वार्षिक प्रतिवेदन
Annual Report
2015-16

भाकृअनुप-भारतीय चावल अनुसंधान संस्थान
ICAR-Indian Institute of Rice Research

An ISO 9001 : 2008 Certified Institute

Rajendranagar, Hyderabad - 500 030

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Preface

I am pleased to place before you the Annual Report of the ICAR-Indian Institute of Rice Research for the period 2015-16 which is the Golden Jubilee year of AICRIP. I am also happy to inform you that during the golden jubilee year, I have taken over as the first Director of IIRR. As part of the golden jubilee celebrations a series of events were planned and executed. During the year under report IIRR coordinated multidisciplinary multilocation rice production technologies under All India Coordinated Rice Improvement Project (AICRIP) and pursued lead research in thrust areas of irrigated rice ecology. In addition, specific objective oriented collaborative research projects were formulated and implemented. To commemorate the 50 years of AICRIP an International Rice Symposium was successfully organised. Exchange of germplasm and breedng lines has been one of the important activities which was accomplished with great zeal.

Inspite of deficit monsoon, we could achieve a near record rice production of 104.8 million tonnes. The progress of research during the period of report is quite encouraging with 42 varieties including 4 hybrids released for cultivation. The breeder seed production was also satisfactory with 443 tonnes from 240 varieties. Several proven rice production technologies were demonstrated through 449 FLDs covering 19 states.

The year 2015 has been very fruitful specially for IIRR with release of five varieties, one with high zinc, 3 with early duration and multiple stress tolerance and 1 suitable for aerobic condition. Other research accomplishments include identification of biotic stress tolerant genetic stocks, QTLs for high yield and several germplasm accessions / traditional varieties with desirable cooking and nutrional quality traits. Several scientists have received awards and recognition for their valuable scientific contribution.

IIRR took lead in organizing farmer-scientist interactions along with other ICAR Institutions, SAUs, ICRISAT and Departments of Agriculture of Telangana and Andhra Pradesh through Rythu Sadbhavana Yatra. The research highlights of the coordinated efforts, comprehensive results of lead research and brief institutional activities are presented in this annual report.

Hyderabad
10th June 2016

V Ravindra Babu
Director

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कार्यकारी सारांश

अखिल भारतीय समन्वित चावल सुधार कार्यक्रम

केंद्रीय उप समिति फसल मानक, अधिसूचना और किस्मों की रिलीज और राज्यवर किस्म पहचान और विज्ञप्ति समिति ने 42 किस्मों और चार संकर किस्मों को जारी करने के लिए अनुमोदित किया। केंद्रीय उप समिति फसल मानक, अधिसूचना और किस्मों की रिलीज समिति ने 15 किस्मों और तीन संकर किस्मों(के आर एच 4,के पी एच 460 और एडी भी 8301) को जारी करने के लिए अनुमोदित किया। राज्यवर किश्म पहचान और विज्ञप्ति समिति ने 27 किस्मों : आंध्र प्रदेश (1), गुजरात (2), कर्नाटक(2),केरल (5), महाराष्ट्र (1),मध्य प्रदेश (1),मणिपुर (1),तेलंगाना (3),उत्तराखंड (4) और पश्चिम बंगाल (7) 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।

वर्ष 2015 के दौरान 42 किस्म परीक्षण, एक स्क्रीनिंग नर्सरी और तीन संकर चावल परीक्षणों का आयोजन देश के 27 राज्यों में 160 स्थानों और 2 केंद्र शासित प्रदेशों में 682 प्रयोगों में किया गया। इसके अलावा 14 इंजर नर्सरी,666किश्मों को 58स्थानों पर परीक्षण के लिए शामिल किया गया।

केंद्रीये उपसमिति (फसल मानक और अधिसूचना) और राज्यवर किश्म पहचान और विज्ञप्ति समिति ने 42 किश्मे और चार संकर को जारी करने के लिए 2015-2016 में अनुमोदित किया।

पहचान समिति 14 किस्मों और संकर की 3 किस्मों राज्यों की अलग-अलग पारिस्थितिकी में रिलीज के लिए पहचान की गई।

666 प्रविष्टियों में से 14 आईएनजीईआर नर्सरी में परीक्षण किया गया। 61 प्ररूपी स्वीकार्यता और बहु स्थान के परीक्षण के लिए उपज पर आधारित होनहार पाए गए।

217 चावल की किस्मों और 8 चावल संकर के पैतृक लाइनों के ब्रीडर बीज उत्पादन के देश भर में 43 केंद्रों पर आयोजित किया गया था। डैक इंडेंट के अनुसार ब्रीडर बीज के 7757.42 क्विंटल के कुल उत्पादन 4328.42 क्विंटल के लक्ष्य के मुकाबले हासिल की गयी थी। इस प्रकार लक्ष्य की तुलना में 79 % अधिक उत्पादन किया गया ।

फसल उत्पादन

सस्य विज्ञान

पोषक तत्व प्रबंधन के तरीकों में, पत्ता रंग चार्ट (एलसीसी) आधारित एन खुराक उर्वरक सिफारिश सबसे अधिक उपज देने में कामयाब हुआ ।

विभिन्न पोषक तत्वों के संयोजन के साथ -साथ फसल स्थापना के तरीकों का मूल्यांकन दस से अधिक स्थानों में स्पष्ट रूप से संकेत है की एसआरआई सिद्धांतों में सीधे वरीयता प्राप्त चावल गहनता की प्रणाली बनिस्पत(4.7 टन / हेक्टेयर) की श्रेष्ठता उपज उत्पादन में दर्ज़ की गयी।

क्षेत्र विशिष्ट पोषक तत्व प्रबंधन पर पोषक तत्व आधारित विशेषज्ञ से पता चला की यह सभी स्थानों में उपज बढ़ाने में प्रभावी था। कुल मिलाकर औसत 5.49 टन / हेक्टेयर उपज था क्षेत्र विशिष्ट पोषक तत्व प्रबंधन में।

यंत्रीकृत प्रणाली चावल गहनता ने बेहतर प्रदर्शन दिखाया जिसमे औसत उपज 5.49 टन / हेक्टेयर सभी क्षेत्रों में दर्ज़ की गयी । इसके बाद सफल रहा मैन्युअल हैंड ट्रांस्प्लांटिंग इन लाइन्स और पोखर प्रतिरोपित चावल के लिए फसल प्रबंधन (5.26 टन / हेक्टेयर)।

नया संयोजन शाक की आर्थिक और कुशल खुराक पेनोक्स्सुलम + बूटक्लोर @717.5 ग्राम एआई /हे प्रतिरोपित चावल में खरपतवार के नियंत्रण के लिए प्रभावी था।

अधिक उपज देने वाली किस्मों, मन्दविजय और धनरासि बेहतर खरपतवार दबाने की क्षमता प्रदर्शित किए हैं। संकर और लंबी अवधि अधिक उपज देने वाली किस्मों कम अवधि किस्मों में अधिक खरपतवार दबाने की क्षमता पाए गए।

बोआई की पारंपरिक विधि में अनाज उपज की तुलना में चावल सघनीकरण प्रणाली (श्री) में अनाज उपज सूचक मूल्यों की पहचान की गयी।

आरडीएफ़ + एन के विभाजन आवेदन पर उच्चतम खरीफ चावल की उपज (5.0 टन / हेक्टेयर) हुई।इसके बाद आज़ोटोबक्टेर +पीएसबी+ भूरे रंग खाद ढइंचा + अवशेषों गीली घास के द्वारा। स्थान विशेष प्रथाओं यथा एनपीके सिफारिश + $ZnSO_4$ (100:50:50:20) मांड्या स्थान में दर्ज की गई।

वर्षाधारित उपरीली पारिस्थितिकी प्रणाली में पोषक अनुसूची जविक खाद और 75% पोषक अनुसूची के लगाने में और मृदा स्वास्थ्य को बढाने में आशाजनक पाया गया।

मृदा विज्ञान

उपज अंतर विश्लेषण टीटाबर ,फ़ैज़ाबाद,कानपुर और चिनसुरह स्थानो पर यह दर्शाया है की उपज में भारी अंतराल पाया गया।यह स्थापित होता है की साइट विशिष्ट पोषक तत्व प्रबंधन अच्छी उपज पाने के लिए उपयुक्त विधि है। पोषक तत्व विशेषज्ञ सॉफ्टवेर आधारित सिफारिश से यह पाया गया है की 45 to 140 % की उपज वृधि हुई है। उपज अन्तर 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 आरडीएफ़ पर और कृषकों के द्वारा खाद व्यवहार पर श्रेष्ठतर पाया गया।

जब किस्मों की जाँच खारा और अमलिए मिट्टी संशोधन में किए गए तो परिणाम शानदार रहे थे और किस्म भिन्नता लवणता सहिष्णुता के लिए देखा गया । 60-95 फीसदी की भारी वृद्धि कानपुर में जिप्सम उपचारित मिट्टी में दर्ज किया गया था।

उच्चतम पैदावार डीआरआर धान 43 में दर्ज किए गए (4.37 टन / हेक्टेयर) और सीएसआर36(4.26 टन / हेक्टेयर), जीएसआर36(4.26 टन / हेक्टेयर) और डीआरआर धान42 में दर्ज किए गए। इसी तरह, सकारात्मक प्रतिक्रिया मोड्कोंपू में अम्लये मिट्टी के लिए चूना प्रयोग का कई किस्मों जैसे 27पी- 63, पी ए 6444 और यूस312 में पाया गया। कई किस्में जैसे पी ए 6444, 27 पी -63, और एच आर आइ-174 चूना रहित मिट्टी प्रयोग में अच्छी उपज देने में सफल हुये। जी एस आर 148, जी एस आर 119 और डीआर आर Dhan 43 रांची में, अगोनोबोरा , यूस312, 27पी -36 और पी ए 6444 तीताबोर में अम्लेये मिट्टी के लिए चूना प्रयोग पर सफल पाये गए।

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 क्रमश: लगभग 12-21 प्रतिशत सिंचित जल की बचत होगी।पानी और पोषक तत्वों के परस्पर क्रिया प्रभाव एरोबिक चावल के प्रदर्शन में विशिष्ट था। पानी की उत्पादकता 4.4 – 5.1 किलोग्राम / हेक्टेयर एमएम जल मापी गयी। पानी की आवश्यकता प्रतिशत बचत 10 to 14%,पाये गये ।

27 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।आरडीएफ़ +5t FYM/ha के संयुक्त उपयोग के अनुरूप श्रेष्ठता दो स्थानो (मरुटेरू और तीताबोर) पर 27 साल की लंबी अवधि के प्रयोग में दोनों सत्रों में देखे गए। फोस्फतसे,ग्लूकोसिडसे और डीहयड्रोजिनेस की उच्चतम गतिविधि FYM at 10t/ ha/ NPKZnS + FYM/ 50%NPK + 25% GM-N + 25% FYM-N के उपचार में देखी गई।

प्रतिरोपित चावल की सर्वोच्चता डीएसर के ऊपर 13-46% की कई स्थानो जैसे राजेन्द्रनगर, कानपुर,मोड्कोंपू, और पुडुचेरी में पाई गई।

पादप क्रिया विज्ञान

अखिल भारतीय समन्वित चावल सुधार कार्यक्रम पादप क्रिया विज्ञान के 45 परीक्षणों को खरीफ 2015 के दौरान भारत भर में फैले कुल 13 स्थानों (6 वित्त पोषित और 7 स्वैच्छिक केन्द्रों)में आयोजित की गई।

- ✧ औसत अनाज फसल उपज 9% इमिडजोले के उपयोग के बाद दर्ज की गई थी और सिलिकसोल के उपयोग के बाद >8% अनाज फसल उपज दर्ज की गई। इमिडजोले और सिलिकसोल के उपयोग के बाद झोंका रोग की घटनाओं में कमी दर्ज की गई थी। सिलिकॉन घुलनशील के अनुप्रयोग से सामान्य फसल और मृदा स्वास्थ्य में सुधार पाया गया।

ऊंचा तापमान के तहत अध्ययन पर आईईटी 23356 अधिक उपज दर्ज की। इसके बाद क्रम से आईईटी 23354, पी ए-6129, आईईटी 23947 आईईटी 23339

और सोमाली किस्मों ने उपज दर्ज की। गर्मी सहने की क्षमता सूचकांक के आधार पर डीआरआरएच -106, डीआरआरएच-107, आईईटी 24075, सोमाली, आईईटी 23979, और आईईटी 24082 को गर्मी सहिष्णु किसमे माना जा सकता है।

सूखे सहिष्णुता सूचकांकों के आधार पर आईईटी 25108, आईईटी 24679, नरेंद्र-97, आईईटी 25134, आईईटी 25141 और आईईटी 25104 अपेक्षाकृत सूखा सहिष्णु किसमे हैं।

कई अजैव तनाव सहिष्णुता पर आधारित अदध्यानों से पाया गया की आईईटी 23216, सोमाली, आई आर 82635-B-B47-1 और आईईटी 24674 किस्मे लवणता, सूखा जलमग्नता और कम तापमान के लिए सहिष्णुता है।

कीट विज्ञान

29 स्थानों पर किए गए कीट सर्वेक्षण की रिपोर्टों से पता चला है की सकोली,राजेन्द्रनगर और पंतनगर में व्यापक रूप से बीपीएच के फैलने की खबर है। केसवोर्म से पूरी फसल नुकसान होने वाले की खबर सकोली,मोड्कोंपू और कर्जत से आई है। आर्मिवोर्म म्यथिमना सेपरता से पूरी फसल नुकसान होने वाले की खबर खुदवानी से आई है।

मेजबान पौधा प्रतिरोध के अध्ययन 1832 प्रविष्टियों और इन 201 वैध परीक्षणों में 12 कीटों के खिलाफ मूल्यांकन किया गया। इन प्रतिक्रियाओं के परिणामों के विभिन्न कीटों के खिलाफ होनहार के रूप में 52 प्रविष्टियों की पहचान की गई ।

कीटनाशक मूल्यांकन परीक्षण 34 स्थानों पर किए गए। फ्लुएंडीयमिडे +ठियाक्लोरीद @ 120 ग्राम एआई /हे स्टेम बोरर और पत्ती फ़ोल्डर के खिलाफ मानक चेक कीटनाशक ऋणकसीपीर के प्रदर्शन जैसा पाया गया।

वानस्पतिक कीटनाशक मूल्यांकन परीक्षण 24 स्थानों पर किया गया और पता चला की नीमाजल औरनिंबेकिडीने स्टेम बोरर के खिलाफ प्रभावी पाए गए पर बीपीएच , डबल्यूबीपीएच और जीएलएच के खिलाफ मामूली प्रभावी रहे थे।

स्टेम बोरर की जाति की संरचना की निगरानी से पता चला की चार प्रजातियों 12 स्थानों में प्रमुख है और येल्लो स्टेम बोरर की उपस्थिति 12 स्थानों पर वितरित है।

कीट प्रबंधन के लिए पारिस्थितिक इंजीनियरिंग अध्य्यन चार स्थानों पर किया गया। इन अध्यानों से पता चला की जैविक खाद , रिक्ति और जल प्रबंधन और मेड़ पर फूल पौधों की बढ़ती का संयोजन प्राकृतिक दुश्मन की आबादी वृद्धि में सहायक है।

गहन जैव कीट प्रबंधन परीक्षण चार स्थानों में शुरू किया गया और पता चला है कि कीटों का प्रकोप कम हो गया था ।

10 स्थानों पर आयोजित समन्वित कीट प्रबंधन से पता चला की आईपीएम के तरीकों से गाल मिज, बीपीएच और स्टेम बोरर की घटनाओं में कमी हुई है। आईपीएम के तरीकों से प्रमुख चावल बीमारियों की गंभीरता कम हुई है। आईपीएम के तरीकों से खरपतवार आबादी और खरपतवार बायोमास भी काफी कम हो गई थी। कीट घटना कम होने के कारण, अनाज की उपज आईपीएम भूखंडों में काफी अधिक था।

प्रमुख कीटों की जनसंख्या गतिशीलता का मूल्यांकन प्रकाश जाल के माध्यम से 30 केन्द्रों में किया गया और संकेत है कि येल्लो स्टेम बोरेर और प्लान्थोप्पेर्स प्रमुख कीट है ।

पादप रोग विज्ञान

2474 प्रविष्टियों में से पाँच अलग अलग स्क्रीनिंग नर्सरी में होनहार प्रविष्टियों लीफ़ ब्लास्ट के विरुध की संख्या 51 थे, नेक ब्लास्ट के लिए 26, 56 शीथ ब्लायट के लिए,56 ब्राउन स्पॉट के लिए,9 शीथ रॉट के लिए, 58 बकटेरियल ब्लायट के लिए, 27 राइस टुंग्रो के लिए। 40 लीफ़ स्काल्ड के लिए और 26 ग्रैन डिस्कोलौरेसन के लिए।

1015 जर्मप्लाज्म संखिकी का मूल्यांकन में आइसी 211168 और 217196 दो प्रविष्टियों ने अधिक रोग प्रतिरोधक क्षमता को दिखाया है।

- ✧ बैक्टीरियल ब्लाइट रोगज़नक़ और ब्लास्ट की विषाक्तता की निगरानी अध्ययन में पता चला की अदूतरी, मरुटेरू, पटना, नवसारी,कौल और रायपुर में ब्लास्ट की विषाक्तता में बदलाव पाया गया था।
- ✧ संयोजन कवकनाशी आईसीएफ-110 (tricyclazole 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 (tricyclazole 18% + मंकोजेब 62% डबल्यूपी) @ 2.5g / l को शेयथ रोट के विरुध उपयुक्त पाया गया।

विशेष आईपीएम परीक्षण पर डेटा से पता चला की आईपीएम के तरीकों से प्रमुख रोगों की बीमारी की घटनाओं में कमी हुई है और बीमारी की घटनाओं की गंभीरता की प्रगति में रोक लगी है।

बुआई के तीन अलग-अलग तिथियों में फाल्स स्मट पर परीक्षण से पता चला की लुधियाना और टीटाबर में उच्च रोग संक्रमण का पता चला जब फसल 1 और जून के दूसरे सप्ताह पर बोया गया था। संकर का परीक्षण के अलावा, KRH 2 में रोग लगने की इन स्थानों पर अत्यधिक संभावना 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।

उत्पादन उन्मुख सर्वेक्षण भारत के 18 राज्यों में आयोजित किया गया। लीफ़ ब्लास्ट, नेक ब्लास्ट, ब्राउन स्पॉट, शीथ ब्लायट, शीथ रॉट, बकटेरियल ब्लायट, फाल्स स्मट देश भर में कम और मध्यम तीव्रता से फैल रहे हैं ।

प्रौद्योगिकी स्थानांतरण

चावल प्रौद्योगिकियों को 19 राज्यों और देश के पांच प्रमुख चावल पारिस्थितिक तंत्र को 449 हेक्टेयर क्षेत्र में प्रदर्शन किया गया। 449 एफ एलडी में 62 % सिंचित चावल पारिस्थितिकी तंत्र में आयोजित की गई और 16.7% वर्षा आधारित ऊपरी भूभाग में आयोजित की गई। 10% से अधिक उथले नीचे के क्षेत्रों में आयोजित किए गए। 2.23 % पहाड़ी परिस्थितियों में में आयोजित की गई। और 5.68 % समस्याग्रस्त मिट्टी में आयोजित की गई।

वर्ष 2015-16 के दौरान, आरकेएमपी सी-डैक हैदराबाद के सहयोग से भारतीय एक्सटेंशन पेशेवरों और किसानों के लाभ के लिए मोबाइल क्षुधा की श्रृंखला विकसित किया गया है।

आईसीएआर- IRRI कार्य योजना गृस्प थीम 6 के भाग के रूप में एक अभिनव भागीदारी विस्तार विधि (राइसचेक) प्रथाओं की पहचान करने के लिए तेलंगाना और तमिलनाडु में पेश किया गया है।

अग्रणी अनुसंधान

फसल सुधार

पौधा प्रजनन

IET 23832 (RP 5886-HP 3-IR80463-B39-3), पहला जस्ता भरी किस्म सीभीआरसी द्वारा जारी किया गया। इसमे उच्च जस्ता (22 पीपीएम) पॉलिश चावल और औसत 5.2 ट/हे उपज देने वाली किस्म है। इसे तमिलनाडु, आंध्र प्रदेश, तेलंगाना और कर्नाटक सिंचित पारिस्थितिकी के लिए अनुशंसित किया गया है।

पाँच भविष्य की पीढ़ी के चावल लाइनों जिनमे 6.5 to 7 t/ha उपज क्षमता है और उसे ट्रॉपिकल जपोनिका के उपयोग के द्वारा विकसित किया गया है।

सीबीआरसी द्वारा अनुसंशित डी आर आर धान 46 जिसमे 22.7% उपज उपलब्धि है सहभागी धान के ऊपर को जारी किया गया बिहार,मध्य प्रदेश और महाराष्ट्र के लिए। दो सूखा सहिष्णु किस्मों अर्थात् त्रिपुरा खाराधान 1 और त्रिपुरा खाराधान 2 त्रिपुरा राज्य के लिए अनुशंसित किया गया है।

चिनसुरह नोना धान 2 जोकि ओ रूफीपोगोन से व्युत्पन्न है तटीय लवणीय क्षेत्रों के लिए उपयुक्त पाया गया था और पश्चिम बंगाल में जारी किया गया।

तीन लाइंस RP 5434-RAU 26-4, RP 5433-RAU-27-17 and RP 5433-RAU-19-2 जोकि 5ट/हे उपज छमता रखता है जिनके पास अच्छी ठंड सहिष्णुता अंकुर चरण में है की पहचान की गई।

एक किस्म आईआर 64 / एसीसी 2190 से निकाली गई ग्रीन हाउस और खेतों की स्थिति में प्लांट हॉपर के प्रतिरोध के लिए होनहार पाये गए।

IET 24395 जो व्युत्पन्न है MTU 1075/MTU 1010 के क्रॉस से, को उत्कृष्ट पाया गया उपज लाभ के लिए। (> 5%) और उसे अंतिम वर्ष के लिए खरीफ 2016 के दौरान एवीटी -2- देर परीक्षण के लिए अनुसंशित किया गया।

दो चावल आधारित उत्पादों अर्थात । , दांत दर्द से राहत जेल और मच्छर से बचाने वाली क्रीम लोशन उपयोग चावल का तेल और भूरे रंग के चावल की भूसी से विकसित किए गए। विकसित चावल आधारित बेक्ड उत्पादों अर्थात् केक , कुकीज, पाई कृस्ट , मुफ़्फ़िंस और चावल की भूसी का तेल जो वनस्पति घी से

लोगों की तुलना उपभोक्ता वरीयता के मामले में बेहतर होना पाया गया है।

- ❖ इन विवों ग्लाइसेमिक इंडेक्स अध्ययन में पाया गया की धनरासि (59.3) और संपदा (56.8) चावल की किस्मों में कम ग्लाइसेमिक इंडेक्स है।

पकने के बाद अच्छा केर्णेल बढ़ाव के लिए लाइन्स विकसित किए गए इनके क्रॉस से vasumathi/आइ इटी 19492, पूसा 1121/ आइ इटी 18990, सुगंधमती/ आइ इटी 19492, आइ इटी 18033/ आइ इटी 18004 और आइ इटी 18033/ आइ इटी 19492

तीन स्थानीय प्रजातियाँ/ जंगली धान की प्रजातियाँ जो की उत्तर पूर्वी राज्यों की हैं जैसे पुनशी, मोइरांग, फौ-ख्कोगंगिबी और थड्क्ग्जंग-फौ ब्लास्ट नर्सरी में स्कोर 3 के साथ प्रतिरोधी पाए गए।

आनुवंशिक अध्ययन में शीथ ब्लाइट सहिष्णुता की मात्रात्मक प्रकृति का पता चला है।

एमाइलोज और एम्यलोपेक्टिन विश्लेषण पहली बार के लिए गीला प्रयोगशाला विधि का उपयोग कर एकल अनाज के स्तर पर प्रदर्शन किया गया।

संकर चावल

DRRH-92 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 जोन III और जोन VI में खेती के लिए उपयुक्त है।

जो व्युत्पन्न है आंशिक रेस्टोरर सुधार कार्यक्रम से मध्यम अवधी के AVT-1 परीक्षण के लिए अनुसंशित किया गया।

राजेंद्रनगर स्टेशन परीक्षण में खरीफ 2015 के दौरान 10 उत्कृष्ट संकर यथा APMS 6A/TCP-583, APMS 6A/ TCP-647, IR 68897A/TCP-643, APMS 6A/19-18R, IR 79156 A/19-18R, APMS 6A/7-65R, APMS 6A/PRP-78, IR 79156 A/ PRP 78, APMS 6A/PRP 123और IR 79156 A/AR 9-21R पहचाने गए।

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 IR64 से 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 तुंग्रो वायरस की एक दक्षिण भारतीय आइसोलेट्स का पूरा जीनोम की पहचान की गयी और NCBI डेटाबेस में जमा किया गया

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

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 N2O उत्सर्जन यूरिया की तुलना में काफी कम कर दिया है। कुल N2O-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। 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 क्रियाविज्ञान

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 सी पी सी आर आई 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 तुंगरों 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

छत्तीसगढ़ के मैदान में स्थायी चावल उत्पादन प्रौद्योगिकियों के लिए प्रमुख खतरों में से है प्रतिरोधी किस्मों, गरीब जल निकासी, पोषक तत्वों की कमी, धीमी गति से बीज प्रतिस्थापन , श्रम समस्याओं, समय पर सूक्ष्म पोषक तत्वों और बायोफर्टीलाइजर की अनुपलब्धता और ट्यूबवेल की अनुपलब्धता और लागत बढ़ना रहे हैं।

किसानों में लिंग आयाम आधारित अध्ययन से पता चलता है की कृषि से संबंधित कामों से निर्णय और कृषि से संबंधित प्रमुख कार्य करना पुरुष सदस्यों द्वारा लिया जाता है। जलवायु परिवर्तन के संबंध में ऐसा पता चला है कि रंगा रेड्डी जिले में 2013 में चावल की खेती के लिए एक अच्छा साल था।

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।

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 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 को किया गया।

हिन्दी पखवाड़ा का आयोजन: इस निदेशालय द्वारा 14 सितंबर ,2015 से 29 सितंबर 2015 तक का आयोजन किया गया जिसका उद्घाटन परियोजना निदेशक महोदय ने किया। इस सिलसिले में कई कार्यक्रमों का आयोजन किया गया।

All India Coordinated Rice Improvement Project

During 2015-16 forty two varieties and four hybrids were released 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 15 varieties and three hybrids (KRH 4, KPH 460 and ADV 8301). The State Varietal Release Committees released 27 varieties; for Andhra Pradesh (1), Gujarat (2), Karnataka (2), Kerala (5), Maharashtra (1), Madhya Pradesh (1), Manipur (1), Telangana (3) Uttarakhand (4) and West Bengal (7). These high yielding varieties (HVYs) were released for cultivation in different ecologies *viz*., irrigated, aerobic, basmati, rainfed shallow low land, deep water and coastal saline areas. Many of these varieties are resistant/moderately resistant to biotic stresses.

Crop Improvement

- During the year 2015, 42 varietal, one screening nursery and three hybrid rice trials were conducted in 682 experiments at 160 locations in 27 states and 2 union territories covering all the 7 zones in the country. In addition, 14 INGER nurseries involving 666 entries were tested at 58 centers.
- Forty two varieties and four hybrids were released during 2015-16 by Central Sub Committee on Crop Standards, Notification and Release of Varieties (CSCCSN & RV) and State Varietal release Committee (SVRC).
- The varietal identification committee identified 14 varieties and 3 hybrids for release in different states across ecologies.
- Of the 666 entries were tested in 14 INGER nurseries, 61 were found promising based on phenotypic acceptability and yield for multi location testing.
- 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 IIRR 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.

Crop Production

Agronomy

- Among nutrient management methods, Leaf Color Chart (LCC) based N application resulted in highest yield across all the locations closely followed by 150% recommended fertilizer dose.
- The evaluation of crop establishment methods along with different nutrient combinations over ten locations clearly indicated superiority of System of Rice Intensification (SRI) (4.7 t/ha) over direct seeded with SRI principles (4.26 t/ha).
- Site Specific Nutrient Management (SSNM) results based on Nutrient Expert revealed that, it was effective in increasing the yield in all the locations. Over all mean yield was 5.49 t/ha under same treatment followed by SSNM based on LCC (5.32 t/ha).
- Mechanized System of Rice Intensification (SMSRI) showed better performance with overall mean grain yield in all locations (5.49 t/ha) followed by manual hand transplanting in lines and crop management for puddled transplanted rice (SRI) (5.26 t/ha).
- The economical and efficient dose of new combination herbicide *i.e.,* Penoxsulam + Butachlor @717.5 g a.i./ha was effective for control of weeds in transplanted rice.
- The high yielding varieties, Mandyavijaya and Dhanrasi exhibited better weed suppressing ability. Hybrids and long duration high yielding varieties were found

to have better weed suppressing ability over short duration varieties.

