founder Scientist member of AICRIP, visited IIRR and inaugurated 2nd pre rice group meeting for hill region 2015 on 20th February.

Dr. J S Sandhu, DDG Crop Sciences, ICAR visited IIRR on March 8th 2015 to review the activities of IIRR and Golden Jubilee Celebrations. He visited IIRR field experiments, Inaugurated renovated Jaya Hostel and new library facility, and later had in-depth discussions with Project Director regarding the Golden Jubilee celebrations and other issues related to functioning of IIRR. He addressed the administrative and scientific staff on various issues.

Project Completion Reports

ICAR-DBT Network: Identification and functional analysis of genes related to yield and biotic stresses (Rs. 943.02 lakhs) (2009-2014)

Sub-project-1: High resolution mapping, identification and functional analysis of rice tungro virus resistance genes (Principal Investigator- Dr. C.N. Neeraja; Co-investigators- Dr. D. Krishnaveni, Dr. Satendra Kumar Mangrauthia, Dr. S. M. Balachandran, Dr. Chitra Shanker)

With an objective of validating the identified candidate gene for RTV resistance, the present project aims at functional analysis of identified putative candidate gene LOC_Os07g29820 with predicted product of putative nucleotide-binding leucine-rich-repeat protein associated with RTV resistance. Under Phase II, using two F2 and BCnFn mapping populations involving TN1, IR64 (susceptible) and Utri Rajapan (resistant), 100 microsatellite based markers, 210 candidate gene based markers, a putative candidate gene. the identified candidate gene has shown tight association with RTV resistance through mapping. LOC_Os07g0481400 showed 7.5 fold expression change between infested and control sample after six hours of infestation in Utri Rajapan, while in TN1 has not shown difference in fold change between infested and control samples and the other three genes in the vicinity didn't show any fold change suggesting the involvement of this gene in RTV resistance. Thus the identified candidate gene needs to be functionally validated through the development of transgenics, complementation tests, RNAi silencing, promoter and expression analysis. The identified candidate gene needs to be cloned in the susceptible genotype and the expression of resistance to be studies. Gene validation is also being targeted using the identified miRNA species *viz.,* OsmiR167a in the candidate gene. Sequence analysis of the candidate gene along with the upstream region will be attempted to identify the structural and regulatory elements different between susceptible and resistance genotypes. Efforts will be intensified Virus Induced Gene Silencing for the validation of gene. Delineation of resistance and the role of candidate gene against virus and vector will be attempted. Quantification of RTSV and RTBV particles in the susceptible and resistant genotypes will be standardized to determine the level of virus titre to disease and its resistance. The candidate gene in five elite rice lines introgressed with qRTV7 resistance gene/QTL will be validated and the genotypes will subjected to field evaluation at endemic locations

Sub-project-2: Functional characterization of novel bacterial blight resistance genes from wild relatives of Oryza spp (Principal Investigator - Dr. R.M. Sundaram, Co-investigators - G.S. Laha, T. Ram, S.M. Balachandran, S.K. Mangrauthia)

Fine-mapping of the dominant BB resistant gene *Xa33* introgressed from *O. nivara* accession was carried out with mapping populations developed by backcrossing introgressed lines with the recurrent parent Samba Mahsuri. A 49-kb genomic region on Chr. 4 (where *Xa33* has been mapped) flanked by two closely linked SSR markers, RMWR7.1 and RMWR7.6 was analyzed for putative expressed genes. A total of eight genes were found in the genomic region of interest. Of these, a gene encoding serine-threonine kinase was observed to the most probable candidate for *Xa33.* Mining of novel alleles for the major bacterial blight resistance gene, *Xa27* introgressed and cloned from *O. minuta* was carried in a collection of 28 rice genotypes which included wild species of *Oryza* and cultivated varieties. Sequence polymorphism analysis of alleles detected numerous InDels in non-coding regions and

synonymous and non-synonymous mutation. Four bacterial blight resistance genes *Xa33, Xa21, xa13* and *xa5* were pyramided in Samba Mahsuri background through MAS. In addition to plant R genes, genetic variability in the pathogen population is being studied in a collection of 130 isolates of *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) from different hot-spot locations across the country and maintained at the Directorate of Rice Research, Hyderabad and 22 pathotypes of the pathogen were identified across the country. A primer pair called JEL, based on the repetitive element IS1112 was found to be useful for studying the genetic diversity of the pathogen.

Sub project I A: Fine mapping of yield enhancing QTLs from wild rice (co-investigators-Dr. Jyothi Badri & Dr. Divya Balakrishnan)

Wild species are an important source of yield enhancing QTLs. The project was initiated with following objectives i)To fine map major yield enhancing QTLs from wild species ii)To evaluate the effect of yield QTLs in other backgrounds of rice and iii)To analyse the function of the candidate genes. Two major yield enhancing QTLs *yld 2.1* and *yld 8.2* were identified from *O. rufipogon* WR120 (Marri *et al.* 2005). QTL *yld2.1* was (5 Mb region) dissected into 7 sub QTL regions with 8 polymorphic markers (Prasad Babu *et al.* 2009). Sub-QTL3 showed a significant increase in yield with 17 – 20 % higher grain yield/plant (Sudhakar *et al.* 2012). IL50-7 has 7 homozygous subQTL *yld2.1* markers for yield. F2 mapping population of 1200 lines was developed from the cross of IL50-7 X KMR3. 750 F3 families were evaluated for height, tiller number, days to flowering and yield/plant. Based on F2 and F3 grain yield data, 33 high yielding and 33 low yielding F3 families were advanced to F4 generation for selective genotyping.

Twenty seven selected KMR3 high-yielding introgression lines were used to develop hybrids. In all, 43 out of the 67 hybrids showed >50% heterosis compared with that of KRH2. Heterosis for yield per plant ranged from 17.6% to 84.9% and heterobeltiosis from 18% to 77%. The 11 highest-yielding hybrids showed >40 g yield per plant. Seven of these 11 showed both flanking markers of sub-QTL3, three had one flanking marker of sub-QTL3, and one had a flanking marker of sub-QTL2 of *yld2.1* from *O. rufipogon*. (Sudhakar *et al.* 2014).

Evaluating Sub QTL 3 of *yld2.1* in restorer KMR3 ILs for hybrid rice production: The five selected ILs (IL50-7, IL-5012, IL50-13, IL-363-5 and IL86-18) with sub QTL3 markers from *O. rufipogon* and KMR3 were crossed with 6 CMS lines. The 36 hybrids along with corresponding parents and 5 popular hybrids KRH2, DRRH2, DRRH3, PA6201 and PA6444 were used as standard checks and evaluated for 14 yield related traits. Data was analysed for general/ specific combining ability, heterosis, mid parent heterosis and heterobelteoisis. The seven hybrids IR58025A/IL86-18, APMS6A/IL50-7, APMS6A/IL86-18, CRMS32A/IL50-7, IR79156A/IL86-18, APMS10A/ IL50-7, APMS10A / IL50-13 showed better heterosis and high yield (Sudhakar *et al.* 2014).