- RDF + split application of N resulted in highest *kharif* rice yield (5.0 t/ha) followed by Azotobactor + PSB + brown manuring with Dhaincha + residue mulch @ 2 t/ha + 75% RDF. Location specific recommended practices of NPK + ZnSO4 (100:50:50:20) at Mandya location recorded highest yield (7.91 t/ha) than rest of the treatments.

Soil Science

- Yield gap analysis highlighted the steep gaps in yield obtained from the fields receiving recommended fertiliser dose (RDF) and farmer fertiliser practice (FFP) which necessitates site specific nutrient management to realize the uniform best. There was an increase in rice grain yield from 45 to 140 % in nutrient expert (NE) tool based recommended plots compared to absolute control. Increased rice yield to an extent of 60-95 % was recorded in gypsum ameliorated sodic soils in Kanpur. The highest yields were recorded in DRR Dhan 43 (4.37 t/ha), CSR 36 (4.26 t/ha), GSR 129 (4.24 t/ha) and DRR Dhan 42 (4.19 t/ha) with 100% GR supplementation.
- Genotypes 27P-63, PA 6444 and US 312 recorded significant rice yield in limed acid soils of Moncompu. Increased yield due to liming was also recorded in GSR 148, GSR 119 and DRR Dhan 43 at Ranchi and Aghonibora, US 312, 27P36 and PA 6444 at Titabar.
- The positive interaction effect of water and nutrients through increase in yield was recorded in aerobic rice. Water productivity (kg grain/ha mm water used) ranged from 4.4 – 5.1 kg grain/ha mm water. There was 10-14 % saving in water requirement with 100 and 75% cumulative pan evaporation (CPE) irrigation, respectively over 150% CPE. Application of nutrients up to 180 kg N, 60 kg P2O5 and 100 kg K2O/ha significantly improved the grain yield.
- Consistent superiority of conjunctive use of RDF+5t FYM/ha was maintained at MTU and TTB in *kharif* and *rabi* seasons in a long term experimentation of 27 years. The highest enzyme activity of phosphatase, glucosidase and dehydrogenase was observed in the treatment receiving FYM at 10t/ha, NPKZnS + FYM, and 50%NPK + 25% GM-N + 25% FYM-N in Maruteru and Titabar as well.
- The supremacy of transplanted rice in production over DSR and aerobic rice by an extent of 13-46% was witnessed across locations namely IIRR, Kanpur, Moncompu and Puducherry. In case of nutrient management practices, maximum yields were obtained with RDF+ organics at IIRR and Puducherry and with RDF at Kanpur and Moncompu.

Plant Physiology

- A total of 45 trials of plant physiology AICRIP were conducted at 13 locations (6 funded and 7 voluntary centres) spread across India during *Kharif* 2015.
- The mean grain yield recorded after harvest was increased by 9% by Imidazole (T2) application and Silixol treatment enhanced the mean grain yield for all varieties and locations by >8% over control treatment (T1). Application of Imidazole and Silixol had reduced the incidence of Blast and both the treatments are effective.
- IET 23356 recorded higher yield under elevated temperature followed by the entries viz., IET 23354, PA-6129, IET 23947 IET 23339 and Somali. Based on the heat tolerance indices entries like DRRH-106, DRRH-107, IET 24075, Somali, IET23979, and IET 24082 could be selected as relatively heat tolerant genotypes.
- RUE and NUE in Rice: Sampada x Jaya/2 (G3), BPT-5204, Sampada and Varadhan x MTU1010/2 (G5) showed high NUE (<5% reduction in grain yield under low N). The lines derived from the crosses Varadhan x BPT 5204/10 (G2),Varadhan x BPT-5204/6 (G2), Sampada x Jaya/3 (G4), Varadhan and Jaya showed high YSi value with non-significant stability variance (σi2) performed

well across locations and produced higher grain yield under 50 kg N ha-1 .

- Based on drought tolerance indices (DTI) the entries IET25108, IET24679, Narendra-97, IET25134, IET25141 and IET 25104 showed high DTI values and are relatively drought tolerant.

- Based on multiple abiotic stress tolerance under both laboratory and field conditions the entries viz., IET23216, Somali, IR 82635-B-B47-1 and IET24674 were found to posses higher tolerance to salinity, drought submergence and low temperature.

Entomology

- Pest surveys undertaken at 29 locations revealed reports of outbreaks of BPH from Sakoli, Rajendranagar and Pantnagar. Caseworm damage to entire crop was observed at Sakoli, Moncompu and Karjat. Outbreak of army worm, *Mythimna separata* was reported at Khudwani.

- Host plant resistance studies comprised of 1832 entries evaluated against 12 insect pests in 201 valid tests (47 greenhouse reactions+154 field reactions). The results of these reactions identified 52 entries (2.8% of the tested) as promising against various insect pests. Of these 6 entries (11.5%) were under retesting.

- Insecticide Evaluation Trial (IET) carried out at 34 locations revealed that the performance of flubendiamide plus thiacloprid @ 120 g a.i./ha was at par with the standard check insecticide rynaxypyr against stem borer and leaf folder, while against gall midge all the treatments were at par. DPX-RAB 55 @ 25 g a.i./ha followed by standard check dinotefuran were effective against planthoppers and leafhoppers.

- Botanical Insecticide Evaluation Trial (BIET) carried out at 24 locations revealed that Neemazal and Nimbecidine were found effective against stem borer. Against sucking pests-BPH, WBPH and GLH, botanicals were moderately effective. The botanical treatments were relatively safer to BPH predator-mirid bug than spiders.

- In the trial on Effect of Planting Dates on Insect Pest incidence (EPDP) conducted at 20 locations pest incidence was moderate to severe across locations and relatively high in late planting.

- Monitoring of species composition of stem borer revealed the presence of four species distributed over 15 locations with YSB being dominant in 12 locations. *Tetrastichus schoenobii* was the dominant egg parasitoid followed by *Trichogramma* and *Telenomus* sp. *Anagrus*, *Oligosita* and *Gonatocerus* were the parasitoids reported on hopper eggs.

- Ecological Engineering for Pest Management (EEPM) taken up in four locations showed that combination of organic manuring, alleyways, spacing and water management and growing of flowering plants on bunds increased the natural enemy populations like mirids, spiders and coccinellids and increased egg parasitisation.

- Bio intensive pest management trial (BIPM) initiated in four locations showed that the pest incidence was either reduced in (BIPM) or on par compared to Farmers' practice. There was also an increase in natural enemy population in the BIPM plots.

- Yield Loss Estimation Trial (YLET) carried out at 7 locations revealed a significant negative relationship between per cent white ears due to stem borer and grain yield. Pooled analysis showed that for every 10% increase in white ears there was 3.09 g reduction in grain yield per hill.

- Integrated Pest Management special (IPMs) conducted at 10 locations revealed that adoption of IPM practices reduced the incidence of gall midge, BPH and stem borer damage at respective centers. IPM practices also reduced the severity of major rice diseases. Weed population and weed biomass were also considerably reduced.

Due to reduced pest incidence, grain yield was significantly high in IPM plots resulting in higher BC ratios.

- Population dynamics of major insect pests assessed through light trap at 30 centers indicated that yellow stem borer and planthoppers continued to be major pests.

Plant Pathology

- Of 2474 entries in five different screening nurseries, the number of promising entries were 51 for leaf blast, 26 for neck blast, 56 for sheath blight, 56 for brown spot, 9 for sheath rot, 58 for bacterial blight, 27 for rice tungro virus, 40 for leaf scald and 26 for grain discolouration.
- Of the 1015 germplasm accessions evaluated, two entries showed resistance to more than one disease viz., IC No. 211168 (blast and brown spot) and 217196 (brown spot and sheath blight).
- Monitoring of field virulences of blast pathogen revealed minor shift in the pathogen population. Bacterial blight pathogen data indicated a major shift in virulence profile at Aduthurai, Maruteru, Patna, Navsari, Kaul and Raipur.
- The combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) was found effective @1g/l in reducing the both mean disease severity and incidence of leaf blast, neck blast, sheath blight, sheath rot and leaf scald. The combination product, Merger (tricyclazole 18%+ mancozeb 62% WP) 2.5 g/l proved effective against leaf blast, neck blast, sheath blight, brown spot and sheath rot.
- The data on special IPM trial indicated that adoption of IPM practices reduced the progress of disease severity of major diseases compared to farmers' practices. The highest disease severity was (BLB-56.50%, ShB-31.37%) observed in case of the fields where farmers practice was followed compared to BLB-11.31% and ShB-31.37% in plots where IPM was practiced.
- The trial on false smut with three different dates of sowing revealed high disease infection at Ludhiana and Titabar when crop was sown on 1st and 2nd week of June. Among the hybrids tested, KRH 2 was highly susceptible across the locations followed by DRRH 3 and US 312.
- Production oriented survey conducted in 18 states of India indicated that diseases like blast, neck blast, brown spot, sheath blight, sheath rot, false smut and bacterial blight were wide spread in low to moderate intensity across the country. Bakanae has become a problem in Haryana, Himachal Pradesh, Jammu and Kashmir and Punjab. A new disease called crown rot caused by Erwinia chrysanthemi was reported from different districts of Telangana.

Transfer of Technology

- A cafeteria of rice technologies were demonstrated in 449 hectares area covering 19 states and five major rice ecosystems of the country. Out of 449 Front line demonstrations (FLDs), about 62% were conducted in irrigated rice ecosystem and 16.7% of FLDs were conducted in rainfed uplands. More than 10 % of FLDs were organized in shallow lowlands and 2.23% in hill ecologies. About 5.68% of the FLDs were conducted in areas with problem soils.
- During the year 2015-16, RKMP-IIRR in collaboration with C-DAC Hyderabad has developed a series of mobile apps for the benefit of Indian Extension Professionals and Farmers. Under Rice Knowledge Management Portal (RKMP) activities, an extension interface / platform is being developed for extension professionals of the country.
- As part of ICAR-IRRI workplan GRiSP Theme 6, an innovative participatory extension method (RiceCheck) has been piloted in Telangana and Tamil Nadu for identifying the key checks and practices.

Lead Research

Crop Improvement

Plant Breeding

- IET 23832 (RP 5886-HP 3-IR80463-B39-3), the first zinc rich variety was released by CVRC. It has high zinc content (22 ppm) in polished rice with mean yield of 5.2 t/ha and Recommended for Tamil Nadu, Andhra Pradesh, Telangana and Karnataka under irrigated ecology
- Five future generation rice lines (FGR) possessing 6.5 to 7 t/ha yield potential were developed by utilizing tropical *japonicas.*
- DRR dhan 46 with 22.7% yield gain over the check Sahbhagidhan was released by CVRC for the states of Bihar, Madhya Pradesh and Maharashtra. Two drought tolerant varieties namely Tripura Kharadhan 1 and Tripura Kharadhan 2 were released in the state of Tripura.
- Chinsurah Nona Dhan 2, a derivative of *O. nivara* was found suitable for coastal saline areas and released in West Bengal
- Three lines *ie.*, RP 5434-RAU 26-4, RP 5433-RAU-27-17 and RP 5433-RAU-19-2 with > 5 t/ha yield possessing good cold tolerance at seedling stage were identified.
- An elite culture derived from the cross IR 64/ACC 2190 was found promising having resistance to planthoppers in field and green house conditions.
- IET 24395 derived from the cross MTU 1075/ MTU 1010 was found to be superior over the best varietal and hybrid checks with > 5% yield advantage and promoted to final year of testing in AVT-2- Late trial proposed during *kharif,* 2016.
- Two rice based products *viz.*, tooth pain relief gel and mosquito repellent lotion were developed utilizing rice bran oil and brown rice extract. Rice based baked products namely cake, cookies, pie crusts, muffins and doughnuts developed using rice bran oil spread (RBOS) were found to be superior in terms of consumer preference compared to those made from vanaspathi ghee and rice bran oil. Most of them contained low amount of transfats.
- In vivo Glycemic acid (GI) studies revealed low GI in Dhanrasi (59.3) and Sampada (56.8) rice varieties.
- Lines with good kernel elongation after cooking (16 to 20 mm) were generated from the crosses Vasumathi/IET 19492, Pusa 1121/IET 18990, Sugandhamati/IET 19492, IET 18033/ IET 18004 and IET 18033/ IET 19492 *etc.*
- Three land races/wild rices of North eastern region *viz.,* Punshi, Moirang-Phou-Khokngangbi and Thangjing-Phou were found to be resistant with score 3 in Uniform Blast Nursery.
- Genetic studies revealed quantitative nature of sheath blight tolerance. Employing SSRs putative quantitative trait loci were identified in the donor, RP 2068-18-3-5. A single minor QTL was detected on chromosome 5 with 7.8 % phenotypic variance.
- Studies on grain chalkiness indicated decrease in amylose content while amylopectin increased with the increase in chalky area percentage. The grain density was less in varieties cultivated at high temperature.

Hybrid Rice

- DRRH-92 successfully completed two years of testing in AICRIP trials (IHRT-MS). It is a high yielding hybrid with MS grain type having BPT 5204 grain type quality traits and medium duration. It showed yield superiority over the checks on in Zone III & VI.
- IET No 25352 (RP 5933-1-19-R-2) derived from partial restorer improvement programme was promoted to AVT-1 medium duration trial. The IET 25352 registered yield superiority over best check in zone IV with 34.63% and in zone V with 12.18% and ranked third in the trial.

- In the station trial during *kharif* 2015, 10 promising hybrids *viz*., APMS 6A/TCP-583, APMS 6A/TCP-647, IR 68897A/TCP-643, APMS 6A/19-18R, IR 79156 A/19-18R, APMS 6A/7-65R, APMS 6A/PRP-78, IR 79156 A/ PRP 78, APMS 6A/PRP 123 and IR 79156 A/AR 9-21R were identified.
- In the biotic & abiotic resistance breeding for parental line improvement, two popular maintainer lines *viz*., IR58025B and APMS6B were fortified with BB (*Xa21*) and blast (*Pi2*) resistance genes; attempts are being made to transfer the major drought tolerance QTL, qDTY12.1 and the low P tolerant QTL into the genetic background of the improved version of the elite restorer line, RPHR1005R, possessing Xa21 + Pi54.

Biotechnology

- Promising Bt transgenic IR64 lines with Cry1Ac and BPT 5204 transgenic lines with DREB1A are under evaluation of transgene integration through Thermal Asymmetric Interlaced Polymerase Chain Reaction (TAIL-PCR).
- A sucrose synthase locus LOC_Os2g58480 was identified as polymorphic in two mapping populations *viz*., Rasi / Vibhava and BPT5204/PTB1, and expression studies revealed its association with yield per se.
- A set of hyper-variable genomic and EST-SSR markers (n = 36), GATA motif specific SSR markers (n = 14) and hyper-variable genomic SSR markers (n = 52) have been identified to be highly informative with respect to assessment of parental genetic diversity and prediction of heterosis in the hybrids.
- Targeting a 20-bp polymorphism in the candidate gene for WA-CMS trait, *WA352*, located in the mitochondrial genome of rice, a robust, co-dominant functional marker, named RMS-3-WA352 has been developed and validated among all the WA-CMS lines and maintainer lines of rice.
- In a study on wild abortive-cytoplasmic male sterility (WA-CMS), a co-dominant marker was developed named RMS-PPR9-1, targeting an indel polymorphism in fertility restorer gene *Rf4*, *viz*., *PPR9*.
- Ten SNP markers were developed by targeting four key genes playing important role in starch bios synthesis through KASPER assay. These SNP markers were validated in 100 *indica* genotypes and high allele call rate (95.31%) was achieved with distinct classes.

Crop Production

Agronomy

- The total labour input saving was 21 - 25 % in Mechanised System of Rice Intensification (MSRI) as compared to SRI. MSRI and SRI performed similarly with respect to B:C ratio.
- Leaf Color Chart (LCC) based nitrogen management practice resulted significantly higher gross returns, net returns and B:C ratio as compared to other nitrogen management practices except Soil Test Crop Response (STCR) based nitrogen management practice.
- The major nutrient uptake in grain and straw increased with increase in fertilizer dosage along with addition of biofertilizers. The highest uptake of major nutrients was at 125% RDF + Biofertilizers and lowest with 75% RDF.
- In bio-fortification screening trial, lines-BLVR 86, 70, 349, RPHP 105, 106 were promising with respect to growth and yield parameters.

Soil Science

- Grain yield performance and several NUE indices indicated that the genotypes Tulasi, Rasi and Vikas from early; KRH2 and Varadhan from medium and Dhanrasi from long duration group were the most. GSR lines *viz*., HUANGHUAZHAN, TME 80518, and IRRI 105 exhibited efficiency at sub-optimal N level (N0) and responded to applied N (N 100).
- N_2O emissions were significantly reduced from the rice field by use of all the three nitrification inhibitors namely, Dicyandiamide (DCD), Neem Coated Urea

(NCU) and Karanjinas compared with urea. Total N_2O–N emissions were the highest with urea (0.73 kg/ha) followed by Karanjin + Urea (0.62 kg/ha). The highest inhibition of total N_2O emission (53%) was recorded from plots treated with Urea + DCD.

- The inoculation with *Gluconacetobacter diazotropicus* was found to improve the seedling leaf water content (39.4%) and reduced electrolyte loss (58.1%) under water deficit stress in comparison with uninoculated seedlings which showed 27.4% and 61.6%, respectively. Inoculation was also found to improve the recovery of plants after resuming irrigation.

Plant Physiology

- Correlation and regression studies indicated that Pn is positively associated with carboxylation efficiency, gs and ETR. The positive association with ETR and PN indicate that this parameter can be used to screen large number of genotypes as measuring ETR is faster. The PN was significantly associated with TDM and grain yield.
- Multiple regression analysis based on *lmg* (Lindeman, Merenda and Gold) metric indicated that the carboxylation efficiency (P_N/C_i) contributed >30% to the R^2 value of 0.86 followed by transpiration (14%) and ETR (11%).
- **Based on the ideotype breeding experiments in rice**, it was found that KRH-2, PHB-71 and 13-7 (hybrids cluster), Jaya, Swarna and Sampada *(indica* cluster) and TJP-27, TJP-197 and TJP-139 (tropical *japonica* cluster) can serve as potential donors to get increased grain yields with good grain quality and ideal morpho-physiological traits associated with grain yield.

Crop Protection

Entomology

- Of various breeding lines and germplasm accessions evaluated against hoppers, PTB 33, RP 2068, T12 and IC216750 were highly resistant to BPH, *Nilaparvata lugens*. The entries MO1, IC75864 and IC215298 were resistant to WBPH, *Sogatella furcifera*.
- The back cross inbred line RP5588-B-B-B-63 developed from *O. glaberrima* recorded low damage for stem borer, *Scirpophaga incertulas* suggesting antibiosis as one of the mechanisms of resistance.
- RP5588-B-B-B-32 derived from *O.glaberrima and* a BPT mutant been identified as a new source of resistance to Asian rice gall midge, *Orseolia oryzae* with nil damage under greenhouse.
- Thirteen Backcross Inbred Lines (BILS) derived from a cross between Swarna (*O.sativa*) and a wild accession *O. nivara* – 81848, 11 mutant lines and 7 germplasm entries recorded low damage by leaf folder, *Cnaphalocrocis medinalis*
- A newer insecticide BCS CL 73507 SC 200 was found effective in reducing the damage by stem borer, *S. incertulas* and leaf folder, *C. medinalis* in rice under field conditions.
- Lemongrass, eucalyptus,oregano and camphor oils at 0.2% significantly reduced stem borer(*S. incertulas)* and leaf folder, *C. medinalis* damage and their efficacy was comparable with insecticide rynaxypyr. Olfactory response of BPH, *N.lugens* to various oils revealed that eucalyptus oil at 10 µl and neem oil at 20 µl were highly repellent to female hoppers. In EAG test, highest reaction (repellent) by hispa, *Dicladispa armigera* was recorded in eucalyptus oil followed by camphor and rosemary oils.
- The mean parasitisation of brown planthopper, N.*lugens* eggs near a border of yellow marigold, orange marigold and Gaillardia was significantly higher when compared to parasitisation without flower border. Laboratory studies on biology of Anthocorid predator revealed that the bug was predominantly an egg predator on BPH, *N.lugens*.
- The pink stem borer (PSB), *Sesamia inferens* lure resulted in cumulative catches of PSB.

- Entomopathogenic nematode (EPN), *Heterorhabditis indica* significantly reduced white ear damage caused by the yellow stem borer in field evaluation. An indigenous EPN, isolate Drr-Ma3 was identified as *Metarhabditis amsactae* based on morphological and molecular characterization.
- Two genotypes (LD24 and Khao Pahk Maw) showed highly resistant reaction to rice root-knot nematode, *Meloidogyne graminicola*. Nematode analyses in SRI system revealed that the total nematode abundance was more in SRI compared to the normal transplanted system.

Plant Pathology

- The blast resistant genes like *Pi1*, *Pi2* and *Pi54* were introgressed into elite cultivar Samba Mahsuri and Introgressed lines are under evaluation for blast resistance.
- Sheath blight tolerant lines *viz.*, SM-801, Ngonolasha, Wazuho phek, Gumdhan, BG-380-2, RP-2068-18-3-5, Phougak and Thangmoi were identified from North Eastern India.
- Among the cultivars evaluated under glass house conditions on three different sowing dates *viz.*, early, mid and late for false smut disease, the genotype HKR 47 showed high number of smut balls (10 Nos.)
- Isolated microbial antagonist's *viz.*, Fluorescent *Pseudomonas* sp, *Trichoderma viride, Penicillium* sp. and *Aspergillus* sp. and these were tested for their antagonistic activity against *Rhizoctonia solani* under *in vitro* conditions and found effective in suppressing the growth of the fungus.
- 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).
- Genotyping and phenotyping of BB isolate 392 *Xoo* strains have been completed and categorized into 22 pathotypes.
- The combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) 1.0g/l was identified as an effective molecule to reduce the blast and sheath blight disease of rice.

Transfer of Technology

- The major threats to sustainable rice production technologies in Chattisgarh plain zone as perceived by farmers are non availability of resistant varieties, poor drainage, nutrient deficiency, slow seed replacement, labour problems, non availability of micro nutrients and biofertilizers in time and increased cost of tubewells.
- Gender dimensions study in farmers indicated that the major work related to agriculture was predominantly decided by male members of the family. Regarding the climate change they perceived that in Ranga Reddy district 2013 was a good year for rice cultivation, followed by 2014 as average and 2015 as a bad year in which rice area was reduced by 40 % and 75 %, respectively.
- The video extension module studies in Telangana and Rice check programme studies in Tamil Nadu indicated that in both these provinces, impact of knowledge interventions was found to be significant when blended with field demonstrations.
- Adequate training in the agribusiness related area, effective marketing strategies, extension efforts such as technology demonstration and dissemination strategies, value addition initiatives were the critical success factors in the public-private partnership in agricultural extension and advisory services.
- The baseline study in village Ankushapur District Karimnagar revealed that though farmers are aware of IPM as a concept, they are not aware of the important IPM components to be followed in rice.

Introduction

Introduction

50 years of AICRIP and Evolution of IIRR

The journey of All India Co-ordinated Rice Improvement Project started in 1965, with its head quarters at Rajendranagar, Hyderabad. The pre-AICRIP Indian rice research system was isolated, in some research establishments and universities. The varied difference of opinion regarding the testing of first semi-dwarf rice variety TN (1), in every major rice growing areas of India led to the establishment of first nationally co-ordinated rice improvement project with a full time co-ordinator. To begin with, AICRIP work was carried out at 22 network centers in 7 zones each under the responsibility of a Zonal Coordinator. The zonal headquarters were Khudwani, Jorhat, Faizabad, Patna, Hyderabad, Cuttack and Coimbatore. Twelve regional stations *viz,* Palampur, Pantnagar, Kapurthala, Chinsurah, Sambalpur, Raipur, Maruteru, Karjat, Nawagam, Mandya, Aduthurai and Pattambi were established in the major rice growing states of the Country. Upper Shillong, Kalimpong and Imphal were identified as testing centers.

Considering the progress and future challenges, during fifth five year plan (1974-79), ICAR provided 23 additional centers, thus raising the number to 45. In order to meet the objective of technology development and evaluation, the AICRIP was elevated as the **Directorate of Rice Research (DRR)** in April, 1983 with the added mandate of pursuing research on irrigated rice for strengthening and stabilizing rice production in the country. During VI plan period (1980-85), 8 more sub centers were sanctioned raising the total to 53. There were a total of 61 centers including 8 subject related special centers. In the VII plan period (1985-86 to 1989-90) the number of centers was reduced to 50 (18 main and 32 sub centers). During the VIII plan (1992-97), there were 51 approved centers of which six centers were withdrawn and Karnal center 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. During the ongoing XII plan (2012 – 2017), two centers *viz.*, Karimganj and Sabour have been withdrawn. So, currently there are 45 funded centers under AICRIP (Fig.). In addition to these funded centers, there are more than 100 voluntary centers where trials were conducted on voluntary basis in each discipline.

DRR was upgraded to national institute status as **'Indian Institute of Rice Research (IIRR)'** during the golden jubilee year, from 15th December 2014. The institute activities are aimed at accomplishing the vision, mission and mandate of IIRR keeping in view the "Farmer First" motive of ICAR.

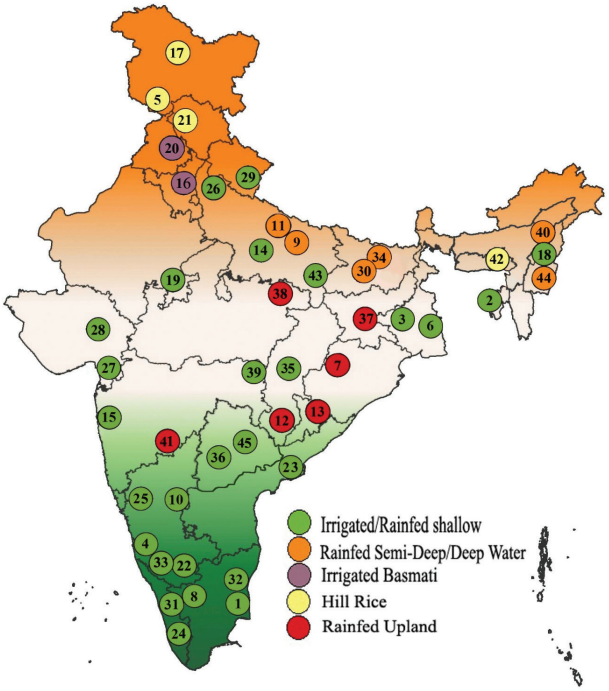


Fig. Funded centers of AICRIP in India under different rice ecologies

VISION

Welfare of the present and future generations of Indian rice farmers and consumers by ensuring food, nutritional and livelihood security

MISSION

Develop technologies to enhance rice productivity, resource and input use efficiency and profitability of rice cultivation without adverse affect on the environment

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 and anticipatory research in the major thrust areas of irrigated rice aimed at enhancement of production, productivity and profitability while preserving environmental quality.**
- **To develop, 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 and through 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.**

Organogram of AICRIP-IIRR

On the occasion of Golden jubilee year, ICAR-IIRR takes highest pride for successful conduct and coordination of 50 years of AICRIP in India. AICRIP is the largest research network on a single crop comprising of 45 funded and over 100 voluntary centers covering all the rice growing states in the country. At present, more than 300 scientists of the State Agricultural Universities (SAU's), State Departments of Agriculture and ICAR institutes carry out planned experiments/ trials of breeding, agronomy, soil science, plant physiology, entomology and pathology at various locations.

ICAR- IIRR is one of the crop based institutes of ICAR under direct supervision of the Deputy Director General, Crop Sciences. IIRR is organized into four sections and ten units for fulfilling its mandate effectively, along with centralized service wings and administration. Director, IIRR is also the National coordinator of AICRIP and its activities are integrated into the mandate with senior most scientists of each discipline acting as the Principal Investigators (PIs) of the programme. Research and Institutional activities are planned and guided by Research Advisory Committee (RAC) and Institute Management Committee (IMC) while the progress is critically evaluated by the Quinquennial Review Committees (QRT). This institute has well equipped with state of the art laboratories, centrally air cooled greenhouses, biosafe transgenic greenhouses, growth chambers, well laid out experimental farms at Rajendranagar, IIRR campus and ICRISAT campus.