Transcriptome analysis of KMR3 IL50-7 (In collaboration with Dr Rajeshwari Ramanan, CCMB): A whole genome expression analysis was carried out in leaf and panicle of KMR3 and IL50-7 using Affymetrix Rice Genome Array. Only 2% genes were differentially expressed between the two lines. There were 499 up-, and 598 down-regulated genes in leaf, and 897up-, and 412 down-regulated genes in panicle. Only 3 up-regulated genes and 2 down-regulated genes were common to both leaf and panicle. In leaf, 18 genes were up-regulated more than 10-fold and up to a maximum of 66-fold and 32 genes were down regulated more than 10-fold and up to a maximum of 119-fold. 5 and 4 pathways were up-regulated and 3 and 9 pathways were down-regulated in leaf and panicle respectively. A 66-fold upregulated candidate gene *Os11Gsk*, showed no transcript in KMR3 but was highly expressed in *O. rufipogon* and IL50-7 (Sudhakar *et al.* 2012). IET 21943(RPBIO 4919-50-13) from the cross KMR3/*O.rufipogon* was identified for release as state variety in West Bengal after CSTVT trial.

QTL mapping in Swarna/ *O. nivara* ILs: Advanced backcross QTL (AB-QTL) analysis was carried out in two Swarna/*O. nivara*-derived BC2F2 populations. For nine traits, we identified 28 QTL in population 1 (Swarna X *O.nivara* IRGC 81848) and 26 QTL in population 2 (Swarna X *O. nivara* IRGC 81832) (Swamy *et al.* 2011). Five major effect QTLs for yield per plant (*yldp3.1, yldp3.2, yldp4.1, yldp8.1 and yldp11.1)* were identified in BC2 test cross progeny of population 2 (Kaladhar *et al.* 2008). QTLs for 12 grain quality traits were mapped in both mapping populations (Swamy *et al.* 2012).

IL 65S (Swarna X *O.nivara* IRGC 81848) is a unique line which differs in many morphological traits compared to recurrent parent Swarna and has part of *yld2.1* from *O. nivara* (Swamy *et al.* 2011). 480 F2 plants were generated from the cross Swarna X IL65S and 440 F3 families were advanced to F4. The 440 F3 families were field evaluated for morphological, physiological and yield related traits. Out of 2000 genomewide SSRs, only 130 showed polymorphism between Swarna and IL65S. IET 21542 (RP Bio 4918-248S) from the cross Swarna/*O.nivara* IRGC81848 was released as DRR Dhan40 in Maharashtra, Tamil Nadu and West Bengal after Irrigated Medium trials in AICRIP. RP Bio 4918-228S was identified as multiple pest resistant line.

Sub project 4A: Functional validation of candidate gall midge resistance genes (Principle Investigator - J. S. Bentur, Co-investigators- A.P. Padmakumari & C. N. Neeraja)

The salient achievements include, Kavya a gall midge resistant variety with HR- reaction , Gm1 gene was mapped on to Chr 9 and 20 putative candidate genes were identified in the region between the two flanking markers RM23901 and RM23982 .

Gm4 gene was mapped on to Chr 8 in Abhaya and 70 genes were identified in between the flanking markers RM22543 and Rm22571. Of these 2 genes, Os 08g0196200 and Os 08g 0197300 were found to be associated with leucine rich repeat 2 containing proteins.

Gm8 gene was identified from Aganni and mapped on to Chr 8 flanked by RM 22685 and RM 22709. In this marker delimited region 38 primers were designed for the "Proline rich Protein" which was confirmed by the relative level of expression in the S and R lines of TN1 X Aganni mapping populations. 27 genes were shortlisted for real time validation. PR Bet V I family protein was upregulated by >2 fold at 120h after egg hatching in Aganni and its derived ' R' line.

Studies to understand the common pathways between 'R'and 'S lines with HR + and HR – reactions found upregulation of PAL, RBO in HR + and von willebrand factor in HR- reaction which is evident in Kavya (at 24h) and Aganni (at 120h) after infestation.

Map based approach helped in identification of candidate genes for Gm4 and Gm8 along with their susceptible alleles. A total of 100 pair of primers was designed for initial validation of EST-SSR markers for identification of gall midge biotypes.

DBT Network Porject: Characterization and use of EMS induced mutants of rice variety Nagina 22 for yield, drought tolerance and phosphorus use efficiency in rice (2007-14)

The focus in this project was to develop and characterize EMS induced mutants of Nagina 22 for functional genomic studies. At DRR the focus was on Phosphorus use efficiency, yield and drought –stay green trait. A total of 1800 mutants were screened for drought tolerance in the field under normal conditions. Out of 1800, 104 mutants were selected as drought tolerant mutants and 19 mutants as drought susceptible based on their phenotype, physiology and grain yield performance. Ten mutants were identified as stay green mutants. These stay green mutants were also found to be drought tolerant. A total of 6000 mutants were screened for tolerance to low phosphorus (Olsen value <2) in field conditions. 54 mutants were identified as gain of function mutants for tolerance to low phosphorous and 17 mutants as loss of function mutants compared with N22.

A set of 500 mutants were screened under normal field conditions. Twenty mutants which were dwarf, late flowering, low tillering, high tillering and fine grain were identified. Field trials were conducted under low P and normal conditions using 8 low P tolerant mutants and eight low- P susceptible mutants and characterised using photosynthetic, biochemical parameters, enzymes and protein for PUE. A set of 100 mutants were tested in low P condition and normal condition for comparison in yield and tiller no, 4 tolerant mutants and 6 susceptible mutants (yield lesser than N22) were identified. 15 PHO2 mutants from NRCPB were also evaluated in low P field.A set of 200 mutants were tested in low P condition and normal condition for comparison in yield and tiller no, 20 tolerant mutants and 6 highly susceptible mutants (died in low P field) and 10 susceptible mutants (yield lesser than N22) were identified.

The best low P tolerant mutant was crossed with N22, F2 population was grown in low P condition and tiller number segregated in 3:1 ratio indicating its monogenic inheritance. NH 686 is also multiple abiotic stress tolerant F2 seeds have been obtained from 12 crosses between mutants and N22. NH686 also has high zinc in seed and is in AVT2 of Biofortification trails in ACRIP.

Department of Science and Technology (Govt of India) project- 'Silencing of Rice tungro Virus through RNAi approach' (Principal Investigator: S K Mangrauthia)

Molecular variability analysis of *Rice tungro spherical virus* (RTSV) was carried out using different virus isolates collected from India. Sequence analysis revealed that Indian isolates of RTSV diverged into two lineages of Hyderabad, Cuttack, Puducherry and West Bengal, Kanyakumari and Coimbatore. Besides deciphering the molecular diversity, the divergence of two major groups (Indian and other Asian) of RTSV with more number of sequences available in NCBI database was revealed. Sequence difference count matrix analysis of the CP3 gene revealed that Indian RTSV population is significantly different in its molecular genetic composition from rest of the world. This study is important as it provides a way to draw more effective strategies against this virus. Further, it helped in designing an efficient RNAi construct that has ability to target conserved region of RTSV genome for broad spectrum resistance. The RNAi vectors were constructed based on the principle of antisense and inverted repeat approaches, using siRNA rich region of conserved RTSV-CP gene. RNAi inducing rice transgenic plants were obtained which showed resistance against RTSV. These plants harbored conserved coat protein gene sequence of RTSV in antisense orientation. The presence of RTBV and absence of RTSV in tolerant transgenic plants clearly demonstrated the silencing of RTSV genome in RNAi inducing rice transgenic plants.

Personnel

S. No	Name	Designation	E-mail	Remarks
1	Dr. B.C. Viraktamath	Project Director	pdrice@drricar.org	Superannuated on 31/03/2014
Plant Breeding				
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Objective (s)	Wt.	Action(s)	Success Indicator(s)	Unit	Wt.	Target / Criteria Value					Achieve-ments	Performance		Percent achieve-ments against Target values of 90% Col.	*Reasons for shortfalls or excessive achievements, if applicable
						Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw Score	Weight-ed Score		
Identification & validation of technologies for different ecologies under AICRIP	36	Development of improved varieties suited to diverse agro ecologies	Varieties/ hybrids identified for release	No.	15	19	16	13	10	7	19	100	15	118.75	Aggressive efforts of private sector resulted in release of more number of varieties/ hybrids
		Organizing multi-disciplinary multi-location trials	Entries evaluated	No.	14	1260	1050	840	630	420	1169	92.78	12.98	111.33	Efforts of AICRIP co-operating centers led to more nominations
			Management practices identified	No.	7	11	9	7	5	3	9	90	6.30	100	**NA**
Genetic enhancement for yield, quality and resistance for sustainable rice production	27	Evaluation of genetic material for crop improvement programme	Breeding/ germplasm lines &experimental hybrids evaluated	No.	13	670	580	490	400	310	590	91.55	11.90	101.72	NA
			Lines identified for unique traits	No.	10	10	9	8	7	6	9	90	9	100	NA
		Seed production programme to ensure quality seed availability	Breeders seed produced	MT	3	720	600	480	360	240	650	94.16	2.82	108.33	NA
			Truthfully labelled seed produced	MT	1	65	60	55	50	45	70	100	1	116.67	Efforts from Blight out project supported by CCMB to popularise imp. samba Mahsuri among 4 states *viz.*, AP, TS, TN &KA resulted in more TFL seed production in collaboration with farmers

Development and dissemination of appropriate crop production & protection technologies for maximizing yield	17	Development of new technologies	Production/ protection technologies tested	No	11	35	31	27	23	19	33	94.28	10.37	106.45	Efforts from production & protection scientists resulted in testing new technologies
		Dissemination of technologies	Trainings organized	No.	5	8	6	4	2	0	8	100	5	133.34	Approval & release of funds under Consortia Research Platform (CRP) on Biofortification encouraged us to conduct training programs to research partners during January 2015
			Demonstrations of technologies conducted	No.	1	660	550	440	330	220	454	82.54	0.82	82.54	Co-operators could not conduct FLDs due to late monsoon, unfavourable weather conditions and unavailability of seed material
Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	22	18	14	10	6	18	90	2.7	100	**NA**
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	09.07.2014	30.06.2014	100	2	100	**NA**
Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	99.4	100	2	101.43	**NA**
Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014 – 2015 for Approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014	April 29, 2014	100	2		**NA**
		Timely submission of Results for 2013-2014	On-time submission	Date	1	May 1, 2014	May 2, 2014	May 5, 2014	May 6, 2014	May 7, 2014	April 29, 2014	100	1		**NA**

Enhanced Transparency/ Improved Service delivery of Ministry/ Dept.	3	Rating from Independent Audit of implementation of Citizen's/ Clients Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	100	100	2		**NA**
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100	1		**NA**
Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov.1, 2014	Nov.2,2014	Nov.3,2014	Nov.4, 2014	Nov.5,2014	Jan 12, 2015	100	2		**NA**
		Implementation of agreed milestones of approved Mitigating Strategies for Reduction of Potential risk of corruption (MSC)	% of implementation	%	1	100	90	80	70	60	90	100	1		**NA**
		Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80	0	0	0		Consultant has been reappointed
		Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	90	80	70	60	85	85	1.7		**NA**

Total Composite Score: 92.59 Rating: Very Good

Procedure for computing the Weighted and Composite Score

1. **Weighted Score of a Success Indicator = Weight of the corresponding Success Indicator x Raw Score / 100**
2. **Total Composite Score = Sum of Weighted Scores of all the Success Indicators**