Linkages – ICAR-IIRR has the largest network of linkages and collaborations with organizations both in India and abroad. It has research linkages with national institutes like Delhi university (DU),National Institute of Nutrition (NIN), Centre for Cellular and Molecular Biology (CCMB) and Centre for DNA fingerprinting and Diagnostics (CDFD) and also with Protection of Plant Varieties and Farmers' Rights Authority (PPV& FRA). Internationally, it has strong collaboration with CGIAR institutes such as International Rice Research Institute (IRRI), International Crop Research Institute for Semi Arid Tropics (ICRISAT) and International center for Genetic Engineering and Biotechnology (ICGEB). IIRR also has a strong mode of operational linkage with the private sector, especially related to hybrid rice technology and fertilizer and chemical companies through testing new molecules of pesticides and herbicides related to entomology, pathology and agronomy sections.

ICAR-Indian Institute of Rice Research

Infrastructure

The Institute provides state of the art facilities for laboratory as well as field experiments for basic and applied research in Molecular Biology, Plant Pathology and Entomology. Institute is equipped with centrally air cooled greenhouses for screening germplasm for resistance against pests and diseases, transgenic poly-houses for containment , net-houses, growth chambers, blast screening facility, and heat tunnels for physiology experiments. Field facilities include well laid out experimental farms at Rajendranagar (20 ha) and Ramachandrapuram (40 ha) with a wild rice garden and pollination chambers along with adequate farm machinery, godowns and limited cold storage facilities.

IIRR is equipped with a centrally air conditioned auditorium with 350 seating capacity, seminar halls, VIP 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 fully digitized with over 4,654 books, 6,500 bound volumes and subscription to 55 Indian and 13 foreign journals. The institute hosts a museum where the significant achievements of the institute are exhibited as posters, maps and other visuals for the benefit of visitors.

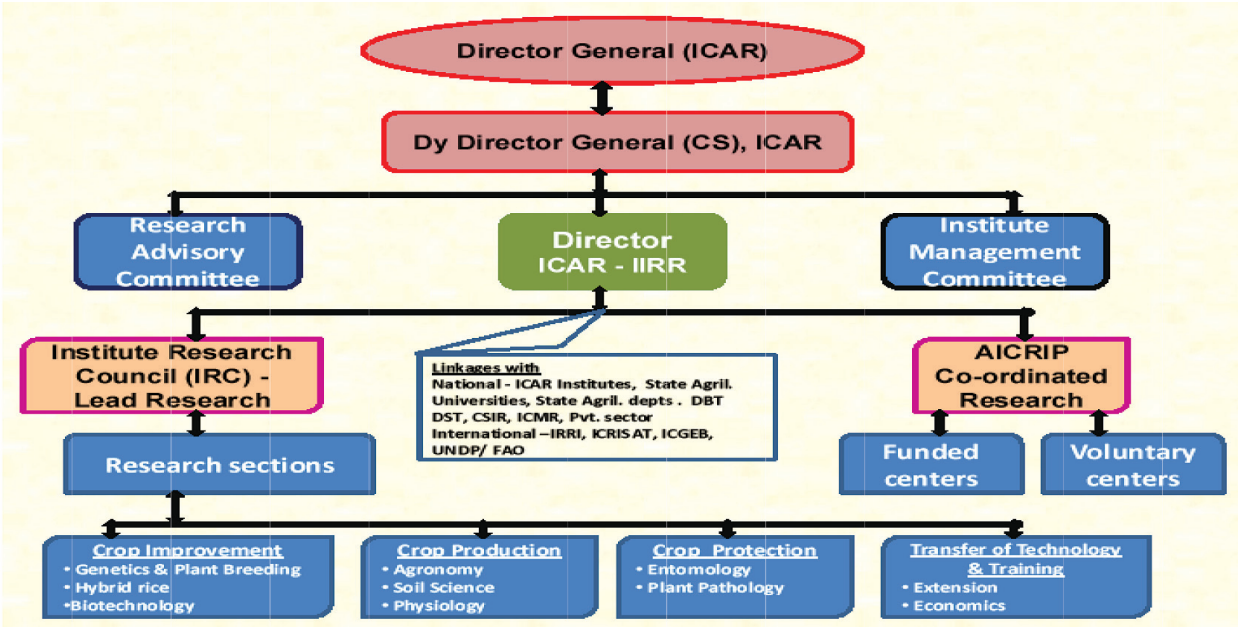


Fig. Organogram of ICAR-IIRR

SVS Shastry Auditorium

Farm Office cum Laboratory at IIRR Farm, ICRISAT Campus

Administrative Block

New Block for Germplasm at IIRR farm, ICRISAT campus

Staff

	Sanctioned	Filled	Vacant
Director	**1**	**1**	**-**
Scientific	71	62	9
Technical	53	40	13
Administrative	32	25	7
Supporting	17	9	8
Total	**174**	**137**	**37**

Budget

Statement showing budget allocation during 2015-16 with actual expenditure

(Rupees in lakhs)

Item	2015-16 (Plan)		2015-16 (Non-Plan)	
	Outlay	Expenditure	Outlay	Expenditure
IIRR, Hyderabad	463.00	447.00	2221.98	2210.00
AICRIP, Hyderabad	2542.50	2511.24		

Research Achievements in 50 years

All India Coordinated Rice Improvement Programme (AICRIP) was instrumental in testing and releasing varieties for the country since its inception in 1965. With added research objectives Directorate of Rice Research and IIRR have contributed to advancements in fundamental understandings on rice biology and its interaction with the environment apart from developing molecular as well as agricultural technologies for rice breeding and cultivation. Since the release of the first rice variety Jaya in 1968, twenty four thousand and nine hundred elite lines developed by different cooperating centres were tested in multi-location trials across the country under the umbrella of 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 possess 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 significant contributions of IIRR are enlisted below

- Development of first MAS derived product "Improved Samba Mahsuri" which possesses 3 BB resistant genes *xa*5, *xa*13 & X*a*21 conferring resistance to BLB of rice. 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.
- 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. On IIRR initiative, 71 extant, notified varieties of rice were IPR enabled with PPV&FRA granting registration certificates.
- IIRR has developed a rapid and reliable assay for assessment of purity of seed-lots of rice hybrids and CMS lines.
- Identification molecular markers for the major fertility restorer genes *Rf3* and *Rf4* for use in hybrid rice programme and for targeted improvement of elite restorer and maintainer lines for disease resistance.
- Identification of superior alleles of blast resistant genes *Pi54, Pita and Pib* from germplasm collections and fine maping of novel resistant genes *Xa33* (for BB), *Gm3 & Gm8* (for gall midge).
- Development of functional markers have been developed for major blast resistant gene *Pi54* and the major QTL controlling grain length, *Gs3*, for aroma (*BADEX 7-5*).
- 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 short listed for Bio-Safety Research Level (BRL-1) testing.
- 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.
- Development of suitable package for aerobic rice system which reduced the water requirement by 30-40% over continuous flooding.
- 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.
- Regular application 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 to save cost of labour and to enhance yield.
- Organic farming systems requires 4-8 crop cycles to stabilize productivity and improvement of physical 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 have been developed.

- Identification of Effective ecofriendly insecticides such as granular formulations of carbofuran, chlorantriniprole and spray formulations of chlorpyriphos, ethofenprox, cartap 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 as trap crop for every 9 rows of any main crop to manage stem borer damage with additional income from PB1 crop.
- Utilizing some of the resistant donors, several disease resistant varieties have been developed like Swarnadhan, Rasi, Sasyasree, Kasturi, VL Dhan 39, Himalaya, Sujatha, Co43 for blast and 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.
- Aerobic rice developed by IIRR - DRR Dhan 41 (IET 22729) is the rice variety developed and released under aerobic ecology utilizing less water. It is identified for release in Bihar and Karnataka.
- The year 2015 witnessed several distinct innovations in terms of new varieties and technologies through AICRIP as well as multidisciplinary lead research programs.
- DRR Dhan 45, a high Zn variety; DRR Dhan 42, a drought tolerant and high yielding; DRR Dhan 43 and DRR Dhan 44 short duration varieties with moderate tolerance to biotic (BPH and blast) and abiotic stress (drought) were released.

Research Achievements-AICRIP

- Crop Improvement
  - New Varieties and Hybrids released
- Crop Production
  - Agronomy
  - Soil Science
  - Plant Physiology
- Crop Protection
  - Entomology
  - Plant Pathology
- Transfer of Technology

All India Co-ordinated Rice Improvement Project

Crop Improvement

New Varieties and Hybrids released

Forty two varieties and four hybrids were released during 2015-16 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 15 varieties and three hybrids (KRH 4, KPH 460 and ADV 8301).

The State Varietal Release Committees released 27 varieties; for Andhra Pradesh (1), Gujarat (2), Karnataka (2), Kerala (5), Maharashtra (1), Madhya Pradesh (1), Manipur (1), Telangana (3**)** Uttarakhand (4), and West Bengal (7). These high yielding varieties (HVYs) were released for cultivation in different ecologies *viz*., irrigated, aerobic, basmati, rainfed shallow low land, deep water and coastal saline areas. Many of these varieties are resistant/moderately resistant to biotic stresses.

Varieties released by Central and State variety release committee during 2015-16

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco System	Grain Type	Yield (Kg/ha)	Reaction to Pests and disease	State
Central releases :										
1	Pant Basmati 1	21665	UPRI 2007-15	-	101	Irrigated	ELS	4850	R- BPH, MR- SB, MR- BS, BL, ShBl	UT, UP, Dl
2	Pant Basmati 2	21953	UPR 3506-7-1-1	UPRBS 9241/ UPR 2268-5-1-5	95	Irrigated	LS	4754	R- SB, MR- BLB, BS, BL	PU, UP, UT, HA
3	Indira Aerobic 1	21686	R 1570-2649-1-1546-1	Swarna / IR 42253	85-90	Aerobic	MS	4000-4500	-	GU, CH, TN
4	KRH 4	22402	Hybrid	CRMS 32 A / MSN 36	97	Irrigated Transplanted Aerobic	MS	8000-8500	R- ShR	GU, MH
5	HKR 48	18227	HKR 99-60	PR 110/ BG 936	88	Irrigated Early	LS	7000	MR- BLB, LF	-
6	Pusa Basmati 1609	22778	Pusa 1609-09-9-4	Pusa 1602 / Pusa 1603	120	Basmati	ELS	4600	R- NBl, BL	UP, Dl, UT, PU
7	Chandra	23409	MTU 1153	MTU 1010/ MTU 1081	115-120	Irrigated Early	LB	7500-8000	R- FS, MR- BL; SR, RTV, WBPH, GLH	PU, BI, CH, MH MP, KA, KE,TN
8	KPH 460	22938	Hybrid	-	100	Irrigated	MS		MR- BL	GU, MH, AP, TS, KA, TN
9	Binadhan 8	-	IR66946-3R-149-1-1	-	100-105	Saline and Alkaline	MB	4500-5000	BLB, SB, BPH, Hispa	WB, TR, AS
10	Binadhan 10	-	PBRC-37	IR42598-B-B-B-B-12/ nonabokra	90-95	Saline and Alkaline for boro	MB	5000-6000	-	WB, TR, AS
11	Binadhan 11	-	IR09F436	-	100-105	Submergence	-	4200	-	WB, TR, AS
12	Binadhan 12	-	IR077101	-	110-115	Submergence	MS	3500	-	WB, TR, AS

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco System	Grain Type	Yield (Kg/ha)	Reaction to Pests and disease	State
13	Sukhadhan 5	-	IR83383-B-B-108-3	-	-	Drought	-	-	-	UP, BI
14	Sukhadhan 6	-	IR83383-B-B-129-4	-	-	Drought	-	-	-	UP, BI
15	ADV 8301	22410	A 1104 (Hybrid)	-	93	Irrigated	MS	-	-	GU, MH, AP, TN
16	DRRdhan 46	23420	-	-	93	Irrigated	LS	-	-	MH, BI, MP

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco System	Grain Type	Yield (Kg/ha)	Reaction to Pests and disease	State
State Releases :										
Andhra Pradesh										
1.	Sri druthi	22577	MTU 1121	Samba Mahsuri/ MTU BB 8-24-1	125	Irrigated	MS	7500-8000	R- BL, BPH	AP
Gujarat										
2.	GNR-3	22103	NVSR-178	IR 28/ GR-4	84-88	Irrigated Transplanted areas	LB	-	R- BLB, BL, MR-SB, LF	GU
3.	GNR-4	23815	NVSR-303	NAUR-1/ Lalakada	105-110	Irrigated Transpalnted	MS	-	-	GU
Karnataka										
4.	BRP-1		IRGA-318-11-6-9-2 B Red	New Rex // IR 19743-25 / BR IRGA 409	98	Lowland	4500-5000		R- BL, GM	KA
5.	BRP-1-2-1		BMR-1-2-1	Local Selection	109	Midland	4500-5500		R- BL, BLB, GM	KA
Kerala										
6.	Shreyas (MO 22)	23776	KAUM-112-10-6-5	Pavithra/ Triguna	85-90	Wetland Ecosystem of Kuttanad	LB	7000-7500	-	KE
7.	VTL 9			Mutation of land race Chettivirippu	110	Costal Saline	MB	4025	-	KE
8.	EZHOME - 4	22608	KAU JO 532-1	Jaya/ Orkayama	105-110	Kaipad Saline Tract	MB	5100	-	KE
9.	JAIVA	23742	Culture KAU MK 157	Mahsuri / Kuthiru	105-110	Organic Non-saline Wetland	MB	5000	-	KE
10.	AMRITHA	23939	OM 2	Sagara / Pankaj	130	Deep Water Saline	LB	3200	-	KE
Maharastra										
11.	Karjat 9			Kasturi / IR 50	120-125		MS	4500-5000	R- BPH, WBPH, MR- NBl, BLB, SB; R- BL	MH

S. No.	Variety Name	IET No.	Designation	Cross combination	FD	Eco System	Grain Type	Yield (Kg/ha)	Reaction to Pests and disease	State
Madhya Pradesh										
12.	JRB 1	23422	JRB-1	Local Selection	120-125	Irrigated	SB	4525-7140		MP
Manipur										
13.	RC-Maniphou-13	24200	RCM-30	KD-2-6-3/ Akhanphou	-	Irrigated	-	-	-	MN
Telangana State										
14.	Kunaram Sannalu		KNM 118	MTU 1010 / JGL 13595	90	Irrigated	LS	7500	MR- BL	TS
15	Telangana Sona		RNR 15048	MTU 1010 / JGL 3855	95	Irrigated	SS	7500	R-Blast	TS
16.	Bathukam-ma	22793	JGL 18047	MTU 1010 / JGL 13595	90-100	Irrigated	LS	7000-7500	R-BL, BLB,BPH, GLH	TS
17.	Somanath	20898	WGL-347	NLR-145/ Kavya	105	Irrigated	MS	6000-6500	R-GM (Biotype 1 &5), MR- NBl, BS	TS
Uttarakhand										
17.	Pant Dhan 23			UPR 2962-6-2-1	95	Irrigated	LS	4533	MR- BLB, SB	UT
18.	Pant Sugandh Dhan 25		UPR 2825-30-1-2	Tilakchandan / Basmati 376	100	Irrigated	LS	3610	MR- BLB, SB	UT
19.	Pant Dhan 26		UPR 3425-14-3-1	Mahamaya / Gayabyeo	80	Irrigated	MS	4533	MR- BLB, SB	UT
20.	Pant Sugandh Dhan 27		UPR 3488-6-2-1	UPR 1840-31-1-1 / Pusa Sugandh 2	90	Irrigated	LS	4454	MR- BLB, SB	UT
West Bengal										
21.	Puspa	17509	CNB 1259-5-21	Selection from BG 731-2	79		SB	4500-5000	R- Bl, RTD, LF, BPH, SBWE, SBDH	WB
22.	Dhiren (BNKR-1)	20760	CN 1340-76-1-BNKR 23-7-1	IR 42/ Patnai 23	142		SB	5000-5500	MR- BL, NBl, BS, ShR, LF	WB
23.	Chinsurah Nona 2	21943	RP Bio 4919-60-13	KMR-3/ *O. rufipogan*	135	RSL	MB	5200	-	WB
24.	Muktashree	21845	CN 1794-2 (IR 73933-8-2-23	Selection Kamal Local	130	Scented	LS	4400	-	WB
25.	Pan-802	23498	PAN 802	014 A/ AN 268	120-122		LS	6500-7000	-	WB
26.	Pan-2343	21395	ANS- 2423 (Hybrid)	-	120-122		SB	5500-6500	-	WB
27.	Sukumar	21261	CN 1646-6-11-9	Pusa Basmati 1/ IR 64	120-130		LS	4000-4300	-	WB

Coordinated varietal testing

During the year 2015, 42 varietal trials and 1 screening nursery were conducted in 648 experiments at 126 locations (42 funded, 84 voluntary centres) in 27 states and 2 Union Territories covering all the 7 Zones in the country. The 42 trials were constituted with 1226 entries including 141 checks. 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, 14 INGER nurseries involving 666 entries were tested at 58 centers. After three years of testing in AICRIP trials, three hybrids and 42 elite breeding lines from 13 centers were found promising for various ecosystems like irrigated, aerobic, basmati, Rainfed shallow low land, deep water and Coastal saline (Appendix 1) and the promising hybrids identified based on overall mean yield advantage over the checks in hybrid trials are given in Appendix 2.

Monitoring of AICRIP trials at Malan, Himachal Pradesh

International Network for Genetic Evaluation of Rice (INGER) nurseries

INGER nurseries are the important source of improved genetic resources developed in different countries for utilization in the breeding programme. During 2015, fourteen INGER nurseries with 666 diverse and elite rice breeding material were evaluated at 58 different locations spanning different ecologies. The superior lines were identified in different trials based on yield, resistance/tolerance to biotic/abiotic stresses, maturity duration and overall phenotypic acceptability.

List of promising entries in INGER nurseries

1. International Irrigated Rice Observational Nursery (IIRON)

   Module 1: IR 10A270, IR 11A257, IR 11A293, IR 11A302 and IR 11A429

   Module 2: IR 10N389, IR 11A108, IR 11A307, IR 11A316, IR 11A546, IR 11N294 and IR 79643-23-3-3-3
2. International Temperate Rice Observational Nursery (IRTON): *IR 10K182, IRRI 102 and IR 13K177*
3. International Rainfed Lowland Rice Observational Nursery (IRLON): *IR14L116, IR13L188 and IR 95836-14-3-1-2*
4. International Upland Rice Observational Nursery (IURON): *IR13L114, IR12L369, IR13L406 and IR13L413*
5. International Rice Heat Tolerant Nursery (IRHTN): *IR 11C208*
6. International Rice Soil Stress Tolerance Nurseries (IRSSTN)

   Module 1: IR14T114, IR13T145 and IR 55179-3B-11-3

   Module 2: IR 58443-6B-10-3, IR11T185 and A 69-1
7. International Rice Blast Nursery (IRBN): *IRBLKM-TS[CO], IRBLSH-B[CO], IRBLTA-ME[CO] and IR 09N127*
8. International Rice Bacterial Blight Nursery (IRBBN): *IR-BB1, IR-BB13, IR-BB52 and HHZ-5-DT20-DT3-Y2*
9. International Rice Brown Plant Hopper Nursery (IRBPHN): *MILYANG 46 (CHEO NGCHEONGBYEO, MILYANG 55 (SAMGA NGBYEO), BG 367-2,*
10. Green Super Rice for Irrigated Lowland (GSR-IRLL): *HHZ 10-DT5-LI1-LI1, HHZ, SAL19-Y1, HHZ 15-SAL13-Y1, HHZ 16-SAL13-LI1-LI1, HHZ 18-Y3-Y1-Y1, HHZ 21-Y4-Y2-Y1*
11. Green Super Rice Rainfed Lowland (GSR-RFLL): *HHZ 10-DT5-LI1-LI1, HHZ 15, DT7-SAL2, HHZ 15-SAL13-Y1*
12. MAGIC Global: *IR 104473:2-B-20-17-10-2-3-B and IR 104444:12-B-9-4-7-5-3-B,*

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 IIRR 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 1).

Monitoring of AICRIP trials at ZARS, Mandya Karnakata

Crop Production

Agronomy

The Coordinated Agronomy Programme organized 282 experiments conducted at 56 locations during *rabi* 2014-15 and *kharif* 2015. Elite genotypes (58 AVT-2 cultures) belonging to 15 groups *viz*., early hill (irrigated), medium hill (irrigated), upland hill (direct seeded), early, mid early, medium, basmati, aromatic short grain, IHRT medium slender, aerobic (direct seeded), alkaline and inland saline in transplanted, rainfed shallow lowland, semi-deep water and deep water situation were evaluated for their response to graded levels of nitrogen (NVT). In addition, twelve trials on cultural management, four on weed management and one trial 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 92 per cent. Results obtained from these trials are summarized here under.

Evaluation of rice establishment methods for higher productivity and profitability on puddled soil

The experiment was conducted during *kharif* 2015 in RBD design with four replications. Treatments consisting of five crop establishment methods {M_1: Manual transplanted rice; M_2: Mechanized transplanting; M_3: Wet direct row seeded rice using drum seeder; M_4: Wet direct seeded rice by broadcasting and M_5: Optional method of sowing (Location specific)} were assessed for their productivity performance at three locations and the results revealed that, wet direct row seeded rice using drum seeder resulted in the highest yield at Coimbatore. However, manual transplanting performed better at Pusa and Ranchi with 4.53 t/ha and 4.42 t/ha, respectively.

Evaluation of nutrient management practices for enhancement of the productivity in different rice establishments methods

To identify the optimum and cost effective nutrient management practices in different crop establishment methods a trial was conducted at 8 locations. Experiment was laid out in split plot design with 3 main plots and 5 subplots. Mechanical transplanting method with all the principles of SRI resulted in the highest yield across all the locations. The highest yield was recorded at Rewa (6.3 t/ha). Similarly, among nutrient management methods LCC based N application resulted in the highest yield across all the locations followed by 150% recommended fertilizer dose.

Long term effects of nutrient management on SRI *vis a vis* conventional flooded rice on soil fertility and sustainability of rice based cropping systems

A study initiated during *kharif* 2012 was continued during 2015 at 10 locations. The treatments were combination of three methods of crop establishment {(SRI, Direct seeding using drum seeder/ dibbling of sprouted seed at 25 x 25 cm fb SRI principles (saturation method of water management, weeding with cono-weeder and fertilizer management) and normal transplanting

(30-35 days old 3-4 seedlings/hill planted at 20 cm x 15 cm spacing with flooding [2-5 cm] water management) as main plot and seven nutrient management practices (F_1- 100% of recommended dose of inorganic fertilizers i.e. RDF (120:60 :40 kg N:P:K/ha), F_2- 50 % inorganic + 50% (equivalent of N dose) organic, F_3- RDF through organic source (equivalent of N dose), F_4-150% RDF, F_5- No fertilizer (Control), F_6- 50% inorganic + 50% through bio fertilizers and F_7-location specific fertilizer management in sub-plots. The evaluation of crop establishment methods along with different nutrient combinations over ten locations clearly indicated superiority of SRI method (4.7 t/ha) than that of direct seeded followed by SRI principles (4.26 t/ha). Application of 150% RDF followed by 100% RDF as inorganic fertilizer was found promising in terms of grain yield.

Evaluation of cultivars for weed competitiveness under puddled transplanted and direct wet seeded rice

The trial was initiated in *kharif* 2015 with the objective of evaluating different groups of cultivars (released and under cultivation) for weed suppressing ability and yield performance. The trial was conducted at eight locations in split plot design with three replications. The main plot treatments comprised of wet direct seeding under puddle condition (DSR) and transplanted rice with alternate wetting and drying irrigation (AWD). The sub plots treatments included high yielding varieties and hybrids *viz*., Mandya vijaya, Dhanrasi, PA 6444 ,KRH 2, RP Bio226, DRR Dhan 44, Tulasi and JGL 17004 along with two local high yielding varieties. Across the locations, the yield attributes and grain yields were higher in transplanting system with alternate wetting and drying compared to direct sown rice under puddle irrigated condition. Among the hybrids (KRH 2 followed by PA 6444) recorded higher yield attributes and grain yields with lower weed dry biomass and weed population than the high yielding varieties. Among the high yielding varieties, Mandya Vijaya and Dhanrasi exhibited better weed suppressing ability and registered lower weed population and weed biomass during the season and short duration varieties (Tulasi and JGL 17004) registered higher weed population, weed biomass and lower grain yields. The this study revealed that hybrids and long duration high yielding varieties are found to have better weed suppressing ability.

Soil Science

Eleven different locations representing important rice growing regions and typical soils were identified where nine trials were conducted during *rabi* 2014-15 and *kharif* 2015.

Long term soil fertility management in rice based cropping systems

Long term soil fertility management experiment in rice based cropping system in its 27th year also showed the consistent superiority of conjunctive use of recommended fertiliser dose (RDF) + 5 tonnes of farm yard manure (FYM)/ha at test centres, Maruteru (MTU) and Titabar (TTB) in *rabi* and *kharif*. Trend analysis of rice productivity indicated a relatively lower rate of growth with RDF (2 and 21 kg/ha/year at MTU and TTB, respectively) while RDF + FYM resulted in much higher growth rate (82 and 92 kg/ha/year). Enzyme activity of phosphatase, glucosidase and dehydrogenase was higher in treatments receiving 10t FYM/ha, NPKZnS+FYM and 50%NPK+25% GM-N+25% FYM-N across locations.

Monitoring of AICRIP trials at APRRI, Maruteru, AP

Yield gap assessment for bridging through site specific integrated management

Steep rice yield gaps were observed between the fields which received RDF and FFP (farmer fertiliser practice) when yield gap analysis was done in different test centres including Titabar, Faizabad, Kanpur and Chinsurah. These results

underscored the scope for gap reduction so that the uniform best could be reaped.

Management of sodic soils

In a comparative study, 60 – 95 % of yield increase was recorded in sodic soils amended with gypsum over un-amended soils during *kharif* 2015 in Kanpur when tested with twenty different genotypes. The results also indicated the order of rice yield; DRR Dhan 43 > CSR 36 > GSR 129 > DRR Dhan 42 with 4.37, 4.26, 4.24 and 4.19 t/ha, respectively with 100% GR (gypsum requirement) supplementation.

Nutrient and water requirement for aerobic rice cultivation

The performance of aerobic rice was significantly influenced by water regimes and nutrient application. Water productivity (kg grain/ha mm water used) achieved was in the range of 4.4 – 5.1 kg grain/ha mm water coupled with a 10 to 14% of saving in water requirement with 100 and 75% CPE (cumulative pan evaporation), respectively over 150% CPE. Application of 180 kg N, 60 kg $P_2O_5$and 100 kg K_2O significantly improved grain yield.

Nutrient use efficiency and productivity in early and late sown rice

The time of crop establishment influenced both nutrient use efficiency (NUE) and rice productivity as well with optimum planting in *rabi* and normal sowing in *kharif* where the highest grain yield and nutrient uptake were recorded. Among the nutrient management practices, 100% RDF+ZnSFeB+ green manure+Vermi compost + Rice straw in *rabi* at Ghagraghat and Karaikal and 150% RDF+Zn (with N in 3 splits of 1/3 each) in *kharif* at Faizabad, Khudwani and Maruteru yielded significantly over others.

Screening of rice genotypes for acid soils and related nutritional constraints

Genotypes 27P-63, PA 6444 and US 312 were responsive through increased yield to liming in the acid soils of Moncompu while genotypes PA 6444, 27P-63 and HRI-174 were high yielders in un-limed acid soils with recommended NPK fertilisation alone. Genotypes GSR 148, GSR 119 and DRR Dhan 43 performed better in Ranchi and Aghonibora while US 312, 27P-3 and PA64444 at Titabar recorded significantly higher yields in response to amendment with lime.

Plant Physiology

Influence of Silicon solubilizers on stress tolerance in rice genotypes.

Based on the studies conducted at IIRR it was found that application of Imidazole to the soil improves the silicon solubilisation and improves the uptake of silicon by the rice plants.

Number of panicles per sq.m was significantly influenced by the application of Imidazole and Silixol. Silicon treatments significantly ($p<0.05$) affected the TDM and grain yield. Imidazole application increased the mean TDM by 11.4% over control. Silixol treatment resulted in >4% increase in mean TDM.

The mean grain yield increased by 9 and 8% with Imidazole and Silixol respectively. The data also revealed that application of Imidazole and silixol reduced the incidence of Blast.