***Mandatory**

Appendix 1

Promising entries in Varietal Trials, *Kharif* 2014

S. No	IET NO / Designation	Source trial	Cross combination	Yield (kg/ha)	FD (Days)	Grain type	Remarks	Suitable for states
1	23377 CRR 523-2-2-1-1	IVT-VE DS	Kalinga III / Bhupen	3237	91	LS	R-BL	Rainfed upland areas in Jharkand
2	23329 CR 3638-1-2 -IR 78908-126-B-2B-CR-1-2	AVT1-E DS	Vandana/IR64	2062	76	SB	MR-BL	Rainfed upland areas in Madhya Pradesh and Bihar
3	23345 CRR680-B-B-25-4	AVT1-E DS	IR78875-176-B-2/ IR78875-207-B-3	1991	74	LB	MR-BL, RTD	Rainfed upland areas in Maharashtra and Jharkhand
4	23333 CR3617-1-1-2-1-1	AVT1-E DS	Satabdi/ CR2340-1	2065	75	SB	MR-BL, BS	Rainfed upland areas in Jharkhand
5	23337 CR3693-1-1	AVT1-E DS	IRRI 132/IR 78877-208-13-1-1	4141	79	LB	MR-BL	Rainfed upland areas in Madhya Pradesh and Jharkhand
6	23355 RP 5125-9-6-2-1-IR 84898-B-B	AVT1-E DS	IR 78877-208-B-1-1/IR78878-53-2-2-2	2309	76	LB	MR-BL, SR	Rainfed upland areas in Madhya Pradesh, Bihar and Jharkhand
7	23150 (OR 2329-3)	IVT-RSL	OR 1530-8/IR 68181-8-49	6441	123	MS	MR-BL	Rainfed Shallow Lowland areas in Karnataka
8	23148 (CR 1898-32-69-CN-12-2)	IVT-RSL	Selection	6276	111	SB	MR-NBL, BS	Rainfed Shallow Lowland in Karnataka
9	22654 (NDR 4110-9-5)	AVT 1-SDW	Madhukar/ Sona	4674	116	MS	MR-NBL, SR	Rainfed Lowland in Uttar Pradesh and Andhra Pradesh
10	22302 (CR 2416-12-1-1-1)	AVT 2-DW	Durga/ Hatipanjari	5294	156	SB	MR-BB,SR	Rainfed Lowland areas in Odisha
11	23422 (JRB-1)	AVT 2-E TP	Selection from Swarna in farmers' fields	5486	93	SB	MR - BL, NB	Irrigated areas in Odisha, Bihar, Uttar Pradesh, Madhya Pradesh and Maharashtra, Kerala
12	23409 MTU 1153 (MTU II 320-41-2-1)	AVT 2-E TP	MTU-1010/ MTU-1081	5514	91	LB	MR -BL,GS	Irrigated areas in Bihar, Madhya Pradesh, Kerala, Karnataka, Andhra Pradesh and Tamil Nadu
13	22878 HRI-179 (Hybrid)	AVT 2-E TP	-	5553	92	LB	MR - BL, NB,BB	Irrigated areas in Chhattisgarh
14	23420 RP 5333-41-2-3(IR 83383-B-B	AVT 2-E TP	IR 72022-46-2-3-3-2/IR 57514-PMI-5-B-1-2	5188	91	LS	MR - BL, RTV	Irrigated areas in Bihar, Madhya Pradesh Andhra Pradesh, Tamil Nadu and Puducherry.
15	23429 CN 1756-3-3-1-MLD 17	AVT 2-E TP	IR 50/ADT 41	5419	94	SB	MR - BL, SR	Irrigated areas in Uttarakhand, Odisha, Bihar, Uttar Pradesh and Tamil Nadu
16	23435 RP 5333-29-3-6-IR 83383-B-B)	AVT 2-E TP	IR 72022-46-2-3-3-2/IR 57514-PMI-5-B-1-2	5133	90	LS	MR - BL	Irrigated areas in Karnataka, Tamil Nadu, Puducherry, Bihar, Madhya Pradesh, Punjab and Haryana.
17	IET-23275 HKR 08-62	AVT – 2 IME	UPR 1230-9-2/ IET 16833	6113	100	LS	MR- BL, NBL, BBL	Irrigated areas in Bihar

S. No	IET NO / Designation	Source trial	Cross combination	Yield (kg/ha)	FD (Days)	Grain type	Remarks	Suitable for states
18	23324 CN1752-18-1-9-MLD19	AVT – 2 IME	IR-50/IET 4786	6129	94	SB	MR-LBL	Irrigated areas in Odisha, Chhattisgarh, Bihar, Tripura, Rajasthan, Tamil Nadu
19	22913 CNRH-102(Hybrid)	AVT 2-IM	-	6157	106	LB	MR - BL, NB,SR,GS	Irrigated areas in Chhattisgarh
20	23230 WGL 536	AVT 2-IM	WGL 14/ Meghuri sona	4372	108	MS	MR - NB	Irrigated areas in Maharashtra
21	23088 NP 9381	AVT1-L	PRN 6565/PRN 3941	5488	119		MR - BS,BB, R-NB,GM1	Irrigated areas in West Bengal
22	23210 Bulk 18	AL & ISTVT-Alkalinity	CSR 23/CSR 27	3430	104	MS	--	Promising in Haryana (Inland salinity)
23	22648 CR 2713-179	AVT 2-ASG	Swarna / Geetanjali	4354	115	SS	MR-GS	Promising in West Bengal, Chattisgarh, Assam
24	23194 NLR 40054	AVT 2-ASG	MTU 7029/NLR 19994	4841	107	MS	R-GM1	Promising in Odisha, Chattisgarh, West Bengal and Uttar Pradesh
25	22649 CR 2713-180	AVT 2-ASG	Swarna / Geetanjali	4486	116	MS	MR-SR,GS	Promising in Odisha, West Bengal, Chattisgarh and Assam
26	23193 CRL 74-89-2-4-1	AVT 2-ASG	Pankaj/Padumoni	4908	113	MS	-	Promising in Odisha, Chattisgarh, West Bengal and Assam
27	22982 VL 8657	AVT 2-U(H)	RC PL 1-45/ VL3861	2711	83	SB	-	Promising in Himachal Pradesh (Low elevation) and Uttarakhand (Medium elevation)
28	22978 HPR 3195	AVT 2-U(H)	Pure line Selection from IC 3131180	3746	81	LB	-	Promising in Himachal Pradesh, Meghalaya and Manipur (Low elevation)
29	22984 RCPL 1-412	AVT 2-U(H)	Selection from IURON (BP 3180-MR 6)	3869	95	LB	-	Promising in Meghalaya and Himachal Pradesh under low elevated hills
30	23463 R 1240-913-2-1013-1	AVT 2-Aerob	Mahamaya/ NSN-9	4447	92	LB	MR-RTV, R-WBPH	Promising in Tamil Nadu
31	*23445 GK 5022 (Hybrid)*	AVT 2-Aerob	GK 5022A/GK 5022R	4232	93	LS	MR - BL	Promising in Bihar
32	23450 CR 3631-1-3 (IR 83929-B-B-291-91-3-1-1-2-CR-1-2)	AVT 2-Aerob	IR 78878-53-2-2-2/CT 6510-24-1-2	-	-	MS	MR - BL, GS, R-WBPH	Promising in Odisha
33	22704 (Repeat) MGD-1104	AVT 2-Aerob	Tequing / Binam	-	-	SB	MR - BL, RTV, R-WBPH	Promising in Bihar and Tamil Nadu

Appendix 2

Promising hybrids identified in different hybrid rice trials (2014)

	DFF	Promising in
IHRT-E		
HRI-184 (IET 24798)	96	Over all
SVZ-1109 (IET 24796)	90	North
SAVA-134 (IET 24797)	94	North
IHRT-ME		
KPH-468 (IET 24824)	96	Over all
KPH-473 (IET 24825)	95	Over all
RH12N0083 (IET 24814)	99	Over all
IHRT-M		
PR 14107 (IET 24880)	103	Over all
PR 14105 (IET 24879)	105	East & West
RRX-016 (IET 24884)	102	North

IHRT-MS		
KPH-459 (IET 24888)	100	Over all
PR 14112 (IET 24893)	103	Over all
28P09 (IET 24156)	106	Over all
MLT (Non MS)		
25P25 (Early)	93	West
27P31 (Mid Early)	99	South
27P52	105	Over all
MLT (MS)		
KRH-4	101	Over all
27P63	104	West
KPH-199	98	South