Screening for high temperature tolerance in rice genotypes

Polyhouse supported by metal frame had resulted in an increase in temperature inside the tunnel. The order of yield was IET 23356 > IET 23354 > PA 6129 > IET 23947 > IET 23339 > Somali under elevated temperature indicating heat tolerance. The grain yield recorded under elevated temperature showed strong association with GMP, YI, MP, K2STI and HIS and these indices are useful in screening for high temperature tolerance. Based on stability analysis, IET23356, 23947,IET 23957 and Somali can be selected as high yielding genotypes under heat stress condition.

Evaluation of Radiation and Nitrogen use efficient promising rice genotypes

Improving NUE will ensure lower level of N fertilizer usage thus reducing environmental contamination. Under National Innovative climate resilient project (NICRA) one of the major activities undertaken was developing nitrogen use efficient rice varieties. The performance of the 12 entries was evaluated

based on grain yield recorded under low N treatment. With the exception of Varadhan x BPT 5204/6 (G1) all the entries included in this trial showed reduction in grain yield under 50 kg N ha^{-1} (T2). In Sampada x Jaya/2 (G3), BPT-5204, Sampada and Varadhan x MTU1010/2 (G5) the reduction was <5% over recommended N level. These genotypes which showed <5% reduction in grain yield have higher N use efficiency. Based on the YSi value the genotypes Varadhan x BPT 5204/10 (G2),Varadhan x BPT-5204/6 (G2), Sampada x Jaya/3 (G4), Varadhan and Jaya performed well across locations.

Screening of elite rice cultures for drought tolerance:

The study was conducted with 51 rice cultivars to identify drought tolerance traits at Pattambi and Rewa under rainfed and irrigated conditions.. Based on yield under rainfed condition IET 25120, 24692, 25112, 25110, 25129, Tulasi, 25103, 25104, 25113 and 25135 performed relatively better at PTB where as at REWA the reduction in grain yield under rainfed condition was <10% in IET 24679, 25134, 25138 and IET 25111. Based on drought tolerance indices the IET 25108, IET24679, Narendra-97, IET 25134, IET25141 and IET 25104 showed drought tolerance. Among the drought indices GMP, HM, DTI, DSI, YSI and K2STI showed strong association with yield under rainfed condition.

Physiological characterization of selected genotypes for multiple abiotic stress Tolerance

IET 23216, Somali, IR 82635-B-B47-1 and IET 24674 were found to posses higher physiological characters for multiple abiotic stress *viz*., salinity, drought, submergence and low temperature. Most of the NICRA lines showed superior performance under multiple abiotic stresses along with checks AC 39416A and Sahabhagidhan.

Crop Protection

Entomology

During *kharif* 2015 seven trials encompassing various aspects of rice Entomology involving 361 experiments (93.3%) were conducted at 39 locations (32 funded + 7 voluntary) in 22 states and one union territory.

Pest Survey Report

Pest surveys undertaken at 29 locations revealed reports of outbreaks of BPH from Sakoli, Rajendranagar and Pantnagar. Caseworm damage to entire crop was observed at Sakoli, Moncompu and Karjat. Outbreak of army worm, *Mythimna separata* was reported at Khudwani.

Monitoring of Entomology Trials

Host plant resistance studies comprised of seven screening experiments involving 1832 entries which included 1612 pre-breeding lines, 119 hybrids and 74 germplasm accessions and 143 check varieties. These entries were evaluated against 12 insect pests in 201 valid tests (47 greenhouse reactions+154 field reactions) and identified 52 entries (2.8% of the tested) as promising against various insect pests. Of these promising materials, 6 entries (11.5%) were under retesting. Four breeding lines *viz*., BPT 2671, CB 05 022, CB 09 123 and CB 12 701 were found promising against planthoppers in 4 tests. In Gall Midge Special Screening trial (GMSS) 79 germplasm accessions and 31 gene pyramided lines *(Gm4 or Gm8 or both.)*were evaluated and Vellaiilankalyan is identified as promising. Field evaluation of 60 entries against rice leaf folder in Leaf Folder Screening Trial (LFST) revealed IET 22155 and RP Bio 4918-142 as promising in 4 and 3 valid tests. In Stem borer screening trial (SBST), 55 entries were evaluated in 16 field tests and eight entries *viz*., JGL 23655, JGL 23824, JGL 23746, IIRR-BIO-SB-3, RP 5893-259-17-13-6-1-B-B-4, JGL 21836, RP 5588-B-215 and IIRR-BIO-SB-9 were promising. Multiple Resistance Screening Trial (MRST) was constituted with 25 entries

evaluated in 12 greenhouse and 39 field tests against 10 insect pests. 10 entries were identified as promising in 7-10 tests of the 51 tests against 3-6 pests. Four entries each in NSN1 and NSN2, IET 25148 in NSN hills and DRRH3 in NHSN were identified as promising.

Insect biotype studies

Evaluation of the gene differentials in Gall midge biotype monitoring trial (GMBT)in one greenhouse and 8 field tests against 5 biotypes and one population of gall midge identified W1263 (*Gm1*), Aganni(*Gm8*) and INRC 3021(*Gm8*) as promising in 7-8 of the 9 tests. Evaluation of the gene differentials through single female progeny testing in GMPM trial revealed Aganni (*Gm8*) as promising at Sakoli and Ragolu. Planthopper special screening trial (PHSS) with 16 gene differentials revealed three gene differentials *viz*., T12 (ACC 56989) with *bph7* gene, Rathu Heenati with *Bph3+Bph17* genes and OM 4498 with unknown genetics as promising.

Chemical Control Studies

Insecticide Evaluation Trial (IET) was carried out at 34 locations to evaluate the efficacy of two newer insecticides *viz*., DPX-RAB 55 and flubendiamide plus thiacloprid. Based on the performance flubendiamide plus thiacloprid was at par with the standard check insecticide rynaxypyr against stem borer and leaf folder. DPX-RAB 55 followed by standard check dinotefuran were effective against planthoppers and leafhoppers. Rynaxypyr treatment yielded the highest followed by DPX-RAB 55.

Botanical Insecticide Evaluation Trial (BIET) was carried out at 24 locations to evaluate the efficacy of four commercial formulations and neem oil along with recommended insecticide, dinotefuran against major insect pests of rice. The botanicals-Neemazal and Nimbecidine were found effective against stem borer. In case of gall midge all the treatments showed efficacy in reducing the damage. Against sucking pests-BPH, WBPH and GLH, the insecticide, dinotefuran was the most effective treatment in reducing the populations of the hoppers while botanicals were moderately effective. Results on effect of botanicals on natural enemies revealed that treatments were relatively safer to mirid bug than spiders. Highest grain yield of 4716 kg/ha was recorded in Neem oil followed by Neem azal with 4604 kg/ha.

Ecological studies

Effect of planting dates on insect pest incidence (EPDP) trial was conducted at 20 locations during *kharif* 2015. In general, the pest incidence was moderate to severe across locations and relatively high in late planting. Dead heart damage was low at 15 locations in all the plantings while it was high in normal planting. Gall midge damage was observed at 7 locations with highest damage in late planting. Of the 16 locations at which leaf folder incidence was observed, highest damage was recorded in late planting. Highest population of BPH (16/ hill) and WBPH (20/ hill) was recorded in late planting. For the first time, *Pyrilla* sp was observed in normal planting at New Delhi. Insect Pest Incidence in Selective Mechanization Trial (PISMT) showed the incidence of stem borer, leaf folder, gall midge, BPH, WBPH, GLH, whorl maggot and hispa in all the treatments. Across all the locations, grain yield was significantly high in drum seeding except at Aduthurai, wherein SMSRI recorded highest grain yield (6990 kg/ha).

Biocontrol and Biodiversity

Monitoring of species composition of stem borer revealed the presence of four species distributed over 15 locations with YSB being dominant in 12 locations. *Tetrastichus schoenobii* was the dominant egg parasitoid followed by Trichogramma and Telenomus sp. *Anagrus*, *Oligosita* and *Gonatocerus* were the parasitoids reported on hopper eggs. Ecological engineering for pest management (EEPM) taken up in four locations showed that combination of organic manuring, alleyways, spacing and water management and growing of flowering plants on bunds increased the natural enemy populations like mirids, spiders and coccinellids and also enhanced egg parasitisation. Bio intensive pest management trial (BIPM) initiated in four locations showed that the pest incidence was either reduced in (BIPM) or on par compared to Farmers' practice. There was also an increase in natural enemy population in the BIPM plots.

Integrated Pest Management

Yield loss estimation trial (YLET) was carried out at 7 locations for stem borer, leaf folder and hispa. Regression analysis revealed a significant negative relationship between per cent white ears and grain yield at Pantnagar, Ludhiana, Chinsurah and Raipur. Pooled analysis of white ears vs natural logarithm of grain yield revealed a significant regression ($R^2 = 0.466$; $P \leq 0.0001$; n = 511). Every 10% increase in white ears resulted in 3.09 g reduction in grain yield per hill. Based on this model, per cent reduction in grain yield was predicted for varying levels of white ear damage.

Demonstration of IPM

Integrated Pest Management special(IPMs) was conducted at 10 locations during *Kharif* 2015 with an objective of managing all pests including insects, diseases and weeds in a holistic way in farmers' fields involving them in a participatory mode. Adoption of IPM practices reduced the incidence of silver shoots at Jagdalpur (14.47% SS), Pattambi (9.97% SS) and Titabar (0.63%SS). Similarly BPH population was low in IPM plots at Gangavathi (6 to 13.8/ hill and Maruteru (18.8/ hill) and white ears were low in IPM (3.42%) than in farmer practices (18.50%) at Chinsurah and Raipur (3.49% WE in IPM & 22.2% WE in FP).

Population dynamics of major insect pests

Light trap data received from 30 centers during the year 2015 revealed yellow stem borer as most wide spread at 28 centers with the highest peak catch (1672 females + 772 males) occurring during 20th week at Maruteru followed by Aduthurai (2122 females) during 4th week and Pattambi (1623 females) during 3rd week. Brown planthopper was reported from 26 centers, with maximum peak population (107634 insects/ week) occurring during 34th week at Pattambi followed by Sambalpur (52350 insects/week during 44th week) and Gangavathi (24739 insects/ week during 48th week). Gall midge was reported from 11 centers with a highest peak population of 1907 insects/week during 12th week at Maruteru. Population dynamics of major insect pests assessed through light trap indicated that yellow stem borer and planthoppers continued to be major pests.

Plant Pathology

Host plant resistant studies under five national screening nurseries comprising of 2474 entries of advanced breeding lines and new rice hybrids and germplasm accessions were evaluated for their reactions to major rice diseases at various locations. The promising entries identified against each disease are given in the table.

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

The experiment was conducted at 23 locations. Raminad str-3, Tetep and Tadukan were resistant in most of the locations where as Raminad str-3 was susceptible only at Cuttack and Ponnampet. Tetep was susceptible at Upper Shillong, Almora and Jagdalpur. Tadukan was susceptible at Almora, Ghaghraghat and Upper Shillong. The susceptible checks like HR 12 and CO 39 recorded low disease score at Almora, Ghaghraghat, Gerua, Masodha, Karjat, Pattambi and Sabour. The resistant check Rasi recorded high disease score at Almora, Cuttack, Imphal, Jagdalpur, Malan, Upper Shillong and Umiam. The difference in disease reaction score of susceptible and resistant checks reveals that there is a shift in the blast pathogen population.

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

The trial consisting of 22 near isogenic lines with different bacterial blight resistance genes and their combinations was conducted at 26 hot spot locations. Most of the single genes were found susceptible at most of the locations. BB resistance gene *xa13* was found susceptible in 11 locations while *Xa21* was found susceptible in 13 locations. The isolates from Maruteru, Aduthurai, Patna,

Disease	Promising entries in Various Screening Nurseries (NSN1, NSN2, NSNH, NHSN, DSN, GSN)
Leaf blast	IET # 24334, 24104, 25480, 24117, 24816, 24814 and 24846 in NSN-1; 25110, 25047, 25111, 25593, 25617, 25619, 25630, 25567, 25618, 25289, 25232, 24704, 25325, 25328 and 25082 in NSN-2; IET # 24220, 24207, 25160, 25149 and 25161 in NSN-H; IET # 24926, 24920 and 24972 in NHSN; RP2015DN142, RP2015DN180 and RP2015DN173 in DSN and IC # 211168, 75790, 75965, 76001, 76072, 75779, 75988, 17117X, 75789, 75771 and 76073 in GSN.
Neck blast	IET # 23272, 23052 and 24474 in NSN-1; IET # 25662, 25005, 25017, 25036, 25038, 25039, 25631, 25226, 25202, 25272, 25601 and 25441 in NSN-2; IET # 25160, 25165, 24193 and 25145 in NSN-H; IET # 24925, 24980 in NHSN and RP2015DN130, RP2015DN173-1 and RP2015DN180 in DSN
Sheath blight	IET # 23017, 23934, 23895, 23565, 24436, 22637, 243954, 24480 and 23052 in NSN-1; IET # 25223, 24518, 25185, 25227, 24519 and 25196 in NSN-2; IET 25170 and 25157 in NSN-H; IET # 24963, 24926, HRT-MS-20, IHRT-M-55 and IHRT-M-44 in NHSN and CBT-12-132, CBT-05-022, CBT-11-107 and DRR-BL-155-1 in DSN and IC # 216801, 216953, 216958, 216990, 217196 and 217610 in GSN.
Brown spot	IET # 24443, 24263, 24570, 24599, 24391 and 24565 from NSN-1; IET # 24997, 25027 and 25554 in NSN-2; IET # 24993 , 24901, 24928, 24923, 24919, 24926 in NHSN and IBT-BR-218, IBT-BR-96, RP-Patho-12, RP-Patho-11 and IBT-BR-126 in DSN and IC # 211168, 217012, 217091, 217210 and 217196 in GSN.
Sheath rot	IET # 24391 and 24789 in NSN-1; 25492, 25340, 24527, 25018, 25086, 24489 and 25427 in NSN-2
Bacterial leaf blight	IET # 24565, 25678 and 24440 in NSN-1; IET # 25235, 25245, 25606, 25207, 25458, 25451 and 25356 in NSN-2; IET # 24201, 25149, 25155 and 25156 in NSN-H; IET # 24892, 24888, 24891, 24982, 24936, 24931 and 24993 in NHSN and RP2015DN198, PJTSAU-BR-16, PJTSAU-BR-126, RP2015DN180, PJTSAU-BR-14, PJTSAU-BR-21 and RP2015 DN128 in DSN and IC # 76015, 76051 and 76052 in GSN.
Rice tungro disease	IET # 24028, 24570, 23656, 24747 and 23272 in NSN-1; IET # 25025, 25536 and 25543 in NSN- 2; 24949, 24959, 24975 and 24888 in NSN-H; VL-31802-14, KNM-1723, RP-Patho-10, VL-31743-13 and VL-31430-9 in DSN.
Multiple disease resistance (a minimum of 2 Diseases)	IET # 23052 (neck blast and sheath rot), 24395 (sheath blight and BLB) and 24570 (brown spot and rice tungro disease) in NSN-1, IET# 24519 (sheath blight, BLB and leaf scald) in NSN-2; IET # 25160 (leaf blast, neck blast and sheath blight) in NSN-H; IET # 24926 (leaf blast, sheath blight and brown spot) and 24982 (leaf blast, BLB and glume discoloration) in NHSN; RP2015DN180 (leaf blast, neck blast, glume discoloration and bacterial leaf blight), RP2015DN130 (neck blast and sheath blight), RP2015DN173 and RP2015DN180 (leaf blast and neck blast), RP2015DN198 (sheath blight and bacterial leaf blight), IBT-BR-126 and IBT-BR-96 (brown spot and glume discoloration) in DSN and IC # 211168 (blast and brown spot) and 217196 (brown spot and sheath blight) in GSN.

Navsari, New Delhi, Coimbatore, Kaul and Chiplima were highly virulent and isolates from Aduthurai, Maruteru, Patna, Navsari, Kaul, Raipur and IIRR showed moderate to high virulence on IRBB 55 possessing *xa13* and *Xa21*. These data indicate a major shift of pathogen virulence profile at Aduthurai, Maruteru, Patna, Navsari, Kaul and Raipur. All the less virulent strains grouped together while the virulent and highly virulent made a separate cluster.

Disease Observation Nursery

The trial was conducted at 8 locations *viz*., Chinsurah, Malan, Mandya, Maruteru, Moncompu, Navsari, Pusa and Raipur. Terminal disease severity of leaf blast, neck blast, brown spot, sheath blight, sheath rot, false smut and bacterial leaf blight diseases were recorded. Results revealed that delayed sowing/planting enhanced the disease development of leaf and neck blast, brown spot, sheath rot, false smut and bacterial leaf blight, whereas early sowing/planting favoured sheath blight disease development across the locations.

Monitoring of Pathology Trials

Evaluation of new and commercially available fungicides for location specific diseases

The formulations *viz.*, ICF-110 (tricyclazole 45% + hexaconazole 10% WG), Merger (tricyclazole 18% + mancozeb 62% WP), Companion (mancozeb 63% WP + carbendazim 12% WP), tricyclazole 75% WP, hexaconazole 5% EC and mancozeb 75% WP and carbendazim 50% WP were evaluated against leaf blast, neck blast, node blast, sheath blight, sheath rot, brown spot, grain discoloration leaf scald and stem rot. ICF-110 (tricyclazole 45% + hexaconazole 10% WG) was found significantly effective in reducing disease severity and incidence of neck blast, sheath blight and sheath rot. Merger (tricyclazole 18%+ mancozeb 62% WP) @ 2.5 g/l significantly reduced the severity and incidence of most of the diseases in varied test locations.

Integrated disease Management

Adoption of integrated disease management practices (like application of organic amendments, adoption of different cultural practices, balanced application of fertilizers and need based application of fungicides) reduced the intensity of diseases like leaf and neck blast at Mandya and sheath blight at Chiplima, Maruteru, Moncompu, Pattambi and Pantnagar. IDM practices like application of balanced dose of fertilizers and copper oxychloride significantly reduced BLB intensity at Faizabad, Moncompu, Maruteru and Raipur. Overall results reveal that the adoption of suitable disease management practices, can certainly reduce the disease severity and incidence and thereby significantly increase the grain yield across the cultivars.

Integrated pest management (special trial): Results from the special IPM trial indicated that the incidence of all the diseases observed *viz.*, leaf blast (LB), neck blast (NB), bacterial leaf blight (BLB), sheath blight (ShB), brown spot (BS) and sheath rot (ShR) was less in the plots where IPM was followed when compared to the plots with farmers practices.

Screening trial on false smut (special trial): Among the three different sowing dates, high disease infection of false smut was observed at Ludhiana (23.93% of IP; 1.04% of IS) and Titabar (18.46% of IP; 15.06% of IS) when the rice crop was sown on 1st and 2nd week of June, 2015 respectively. Disease infection was high at Kaul and Sabour, when the crop was sown on last week of June, 2015. Among the hybrids tested, KRH 2 was highly susceptible across the locations followed by DRRH 3 and US 312. Though variation was observed in sowing period across the locations, disease incidence was more only when the booting/flowering stage of the rice crop, coincided with low temperature.

Production Oriented Survey (POS)

Production oriented survey was conducted in 18 states of India involving 20 AICRIP centres. Hybrid rice cultivation is gradually spreading to most of the Indian States and has occupied a large area in states like Chhattishgarh, Himachal Pradesh, Maharahtra, Uttar Pradesh and Haryana. Diseases like blast, neck blast, brown spot, sheath blight, sheath rot, false smut and bacterial blight were wide spread in low to moderate intensity throughout the country. Bakanae has become a problem in states like Haryana, Himachal Pradesh, Jammu and Kashmir and Punjab. A new disease called crown rot caused by *Erwinia chrysanthemi* was reported from different districts of Telangana. Stem rot is becoming a problem in Haryana and Telangana. Among different insect pests, stem borer, leaf folder and BPH were wide spread throughout India. Moderate to severe incidence of black bug from Kerala and blue beetle from Maharashtra. Major 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

Frontline Demonstrations

A cafeteria of rice technologies were demonstrated in 449 hectare area covering 19 states and five major rice ecosystems of the country. Out of 449 FLDs reported, about 62% were conducted in irrigated rice ecosystem; whereas about 16.7% of FLDs were conducted in rainfed uplands. More than 10 % of FLDs were organized in shallow lowlands and 2.23% in hill ecologies. About

5.68% of the FLDs were conducted in problem soils. The mean yield advantage was the highest in Rainfed uplands (39.38 %). Similarly in case of irrigated ecologies (20.77%), Hill ecologies (36%), Shallow lowlands (21.28 %) and problem soils (29.81%), 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 recorded mean yield of 5.27 t/ha where as in Shallow lowlands FLD technologies recorded an average yield of 4.80 t/ha. Average demonstration yields in rainfed uplands was 3.67 t/ha. This shows the attainable yield potential in the farmers' fields, which needs to be considered for planning the extension programs in these regions. In total 39 technologies have been identified from 18 states.

Field day at Hassan, Karnataka

These technologies will help either in withstanding abiotic stresses (such as submergence –Swarna sub-1, Samba Sub-1), improving the field productivity (KRH-4, Palam basmati, Rice ADT 50, HUR-105, HUR 297 under INM, Shiats Dhan -2), solving the local problems (Problem soil management), labour scarcity (mechanical transplanting), early harvest for facilitating rabi crops (CO 51 , CR Dhan 40 and Sahbhagi dhan), better basmati options for farmers (Pusa 1121 and Palam Basmati), consumer preferences (RC Maniphou-10), replacing the popular varieties (CO 51) etc.

Achievements - Lead Research

- Crop Improvement
  - Plant Breeding
  - Hybrid Rice
  - Biotechnology
  - National Professor Project
- Crop Production
  - Agronomy
  - Soil Science
  - Crop Physiology
  - Agricultural Engineering
- Crop protection
  - Entomology
  - Plant Pathology
- Transfer of Technology
- Completion Reports of Externally Funded Projects

Lead Research

Plant Breeding

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

Evaluated one hundred and two rice genotypes for iron and zinc content. In brown rice Zinc content ranged from 11.6ppm to 26.7ppm while iron ranged from 6.9 ppm to 13.2ppm. The top three genotypes with high Zn content were IC 86234 (26.7ppm), IC 145643 (25.3ppm) and IC 137415 (25ppm). Six genes namely *OSNRAMP7* on chromosome 12, *OSYSL 8* on chromosome 4, *OsZIP1* on chromosome 3, *OsZIP8* on chromosome 5, *OSYS18* on chromosome 8 and *OsYSL* 9 on chromosome 4 were associated with high zinc content of brown and polished rice grains.

Developed IET 23832, the first high zinc rice variety with mean zinc content of 22.0 ppm in polished rice without compromising yield . It is a medium duration (125 days) variety with long slender grains, suitable for irrigated conditions. It was recommended for the states of Tamil Nadu, Andhra Pradesh and Karnataka with mean yield of 5.2 t/ha. It has good cooking quality. The variety is a proof of concept for bio-fortification.

Fig. DRR Dhan 45, a high zinc rice variety

GEY/CI/BR/9: Breeding varieties for Boro areas

Eight F_6 populations from 8 crosses were grown at IIRR farm during *Rabi* 2015-16. Segregating populations of 49 crosses were advanced to F_3 generation following bulk selection for evaluation and selection at ideal boro locations. In association with RAU, Pusa seventeen promising lines were selected in F_6 generation having high yield potential (> 5t/ha yield) and cold tolerance at seedling stage during boro. Three lines RP 5434-RAU 26-4, RP 5433-RAU-27-17 and RP 5433-RAU-19-2 having yield advantage of > 5% over the best check in the station trial were identified for nomination to IVT-Boro. From the F_3 bulks sent to Pusa centre , two hundred and twelve single plant selections (F_4) were made from 51 progenies.

F_4 populations from 12 crosses developed at IIRR, Hyderabad have been evaluated at ideal locations *i.e.,* Chinsurah, Pusa, Karimgunj & Titabar. Selections were made based on seedling growth at low temperature and simultaneously showing low sterility at flowering and grain filling at high temperatures. One hundred and fifteen germplasm accessions were evaluated in *Rabi* 2015. The germplasm accessions found tolerant to cold stress were selected.

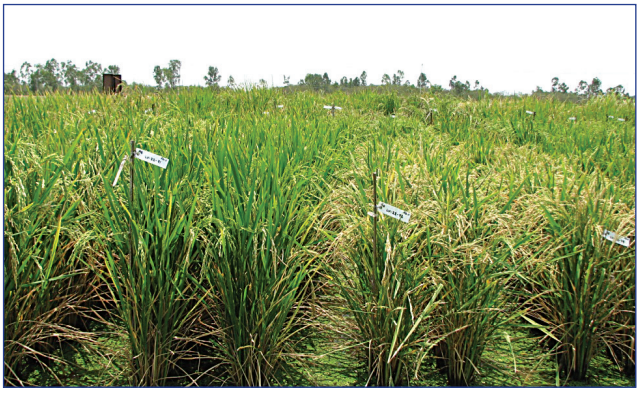


Fig. Advanced generation Boro lines at IIRR Farm

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

Thirty two new designed rice lines called as future generation rice (FGR) along with four checks *viz*. Jaya, NDR359, Swarna and Dhanrasi were evaluated. The yield of the test entries ranged from 5.4 to 7.3t/ha. The checks yield

ranged from 4.8 to 5.7t/ha. Five lines showed significantly higher yield than the best check Dhanrasi with yield of 6.5 to 7.3t/ha and yield advantage of 14 to 28%.

Fig. Future Generation Rice lines

Forty six BC_1F_4 populations derived from *indica* and tropical *japonica* lines with BB, blast and BPH resistance genes were evaluated and as many as 56 single plant selections were made while 121 single plants were selected from 9 crosses in F_5 and F_6 generation. In station trial 39 lines and 4 checks were evaluated in two replications. Considering yield and phenotypic index flowering duration and grain type 16 lines yielded significantly higher than the best check with yield of 6.0 to 6.8t/ha. The BC_4F_2 population of Swarna/ *O.nivara* were screened for BPH resistance. The esults indicated that trait is controlled by two major genes. During *kharif* 2015, three lines (RP5893-B-B-B-B-382, RP5893-B-B-B-B-259 and RP5893-B-B-B-B-181) derived from Swarna X *O.longistaminata* were identified as promising for stem borer tolerance at seven locations in SBST trial and line RP5893-B-B-B-B-382 was found to have high grain yield despite high damage. Whereas, RP5893-B-B-B-B-181showed low damage less than 5% dead hearts. In multi-location screening trial, disease screening nursery lines derived from the cross Jarava/ RPbio226 showed multiple resistance to blast, neckblast, RTD, BLB, BS, sheath rot and sheath blight (Table).

Table: Multiple resistant/tolerant cultures derived from the cross Jarava/ RP Bio 226 with disease score in 0-9 scale

Entry	Blast	BS	Shr	Neck blast	Shbl	RTD	BB
RP2015 DN128	3.7	5.3	4.9	3.6	5.9	3.8	4.4
RP2015 DN104	3.5	4.9	6.0	3.7	6.2	3.8	4.7
RP2015 DN198	3.8	4.7	4.5	5.0	5.2	4.5	3.9
RP2015 DN175	3.8	4.5	4.6	3.3	5.4	3.5	4.6
RP2015 DN180	3.2	4.6	3.5	2.9	5.6	2.5	4.1
RP2015 DN142	3.4	4.3	5.3	3.7	5.6	4.0	4.7
RP2015 DN173-1	3.6	4.5	5.5	2.7	7.2	2.8	5.6
RP2015 DN185	3.7	5.2	6.5	3.7	5.9	3.0	4.9
RP2015 DN130	4.2	5.5	4.4	2.3	5.1	3.5	5.4
TN1	5.6	5.1	5.0	5.4	7.0	4.6	7.4
RPBio226	5.7	4.2	6.8	4.6	6.0	4.4	4.4
Tetep	3.3	4.4	6.4	2.1	5.2	4.0	5.5
Vikramarya	5.5	5.5	6.5	4.6	4.5	3.2	6.4
HR12	6.5	-	-	-	-	-	-

Two QTLs *qDTY2.1* and *qDTY3.1* along with *qSub1* were introgressed in the background of Samba Mahsuri following marker aided selection with financial support from DBT. Under multi-location testing in AICRIP, two lines IET25670 and IET25671 showed 67.3 and 128% higher yield than Samba Mahsuri under drought at reproductive stage and 149.89 and 93.58% higher under submergence of 15 days and was promoted for final year of testing. The QTLs qKSM1.1 qNa/ *KSH 1.1* and *qSSISFH8.1* for salt tolerance at reproductive stage were introgressed from CSR27 into Samba Mahsuri. The lines were evaluated across multi-locations and the results validated that these QTLs are effective at reproductive stage of tolerance. Three entries (IET 25375,

IET25388 and IET25059) showed more than 5% yield advantage over best check and promoted to advanced trial of ALISTVT and CSTVT.

Identified 3 QTLs, *qYLD6.1*, *qYLD11.1* and *qYLD11.2* for yield; three QTLs *qPNCT 1.1, qPNCT 1.2* and *qPNC6.1* for panicle number and two QTLs *qBMCT1.1* and *qBMCT 6.1* for biomass and QTLs for salt tolerance at reproductive stage *qSTR12.1* for Na/K ratio *qSNK12.1* for yield under salinity *qYLSD12.1* and for biomass *qBMST 10.1* were identified from Jarava.

DRR Dhan 46 (RP 5333-41-2-3) with 85 days of flowering duration and yield advantage of 22.7% over Sahbhagi Dhan, was released for the states of Bihar, Madhya Pradesh and Maharashtra.

Fig. DRR dhan 46

Chinsurah Nona Dhan 2: developed by introgressing salt tolerance traits from wild species *O. nivara,* was released for coastal saline areas in West Bengal.

Tripura Kharadhan 1 and Tripura Kharadhan 2**,** the mid early duration varieties with 3.0 - 4.0 t/ha yield under moderate drought and 1.5 to 2.0 t/ha yield under severe drought and long slender grains were released for Tripura as drought tolerant varieties.

IET 23356 and IET 23345 were found to be drought and heat tolerant respectively.

GEY/CI/BR/14: Breeding rice for enhanced phosphorus use efficiency

Ninety genotypes consisting of 40 Green Super Rice entries, popular varieties, elite lines, hybrids and N22 mutants were screened under graded level of Phosphorus (0, 20, 40, and 60 kg/ha) during *Kharif* 2015. The test entries *viz.*, Vikas, Swarna, NDR 359, Rasi and several GSR lines performed better under low P situation and majority have recorded good response with increasing dose of phosphorus. Nine hundred and sixty five progenies of F_6 generation belonging to 10 crosses were evaluated in 2-rows under suboptimal level of soil phosphorus and more than 600 promising plants were selected for preliminary yield assessment. Progenies of 136 selected based on per se performance under low P condition were evaluated under well managed conditions and more than 50 promising plant were selected for yield assessment. All those selected plants were genotyped for presence of *Pup1* and for *Xa* genes also wherein RPBio 226 was used as recurrent parent and positive plants were assessed for background recovery. The plants possessing *Pup1* and more than 85% background genome was evaluated under low P plots to assess their tolerance level and as expected the plants carrying *Pup1* found to have better adaptation under low P situation than their recurrent parents.

GEY/CI/BR/16: Breeding high yielding rice varieties for resistance to planthoppers

Forty six crosses were effected involving high yielding varieties such as Swarna, Samba Mahsuri, NDR 359 and NLR 34449 crossed with 8 donors for resistance to planthoppers. A set of 1200 single plant selections in 16 F_2 populations, 160 single plant selections in 15 crosses of F_3 and F_4 generations and 60 progenies from F_5 and F_6 generation were made considering yield, duration and grain type.

Screened 50 breeding lines (F_6-F_7) derived from 9 crosses at hot spot centre, Maruteru for resistance to plathoppers during *Rabi*, 2015 (Fig). Six of them derived from four crosses, Swarna/ IR 71033-62-15-B, RP bio 226/Ptb 33, IR 64/ACC 2190 and RP bio 226/MTU1064 were selected which showed field resistance (Damage score: 3) to mixed population of planthoppers. For confirming the field tolerance, the material was screened in greenhouse. Only two lines showed BPH resistance (DS: 3). One of them derived from the cross IR 64/ACC 2190 displayed resistance both in field and green house.

Evaluated 15 BPH resistant lines in station yield trials along with checks NDR 359, Jaya and Swarna during *Kharif*, 2015. Six promising

medium to late duration lines were selected namely RP 5440-190-9-8-6-1, RP 5177- 450-10-5-3, RP 4926-352-99-76-23-18, RP 5163-102-3-5-2-2, RP 5709- -340-25-5-1 and RP 5938-123-10-5-1 with 5 to 5.5 t/ha yield potential over the best check. They were nominated to AICRIP trials of 2016.

IET 24395 derived from the cross MTU 1075/ MTU 1010 was found to be superior in West Bengal (5.6 t/ha) in zone 3 and Maharashtra (4.7 t/ha) in zone 6 over the best varietal and hybrid checks and promoted to AVT-2-Late trial to be conducted during 2016.

Fig. Field screening of elite lines at hot spot for reaction to planthoppers

GEY/CI/ BR/18: Investigation into starch properties and chalkiness on rice cooking quality

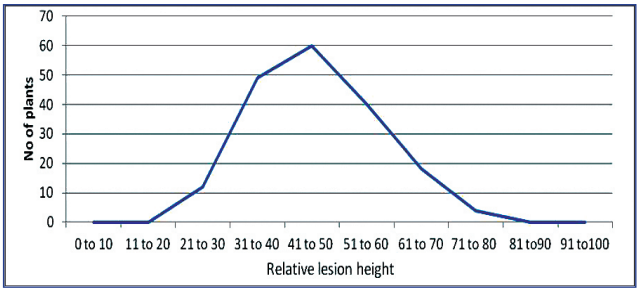
Analysis of chalkiness in 20 rice varieties cultivated under high and normal temperatures indicated that amylose decreases while amylopectin increases with the increase in chalky area percentage. At high temperature, variation in grain appearance itself was noticed among the varieties *i.e.*, all grains were milky white in few varieties (Khudharidhan and Varadhan), normal grains were absent in some other varieties (Sita, Pantdhan 4 and Varadhan) while three forms of grain were seen in remaining varieties (Suraj and S-40). Further, grain density was less in high temperature cultivated varieties which may lead to poor HRR.

GEY/CI/BR/19: Identification of donors and gene(s) for developing resistance to sheath blight disease in rice

Crosses were made between BPT 5204, RP Bio 226, MTU 1010 and Swarna as susceptible parents and Phougak, Ngonolasha, Wazuhophek, RP 2068-18-3-5, Gumdhan, ARC 10531 and Tetep as tolerant parents. F_2 seed of eleven crosses *viz.*, BPT 5204 / Phougak, BPT 5204 / ARC 10531, RP Bio 226 / Tetep, RP Bio 226 / Phougak, RP Bio 226 / Ngonolasha, RP Bio 226 / Wazuhophek, RP Bio 226 / Gumdhan, MTU 1010 / Phougak, MTU 1010 / Tetep, MTU 1010 / Wazuhophek and Swarna / ARC 10531 were generated for screening against sheath blight.

Single plant selections were made in F_2 with superior plant type and tolerance to sheath blight from thirteen different F_2 crosses *viz.*, IR 64/Kenyo, MTU 1010/Kezihum, Swarna/ Meghalaya Lefara, Swarna/Senebumap, MTU 1010/GSR-312, Chittimutyalu/Sapet Maso, Swarna/Phougak, Swarna/Jasmine 85, Swarna/ Sapet Maso, Swarna/Medong Tssok, Swarna/ Kenyo, Swarna/Tetep and BPT 5204/ARC 10531 for further selection.

Recombinant Inbred Lines (n= 183) from the cross of TN1 and RP 2068-18-3-5 were used for identification of QTLs for resistance to sheath blight. None of the RILs had RLH in the range of 0-20 % indicating no resistance reaction for sheath blight. Twelve RILs have shown moderate resistance to the disease with RLH in the range of 21-30% (Fig.)



Five hundred SSRs were used to assess polymorphism between TN1 and RP 2068-18-3-5 of which 52 SSRs covering 12 chromosomes were found polymorphic. Linkage analysis using QTL cartographer revealed a single minor QTL on chromosome 5 which explained 7.8 % PV.

GEQ/CI/BR/20: Development of value added rice based products for different uses

Fifteen released varieties and 8 landraces were analysed for phytic acid content. Among the released varieties phytic acid content in brown

rice varied from 1.89% to 1.14% with a mean of 1.45%. Highest phytic acid content was found in Sampada (1.89%) followed by BPT-5204 (1.76%) while MTU-1010 (1.18%) and Triguna (1.14%) had lowest phytic acid content. There was a reduction in phytic acid content upon germination. Thirty six hours after germination the average value reduced to 1.50 % in Sampada. Phytic acid content further reduces when the brown rice is polished and it varied from 0.72 % to 0.22%.

Six released varieties were subjected to in vivo GI estimation at Foods and Nutrition, PGRC, PJTSAU, Hyderabad. Twenty five gram equivalent carbohydrate of each rice variety were fed to each of the 6 volunteers. Total carbohydrate content of each variety was estimated by physico-chemical method and then a portion containing 25 gram carbohydrate was given to each volunteer. Two varieties, Dhanrasi and Sampada were found to have reasonably low GI values of 59.3 and 56.8, respectively. Two products namely Tooth pain relief Gel and mosquito repellent lotion were developed utilizing rice bran oil and brown rice extract.

Developed five baked products namely cake, cookies, pie crusts, muffins and doughnuts using Rice Bran Oil spread (RBOS). The products were found superior in terms of acceptability compared with those made from Vanaspathi Ghee and rice bran oil. Fatty acid composition of three popular products namely Cookies, Muffins and Cake made from RBOS, RBO and Vanaspathi Ghee, were compared. Products containing Vanaspathi Ghee have very high content of TRANS FATS (cookies, 2.22 g; Muffins, 5.07 g; and Cake, 3.01 g/ 100g of the products) compared to those of RBO (cookies, 0.285g; Muffins, 0.853 g; and Cake, 0.69 g/ 100g of the products) and RBOS (cookies, 0.707g; Muffins, 1.44 g; and Cake, 0.67 g/ 100g of the products).

GEQ/CI/BR/21: Breeding for Quality Improvement of Rice through Conventional and Molecular Approaches

A total of 184 germplasm lines of Manipur were analysed for quality characteristics namely Kernel dimensions, ASV, Amylose content and Gel consistency. The amylose content varied from < 3% to 31.41%; ASV varied from 3 to 7; GC varied from 20 mm to 100 mm. In most of the genotypes, very low amylose (<5%) is found to be associated with soft GC (100 mm). Quality analysis of 779 progenies indicated good kernel elongation after cooking (16 mm to 20 mm) in 293 lines (Fig). These lines are derived from the crosses Vasumati/IET 19492), IET 18033/ IET 18004, Pusa 1121/IET 18990, IET 18004/ IET 18990, Vasumati/IET 18004, Vasumati/IET 19492, Sugandhamati/IET 19492, IET 18033/ IET 18004 and IET 18033/ IET 19492.

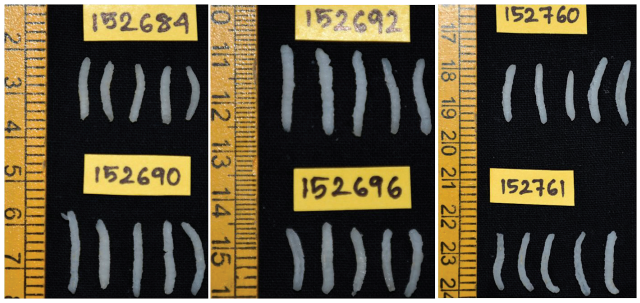


Fig : Promising lines with high KLAC

In an effort to introgress Blast and BLB genes into basmati varieties of Vasumati, Sugandhamati, IET 18006 and Vallabh basmati, 500 BC_2F_3 lines were generated. One ninety two out of 500 lines showed resistant reaction with scores 1-3 against blast in Uniform blast nurseries at IIRR. The same introgression lines were screened for BLB resistance against DX-020 isolate collected from IIRR farm. A set of 450 plants scored 1 and 133 with score 3, on 0-9 scale indicating resistance.

GEY/CI/ BR/22: Identification and introgression of agronomically important traits from wild species of rice

Forty seven crosses were made utilizing various *Oryza rufipogon* accessions as donors and Swarna and Samba mahsuri as recurrent parents.

Thirty nine accessions of land races/wild rices belonging to North eastern region were screened in Uniform Blast Nursery. Three accessions (Punshi, Moirang-Phou-Khokngangbi and Thangjing-Phou) showed resistance reaction with score 3.

Fig. Single interspecific F_1 plant derived from *Oryza sativa* cv. Swarna and *O. rufipogon*

GEY/CI/BR/23: Breeding high yielding rice lines possessing multiple biotic stress resistance/tolerance through conventional and molecular approaches

To screen rice germplasm for allelic variation with respect to major yield enhancing loci (*viz., Gn1a, SCM2, etc)* through phenotyping and functional marker-based analysis. A set of 148 rice germplasm were phenotyped for yield associated traits (*viz.*, grain number, panicle architecture, strong culm, grain weight, grain filling *etc.*). The molecular markers specific for the selected yield enhancing genes such as Gn1a, SCM2, *etc.* were designed and will be utilized for genotyping the selected germplasm lines.

Hybrid Rice

GEY/CI/HY/7: Exploitation of inter sub-specific heterosis in rice (*Oryza sativa* L.)

DRRH-92 successfully completed two years of testing in AICRIP trials (IHRT-MS). It is a high yielding hybrid with MS grain type having BPT 5204 grain type quality traits and medium duration. It has shown yield superiority over the checks on in Zone III & VI (Table).

In the hybrid rice station trial during *Kharif* 2015, 45 hybrid combinations were evaluated and 10 promising ones *viz.*, APMS 6A/TCP-583, APMS 6A/TCP-647, IR 68897A/TCP-643, APMS 6A/19-18R, IR 79156 A/19-18R, APMS 6A/7-65R, APMS 6A/PRP-78, IR 79156 A/ PRP 78, APMS 6A/PRP 123 and IR 79156 A/AR 9-21R were identified.

In Test Cross Nursery (TCN) a total of 415 test crosses were made during 2015 and among the 250 test crosses evaluated, 25 test crosses were found promising.

Forty promising genotypes were identified from the available breeding materials and 35 crosses were attempted between the promising lines. Four hundred eighty single plant selections were made from the breeding materials in various segregating generations.

Table : Performance of DRRH-92 in IHRT-MS trial (*Kharif* 2015)

Hybrid & Checks	DFF	Grain Type	Mean Yield (kg/ha)					Remarks
			Overall	Zone III	Zone V	Zone VI	Zone VII	
DRRH-92 (IET 24159)	103	MS	5478 (24)	5563 [9] (18)	6017 (16)	5000 [12] (26)	5480 (31)	Promoted to IHRT-MS 3rd year testing
DRRH-3 (NCH)	103	MS	5558	5104	6758	4460	6134	
BPT 5204 (NCV)	110	MS	4434	4718	5200	3966	4181	

IIRRH-105 has performed well in IHRT-M trial, and shown the requisite yield superiority over checks in Zone III and is promoted for next stage of evaluation in AICRIP trials (Table).

Table : Performance of IIRRH-105 in IHRT-MS trial (*Kharif* 2015)

Hybrid & Checks	DFF	Grain Type	Mean Yield (kg/ha)							Remarks
			Over all	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	
IIRRH-105 (IET 24971)	96	MS	5458	5128	6202 [8] (12)	3730	6792 (18)	5377	4771	Promoted to AVT-1-IM
US-312 (NCH-ME)	98	MS	5616	5532	5758	4748	6712	5440	5346	
MTU-1010 (NCV-ME)	93	LS	4947	4186	5089	3920	5749	4754	5106	
ZCV	98	SB	5064	6028	5535	3240	5163	5240	4492	

In the biotic & abiotic resistance breeding for parental line improvement, two popular maintainer lines *viz*., IR58025B and APMS6B were fortified with BB (*Xa21*) and blast (*Pi2*) resistance genes; attempts are being made to transfer the major drought tolerance QTL, *qDTY12.1* and the low P tolerant QTL into the genetic background of the improved version of the elite restorer line, RPHR1005R, possessing *Xa21* + *Pi54*.

Nucleus seed production of parental lines of institute's released hybrids *viz*., DRRH-2 and DRRH-3 was taken up and produced seeds of IR 68897A-50 kg, IR 68897B-70 kg, DR 714-1-2R - 30 kg, APMS-A-10 kg, APMS-6B-20 kg and RPHR-1005-15 kg.

Fig. Panicles with increased grain number from the IJ derived lines

GEY/CI/ HY/10: Development of parental lines and hybrids with tolerance to salinity and suitability to aerobic situations

One eighty BC2F3 lines of cross APMS6B/FL478 were genotyped for presence of SALTOL and phenotyped for seedling stage salinity.

Four hundred and twenty one best performing F_8 lines were screened for grain yield & its contributing traits under aerobic and irrigated conditions and also screened for blast-UBN. Among them, 120 found resistant to blast (1-3 scores) and are included in 3 row pedigree and also screened for bacterial blight, wherein 7 lines were found resistant.

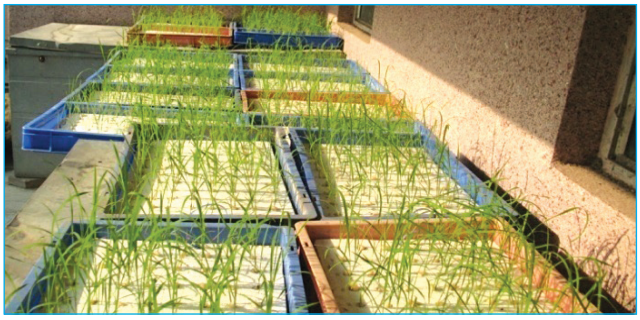


Fig. Screening of BC_2F_3 lines for seedling stage salt tolerance

10 best lines based on yield traits were raised in replicated yield trial for nominations to AICRIP 2016. 29 lines derived from Shabhagidhan/KMR3R having *qDTY12.1* and *Rf4* were raised in 3 row pedigree for further phenotypic evaluation and 32 lines derived from MTU1010/KMR3 and Azucena/RPHR1005 crosses were evaluated in 2 row pedigree for fertility restoration, drought tolerance and other yield traits. Five genotypes ie. three upland (Sabita, Nagina 22 and Vandana) and two lowland (MTU1010 and Swarna) cultivars were screened for seedling vigor related traits. Sabita exhibited best performance followed by vandana and may be a valuable resource for development of genotypes that possess high seedling vigour. Five new restorer lines *viz*., AR19-42, AR19-18, AR7-65, AR7-75 and AR9-21 developed utilizing KMR3R with Shabhagidhan and MTU1010 were evaluated both in irrigated and aerobic conditions and promising combinations will be utilized in development of hybrids ensuing *kharif* 2016. Total 90 (*Kharif* 2015) and 100 (*Rabi* 2016) aerobic lines were test crossed, 70 F_1s were obtained and evaluated in *Rabi* 2016. Three lines derived from MTU1010/KMR3R were used in station trial with five CMS lines. One hybrid in CSTVT trial (IET 24441-IR79156A/50-13-IRRH 102) got promoted to second year of testing in AICRIP 2015.

GEY/CI/ HY/11: Development of CMS line with good agronomic base and out-crossing ability

For the development of CMS lines with good agronomic base and out crossing ability, source nursery (898 entries) was constituted from different sources for effecting the cross and identification

of maintainers in test cross nursery. In test cross nursery, based on morphological observations *viz*., DFF, pollen stain reaction, spikelet fertility (%) and five plants yield on test cross entries (429), identified twenty three maintainers among them some promising maintainers are converting into CMS lines using repeated back cross breeding method and also identified maintainers were included in maintainer nursery for its maintenance, its critical evaluation for different traits and utilization in our further study.

Backcrosses attempted: The promising maintainer lines are used for conversion into new CMS lines development as follows.

Cross Combination	Generation
APMS 6A X ORJ -1130	BC_2 Generation
IR 68897A X ORJ - 1130	BC_2 Generation
APMS 6A X NDR 2109-9-1	BC_3 Generation
Pusa 5A X R-RH2B1-5	BC_4 Generation

Several paired crosses have been generated by utilizing CMS lines *viz*., APMS 6A, IR 68897 A, IR 79156A, CRMS 32A and MNC 1 to 6 with corresponding B lines.

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

To improve the fertility restoration of partial restorers' *viz*., Swarna, Samba Mahsuri and Improved Samba Mahsuri, crosses were generated with KMR3R. The BC_1F_6 generation restorer lines were crossed with four CMS lines *viz*., APMS 6A, CRMS 32A, IR 79156A and IR 68897A and two hundred F_1s were generated to study the fertility restoration and grain yield heterosis. The converted restorers through marker assisted back cross breeding showed 15 to 20 % improved fertility restoration than the partial restorers.

IVT to AVT-1 promotion in the medium duration trial: RP 5933-1-19-R-2 (IET No 25352) (Swrana*1 X IBL 57(Samba Mahsuri /SC5 126-3-4-2) derived from partial restorer improvement programme got promoted to AICRIP AVT-1 medium duration. The IET 25352 registered yield superiority over best check in zone IV with 34.63% and in zone V with 12.18% and ranked third in the trial. In the state of Odisha, it showed 11% yield advantage over best check. New hybrids developed from this project *viz*., IIRRH 111, IIRRH 112 and IIRRH 114 were nominated to AICRIP multi location trials, *Kharif* 2016.

Fig: Improved converted restorers of early, mid-early, medium and late duration

Biotechnology

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

The RIL population of BPT5204/PTB1 was characterized and transgressive variants were identified. Out of the CG based markers surveyed, Gene based primers for sucrose synthase LOC_ Os2g58480 showed polymorphism. On survey of two mapping populations *viz*., Rasi/Vibhava and BPT5204/PTB1, it has shown association with total yield per se. Real time PCR analyses of sucrose synthase LOC_ Os2g58480 showed differential expression

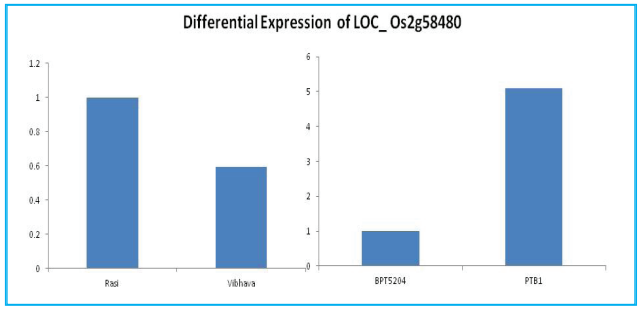
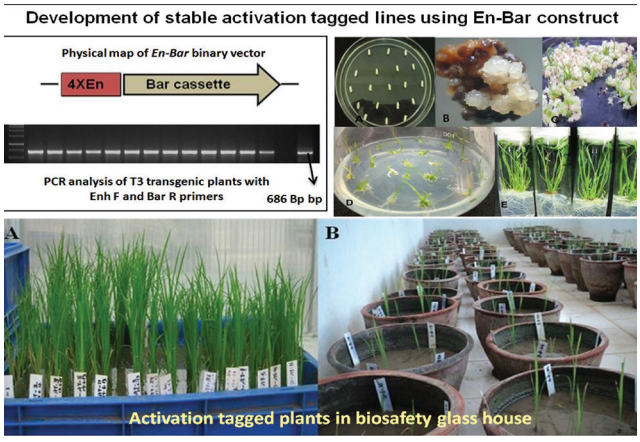


Fig. Expression of Sucros synthase gene

ABR/CI/BT/9: Improvement of rice against biotic and abiotic stresses through transgenic approach

Evaluation of transgenic rice lines IR64 with *Cry1Ac* and BPT 5204 with *DREB1A* : 19 Bt transgenic rice lines with *Cry1Ac* in the

background of IR64 and 40 drought tolerant transgenic lines with *DREB1A* in the background of BPT 5204 (24 lines of DT-33, 10 lines of DT-45 and 6 lines of DT-38) were selected for seed multiplication and analysed for the stability of the transgene integration through PCR. Using gene specific primers a 545 bp fragment, specific to the *Cry1Ac* gene, was amplified in all the plants screened. Similarly using gene specific primers targeting the At *DREB1A* gene a 524 bp fragment, specific to the *DREB1A* gene was amplified in all the plants screened, thus confirming the stability of the transgene even after seven generations. To Further confirm the integration of transgene through flanking sequence analysis in *DREB1A* transgenic lines, Thermal Asymmetric Interlaced Polymerase Chain Reaction (TAIL-PCR) was performed. About 900 bp product of TAIL-PCR was sequenced and analysis of sequencing data revealed the transgene integration locus at 4864K (exactly at 4864591 bp) on chromosome number 6 in the non coding region.



Development and evaluation of activation tagged lines through transgenic approach : Developed tagged lines through Ac-Ds system by using pSQ5 construct. About 2500 T_3 plants were analyzed through PCR, of which 890 plants harboured both Ac-Ds, 600 plants had only Ac and 22 plants had only Ds elements. The Ac-Ds lines were advanced into next generation for further transposition to get stable lines. Using another gene construct, *En-Bar*, developed stable transgenic plants. From these plants about out 1000 T_3 plants were developed from 25 lines and all the plants were analyzed through the PCR using bar gene specific primer. Selected around 15 lines in homozygous condition and evaluated for water use efficiency. Preliminary results of leaf total chlorophyll content (CC), relative water contents (RWC) and proline content of these plants were higher than the control plants.

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

A set of hyper-variable genomic and EST-SSR markers (n = 36) were earlier identified to be highly informative with respect to assessment of parental genetic diversity and prediction of heterosis in the hybrids. Preliminary analysis indicates that the markers have high predictive value (r = 0.65) in rice hybrids. In order to map genomic regions associated with heterosis, a set of five elite B lines were crossed with 24 elite R lines during *Kharif* 2013 and a set of 27 RIL populations have been developed through single-seed descent method. In addition to these RIL populations, a set of doubled haploid lines derived from F_1s from the crosses IR58025B x KMR3R (i.e. parental lines of KRH2), APMS6B x RPHR1005R (i.e. parental liens of DRRH3) are being developed for mapping genomic loci associated with heterosis. To gain some insights into the physiological basis of heterosis in rice hybrids, a set of pot-culture experiments were conducted in completely randomized design with three hybrid checks and two positive and two negative grain yield heterotic rice hybrids along with their parents. The study revealed that (i) α-amylase content of seed, (ii) seedling vigour index, (iii) root length, (iv) root volume, (vi) photosynthetic rate, (vii) transpiration rate values and (viii) stomatal conductance were significantly higher in heterortic hybrid combinations. Further, the (i) total soluble sugars, (ii) starch and (iii) reducing sugars were recorded to be maximum in the hybrids compared to the parents, possibly leading to increased photosynthesis and increase in yield. Through RT-PCR it was identified that PEPC2, NADP-MDH1, PEP CK, SBP, PRK, PEPC2, PEPCK, RUBISCO, NADP-MDH1, SBP, PRK showed higher levels of expression in the heterotic hybrids as compared to their parents.

WA-CMS trait: Earlier, we developed a candidate gene specific marker for WA-CMS trait, named RMS-3-WA352. The marker, which amplifies 247

bp fragment in WA-CMS lines and 226-bp fragment among maintainer lines, was able to accurately identify impurities in seed-lots of WA-CMS lines in commercial seed genetic purity assays. Interestingly, many accessions of Indian wild rice belonging to 'AA' genome were observed to show amplification of WA-CMS specific fragment.

Through a comparative sequence analysis of the putative candidate genes, *viz*., PPR9 and PPR762 (for *Rf4*) and SF21 (for *Rf3*) a set of PCR-based markers capable of distinguishing restorer lines from non-restorers have been developed. Out of a total of six markers developed targeting the PPR9 and PPR762 candidate genes for *Rf4*, a co-dominant marker, named RMS-PPR9-1, targeting an in-del polymorphism in PPR9 was observed to show clear polymorphism and indicating PPR9 is a probable candidate gene for *Rf4*.