Appendix 3

Variety wise Breeder Seed Production during *kharif* 2014

Breeder seed production of rice varieties and parental lines of hybrids as per DAC indents was organized at 43 centers across the country, involving 217 varieties and parental lines of eight hybrids. A total production of 7757.42 quintals of breeder seed was achieved against the target of 4328.42 quintals, thus marking 79% more than the indented quantity. The varieties with indent of more than 30 quintals of breeder seed and parental lines of eight hybrids are listed below:

Hybrid/Variety	Produced by	Quantity Alloted	Quantity Produced
VARIETIES			
BAMLESHWARI (IET-14444, R 738-1-64-2-2)	IGAU, Raipur	35.50	36.00
CHANDRAHASINI (IET - 16800)	IGAU, Raipur	47.10	47.20
COTTONDORA SANNALU (MTU-1010)	ANGRAU, Hyderabad, IGAU, Raipur	500.00	530.00
GONTRA BIDHAN-1(IET 17430)	BCKVV, Nadia	47.50	80.00
IGKVR-1 (IET 19569)	IGAU, Raipur	32.00	33.00
IGKVR-2 (IET 19795)	IGAU, Raipur	31.00	36.00
IGRKVR-1244 (R1244-1246-1-605-1) (IET 19796)	IGAU, Raipur	32.10	34.80
IMPROVED SAMBA MAHSURI	DRR, Hyderabad	30.00	80.00

Hybrid/Variety	Produced by	Quantity Alloted	Quantity Produced
IR-64	DSR, MAU, IGAU, Raipur JNKVV, Jabalpur	131.00	925.27
KARMA MAHSURI (IET 19991)	IGAU, Raipur	40.50	64.20
KHANDAGIRI	OUAT, Bhubaneshwar	84.00	8.00
LALAT (IET-9947)	OUAT, Bhubaneshwar	108.00	110.00
MAHAMAYA (IET-10749)	IGAU, Raipur	70.00	86.40
MTU-7029	ANGRAU, Hyderabad DSR, MAU& PRDF,Gorakhpur	204.00	230.00
NARENDRA-8002 (IET-15848)	NDUAT, Faizabad	58.00	98.00
NAVEEN (CR-749-20-2) (IET-14461)	CRRI, Cuttack	49.00	100.00
PKV HMT	ZARS, Sindewahi	59.00	-
POOJA (IET-12241)	CRRI, Cuttack	120.10	85.00

Hybrid/Variety	Produced by	Quantity Alloted	Quantity Produced
PRATIKSHYA (ORS 201-5)(IET-15191)	OUAT, Bhubaneshwar	129.00	250.00
PUSA - 1121 (PUSA SUGANDH-4)	BEDF New Delhi, DSST &IARI, New Delhi, IARI Regional Station, Karnal	157.00	128.00
PUSA 44	DSST &IARI, New Delhi, IARI Regional Station, Karnal	64.50	75.00
PUSA BASMATI-1	BEDF New Delhi, DSST &IARI, New Delhi, IARI Regional Station, Karnal	50.00	71.00
RANI DHAN (IET-19148)	OUAT, Bhubaneshwar	72.00	135.00
RANJEET (IET - 12554)	RARS, Titabar	91.00	100.00
SAHBHAGI DHAN	CRURRS, Hazaribagh	189.00	189.00
SAMBA MAHSURI (BPT-5204)	ANGRAU, Hyderabad , DSR, MAU & PRDF,Gorakhpur	172.00	233.60
SAMPADA (IET 19424)	DRR, Hyderabad & IGAU, Raipur	41.00	48.00
SHATABDI (IET-4786)	CRRI, Cuttack, RRS, Chinsurah	36.10	40.00
SWARANA-SUB 1 (CR 2539-1) IET-20266	CRRI, Cuttack IGAU, Raipur, RARS, Titabar & RRS, Chinsurah	386.00	372.70
VIJETHA (MTU-1001)	ANGRAU, Hyderabad	231.00	250.00
HYBRIDS			
DRRH-3 (IET -19543)			
A Line	DRR, Hyderabad	0.48	0.50
B Line	DRR, Hyderabad	0.16	0.16
R Line	DRR, Hyderabad	0.16	0.16
KRH2			
IR 58025A	UAS, Bangalore	1.02	20.00
IR 58025B	UAS, Bangalore	0.34	-
KMR-3R	UAS, Bangalore	0.34	30.00
Pant Shankardhan-1			
A Line	GBPUAT, Pantnagar	0.18	0.65
B Line	GBPUAT, Pantnagar	0.06	1.80
R Line	GBPUAT, Pantnagar	0.06	0.04
SAHYADRI 1			
A Line	RARS, Karjat	0.72	0.84
B Line	RARS, Karjat	0.24	0.29
R Line	RARS, Karjat	0.24	0.30
SAHYADRI -2			
A Line	RARS, Karjat	0.03	0.05
B Line	RARS, Karjat	0.01	0.03
R Line	RARS, Karjat	0.01	0.04
SAHYADRI-3			
A Line	RARS, Karjat	0.06	0.09
B Line	RARS, Karjat	0.02	0.03
R Line	RARS, Karjat	0.02	0.05
JRH-5			
A line	JNKVV, Jabalpur	0.24	1.50
B line	JNKVV, Jabalpur	0.08	-
C line	JNKVV, Jabalpur	0.08	1.50
JRH-8			
A line	JNKVV, Jabalpur	0.24	0.50
B line	JNKVV, Jabalpur	0.08	-
C line	JNKVV, Jabalpur	0.08	1.00
	Total (Hybrids)	**4.95**	**59.53**

Appendix 4

Funded AICRIP centers with staff positions during 2014-15

S. No	State	Centre	Total
1	Andhra Pradesh	Maruteru	9
2	Telangana	Rajendranagar	6
3	Andhra Pradesh	Ragolu	1
4	Telangana	Warangal	3
5	Assam	Jorhat/Titabar	7
6	Assam	Karimganj	1
7	Bihar	Patna	6
8	Bihar	Pusa	4
9	Bihar	Sabour	1
10	Chattisgarh	Jagdalpur	4
11	Chattisgarh	Raipur	5
12	Gujarat	Nawagam	6
13	Gujarat	Navasari	3
14	Haryana	Kaul	7
15	Himachal Pradesh	Palampur/Malan	7
16	Jammu & Kashmir	Khudwani	5
17	Jammu & Kashmir	R.S.Pura (Chatha)	5
18	Jharkhand	Kanke/Ranchi	4