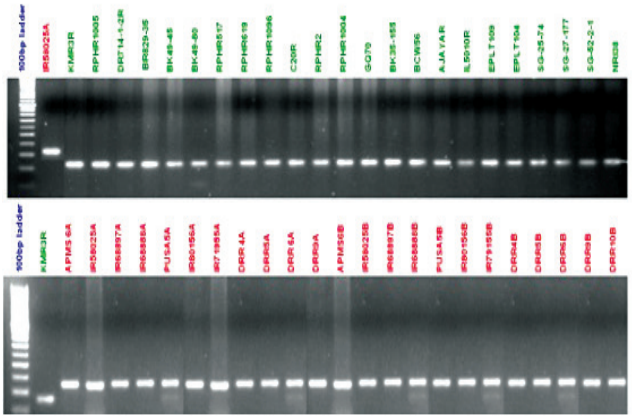
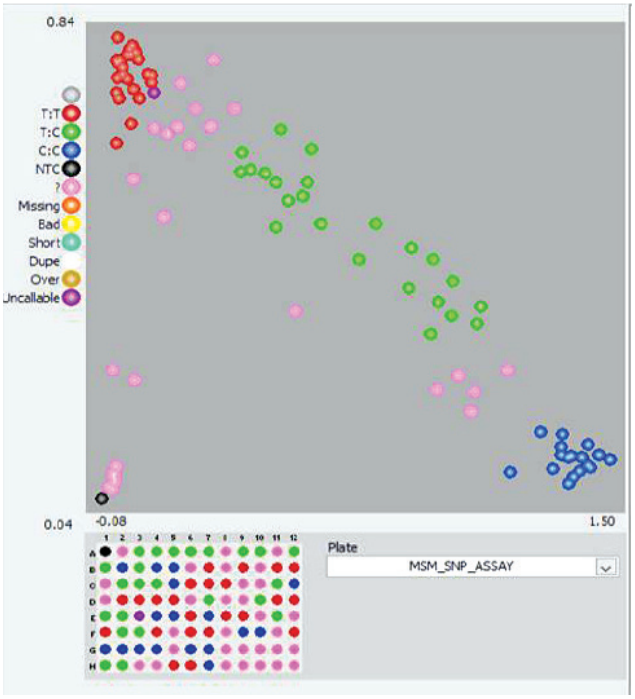


Fig. A functional marker, RMS-PPR9-1 (specific for the candidate gene, *PPR9*) can clearly and unequivocally distinguish fertility restorer lines from maintainer lines

ABR/CI/BT/11: Identification of SNP haplotypes in starch synthesizing genes and their association to the various quality characters

Ten genes involved in starch biosynthesis and candidate gene of qGT-6 (large effect QTL identified for Gelatinization Temperature) were targeted for identification of SNPs. For these SNP's KASP (Kompetitive Allele Specific PCR) SNP assays were designed. KASP assays were standardized using LC-96 RT PCR.

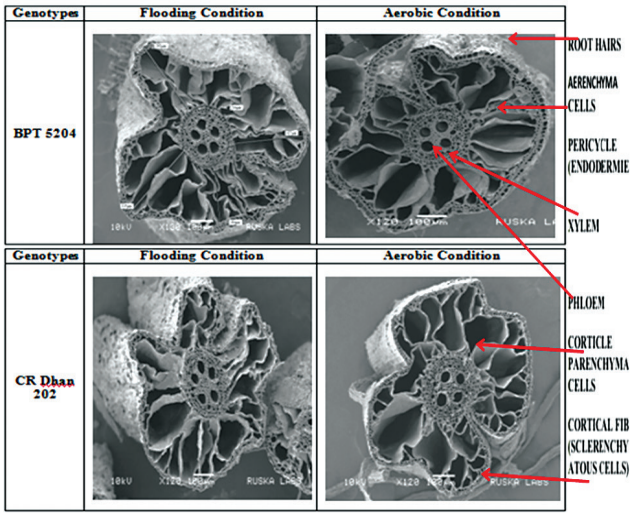


By targeting reported polymorphism in four key genes which are known to play important role in starch biossynthesis, ten SNP markers were designed. Through KASPER assay these markers were standardized, validated with a set of 100 indica genotypes and high allele call rate (95.31%) were achieved with clear distinct classes.

ABR/CI/BT/12: Molecular and physiological studies on the response of rice to aerobic conditions

To understand the adaptation of roots to the aerobic system of cultivation, two diverse rice cultivars like CR Dhan 202 and BPT 5204 were chosen and grown under flooding and aerobic conditions. Root growth parameters like root volume, number of roots, average diameter were estimated by image analysis (using WinRHIZO software) at panicle initiation stage. Similarly, root length, shoot length, number of productive tillers, plant height and root/ shoot fresh and dry weight were recorded. Considering all the parameters, CRdhan 202 performed better under aerobic than flooding condition. To know the variation in anatomical adaptations, scanning electron microscope (SEM) studies were done which revealed striking differences by showing more number of aerenchyma in flooding than under aerobic conditions. To further study the adaptations at molecular level, total RNA was

isolated from root and shoot tissues from these cultivars at PI stage to perform RNA-Seq analysis. The information that will emerge from this work may help the plant breeders to improve the rice lines better suited to the aerobic cultivation.



ABR/CI/BT/13: Candidate gene identification for manipulating growth related genes in rice through computational and expression studies

Sequence comparison was performed between orthologues of 83 genes related to photosynthesis and carbohydrate metabolism in order to identify candidate genes which are amenable to perturbations. With a hypothesis that higher the sequence diversity higher the tolerance to perturbation, average similarity score was calculated for all possible pairs of orthologues of the selected genes. The candidate genes were grouped into three groups based on the similarity score (1) >80% (2) 40-80% (3) <40%. Out of the analyzed sequences 28% were found to be falling in the most divergent 2nd and 3rd groups.

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

Fourteen putative RNAi transgenic lines developed using coat protein gene of *Rice tungro spherical virus* were advanced to T_3 generation. More than 700 plants corresponding to these lines were grown and used for PCR analysis. Seeds were harvested from PCR positive plants. In order to utilize RNAi technology to manage sheath blight disease, RNAi construct targeting the cell wall degrading enzyme of *Rhizoctonia solani* was developed. Polygalacturonase is an enzyme produced in fungi which is involved in the rotting process of plant cells. Polygalacturonase degrades polygalacturonan present in the cell walls of plants by hydrolysis of the glycosidic bonds that link galacturonic acid residues. Polygalacturonan is a significant carbohydrate component of the pectin network that comprises plant cell walls. To clone the polygalacturonase gene sequences of *R. solani*, the fungus was grown in pectin rich media to induce the genes involved in pectin degradation. The fungal mycelium was harvested and total RNA was extracted using RNeasy plant mini kit. The primers were designed using corresponding gene sequences available in NCBI database. Total RNA was subjected to cDNA synthesis using reverse primer and reverse transcriptase. Polygalacturonase gene was cloned in pDrive vector and sequenced for confirmation. RNAi construct (inverted repeat) was developed in the backbone of binary vector pGA3626 by using the polygalacturonase gene sequences of *R solani* and it was mobilized into *Agrobacterium tumefaciens* EHA105. The RNAi construct is being used for rice transformation.

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

A panel of 78 rice lines including popular varieties, EMS mutant lines of Samba Mahsuri, N22 and Pup 1 introgressed lines were characterized for useful root traits under aerobic conditions in polyhouse. On the basis of maximum root and shoot length, dry and fresh weights, root biomass at panicle initiation stage, segregants of BPT5204/Azucena cross *viz*. KK-13 (79.10 cm, 103.2 cm, 15.31 9, 59.019), KK-4 (69 cm, 89.6 cm, 4.53 g, 77.52 g), KK-22 (52.50 cm, 94.00 cm, 52.22 g, 47.19 g), BPT5204 mutants *viz*. Tl-16 (57.5 cm, 109.7 cm, 26.94 g, 65.69 g), Tl-3 (57.5 cm, 104 cm, 6.13 g, 36.65 g), Tl-13 (63 cm, 89.5 cm, 17.01 g, 71.54 g) and TI 26 (52.1 cm,94.3 cm, 11.81 g, 75.71 g) performed better. The entries *viz.* KK13, KK4, Tl-3, Tl-13, Tl-16 and Tl-26 performed well over other entries and aerobic check, CR Dhan 202. Representative roots from each root system were scanned and analyzed using WinRhizo software.

ABR/NP/2: 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.)

Swarna x *Oryza nivara* BILs were screened for yield traits, photosynthesis related traits and seedling vigour. High yielding stable BILs were selected based on phenotyping and genotyping for yield QTLs. Stability analysis was conducted for yield traits using AMMI analysis (SAS) and GGE biplot. 14S line was identified as most stable across the locations and seasons followed by 166s and 248s. Selected BILs were crossed with recurrent parent Swarna and BIL x BIL crosses were also made to combine yield traits and to develop secondary mapping populations.

F_2 mapping population from two crosses Swarna x 166s (228 lines) and 166s x 14s (181 lines) was phenotyped for yield component traits. Genotyping was done following Bulk segregant analysis for the traits grain number, tiller number, panicle weight, 1000 grain weight, number of days to initial flowering in F_2 population of 166s x14s. Yield and vigour related traits were evaluated for 166S derived BILs along with their recurrent parent Swarna and two other sib-BILs 148S, 248S (DRR Dhan 40) at field conditions. Seedling vigour parameters like percentage of germination and shoot and root length of seedlings were recorded. 131 backcross Inbred lines (BILs) derived from a cross KMR3R x *O. rufipogon* were sown and transplanted at IIRR farm and these BILs were phenotyped for yield traits and blast resistance.

Root morphology of promising lines

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

Development of new CSSL MTU1010 x *O. rufipogon* CR 100267: 90 BC_2F_1 plants were genotyped using 70 markers. 240 BC_2F_2 families were raised in field in 3 replicates from 34 BC_1F_1 and 240 BC_2F_1 plants, phenotyped for yield related traits to map QTLs. BC_2F_1 plants were backcrossed with recurrent parent MTU1010 and 350 BC_3F_1 were transplanted in pots for back crossing to generate BC_4F_1.

Swarna x *O. rufipogon* CR 100267: In addition to 7 BC1F1 obtained last year, 56 more BC1F1 were obtained and grown. 270BC2F1 were grown in field and phenotyped for yield traits. After backcrossing and growing 550 BC2F1, DNA was isolated from 90 BC2F1.

QTL mapping from previous BILs

Swarna x *O.nivara* IRGC81848 BILs (S lines): A set of 94 BILs were grown in field and phenotyped for 9 yield traits for two years. In all, 42 QTLs were identified using composite interval mapping. Seven QTLs were detected in both years for PH, DFF, DM, PW, YLDP and BY. *Oryza nivara* alleles were trait-enhancing in 62% QTLs. In all, 34 new QTLs were detected for all the nine traits in BC_2F_8 which were not detected previously in BC_2F_2 of the same cross. The contextual effect of some QTLs was thus obvious. Of the 4 major effect QTLs *qYLDP8.1* for yield per plant and *qBY12.1* for bulk yield were identified in both the seasons. The major QTLs and CSSLs identified here would help in fine mapping and further dissecting yield traits and in rice breeding.

Swarna x *O.nivara* IRGC81832 BILs (K lines): A set of 90 BILs were phenotyped for two seasons and 19 major QTLs explaining 11 to 47% PV were mapped for 9 yield traits. The marker density is being increased but with segregation of 70 SSR itself several highly significant single marker associations were identified specially for panicle weight and in both seasons. One major QTL *qPH1.2* (RM226-RM431) which increases height by 20cm also increased biomass *qBM1.1* by 6g.

In addition, IET 21943 (KMR3 x *O. rufipogon* BIL) was released in coastal saline areas of

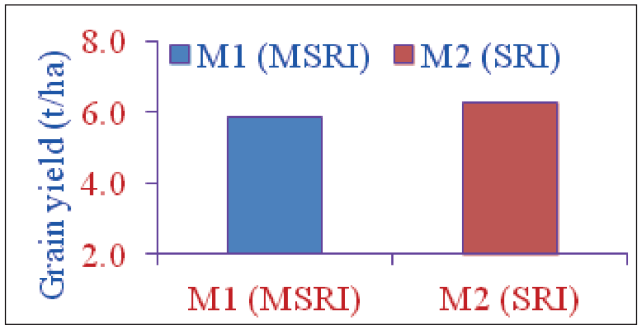
West Bengal after 4 years of testing in AICRIP CSTVT trials and State multilocation trials. A hybrid IET24441 (DRRH102) using this line was promoted to AVT-1 in CSTVT last year and being repeated this year as it gives 5t/ha yield in coastal salinity. IET 24775 (BPT5204 x *O. rufipogon* BIL) with high zinc was promoted to AVT2 for Zone 7 and IET 25459 (Swarna x *O. nivara* BIL) with high protein to AVT1 of AICRIP Biofortification trial. Backcross inbred lines derived from elite x wild crosses are very useful not only for basic studies but also in breeding.

Crop Production

Agronomy

RUE/CP/AG-14: Strategic research on enhancing water use efficiency and productivity in irrigated rice system

A field experiment was conducted on a clay loam soil at Rajendranagar farm, ICAR-IIRR, Hyderabad during the *kharif* and *rabi* seasons of 2014 and 2015. The treatments consisted of two planting methods (MSRI and SRI) as main plot treatments, three irrigation regimes (saturation, 5 cm irrigation at three and five DADPW) as sub plot treatments and four nitrogen management practices (RDN-100 % through inorganic, RDN-75 % inorganic and 25% organic source, LCC and STCR based nitrogen application with target yield of 6.5 t ha^{-1}) as sub-sub plot treatments. The results clearly indicated the significant effect of establishment methods on grain yield. SRI method (6.25 t/ha) resulted in 7 percent higher grain yield than that of Mechanized SRI (5.82 t/ha.) (Fig.). Water management methods also had significant effect on the grain yield where, saturation gave promising and higher grain yield than those of others (Fig.). Further, the nutrient management practices influenced the grain yield significantly and an increase of 10% due to LCC based N application as against the recommended fertilizer of 120 kg N ha^{-1} (Fig.). Significantly higher gross and net returns were recorded with system of rice intensification over MSRI. The total labour saving was 21 - 25 % in MSRI as compared to SRI. MSRI and SRI performed similarly with respect to B:C ratio. Irrigation at 3 DADPW recorded significantly higher net returns and B:C ratio which was comparable with saturation treatment. LCC based nitrogen management practice obtained significantly higher gross returns, net returns and B:C ratio as compared to other nitrogen management practices except STCR based nitrogen management practice.



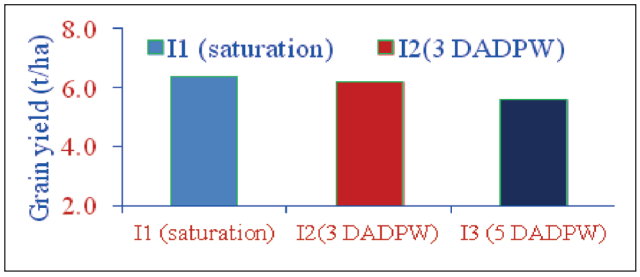


Fig. Grain yield under different establishment and water management methods

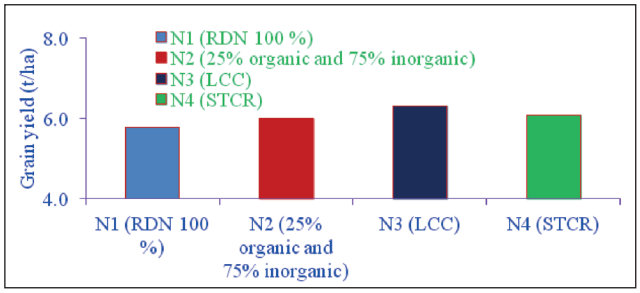
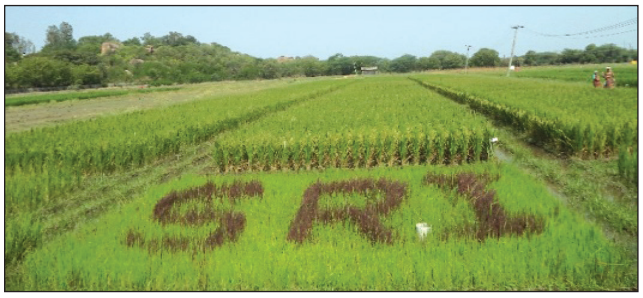


Fig. Rice grain yield under different nitrogen management



RUE/CP/AG-13: Improved agro-techniques for sustainable aerobic rice based cropping system

Partial substitution of chemical fertilizers by biofertilizers in aerobic rice and its effect on succeeding crops

In *kharif* 2015, the study was conducted at research farm of ICAR-IIRR, Rajendranagar, Hyderabad. The recommended fertilizer dose for aerobic rice was 100:50:50 N, P_2O_5 and K_2O. The experiment was carried out in split plot design with hybrid (PA6444) and High Yielding Variety (DRR Dhan 44) as main plots and fertilizer schedules {(75, 100 and 125% recommended N, P and K with bio-fertilizers (Azospirillum + Phosphorus Solubilizing Bacteria + K solubilizing bacteria), and without bio-fertilizers} as subplots. Half dose of N, entire dose of P and K were applied as basal and remaining half dose of nitrogen was applied by topdressing at panicle initiation stage. Bio-fertilizers @5 kg/ha was applied by seed treatment and soil application as per the local recommendation. Ferrous sulfate @1.5% was sprayed at weekly interval for 3 times, and need based irrigations were given at hairline crack stage of the soil except during rainy period. Other crop management practices were followed as per the standard package and practices. Fertilizer schedule of 100 % N, P_2O_5 and K_2O in combination with Azospirillum, PSB and K sol B (43.39 q/ha) was at par with 125% RDF (43.72 q/ha) 125% RDF + biofertilizers (45.59 q/ha) and was found to be the economic optimum with saving of 25% recommended fertilizer dose (Table). The nutrient uptake studies showed that the higher nitrogen, phosphorus and potassium uptake were significantly higher in Hybrid. The uptake increased with increase in fertilizer dosage and addition of biofertilizers. The highest uptake of major nutrients was with 125% RDF + Biofertilizers and lowest with 75% RDF.

Table 1. Comparative performance of HYV and hybrid under different level of fertilizer management

Treatment	No. of panicles/m²	Panicle length (cm)	Filled grain (%)	Panicle wt (g)	100 grain wt (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
Mean of Main factors								
PA 6444	637	23.81	78.65	4.22	2.32	44.90	47.49	50.54
DRR Dhan 44	515	22.81	76.57	4.53	2.54	38.42	40.17	48.04
CD (0.05)	54	0.64	0.37	0.29	0.11	1.54	7.13	1.17
Mean of fertilizer schedules								
125% RDF	603	24.59	80.81	4.83	2.43	43.72	46.71	51.25
125%RDF+Biofertilizers	616	25.59	81.40	5.07	2.44	45.59	48.29	52.91
100% RDF	574	22.63	77.56	3.95	2.39	42.85	43.96	46.74
100%RDF+Biofertilizers	595	23.73	80.31	4.74	2.52	43.39	45.07	48.95
75% RDF	520	21.13	71.53	3.66	2.38	36.43	40.00	43.83
75%RDF+Biofertilizers	548	22.17	74.04	3.96	2.41	37.97	40.96	46.06
CD (0.05)	54	0.36	0.63	0.36	NS*	2.64	3.78	1.25
Interaction								
M and T	NS	0.51	0.89	0.504	NS	NS	NS	1.77
T and M	NS	0.69	0.86	0.514	NS	NS	NS	3.26

*NS: Non-significant

Screening of advanced lines of hybrids and Swarna x O. nivara for biofortification under aerobic condition

The screening study during *kharif* 2015, 10 advanced lines of Swarna x *O.nivara viz*., KMR 3, SM 837, SM 686, SM 463, 166(S), 148, N 22, 143, 145, 7 K and IET 22737 were evaluated against Swarna, the local check. The higher yield attributes, grain yield and total dry matter production were recorded in SM 463 followed by 166(S) and 7 K. Similarly, among 5 hybrid lines, BLVR 86, 70 and 349 were promising for higher growth and yield parameters. Among the lines under biofortification, RPHP 105 and RPHP 106 registered higher values of growth, yield attributes and grain yield than those of RPHP 103, 163 and VRBHP 5.

Soil Science

SSP/CP/SS/11: Assessment and improving nitrogen use efficiency in irrigated rice

A field experiment was initiated in 2010-11 to evaluate the nitrogen use efficiency (NUE) of existing popular rice varieties and to identify efficient rice genotypes for responsiveness and use of soil and applied N. In addition, improvement of NUE using management and molecular approaches was also attempted. The experiment was continued during *kharif* and *rabi* seasons of 2015 with two 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. In another experiment, 35 Green Super Rice (GSR) entries from IRRI were evaluated for their NUE at the same N levels. As a third part, the variety, Varadhan was evaluated at graded levels of N (0, 50, 75 and 100 kg N/ha) with five different nutrient combinations for improving NUE under transplanted rice. Also, the variety BPT 5204 was evaluated with different nutrient combinations under direct seeded rice.

Based on the grain yield performance and several NUE indices, the genotypes Tulasi, Rasi and Vikas from early; KRH2 and Varadhan from medium and Dhanrasi from long duration group were the most promising and ranked top for both soil and applied N utilization and responsiveness. Among the 35 GSR lines, the entries *viz*., HUANGHUAZHAN, TME 80518, and IRRI 105 exhibited efficiency at sub-optimal N level (N0) and also responded to applied N (N 100). A few selected genotypes were subjected to *OsSPL14* (wealthy farmers panicle, WFP) gene expression analysis under low and recommended N. Expression analysis of OsSPL14 (LOC_ Os08g39890) gene reported to be associated with increased panicle branching and higher grain yield through real time PCR in leaf and three stages of panicle has shown differential temporal expression and its association with yield and yield related components across the genotypes under low N. The expression of *OsSPL14* at panicle stage 3, has shown correlation ($p<0.05$) with N% in grain.

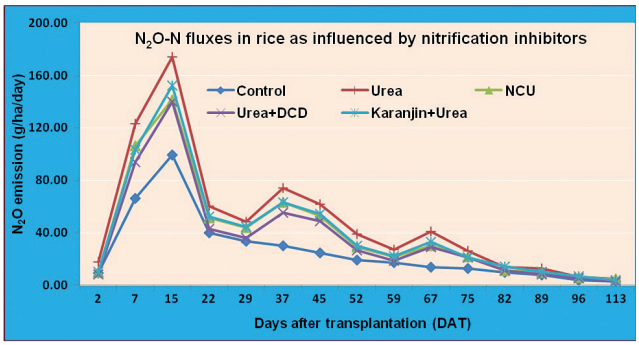
At graded levels of N, grain yield was on par at 75 and 100 kg N/ha with variety, Varadhan and among the N sources, neem coated urea (NCU) was significantly superior to all other sources with its slow N release and high recovery efficiency under transplanted conditions. Whereas, under direct seeded rice (DSR), GA3 spray along with RDF and vermi compost (VC) increased the plant height, panicle length, yield parameters, grain yield, N uptake and enzyme activities.

Table 1. Influence of N levels and sources on grain yield, urease and NUE (Var: Varadhan)

N levels (kg/ha)	Grain yield (t/ha)	N sources	Grain yield (t/ha)	Urease activity (µg/g soil)	N Recovery efficiency (%)
N-0	3.30^{c}	Urea (U)	4.16^{c}	91	31.0
N-50	3.96^{b}	Neem Coated Urea (NCU)	5.20^{a}	64	55.3
N-75	4.43^{a}	Vermi Compost (VC)	3.58^{d}	87	20.1
N-100	4.59^{a}	U+GA3	4.31^{bc}	110	30.6
		NCU+VC+GA3	4.60^{b}	88	41.6

CCR/CP/SS/10: Impact of changing temperatures on nitrogen dynamics and use efficiency in rice

The impact of three nitrification inhibitors *viz*., Dicyandiamide (DCD), Neem Coated Urea (NCU) and Karanjin in addition to prilledUrea and unfertilized control on N_2O emissions, nitrogen use efficiency (NUE) and grain yield of rice was studied under RBD with four replications. The N_2O emissions were significantly reduced from the rice field by the use of all the three nitrification inhibitors as compared with urea. Flux of N_2O-N was the highest from untreated urea (5-174 g/ha/day) and the lowest from unfertilized control (3-99 g/ha/day). With the application of nitrification inhibitors, it ranged between 5-141, 3-140 and 4-152 g/ha/day from NCU, DCD+Urea and Karanjin+Urea, respectively. Total N_2O–N emissions were the highest with urea (0.73 kg/ha) followed by Karanjin + Urea (0.62 kg/ha), NCU (0.60 kg/ha) and DCD + Urea (0.55 kg/ha) and were the least in control with no nitrogen (0.39 kg/ha). Total emissions with Urea, NCU, Urea + DCD and Karanjin+Urea were 86, 54 and 41 and 59%, respectively, higher than control. Total N_2O–N emissions were in the range of 0.46% (with Urea + DCD) to 0.61% (with Urea alone) of the total nitrogen applied through different treatments (120 kg N/ha). The highest inhibition of total N_2O emission (53%) was recorded from plots treated with Urea + DCD followed by NCU (38%) and Karanjin + Urea (32%).



Field experiments were also conducted with four rice varieties (Akshyadhan, Jaya, RP BIO-226 and Sampada) and four hybrids (KRH-2, PA-6444, PHB-71 and DRRH-3) under RBD with three replications, in *kharif* 2015, to study the impact of rice cultivars on nitrous oxide emissions. Significant differences were not observed in N_2O emissions among different cultivars. The cumulative N_2O–N emissions from hybrids varied from 0.60 – 0.61 kg/ha while that of varieties from 0.61 - 0.62 kg/ha. The grain yield, N uptake as well as NUE (Kg yield/kg N uptake) was observed to be higher in hybrids as compared to varieties. The grain yield of PHB-71 was the highest with 6.4 t/ha followed by KRH-2 (6.1 t/ha), PA-6444 (5.9 t/ha) and DRRH-3 (5.6 t/ha). Among varieties, Akshyadhan yielded highest (6.1 t/ha) followed by RP BIO-226 (5.0 t/ha), Sampada (4.7 t/ha) and Jaya (3.9 t/ha). The NUE of hybrids varied from 47 in DRRH-3 to 53 in PHB-71 and in varieties from 32 in Jaya to 43 in Akshyadhan.

Table : 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	-

SSP/CP/SS/13: Utilization of plant growth promoting microorganisms for improving nitrogen and water use efficiency in rice

The effect of *Gluconacetobacterdiazotropicus* inoculation on enhancing tolerance of rice to water stress was studied using surface sterilized seeds of variety Swarna. Inoculation was performed by soaking grains in buffer containing 10^8 bacteria ml^{-1} for 4 hours at 28°C. For the control treatment, another set of seeds soaked in sterile buffer was used. Ten day old germinated seeds were sown in pots and maintained under flooded conditions. Transient water stress was induced by stopping watering after 20 days of transplanting to pots. Detached leaf assays for relative water content, electrolyte leakage and

superoxide production were performed after five days of water stress imposition. Leaves of inoculated seedlings exhibited relatively higher water content (39.4%, Fig. 1) and a lower electrolyte loss (58.1%, Fig. 2) and superoxide radical production under water deficit stress when compared to uninoculated seedlings (27.4% and 61.6%, respectively). Inoculation was also found to improve the recovery of plants after water addition was resumed. The bacterium was thus found to positively influence rice plant characteristics under stressed conditions.

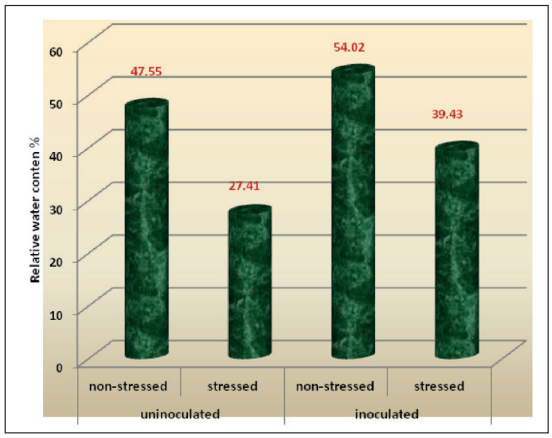


Fig. Relative water content in leaves after inoculation with *G. diazotrophicus*

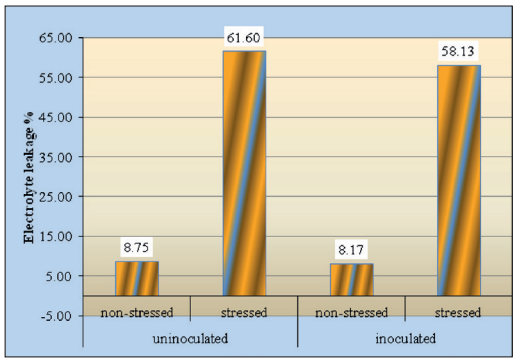


Fig. Electrolyte leakage from leaves after inoculation with *G. diazotrophicus*

Plant Physiology

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

Leaf gas-exchange traits of 60 rice genotypes including green super rice (GSR) genotypes were grown in field and their gas-exchange traits were assessed at flowering stage. The rate of photosynthesis varied between 7.6 µmol (CO_2) m^{-2} s^{-1} (GSR44) to 24 6 µmol (CO_2) m^{-2} s^{-1} (GSR 36) with a mean value of 17.86 µmol (CO_2) m^{-2} s^{-1}. Out of 60 genotypes assessed for net photosynthesis rate, 28 genotypes recorded photosynthesis rate higher than the mean. However, the differences amongst the top 10 genotypes were less than the LSD ($p<0.01$) value indicating minor variation in net photosynthesis rate amongst the assessed genotypes. Significant differences ($P<0.01$) were observed amongst the genotypes for stomatal conductance (gs). The gs was lowest in GSR 44 (0.084 mol (H_2O) m^{-2} s^{-1}) and GSR 142 showed highest gs (0.927 084 mol (H_2O) m^{-2} s^{-1}) with a mean value of 0.316 (084 mol (H_2O) m^{-2} s^{-1}).