S. No	State	Centre	Total
19	Karnataka	Mandya	5
20	Karnataka	Gangavati	4
21	Karnataka	Brahmavar	2
22	Karnataka	Mugad	2
23	Karnataka	Ponnampet	2
24	Kerala	Moncompu	4
25	Kerala	Pattambi	7
26	Madhya Pradesh	Rewa	5
27	Maharashtra	Karjat	6
28	Maharashtra	Sakoli	2
29	Maharashtra	Tuljapur	2
30	Manipur	Imphal (Wangbal)	4
31	Meghalaya	Upper Shillong	4
32	Orissa	Chiplima/Sambalpur	6
33	Orissa	Jeypore	1

S. No	State	Centre	Total
34	Puducherry	Kurumbapet	3
35	Punjab	Ludhiana	7
36	Rajasthan	Kota	2
37	Tamil Nadu	Aduthurai	4
38	Tamil Nadu	Coimbatore	7
39	Uttar Pradesh	Nagina	1
40	Uttar Pradesh	Kanpur	2
41	Uttar Pradesh	Ghaghraghat	4
42	Uttar Pradesh	Varanasi	4
43	Uttar Pradesh	Faizabad (Masoda)	5
44	West Bengal	Bankura	2
45	West Bengal	Chinsurah	6
46	Uttaranchal	Pantnagar	7
47	Tripura	Agarthala/Arundhu-tinagar	2

Appendix 5

On-going projects (2014-15)

Code	Project Title	Project Leader & Associates
P1 : GEY: Genetic enhancement of yield potential and stress resistance in rice for irrigated ecology. **Programme leader: V Ravindra Babu**		
GEY/CI/ BR/12	Redesigning the indica rice plant type by introgressing the traits for higher yield potential and disease and pest resistance from tropical japonica and wild rices.	**T Ram,** G.S.Laha, V. Jhansi Lakshmi, A. P. Padmakumari, D. Krishnaveni, B.Sreedevi, Satendra Kumar Mangrauthia, Ladha Lakshmi
GEY/CI/ BR/9	Breeding varieties for Boro areas.	**LV Subba Rao,** V. Ravindra Babu, Ch. Padmavathi
GEY/CI/ BR/16	Breeding rice varieties for resistance to planthoppers	**G Padmavathi,** G.S.V. Prasad, V. Jhansi Lakshmi, P. V. Satyanarayana, K. Vasantha bhanu
GEY/CI/ BR/14	Breeding rice for enhanced phosphorous use efficiency	**VP Bhadana,** T. Ram, P.Brajendra, R. M. Sundaram, D. Subramanyam, R. M. Kumar
GEY/CI/ BR/19	Germplasm screening and identification of genes for developing resistance to sheath blight in rice	**Jyothi Badri,** N. Shobha Rani, VP Bhadana, Suneetha Kota, V Prakasam, M. Sheshu Madhav
GEY/CI/ HY/7	Exploitation of inter sub-specific heterosis in rice (Oryza sativa L.)	**AS Hari Prasad,** P. Senguttuvel, K.B. Kemparaju, B.C. Viraktamath
GEY/CI/ HY/10	Development of parental lines and Hybrids with tolerance to salinity and suitability to aerobic situations	**P Senguttuvel,** A.S. Hariprasad, P. Revathi, K.B. Kemparaju, Suneetha Kota, G.Padmavathi, B.Sreedevi, D. Subbramanyam, N Somasekhar, B.C. Viraktamath
GEY/CI/ HY/6	Genetic improvement of maintainers and development of CMS lines	**K.B.Kemparaju,** B.C. Viraktamath, A. S. Hari Prasad, P. Senguttuvel, P. Revathi
GEY/CP/ PP/12	Physiological studies for improving ideotype breeding in rice	**P Raghuveer Rao** A.S. Hariprasad, V.P. Bhadana
P 2: GEQ/: Genetic enhancement of grain and nutritional quality for domestic and export purpose **Programme leader: V Ravindra Babu**		
GEQ/CI/ BR/8	Enhancing nutritional quality of rice through bio-fortification	**V Ravindra Babu,** N. Shobha Rani, L.V. Subba Rao, B. Sreedevi, K. Surekha, C.N. Neeraja, G. Padmavathi, D. Sanjeeva Rao, T. Longvah (NIN)
GEQ/CI/ BR/20	Development of value added rice based products for different uses	**M.M. Azam,** D. Sanjeeva Rao, Amtul Waris, Suneetha Kota

Code	Project Title	Project Leader & Associates
GEQ/CI/ BR/13	Genetic enhancement of aromatic short and medium grain rices	**GS Varaprasad,** N Shobha Rani, G Padmavathi, M.S. Prasad
GEQ/CI/BR/21	Breeding for Quality Improvement of Rice through Conventional and Molecular Approaches	**Suneetha Kota,** G.S.V. Prasad, V. Ravindra Babu, M. Mohibbe Azam, D. Sanjeev Rao, G.S. Laha,
GEQ/CI/ BR/18	Investigation into starch properties and chalkiness on rice cooking quality	**D Sanjeeva Rao,** V.Ravindra Babu
P 3 : ABR/: Development and application of biotechnology tools for rice improvement. **Programme leader : SM Balachandran**		
ABR/CI/ BT/9	Genetic improvement of rice against biotic and abiotic stresses through transgenic approach	**SM Balachandran,** A.P. Padmakumari, Ch. Padmavathi, D.Subrahmanyam, S.K. Mangrauthia
ABR/CI/ BT/6	Identification of genes for grain filling in rice (Oryza sativa L.)	**CN Neeraja,** SR Voleti, LV Subba Rao, S.M. Balachandran
ABR/CI/BT-10	Genomic studies on grain yield heterosis and WA-CMS trait in rice	**R. M. Sundaram,** SM Balachandran, AS Hariprasad, P Revathi
ABR/CI/ BT/11	Identification of SNP haplotypes in starch synthesizing genes and their association to the various quality characters	**M.Sheshu Madhav,** RM Sundaram, Sanjeev Rao, K. Suneetha, G.S.V. Prasad
ABR/CPT/PATH/16	Suppression of Rice tungro virus through RNA interference	**SK Mangrauthia** SM Balachandran, D Krishnaveni
ABR/CI/ HY/9	Molecular breeding for fertility restoration, wide compatibility and disease resistance in rice	**P Revathi,** P. Senguttuvel, K. B. Kemparaju, B. C. Viraktamath
NP 2 (ABR/CI/BR/10)	Mapping Quantitative Trait Loci (QTLs) for yield and related traits using backcross inbred lines (BILs) from elite x wild crosses of rice (Oryza sativa L.)	Divya Balakrishnan, **N Sarla,** G Padmavathi, Jyothi Badri
P 4: RUE: Enhancing resource and Input use efficiency **Programme leader: R. Mahendra Kumar**		
RUE/ CP/AG/10	Evaluation of the system of rice intensification (SRI) for its potential to save water and sustaining rice productivity	**R. Mahender Kumar,** B.Sreedevi, V.R.Babu, K. Surekha, Ch Padmavthi, P.C.Latha, M.Sreenivas Prasad, N.Somashekhar, P.Muthuraman, P.Raghuveer Rao, B.Nirmala, B.Shailaja, Vidhan Singh
RUE/CP/AG/14	Resource conservation studies in rice cultivation	**B Gangaiah,** M B B Prasad Babu, T Vidhan Singh, P Raghuveer Rao
R U E / C P / A G / 1 3	Development of suitable agronomic management practices for improving the productivity of aerobic rice	**B. Sreedevi,** T.Ram, P.Brajendra, N.Somasekhar, K Suneetha
P 5: SSP: Sustaining rice system productivity **Programme leader: K. Surekha**		
SSP/CP/SS/11	Assessment and improving nitrogen use efficiency in irrigated rice	**K. Surekha,** V.P. Bhadana, S.R. Voleti, R.M. Kumar, C.N. Neeraja
SSP/CP/ SS/14	Heavy metal assessment in soils, grains and water samples of rice growing areas	**Brajendra,** K. Surekha, MBB Prasad Babu, PC Latha, K. Suneetha and Usha Rani
SSP/CP/SS/13	Utilization of plant growth promoting micro organisms for improving nitrogen and water use efficiency in rice	**PC Latha,** MBB Prasad Babu and B. Sreedevi
SSP/CP/ENG/6	Selective mechanisation in rice cultivation	**T Vidhan Singh** R.Mahender Kumar, B. Gangaiah, B.Nirmala
P6: CCR: Assessing and managing crop response to climate change **Programme leader: SR Voleti**		
CCR/CP/ SS/10	Impact of changing temperatures on nitrogen dynamics and use efficiency in rice	**M.B.B. Prasad Babu,** P.C. Latha and B. Gangaiah
CCR/CP/ PP/9	Physiological studies on Heat tolerance due to ambient and Elevated carbon dioxide in rice	**SR Voleti,** PR Rao, B Sailaja, N Somasekher, PC Latha, K Surekha, Chitrashanker, D.Krishnaveni

CCR/CP/ PP/11	Evaluation of genotypic variation in leaf photosynthetic efficiency and its associated factors in rice	**D Subrahmanyam**, SR Voleti, VP Bhadana
P7: HRI Host plant resistance against insect pests and management. **Programme leader: G Katti**		
HRI/CPT/ENT/11	Assessment of host plant resistance to rice planthoppers and their management	**V. Jhansi Lakshmi**, D Sanjeeva Rao, M Sampath Kuamr
HRI/CPT/ENT/23	Insect-plant interactions with special reference to rice pests – yellow stem borer and gall midge	**AP Padmakumari,** S.R Voleti, T. Ram, C.N. Neeraja, K. Suneetha
HR1/CPT/ENT/19	Assessment of Host plant resistance to leaf folder and its management in rice	**Ch Padmavathi,** LV Subba Rao, N Sarla, M Sampath Kumar
P8: HRP Host plant resistance against pathogens and management. **Programme leader: MS Prasad**		
HRP/CPT/ PATH/15	Assessment of host plant resistance to rice blast disease and management through botanicals	**MS Prasad,** SM Balachandran
HRP/CPT/PATH/13	Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice	**GS Laha,** D. Krishnaveni, D. Ladha Lakshmi, R. M. Sundaram, T. Ram, S. K. Mangrautia
HRP/CPT/PATH/14	Assessment of host plant resistance and strainal variation in rice tungro disease	**D Krishnaveni,** Chitra Shanker S.K Mangrauthia, D. Ladhalakshmi
HRP/CPT/ PATH/17	Epidemiology and management of false smut disease of rice	**D.Ladhalakshmi,** GS. Laha
HRP/CPT/ PATH/18	Characterization and management of rhizoctonia solani causing sheath blight of rice	**V Prakasham,** M. Srinivasa Prasad, G.S. Laha, Joythi Badri
P9: IPM: Integrated Pest management **Programme leader: G Katti**		
IPM/ CPT/ENT/3	Chemical control of rice insect pests as a component of rice IPM	**Gururaj Katti,** V Jhansi Lakshmi, A.P. Padmakumari, Chitra Shanker
IPM/CPT/ENT/21	Botanicals for sustainable management of major pests of rice	**B Jhansi Rani,** Chitra Shankar, M.M. Azam, M. Srinivasa Prasad, M Sampath Kumar
IPM/CPT/ENT/22	Investigations on Nematodes of Importance to Rice Cultivation	**N Somasekhar ,** A.P. Padmakumari, G. Katti, V. Prakasam, P.C. Latha and M. Sheshu Madhav
IPM/ CPT/ENT/13	Arthropod Biodiversity of irrigated rice ecosystem,its functional significance and use in Biological control	**Chitra Shanker,** Gururaj Katti, B Jhansi Rani, M Sampath kumar
IPM/CPT/ENT/20	Semiochemical approaches to manage rice pests with special emphasis on sex pheromones	**M Sampath Kumar,** G. Katti, Ch. Padmavathi
P10: Transfer of technology and training **Programme leader: P Muthuraman**		
TTT/EXT/8	Sustainable rice production practices: Problems and prospects	**P Muthuraman,** S.N.Meera, S. Arun Kumar
TTT/EXT/10	Gender Dimensions in Different Rice -Eco systems-An Exploratory Study in Andhra Pradesh	**Amtul Waris,** P.Muthuraman, S. N. Meera, Arun Kumar, R .Mahender Kumar
TTT/EXT/11	Maximising the impact of rice technologies through ICT applications	**SN Meera,** Arun Kumar S, Amtul Waris, B. Sailaja, Brajendra, P. Muthuraman,
TTT/EXT/9	An Exploratory study on public-private-partnerships: Impact and implications	**S Arun Kumar,** Shaik N. Meera
TTT/ CP/CA/2	Delineation of rice growing ecologies using spatial technologies and crop models	**B Sailaja,** D. Subrahmanyam, K.V. Rao, Shaik N Meera, B.Nirmala
TTT/ECON/1	Yield gaps and constraints in rice production-An econometric analysis	**B. Nirmala, P.** Muthuraman
TTI/TTT/ECON-2	IPR - Competition interaction in rice seed sector – Emerging scenario- implications for enhancing quality seed use.	**P.A.Lakshmi Prasanna**, L.V .Subba Rao, A.S. Hari Prasad , SN. Meera, B. Nirmala, S. Arun Kumar Amtul Waris.