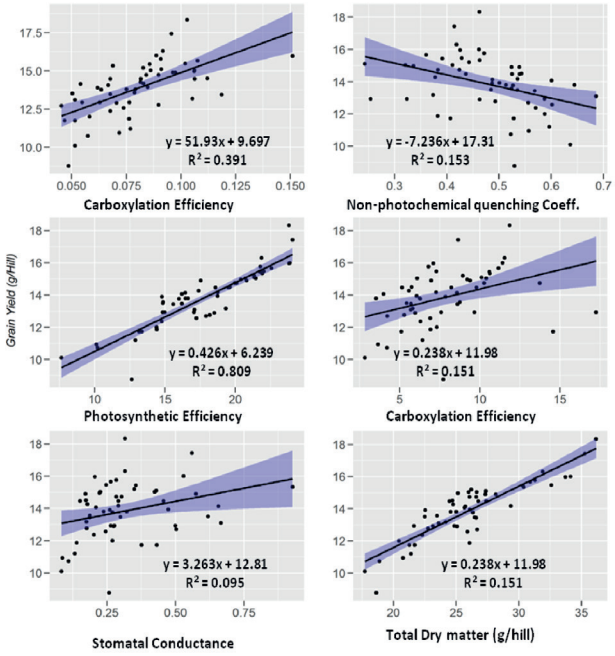


Fig. Relationship between grain yield and other important physiological traits in selected rice genotypes.

The intercellular CO_2 concentration (Ci) is an important gas exchange trait which influences the net photosynthesis. Significant ($P<0.01$) variation was observed amongst the tested genotypes for this important trait. The C_i varied between 146.2 µmol (CO_2) mol^{-1} (GSR 2) to a maximum of 415 µmol (CO_2) mol^{-1} (FGK 115). The mean Ci for all the genotypes was 235.41 µmol (CO_2) mol^{-1}.

The leaf transpiration rate (E) differed significantly ($P<0.01$) amongst the genotypes. The transpiration rate was highest in GSR 34 (17.25 084 mmol (H_2O) m^{-2} s^{-1}) and minimum transpiration rate was observed in GSR 44 (2.82 084 mmol (H_2O) m^{-2} s^{-1}).

Chrophyll fluorescence was estimated simultaneously with leaf gas-exchange traits using) *LI6400XT* photosynthesis measurement system attached to leaf chamber fluorometer (LCF Model 6400-1, LICOR, USA). Significant differences were observed in Apparent Electron Transport Rate (ETR) of the leaf. The mean ETR for all entries was 132 and ETR varied between a maximum of 172 (Vandana) and 63.5 (GSR 5). Similarly, the maximum efficiency of PSII photochemistry (F_v/F_m) varied between 0.705 (Weed tolerant) to 0.775 (GSR 34). For normal unstressed plants the Fv/Fm value will be between 0.70 to 0.80.

The correlation between photosynthesis and other leaf gas exchange traits indicate that PN was positively correlated with gs, PN/Ci (Carboxylation efficiency) and ETR. The positive association with ETR and PN indicate that this parameter can be used to screen large number of genotypes as measuring ETR is faster. The PN was significantly associated with grain yield and TDM.

GEY/CP/PP/12: Physiological approaches for Ideotype breeding in rice

A field experiment entitled "Morpho-physiological traits associated with grain yield for ideotype breeding in rice (*Oryza sativa* L.)" was conducted during *kharif* 2015 and *Rabi* 2016 at research farm, ICAR-Indian Institute of Rice Research, Hyderabad. The experiment was laid out in randomized block design with three replications. The investigation was undertaken to test the performance of different promising genotypes for grain yield associated traits which includes morphological, physiological, biochemical and yield attributing and quality traits to identify the superior donors with good Morpho-physiological traits for ideotype breeding. To test the performance of different promising genotypes for grain yield associated traits which includes morphological, physiological, biochemical, yield attributing and quality traits, different genotypes were selected. The selected experimental material comprised of fifty eight genotypes from three different clusters, *viz*., *indica* cluster, tropical *japonica* cluster and hybrid cluster.

Among all the genotypes, KRH 2, PHB-71, 13-7, DRRH 3 and S-40 which belongs to hybrid cluster, TJP-27, TJP-157, TJP-139, TJP-197 and TJP-4 which belongs to tropical *japonica* cluster and Vijetha, Jaya, Swarna and Sampada which belongs to *indica* cluster showed erect and thick flag leaves, critical LAI values, medium growth duration , high photosynthetic rate, high stomatal conductance, high SCMR values, efficient remobilizers for SCMR, N and sugars content from flowering to maturity stage. High protein content, more phenols content, maximum TDM, maximum panicle weight, maximum grain filling percentages were responsible for higher grain yield. Phenotypic correlation and Path analysis also confirmed that the above traits were the most important characters for selecting genotypes in yield improvement programmes.

Therefore, it is evident tfrom the present experiment conducted in two seasons, that KRH-2, PHB-71 and 13-7 (hybrids cluster), Jaya, Swarna and Sampada (*indica* cluster) and TJP-27, TJP-197 and TJP-139 (tropical *japonica* cluster) can serve as potential donors to get increased grain yields with good grain quality and ideal morpho-physiological traits associated with grain yield.

Agricultural Engineering

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

Direct seeding is going to be viable and cost effective technology over transplanted rice. Efforts were made to improve the efficiency of the Drum seeder by developing riding type of drum seeder. The newly developed drum seeder was tested in *Rabi*, 2016 after changing the reduction gear box with speed reduction ratio of 1:10 at forward speed of 2-3 km/h. The drum seeder was modified by providing pegs so that the seeds get better anchorage and there is less damage by birds as the seeds are buried at A portion of the land was broadcasted to study the difference in yield in comparison with drum seeder. Mechanical transplanter was also used for transplanting 15 day old seedlings.

Wet land weeder developed by NIPHM and IIRR was intensively tested in IIRR farm. As the weight was more movement was difficult. So it was advised to reduce the weight. Futher trials will be conducted after making modifications.

Modified Riding type drum seeder in operation

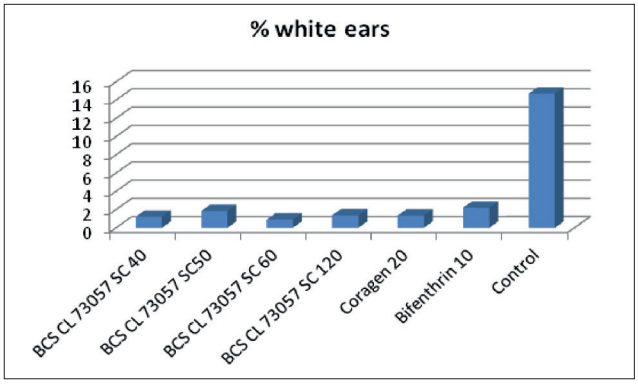


Fig. Field efficacy of a newer insecticide- BCS CL 73507 SC 200 against stem borer

Crop Protection

Entomology

IPM/CPT/ENT/3: Chemical Control as a component of rice IPM

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, *Scirpophaga incertulas* and leaf folder, *Cnaphalocrocis medinalis* in rice during *kharif* 2015-16 at DRR Farm, Rajendranagar. The trial included seven treatments replicated three times in a randomized block design (RBD). The treatments consisted of BCS CL 73507 SC 200 at three doses *viz*., 40, 50 60 and 120 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. Three applications were given at 32, 43 and 56 DAT @ 500 litres of spray fluid per ha.

Stem borer damage ranged from 4.5 to 9.7% dead hearts in insecticide treatments and 9.5 to 11.2% DH in control during 42 to 55 DAT. The white ear incidence varied between 0.9 and 2.2% in insecticide treatments compared to 14.7% in control. All the insecticide treatments were at par and showed significant reduction in white ear damage compared to control (Fig.). BCS CL 73507 SC 200 @ 120 g a.i./ha yielded the highest of 3710 kg/ha significantly higher than BCS CL 73507 SC 200 @ 60 and 50 g a.i./ha showing yields of 3294 and 3240 kg/ha.

HRI/CPT/ENT/11: Assessment of host plant resistance to brown planthopper (BPH) and whitebacked planthopper (WBPH) and their management

Of the 2900 entries consisting of breeding lines and germplasm accessions evaluated against BPH, *Nilaparvata lugens* and WBPH, through mass screening test in the greenhouse, 17 entries for BPH and 2 entries for WBPH were found promising (damage score <3.0). Fifty two entries were moderately resistant to BPH and 37 entries were moderately resistant to WBPH. Lines- PTB 33, RP 2068, T12 and IC216750 were highly resistant and IR 06N233, IC216788, IC216737, IC75961, IC75990, IC76013, IC76000A, IC76010, IC76033, IC215054, IC216944, IC216650, IC216735 were resistant to BPH. The entries MO1, IC75864 and IC215298 were resistant to WBPH.

Thirty two gene differentials were screened for their reaction to the BPH populations brought from West Godavari, Nalgonda, Nellore, Orissa along with greenhouse population. PTB 33 with bph2+Bph3+ and RP 2068-18-3-5 with unknown genetics were resistant to all populations. ARC 10550 with bph5 gene and Chinsaba with bph8 gene were resistant to Nalgonda and Nellore BPH populations. Mudgo with Bph1 gene was resistant to Glasshouse population which will be confirmed in further studies.

IPM/CPT/ENT/13: Arthropod Biodiversity of irrigated rice ecosystem, its functional significance and use in Biological control

Tagetus erecta (*African marigold*) is a commercial flower crop grown in Telangana region and is

also grown on bunds. A field study to assess the impact of yellow and orange commercial varieties and dwarf hybrid of marigold, on parasitisation of hoppers was taken up during *kharif* 2015 by egg baiting with potted plants exposed to oviposition by the three hoppers. The mean parasitisation of brown planthopper eggs was 19.24, 20.84 and 28.41 near a border of yellow marigold, orange marigold and Gaillardia respectively which was significantly higher when compared to parasitisation without flower border (16.78%). The mean parasitisation of GLH eggs was 16.1 per cent without border and 21.77 with Gaillardia.

A culture of the Anthocorid predator was obtained from NBAIR, Bangalore and evaluated for bio-control of brown planthopper, *N.lugens* on rice. This predator took 22-23 days to complete its life cycle on BPH eggs. Observations on predatory efficiency revealed that all nymphal instars of the predator fed on BPH eggs. Total predatory rate ranged from 1-4 BPH eggs per day. The fourth instar stage of the predator fed on 2-3 first instar nymphs of BPH. Studies indicate that this could predominantly be an egg predator.

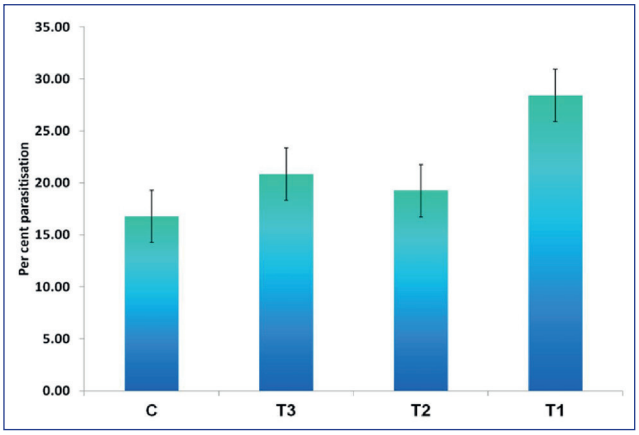


Fig. Effect of flowering borders on egg parasitisation of brown planthopper eggs

C-without flower border; T1 – Gaillardia; T2 –Yellow Marigold; T3 - Orange Marigold

HRI/CPT/ENT/19:Assessment of host plant resistance to leaf folder and its management

Ninty two Backcross Inbred Lines (BILs) derived from a cross between Swarna (*O.sativa*) as a recurrent parent and a wild accession *O. nivara* – 81848 as a donor parent along with 48 mutant lines of BPT 5204, 24 germplasm lines collected from North East region were screened for resistance to rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). Each entry was grown in the field along with TN1 as susceptible check and W 1263 as resistant check after every 10 entries. In each line, 3 plants were screened by enclosing a net and releasing a 3rd instar leaf folder larva and allowing it to feed for 48 hrs. Leaf area damaged was assessed using imageJ software.

The data on frequency of leaf area damaged in BILs revealed a normal distribution curve with values between 62.70 to 346.45 mm^2. The leaf area damaged in TN1 was 293 mm^2 and it was 149 mm^2 in Swarna. Of these, 13 BILs, 11 mutant lines and 7 germplasm entries recorded low damage of less than 100 mm^2 mean damaged area. Leaf parameters like leaf length and leaf width were measured in all the 165 lines along with TN1. Leaf length varied from 26 to 59 cm and leaf width ranged between 0.7 and 2.0 cm.

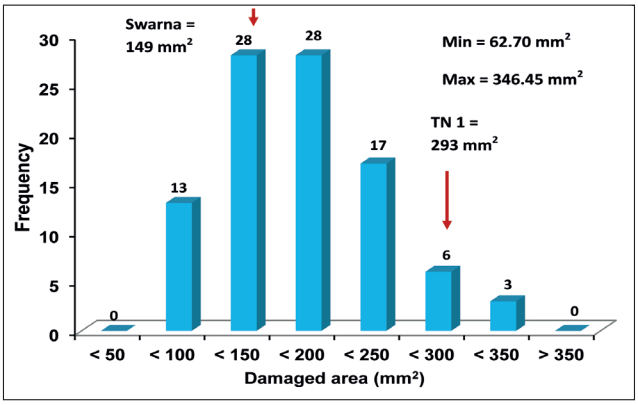


Fig. Phenotyping BILs of Swarna/ O.nivara for resistance to leaf folder

There was a large variation in the trichome density among the BILs and mutant lines of BPT 5204 evaluated. Trichome density varied from 0 to 453 with maximum numbers in NPS 27 BIL

In NPS 41, there are spines on the edge of the leaf and two rows of trichomes on the lower side of the leaf. The role of these trichomes in imparting resistance to rice leaf folder needs to be ascertained.

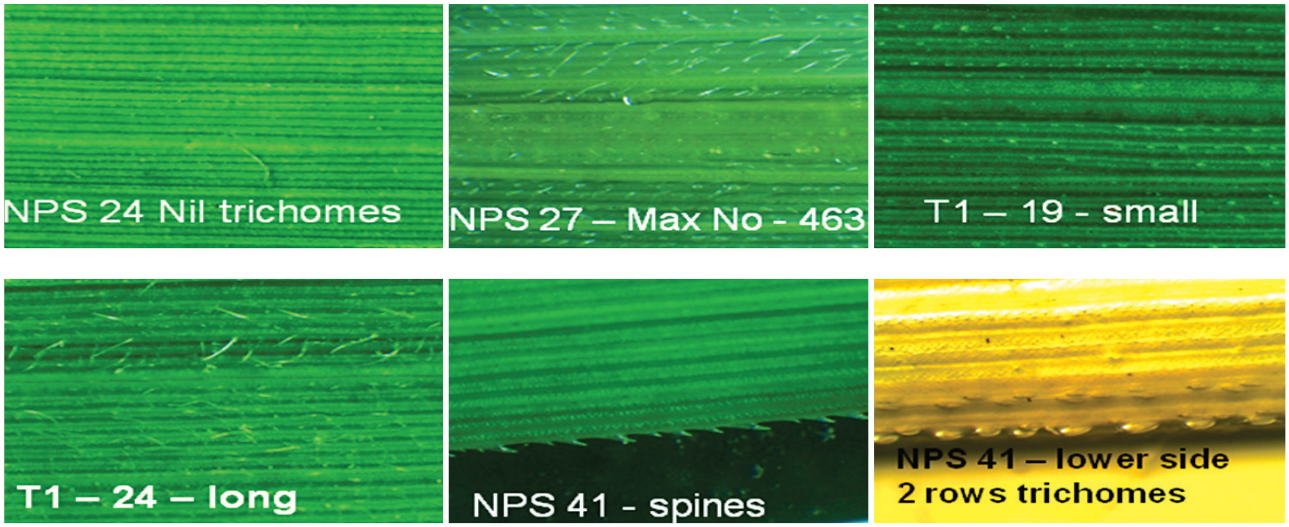


Fig. Trichome variation among the entries screened for resistance to rice leaf folder

IPM/CPT/ENT/20: Semiochemical approaches to manage insect pests of rice with special emphasis on sex pheromones

The pink stem borer (PSB), *Sesamia inferens* (Walker) lure having 5 mg of the pheromone compound resulted a marginal trap catches at PAU farm and farmers field at Ludhiana for the second year of re-testing. Results revealed cumulative catches of 12.6 males/trap/week at PAU, Ludhiana farm. Similar trend of trap catching was also observed at farmers field *i.e.* 7.2 males/trap/week at Malik Pur and 10.6 males/trap/week at Batha Dua villages over study period of 6 weeks from March to April, 2015 indicating that the developed blend was attracting the PSB. Interestingly, blend also attracted good number of army worm, *Mythimna separata* moths during the study period. One of the major compounds of developed PSB blend could be the reason for good catches. *Mythimna separata* species confirmation was also done.

Table : Bio efficacy of PSB blend at different places in Ludhiana

Parameters	Locations					
	PAU farm		Malik Pur		Batha Dua	
	PSB blend	Control	PSB blend	Control	PSB blend	Control
Cumulative catches/trap/week*	7.2 (1- 5)	0	10.6 (1-7)	0	12.6 (1- 8)	0
t-value		9.78**		10.30**		9.78**
df		4		4		4
P-value		<0.01		<0.01		<0.01

* catches of five replicates

Figures in parentheses indicate range in catches (minimum – maximum)

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

A field trial was carried out to evaluate the efficacy of essential oils against stem borer, *S.incertulas* and leaf folder, *C.medinalis* in rice during *kharif* 2015-16. Of 12 essential oils tested in field at 0.2%, lemongrass, camphor and eucalyptus oils were found effective against stem borer with 18.2-19.5% dead hearts damage when compared to 20.6% in control (Fig.). The efficacy of aromatic oils was on par with insecticide coragen. Eucalyptus, oregano and lemongrass oils reduced white ears damage to 12.1-13.2% as compared to 14.8 % in control. Rosemary, eucalyptus and camphor oil treatments showed efficacy against leaf folder which recorded damage of 19.2-20.9% when compared to 30.3% in control.

Five essential oils were tested for their repellency to female BPH, *N. lugens* adults in six-arm olfactometer in the laboratory. Eucalyptus oil at 10 µl was found highly repellent to BPH while camphor oil seemed least repellent. Among various seed oils tried at 20 µl, neem oil showed highest repellency while annona oil was least in efficacy. Out of 14 oils tested in EAG against hispa, *Dicladispa armigera* highest repellent response was recorded in eucalyptus oil which registered a value of 1.04 (-mV) followed by camphor and rosemary oils with a response of 0.81 and 0.75 (-mV) respectively.

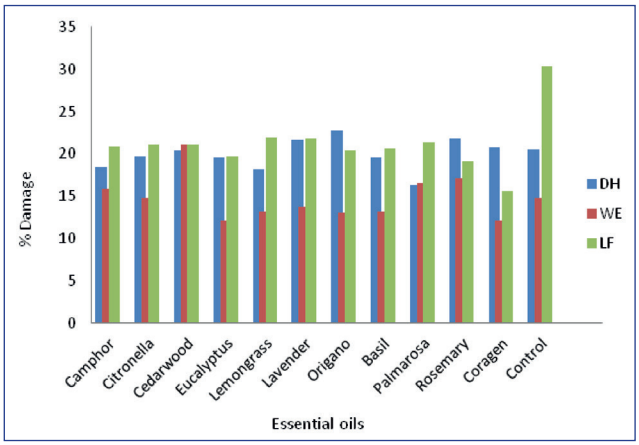


Fig. Field efficacy of essential oils at against stem borer and leaf folder

Project No. IPM/CPT / ENT/22: Investigations on Nematodes of Importance to Rice Cultivation

Field evaluation of indigenous entomopathogenic nematode, *Heterorhabditis indica* against rice yellow stem borer revealed that spraying of entomopathogenic nematode @ $1x10^5$ IJs/m^2 at panicle initiation stage significantly reduced white ear (WE) damage (9.39% WE) caused by the yellow stem borer compared to the untreated control (31.82% WE). Stubble treatment with entomopathogenic nematodes (*Heterorhabditis indica, Metarhabditis amsactae* and *Steinernema glaseri*) immediately after the harvest of rice crop resulted in 6.76 to 22.5 per cent mortality of yellow stem borer larvae located inside the stubbles demonstrating host seeking ability of the nematode.

An indigenous entomopathogenic nematode, *Metarhabditis amsactae* isolate Drr-Ma3 was identified based on morphological and molecular characterization. The symbiotic bacteria associated with *Metarhabditis amsactae* was identified as *Achromobacter insolitus* (MTCC 12544) and the protocol for monoxenic culturing of this nematode in laboratory was standardized.

Fifty two rice genotypes were screened for resistance to rice root-knot nematode *Meloidogyne graminicola*. Two genotypes (LD24 and Khao Pahk Maw) showed highly resistant reaction to the nematode. Nematode penetration, development and root galling were significantly reduced in these genotypes. Five entries (INRC8867, ARC13516N22, W1263, Aganni, and Abhishek) showed resistant, and four entries (Suraksha, INRC8843, BG-380-2, MAS946-1) showed moderately resistant reaction to the nematode. A novel protocol for rapid multiplication of rice root-knot nematode *Meloidogyne graminicola* inoculum in soil free system was standardized.

Nematode analyses in SRI system revealed that the total nematode abundance was more in SRI compared to the normal transplanted system. However, the relative abundance of beneficial (bacterial and fungal feeding) nematodes was higher in SRI compared to that in NTP method. Rice root nematode was predominant in these

samples. Observations on influence of different weed management regimes in aerobic rice on nematode population in soil revealed that mulching with neem leaves and application of herbicide

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

The back cross inbred lines developed from *O. glaberrima* were evaluated for stem borer at multi-locations. The mean white ear damage of 10 selected back cross inbred lines (BILs) of RP5588 and RP 5587 was 7.1-13.7 % when evaluated across locations. RP5588-B-B-B-63 had low damage for stem borer in the second year of testing and cut stem assay revealed neonate larval mortality (28.6± 10.6%) suggesting antibiosis as one of the mechanisms of resistance. Phenotyping through cut stem assays and quantification of grain yield under both infested and uninfested conditions was carried out in the select lines of the RP5588. Two BILs each *viz*., RP 5588-B-B-B-B-51 and RP 5588-B-B-B-B-54 with low damage for white ear (<6% WE) and RP5587-B-B-B-301-2 and RP 5983-181-28-6-5-8-B-B-2-2 with low dead heart damage (<5% DH) have been identified. Neonate larval mortality of these lines varied from 12.5% to 50.0% and they had high antibiosis index, high geometric mean productivity and high relative efficiency index. RP 5893-259-17-13-6-1-B-B-4 (Swarna X *O. longistaminata*) had high grain yield despite high white ear damage suggesting recovery resistance and compensation for grain yield as the mechanisms of tolerance.

Under 'PLOMICS' project till date 4500 BPT mutants lines were screened for stem borer damage at both vegetative and reproductive phase by infesting with egg mass and neonate larvae. The promising lines were identified in each of the generation and screened for stem borer damage. In M7 generation, consistently promising lines for stem borer were evaluated at seven locations and it was found that IIRR-BIO-SB-9, IIRR-BIO-SB-10 and IIRR-BIO-SB-3 were identified as promising with a mean white ear damage of 9.0%, 11.6 % and 12.8%, respectively without reduction in grain yield (>14g/hill).

Gall midge culture was maintained in the greenhouse to ensure effective screening of the materials using standard protocols. Screened nearly 1600 lines in greenhouse against gall midge and identified 57 lines with nil damage. IC 578133 was identified as new source of resistance and was found to have a new gene through marker allelism test. IET 23194, IET 24320, IET 24237, and IET 24667 were confirmed for their resistance to gall midge biotype 1. RP5588-B-B-B-32 derived from *O.glaberrima and* a BPT mutant have been identified as a new sources of resistance to Asian rice gall midge with nil damage under greenhouse.

Plant Pathology

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

Out of 69 entries received through IRBBN-2015 from IRRI, only one test entry (12DS-GMET-22) showed moderate resistance to BB with a score of 5. Most of the IRBB lines with single genes except IRBB21 (possessing *Xa21*) showed susceptible reaction. Most of the gene pyramided check lines except IRBB 50 (*Xa4* + *xa5*), IRBB 61 (*Xa4* + *xa5*+ *Xa7*) and IRBB 62 (*Xa4* + *Xa7* + *Xa21*) showed resistance to the *Xoo* isolate used. Nineteen pyramided lines in the background of Tellahamsa and WGL Sannalu along with checks were evaluated for their resistance to BB with three *Xoo* isolates *viz*., DX020, DX002 and DX027. However, most of the lines showed mixed reactions indicating the segregating nature of the lines. Out of 189 breeding lines received from Plant Biotechnology section, 5 entries showed good level of resistance with score of 1-3 while another 3 entries showed moderate resistance with a score of 5 (Figure 1). In another experiment, 134 M_4 lines (in BPT 5204 background) were evaluated for their resistance to BB under high disease pressure in field, 14 complete lines and 11 individual plants from 11 different lines were found highly resistant.

Fig. Reaction of a breeding line (NPK-77) to bacterial blight of rice

For pyramiding *Xa21* and *Xa38* in Samba Mahsuri, we have used Improved Samba Mahsuri (possessing *Xa21*) as the recurrent parent and PAU 3554 as the donor for BB resistance gene *Xa38*. Till now, we have made 4 back crosses. The selected true BC_4F_1 plants were advanced to generate BC_4F_2 seeds in this *Rabi* season. For pyramiding *Xa21* and *Xa38* in the background of APMS6B, we have crossed APMS6B with PAU 3554 and APMS6B with ISM. In one approach, we are continued backcrossing with APMS 6B and advanced up to BC_3F_1 stage. Now we have crossed both the BC_3F_1s and got the plants positive for both *Xa21* and *Xa38*. Two genes positive true F_1s were advanced to generate BC_3F_2 and BC_3F_3. In another approach, we have crossed both the F_1s in the beginning and selected for both genes and then we have backcrossed with APMS 6B. Selected BC_3F_1 possessing both the genes and also having high BB resistance (to strain DX020) were advanced to BC3F2.

Sixty seven strains of *Xanthomonas oryzae* pv. *oryzae* which were isolated during 2014-15 were characterized for their pathogenic variability on a set of rice differentials. We are categorizing these isolates into different pathotypes according to the scheme developed at our institute. We have also completed the genetic profiling of these 67 isolates using primers Jel-1 and Jel-2. In addition, we have made 55 fresh isolation of *Xanthomonas oryzae* pv. *oryzae* strains from freshly collected leaf samples. These included 37 isolates from Telangana, 7 from Tamil Nadu, 8 from Chhattishgarh and 3 from Andhra Pradesh. We will be characterizing these isolates for their pathogenic and genetic variability.

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

A study was undertaken to describe the sequence divergence and evolution of RTBV isolates present in India and other countries. Phylogenetic analysis based on coat protein (CP) sequences of RTBV generated in this study showed distinct divergence of Indian and non-Indian RTBV isolates into two clusters. Further, Indian RTBV isolates formed two groups- one consisted isolates from Andhra Pradesh and Kanyakumari, and other included isolates from Hyderabad, Punjab, and West Bengal. The results obtained from phylogenetic analysis were further supported with the single nucleotide polymorphisms (SNPs), insertion and deletions (INDELs) and evolutionary distance analysis. Signature sequences and amino acid motifs were identified which showed distinct difference between Indian and nonIndian isolates. This study will help in understanding the geographical evolution and adaptation of RTBV in different rice ecosystems.