Appendix 6

List of Externally funded projects sanctioned during 2014-15

S.No.	Title of the Project	PI	Funding Agency	Duration	Budget (In lakhs)
1	Development of sheath blight disease resistant transgenic rice: Resistant tests in PR protein- expressing transgenic rice and discovery of new RNA silencing strategy	S M Balachandran	DBT	2014-19	153.53
2	Exploiting amiR technology to target viral genes for curtailing the tungro virus infection in rice	S K Mangrauthia	DBT	2015-18	83.108
3	CRP-Biofortificaton	V Ravindra Babu & C N Neeraja	ICAR	2014-17	1500.00~
4	CRP-Agrobiodiversity	L V Subba Rao	ICAR	2014-17	150.00~
			Total		11886.00~

Appendix 7

List of On going externally funded projects during 2014-15

S.No	Title of the Project/Schemes	Name of PI	Funding Agency
1	Seed Production and seed technology research in Rice (NSP)	Dr. LV. Subba Rao	ICAR
2	DUS Tests in Rice(PPV&FRA)	Dr. LV. Subba Rao	PPV&FRA
3	ICAR Network Project for Transgenics in crops : Rice (Transgenic Component)	Dr. S.M. Balachandran	ICAR, GOI
4	ICAR Network Project for Transgenics in crops: Rice (Funtional genomics component-Iron and Zinc	Dr. N. Sarla	ICAR
5	Development Of Indica Rice With Beta Carotene Rice Endosperm Through Marker Assisted Gene Introgression And Their Evaluation	Dr.R.M.Sundaram	DBT_IRRI Project
6	Fine mapping of yield enhancing QTL from wild spicies	Dr. N. Sarla	DBT
7	Development and maintenance of Rice Knowledge Management Portal Development	Dr. Shaik Meera	ICAR
8	Establishment of National Rice Resource Data base	Dr. L.V. Subba Rao	DBT
9	Functional Validation of Identified candidate gall midge resistance genes FGR Ph II 4A	Dr. C.N. Neeraja	DBT
10	Identification and functional validation of BPH resistance genes FGR Ph II 5A	Dr. G Padmavathi	DBT
11	Functional analysis of gene regulatory networks during flower and seed development in rice FGR Ph II 7	Dr. S.M. Balachandran	DBT
12	Identification and functional analysis of novel blast resistance genes in rice FGR Ph II 3B	Dr. M.S. Prasad	DBT
13	Development of Biotic stress resistant rice through marker assisted breeding sub project- I A&B (DBSRR - GCP)	Dr. R.M. Sundaram	DBT
14	Multi locational evaluation of rice germplasm/Agro Biodiversity	Dr. L. V.Subba Rao	ICAR/ NBPGR
15	BMGF " Stress tolerant rice for poor farmers in Africa and South Asia " STRASA	Dr.T.Ram	IRRI
16	Marker assisted breedinbg of abiotic stress tolerant rice varieties with major QTLs for drought, submergence and slat tolerance	Dr.T.Ram	DBT
17	Seed Production in Agriculture (MEGA SEED)	Dr. LV. Subba Rao	ICAR
18	National Initiative on Climate resilient agriculture	Dr. S.R. Voleti	ICAR
19	Identification of candidate genes for enhanced water use efficiency in rice through activation tagging	Dr. S.M. Balachandran	DBT

S.No	Title of the Project/Schemes	Name of PI	Funding Agency
20	"Rice bio-fortification with enhanced iron and zinc in high yielding non-basmati cultivars through marker assisted breeding and transgenic approaches- Phase II"	Dr. C. N. Neeraja	DBT
21	Real time rice pest surveillance programme (NICRA-NCIPM)	Dr. V. Jhansi Lakshmi	ICAR-NCIPM
22	Conversion of Elite partial restorers of rice cultivars in to restorer by Marker-assisted introgression of major fertility restoer genes, Rf4 & Rf3	Dr. Revathi P	DBT
23	Marker assisted Recurrent Selection (MARS) for improvement biotic stress resistance in parental lines of hybrid rice	Dr. Revathi P	DST-women scientist
24	Investigations on System of Rice Intensification (SRI) for water saving and yield optimization in irrigated ecosystem	Dr. R. Mahender Kumar	Ministry of Water resources
25	Exploitation of RNAi technology for management of yellow stem borer in rice	Dr. Sheshu Madhav	DBT
26	Metabolic and molecular profiling of aromatic rice germplasm of India for gaining insights about aroma	Dr. Sheshu Madhav	DBT
27	Molecular and functional characterisation of yield enhancing QTL from wild ricce	Dr. N. Sarla	DBT
28	Identifiction and Molecular Mapping of a novel neck blast resistance gene (s) from local landrances and introgression lines of Oryza	Dr. Sheshu Madhav	DBT-BCIL
29	Molecular mapping and introgression of stigma exsertion trait in hybrid rice parental lines	Dr. Kemparaju	DBT
30	Enhancing scope of marker assisted selection using genomics technologies (En MAS)	Dr. Sheshu Madhav	CSIR
31	Marker assisted introgression of different traits to develop new generation climate adapted varieties	Dr.T.Ram	DBT
32	Evaluation of new herbicide molecules (Rice Co-Herbicide) for its efficiency in Transplanted Rice	Dr. B. Sreedevi	Rice-Co
33	Evaluation of new herbicide molecules (Rice Co-Herbicides) for its efficiency in Direct Seeded Rice	Dr. B. Sreedevi	Rice-Co
34	Evaluation of new fertilizer product "Geofert" An Agro-Nano Technology product in transplanted rice	Dr. R. Mahender Kumar	Geofert
35	Evaluation of "Metal Glyainates" in Paddy	Dr. R. Mahender Kumar	AMSRI Chemicals Ltd
36	Molecular Marker assisted introgression of two major blast resistance genes and a major QTL for grain yield under drought stress in rice	Dr. M. Sheshu Madhav	DBT
37	Common basis of defense induction in rice and mustard against sucking and gall insect pests	Dr. A P Padmakumari	NFBSFARA
38	Modeling network of gene responses to abiotic stress in rice	Dr. D. Subramanyam	NFBSFARA
39	ICAR LBS Outstanding Young Scientist Award Challenge Project "Genomic and transcriptomic analysis of rice hybrids and their parental lines in relation to heterosis"	Dr. R.M. Sundaram	ICAR
40	Marker-assisted introgression of Pup1 into elite rice varieties	Dr. R.M. Sundaram	DBT
41	Effect of foliar and root application of silicate SiO2 in rice	Dr. R. Mahender Kumar	GeolifeAgritech India Pvt. Ltd., Mumbai
42	Evaluation of relative safety DPX-RAB+55 106SC (Trifumezopyrim) against natural enemies of rice *Anagrus sp., Harmonia octomaculata Cyrtorhinus lividipennis* Reuter and *Trichogramma chilonis* Ishii in rice	Dr. G. Katti	Dupont India, Ltd.,
43	CSIR-Blight Out	Dr. L.V. Subba Rao	CSIR

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