Twenty popular rice hybrids were used to screen for rice tungro virus (RTV) disease reaction. Virulent green leafhoppers (GLH) were used as vector to introduce RTV to the rice hybrids. Virus symptoms scores were recorded at 14, 21, 34, 41 and 59 days postinoculation (DPI), which suggested that virus symptoms are greatly influenced by growth stage of plants. To confirm the presence of virus, polymerase chain reaction (PCR)-based detection of Rice tungro bacilliform virus (RTBV) was carried out at 7, 14, 21 and 59 DPI using virus genome-specific primers. Virus presence was observed in all the rice hybrids and check varieties, particularly at later stages of infection. This study shows that phenotyping for tungro virus resistance in rice hybrids at 21 DPI gives most reliable results based on both virus symptoms and presence of virus. Further, to assess the relative difference in population of RTBV, quantitative PCR was performed in all the genotypes at 21 DPI. Yield data were also recorded from control and virus-infected plants to estimate yield loss percentage due to tungro disease. This study is important to understand the

response of rice hybrids to tungro virus disease. Results obtained in this study emphasize that molecular detection of virus is very important to screen the rice plants accurately for tungro disease reaction.

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

A total of 40 blast disease specimens were collected from different locations of Andhra Pradesh and Telangana. Maximum radial growth was recorded in isolate RBDR 1, whereas minimum growth was observed in isolate RBWG 19 and RBMD 34. In pathological variability studies, isolates were evaluated on 8 host differentials along with susceptible check HR-12. Based on leaf blast severity, *M. grisea* isolates were grouped into 11 pathogenic races. In genetic diversity, polymorphism was detected among the isolates using SSR analysis with 4 markers.

A total of 6817 rice lines drawn from various trials composing of Near Isogenic lines, RILs, differentials, advanced lines from aromatic short grain variety improvement programme, IRBN lines from IRRI, aromatic rice variety improvement programme and TRP lines were evaluated on uniform blast nursery beds for resistance against leaf blast. The materials generated in functional genomics project of the department were also evaluated for resistance against rice blast. It was observed that 1529 out of 6817 lines were resistant against blast disease.

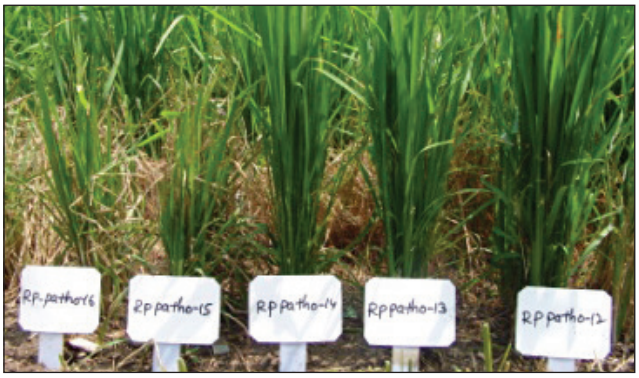


Fig. Phenotypic evaluation of pyramided lines

IET 25483 (RP 5961 Bio Patho 2-18-5) developed from the cross improved Samba Mahsuri*2/ Tetep with one gene (Xa21) for bacterial blight resistance and one gene (Pikh) for blast resistance showed moderate resistance to both BLB (Six out of sixteen locations)and blast (eleven out of seventeen locations). It was found to be superior 19.07% yield advantage over the recurrent parent in southern zone where its recurrent parent was released. It possessed days to 50% flowering, plant height and quality traits similar to recurrent parent. Hence it is considered for promotion for testing in second year of testing.

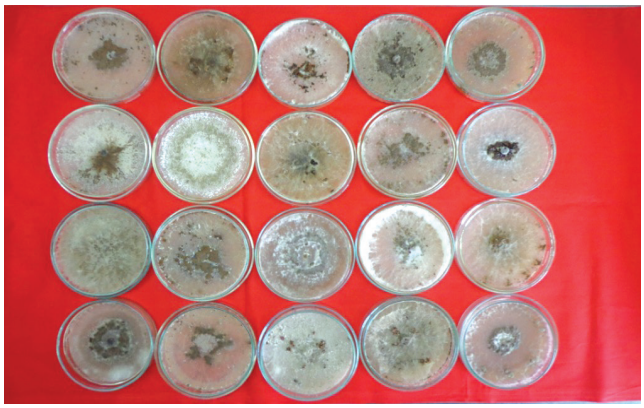
IET 25484 (RP 5960 Patho 7-5-9) developed from the cross of swarna*2/C101 A 51 with Pi2 gene for blast resistance was found to be resistant to blast at nine out of sixteen locations. It recorded yield advantage of 1.66% over the recurrent parent in Southern zone. It is similar to recurrent parent in terms of days to 50% flowering, plant height and quality characteristics. Hence, it is considered for the further testing in the second year.

The trial was conducted to evaluate new and commercially available fungicides on location specific diseases at 21 locations. The formulations *viz.*, ICF-110 (tricyclazole 45% + hexaconazole 10% WG), Merger (tricyclazole 18% + mancozeb 62% WP), Companion (mancozeb 63% WP + carbendazim 12% WP), tricyclazole 75% WP, hexaconazole 5% EC and mancozeb 75% WP and carbendazim 50% WP were evaluated against leaf blast at IIRR. It is on par with the tricyclazole in reducing the disease. *In vivo* evaluation of another fungicide trial revealed that, PDI was least in tricyclazole and kresoxim methyl sprayed plots in which tricyclazole gave maximum grain yield. B: C ratio was found to be highest for tricyclazole (1.29) followed by propiconazole and carbendazim.Increased grain yield over control and other treatments were observed in tricyclazole.

HRP/CPT/PATH/18: Characterization and management of *Rhizoctonia solani* causing sheath blight of rice

Sheath blight disease samples were collected and isolated the fungus (*R. solani*) from Karnataka (Bannikod, Bevinahalli, Shivanahalli, Anagavadi, Kadlegundi, Bellahally, Nanjanagud, Bannuru and keregodu) Telangana (Nalgonda and Siliguri) and Tamil Nadu (Coimbatore and Aduthurai).

All the 20 isolates from Karnataka showed more or less uniform growth and growth rate. The color varied between from pure white to pale brown color on upper side of the petriplate and sandy yellow to olive green on bottom side of the petriplate. Appearance of the mycelium varied between appressed and cottony growth. Sclerotia mostly grouped at centre among the isolates and scattered in few isolates.



Cultural variability among the isolates

Pathogenic variation among *R. solani* isolates was studied through typha method of inoculation in variety TN-1. To know the pathological variability observed the parameters *viz.*, infected tillers, lesion height, lesion number, size of the lesion (l*b), color of the lesion, lesion structure, appearance of first lesion from the base, distance between two lesion and disease score. Isolates from Anagavadi and Mysore showed lesion on the leaf and found highly virulent among the tested isolates.

Promising genetic sources were identified through screening of breeding materials, germplasm *etc.* 319 F3 lines (BPT 5204 X ARC 10531) and 262 F3 lines (BPT 5204 X Tetep) of breeding materials were screened against sheath blight under IIRR-field through artificial inoculation method. Among the 582 lines evaluation, 32 lines were observed to have RLH% in the range of <20% that denotes moderate level of resistance. About 43 HWR entries from IRRI were screened against sheath blight under field through artificial inoculation method. Among the entries HWR15 was found resistant against sheath blight. Around 95 NPK (Swarna X *O. nivara* – IRGC 81848) and 100 NPS (Swarna X *O. nivara* – IRGC 81834) lines were screened against sheath blight under IIRR-field through artificial inoculation method. Out of these lines 6 lines showed promising.

Field experiment of new combination fungicides effectively reduced the disease severity compared to check (DS – 94.8%). The new combination fungicide ICF-110 (tricyclazole 45% + hexaconazole 10% WG) at 1.0 g/l sprayed plot showed less disease severity (DS:31.2%) and highest grain yield compared to check plot (4096 Kg/ha).

Table : Evaluation of new combination fungicide against sheath blight under field condition

Treatments	Dose	Disease severity	Yield (Kg/ha)
ICF-110 (tricyclazole 45% + hexaconazole 10% WG)	1.0 g	31.2 (34.0)	4096
MERGER (tricyclazole 18%+ mancozeb 62% WP)	2.5 g	37.2 (37.6)	3929
Tricyclazole 75% WP	0.6 g	40.9 (39.8)	3473
Hexaconazole 5% EC	2 ml	31.8 (34.4)	3763
Mancozeb 75% WP	2.0 g	36.9 (37.4)	3270
Companion (mancozeb 63% + carbendazim 12% WP)	1.5 g	34.5 (36.0)	3685
Carbendazim 50% WP	1.0 g	37.7 (37.9)	3588
Control	-	94.8 (76.9)	2849
General mean		43.1	3582
CV (%)		3.48	10.8
CD at 5%		1.18	414.1

Botanicals were tested against sheath blight of rice during *kharif*-2015 under field condition. Seed powder collected from Chrozophera, Theratia, Argemone, Neem, Psoralia, Cleome, Pongamia, Jatropa and Annona for the bio-efficacy test. All the ten botanicals were reduced the disease severity compared to check (DS–88.9%). The Jatropa extract sprayed plot showed less disease severity (DS:32.6%) when compare to other treatment plots.

HRP/CPT/PATH / 19 : Epidemiology and Management of false smut

A total of 40 isolates representing 18 states were studied for their morphological variation on potato sucrose agar medium. The characteristics

viz., form, elevation, margin of the colony, colour, sector formation, zonation, wrinkling, furrow formation formation of chlamydospore and growth were recorded. The isolates collected from Moncompu (9), Nandhiyal (9), DRR (9) were grouped as fast growing isolates whereas isolates collected from Navasari (4.3), Malan (4.3) and Karnal (3.4) grouped as slow grouping isolates. Most of the isolates belonged to circular to irregular form with the elevation of raised/flat. Mycelium of the most of the isolates was observed as entire/filiform and few isolates recorded as undulate. Surface colour of the isolates is being changed from white to yellow and finally as green. Few isolates *viz*., Titabar, Malan-1, Mugad, PAU-1, Pau-2, Warangal-1 and Kasipur recorded only with white color and no further color change was observed. Reverse color of the *U. virens* isolates varied as brown, yellow and green. In addition *U. virens* isolates were tested against *Candia albicans* and results revealed that (Ludhiana (4.2 cm) Sakoli-1 (4.4 cm) recorded with high inhibition zone and isolates *viz*., Sakoli-2, Uchani, and Karnal did not produce inhibition zone which needs further confirmation.

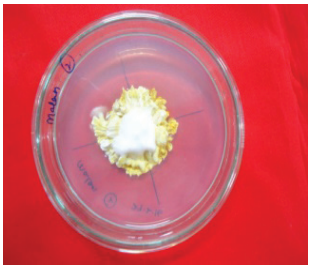


Fig. Malan isolate with wrinkled margin

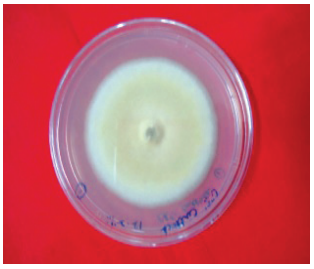


Fig. Cuttack isolate with circular margin

Karnal isolate (which exhibited highest inhibition zone against *Candida albicans*) was chosen for its toxin isolation. Isolated toxin from both from the smut balls and culture filtrate using ethyl acetate. The isolated toxin portion also exhibited its toxic activity against *Candida albicans* and also affected seed germination of paddy seeds.

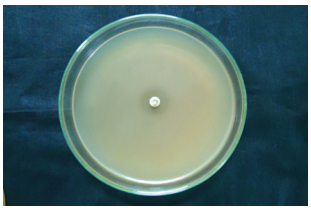


Fig. Toxin (culture filtrate) against Candida albicans

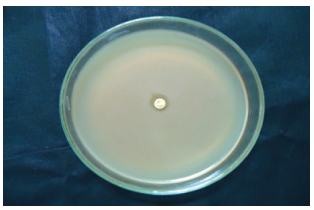


Fig. Toxin (smut balls) against Candida albicans

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

Several native microbial antagonist's *viz*., Fluorescent *Pseudomonas* sp, *Trichoderma viride, Penicillium* sp. and *Aspergillus* sp. were isolated from the rhizosphere soils. The antagonists were tested for their effectiveness to suppress the growth of *Rhizoctonia solani*, the sheath blight pathogen on rice under *in vitro* conditions. Results indicated that the antagonists are effective in suppressing the growth of the fungus. Confirmatory tests are under progress.

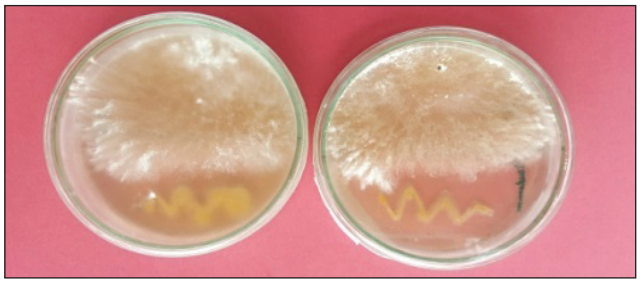


Fig. Effect of *P. fluorescens* on *R. solani*

Fig. Effect of *Penicillium oxalicum* on *R. solani*

HRP/CPT/PATH/21: Host plant resistance on brown spot disease of rice and its management

Brown spot infected rice samples were collected from Northern states *viz*., Punjab & Haryana and from Central parts of India *viz*., Chhattisgarh and Madhya Pradesh. Isolation was carried out from these infected samples. Isolation of brown spot from infected leaf samples lack in sporulation. Hence the isolation was carried out from infected seeds. Rice seed samples (BPT 5204) were collected and analysed for the presence of *B. oryzae* using standard agar plate method through colony characteristics.

Based on colony morphology and conidial characteristics, the cultures were identified as

Bipolaris oryzae. The fungal colonies were round with black fluffy mycelial growth, conidia were curved, fusoid or obclavate, almost cylindrical, pale to golden brown, 5 to 6 septate with hillum and exhibited bipolar germination pattern. One of the major difficulties in isolation of *Bipolaris* is the common contaminant *Curvularia* spp as colonies of both the fungus look similar and identification is only possible through examination of spores. The colonies of *Curvularia* spp. look dark black with flat mycelial growth and conidia are usually black, curved, second cell from the base largest with 2 to 3 septate.

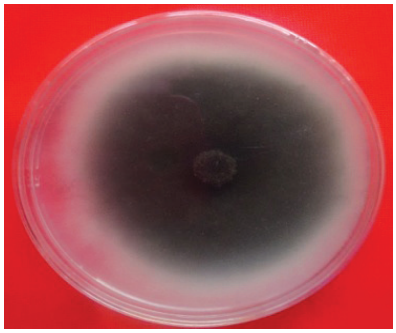


Fig. *Bipolaris oryzae* culture

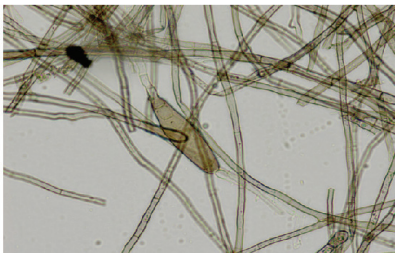


Fig. Conidia (*Bipolaris oryzae*)

Transfer of Technology & Training

TTI/TTT/EXT/8: Sustainable Rice Production Practices: Problems and Prospects

Data collected through structured interview schedule from 180 farmers from the districts of Durg, Raipur and Mahasamund representing the chhattisgrah plain zone, revealed that the major cropping systems followed by the farmers are Rice-Rice, Rice–vegetable and Rice-Utera. The major rice varieties cultivated by the farmers are Swarna, Mahamaya, Danteswari, MTU 1010, Indira sugandh Dhan, BPT 5204, Danteswari and Durgeswari, whereas, the popular rice hybrids cultivated by the farmers are Arize 6444, VNR2245, US 3112, and US 382. In addition to the HYV and hybrids farmers also cultivating indigenous aromatic rice like Vishnubhog, Kalikamod, Shrikamal, Dubraj, *etc*. in small plots for domestic consumption. The major biotic stresses put forth by the farmers are weeds, insect pests like brown Planthopper, gall midge, termites and nematodes, in case of rice diseases, blast, bacterial leaf blight, are causing yield loss.

All the farmers of the study area opined that despite some production constraints rice has provided them employment opportunities, household food security and 56% of the farmers are getting marketable surplus. The major sources of information related to rice cultivation are from fellow farmers (89%), local–agro-input dealers, (78%), KVKs (51%), NGOs (40%), line department (37%) and from the mass media sources (14%). Good many number of ITKs are followed by the rice farmers, if rice scientists validate it and further up scaling it will reduce not only the cost of cultivation also will help sustainable rice farming in the fragile ecosystem. *Biasi* method (*bushening*), control of insect pests and pathogen by using plants and indigenous storage structure made up of mud, ash cow dung jute bags and bamboo sticks are cost effective one.

The SWOT analysis of sustainable rice production in Chhattisgarh revealed the strengths as 1. favorable rice growing environment, 2. good many number of indigenous rice varieties, 3. abundant labour force and adequate water and 4. numerous schemes for stepping up rice production launched by the state and central government. Major weakness are 1. low productivity of the soil, soil related problems like salinity and toxicity, 2. Low seed replacement rate and 3. poor and backwardness of the peasantry and slow pace of mechanization. The opportunities are 1. the prevalence of many seed companies, 2. Chhattisgarh is emerging as a seed hub in central India, 3. Government thrust to irrigation programmers and value addition related to rice and 4. the good number of indigenous technologies practiced by the rice farmers. Threats for sustainable rice production are 1. rainfall fluctuation, 2. climate change, 3. drainage problem and poor water management, 4. price fluctuation, increasing cost of cultivation and 5. the alienation of labour force from agriculture.

Table: Threat to Sustainable Rice Production in Chhattisgarh

S. No.	Major threat to sustainable Rice production	No. of Farmers	Percentage
1	Resistant Variety for both biotic and abiotic stress	162	90%
2	Increase infrastructure cost of Tube wells	79	43.8%
3	Nutrient Deficiency	104	57.7%
4	Slow Seed Replacement	100	55.5%
5	Poor Drainage system	111	61.6%
6	Labour problems	98	54.4%
7	Non-availability micro nutrients and Biofertilisers in time	98	54.4%

TTI/TTT/EXT/9: An Exploratory Study on Partnerships: Impact and Implications for the Rice Sector

Special focus was given to study the public–private partnership in agricultural extension and advisory services through Agri clinics and Agri Business centres promoted by the Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. The cases of Agripreneurs involved in the advisory services were documented mainly with the help of the secondary sources. The result confirms the utilisation of private enterprises to deliver agricultural advisory services as a useful strategy to increase the coverage and effectiveness of the pluralistic extension system in rice sector.

Till April 2016, about 47884 candidates were trained, 20777 ventures were established and out of this about 2058 projects are supported by the banking institutions. In case of Telangana, about 1007 candidates were trained, 363 ventures were established and out of this about only 38 projects are supported by the banking institutions. The analysis of the various reports revealed that adequate training in the agribusiness related area, effective marketing strategies, extension efforts such as technology demonstration and dissemination strategies, value addition initiatives were the critical success factors. The services led to increase in cropping intensity, improvement in farm mechanization, productivity and profitability enhancement, decrease in labour engagement and reduced cost of cultivation. The agripreneurs extended technology demonstration and dissemination services such as distribution of literature, organizing exposure visits, campaigns, interaction meeting, training programmes for the benefit of farmers.

TTI/TTT/EXT/10: Gender dimensions in rice sector: Dissemination of climate resilient rice production technologies to farmers and farm women in selected villages of Ranga Reddy District of Telangana State

Data was collected from four villages Yellamma Tanda, Boiguda, Devunigadda and Rudraram of Ranga Reddy District of Telangana State on farmers' perception of effect of climate variability on rice cultivation practices. Seasonal calendar for workload of women revealed that the months of April and May only non-agricultural work such as fuel wood collection and minor house hold repairs were taken up. The decision making matrix on farming practices indicated that choice of crops, new variety, education and marriage of children were joint decisions; loan procurement, quantity to sell and marketing were solely decided by male members of the family.

Focus Group Discussions (FGDs) : FGDs were organized in the selected villages and the Standard Seed Security Assessment Methodology developed by FAO was applied to collect data. Around 75% of the area under rice cultivation during *Rabi* has been diverted to cultivating vegetables like carrots/beetroot/tomatoes and chillies due to low water and input requirements as reported by farmers of the study area.

Varietal Change : The varietal change as reported by the farmers in the study area indicated that the variety ***Aman Sona*** has replaced BPT-5204 and Hamsa as its duration is more suitable to the rainfall pattern (5.5 months) is a high yielder 40 bags/acre with lodging resistance and was fetching good price in the market.

Seed Source Mapping : The farmers' seed sources for paddy were mapped and it revealed that, agro-input dealers were their main source (80%) followed by 20% from local market, Shamshabad, Ibrahimpatnam and Nagarguda. Own seed was not being used due to problem of mixtures resulting in high weed infestation.

Rating of Agricultural Seasons : In order to understand the farmers' perception of effect of climate variability, their rating of past three agricultural seasons was done. They were asked to rate the seasons based on rainfall, yield and returns on a continuum of good, average and bad years. The farmers' rated the agricultural season in year 2013 as good and the area under rice cultivation was unchanged. The year 2014 was rated as average and subsequently the area under rice was reduced by 40%. The year 2015 was rated as a bad year resulting in reduction of area under rice by 75% and diverted to vegetable cultivation as it is more remunerative.

Interaction of IIRR Scientists with women farmers of Village Yellamma Tanda

TTI/TTT/EXT/12: Maximizing the Impact of Rice Technologies through ICT applications

Advent of Information and Communication Technologies (ICTs) provided enormous opportunities to explore web based extension services like Rice Knowledge Management Portal (RKMP), Agropedia, AgMark, eXtension *etc.* During the year 2015-16 two control experiments were conducted using two approaches *viz*., video dissemination and rice check in Telangana and Tamil Nadu. In Telangana the video extension module was tried using pico projectors during 2015-16 *Kharif* and *Rabi*. Two groups from Nalgonda (40 farmers) and two groups from Mahaboob Nagar (40 farmers) were selected for exposing them with the videos on rice production technologies. A total of three videos on RNR 15048 (collected from ARI, R Nagar) were selected for intensively disseminate the extension messages. The data was collected about the knowledge gain, ease of access, applicability, adoption and relative advantages of video based extension. The micro level impacts made by regular video shows were captured and analysed.

In Tamil Nadu integrated ICT tools were used along with Rice Check program. The rice technologies and knowledge were disseminated among 40 farmers and over a period of one season and the impacts were studied to assess the factorial contribution of ICT interventions. The data was collected about the knowledge gain, ease of access, applicability, adoption and relative advantages of video based extension. The micro level impacts made by regular video shows were captured and analysed.

In both these provinces, impact of knowledge interventions was found to be significant when blended with field demonstrations. Factorial contribution of knowledge interventions (using ICTs and non-ICTs) adoption levels on productivity and income levels were studied.

TTI/TTT/EXT/13: Effectiveness of farmers field school in dissemination of IPM strategies in rice

Village Ankushapur, in Mandal Jammikunta and District Karimnagar was selected for study under this project. The baseline survey was conducted in this village. The population of the village is 1012 and having a cultivable area of around 1200 acres. The major crops grown are rice and cotton (around 500 acres each) followed by minor crops such as maize, vegetables, *etc*. Farmers are using flooding type of irrigation with wells, bore wells supported with canals. The soil is red and black soils with low organic carbon and nitrogen, high phosphorus and medium potash content.

Stem borer, BPH, blast, leaf mite, panicle mite and stem rot are the major insect pests and diseases in rice. Farmers apply 6-12 sprays for the management of pests. Farmers are getting plant protection information mainly from input dealers and Adarsh Rytus. Though the farmers were aware about IPM components and used pheromone traps, yellow sticky traps, neem products, *etc*. in cotton, they are not aware of IPM practices in rice. The other problems in rice cultivation as listed by farmers are low soil fertility, non adoption of seed treatment, non

adoption of alleys formation, usage of higher seed rate, injudicious use of fertilizers especially application of complex fertilizers as top dressing, indiscriminate use of pesticides, usage of excess water, non maintenance of optimum plant population, rodent problem, *etc*.

TTI/TTT/ECON/2: Training, Transfer of Technology and Impact analysis Socio-economic impact assessment of rice production technologies

The farm level socio-economic impact of Direct Seeded Rice (DSR) was studied in Punjab. Comprehensive data sets for 150 rice farmers were collected from three major Direct Seeded Rice districts *viz*., Sri Muktsar Sahib, Bathinda and Kapurthala of Punjab state. The major varieties used by the farmers in the study area are Pusa Basmati 1121, P 44, PR 122, PR 114, PR 118, and PR 111. The DSR farmers used 8.75 kgha^{-1} more seed as compared to transplanted rice and is significant at 5%. The labor costs for weeding were significantly higher for DSR than the transplanting method, due to combined effect of applying more herbicides and manual labour for weed management. Adoption of DSR has resulted in much lesser number of irrigations compared to the transplanted method. The net returns and B:C ratio were higher in DSR (2.47), because of lower cost of cultivation as compared to transplanted method(1.86).

Farmers' perception on advantages and constraints of DSR were ranked by using five point scales of variables and Priority Index was calculated. The results revealed that the reduced requirement for labour and irrigations was the strength of DSR followed by the lower cost of cultivation, less wear and tear of the machinery and more wheat yields. Increased weed infestation, poor crop establishment, difficulty in fertilizer management, problem of voluntary plants and pests and disease incidence were reported as the major constraints in DSR. The total monetary gain estimated through adoption of DSR in Punjab during the year 2015 was worked out to be Rs. 730,000,000.

The impact of System of Rice Intensification (SRI) on farmers' earnings was assessed in Telangana with a sample size of 210 farmers. The advantage of SRI method was seen in case of reduction in cost of cultivation, higher yields obtained per acre and lesser duration for harvesting the crop.

The impact of Chemical weed control with herbicide 'Penoxsulam' was assessed on farmers' fields in Rangareddy district of Telangana for the second year, which, revealed that application of Penoxsulam resulted in timely weed control, drudgery reduction and saving in cost of cultivation by Rs. 3325/- per hectare over the manual weeding.

Visit to DSR fields of Kapurthala

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

The study revealed that as on 20-2-2016, out of total 10998 applications received by PPVFRA, 45% of applications pertained to Rice crop. In total rice applications, farmers variety applications constituted 88% (4305 applications), public sector share was 5% against private sector share of 7%.

However, as on 31-12-2015, among plant varieties registered with PPVFRA (2067), share of rice varieties constituted 46% (946). Only 19% varieties out of the total applications received were registered and share of farmers, private sector and public sectors were 74%, 10% and 16% respectively. Only 61 varieties were new, constituting 6% of total rice varieties registered out of which 90% were from private sector. Only 50 were hybrids constituting 5% of total rice varieties registered and 45 were from private sector. Number of private companies which got their varieties registered with PPVFRA increased in 2015 compared to 2014 and C4 ratio (indicating share of PVP certificates of top 4 companies in total PVP certificates) declined in 2015 compared to 2014.

Odisha is the leading state in terms of number of farmers' varieties registered. A sample survey of (19) farmers from Cuttack and Puri districts of Odisha, who registered their varieties with PPVFRA revealed that farmers as well as several block level AAOs were not aware of the farmers' rights under PPVFRA. As of now many of the farmers' varieties are not being grown on large commercial scale, but they are having special characters like flood tolerance, pest and disease resistance, suitable for preparing products like beaten rice, puffed rice, *etc*. Hence there is a potential for developing high yielding varieties with these special characters in research. This offers scope for enabling the farmers owning these varieties, realize their rights as breeders by their share in benefit of commercialization of newly developed varieties.

As per the suggestions of RAC and IRC the following 10 strategies have been formulated for future Rice Research

1. Enhancing genetic yield potential by utilizing the genome sequence information
2. Enhancing rice yields through pre breeding for broadening the genetic base
3. Improved grain and nutritional quality and value addition
4. Sustaining soil health
5. Enhancing water productivity
6. Improving resource use efficiency *i.e.,* low input with high profitability to farmers
7. Value addition and post harvest processing
8. Integrated pests and disease management
9. Validation and transfer of technologies
10. Farming systems approach

Team IIRR re-oriented Institute Research Projects based on newly formulated 10 thematic areas for future Rice Research

1. Genetic Enhancement of rice yield, stress resistance / tolerance and improved nutritional quality
2. Exploitation of heterotic gene pools and development of hybrids suitable for different eco systems
3. Genomic and biotechnological intervention in identification and discovery of novel genes / allels and introgression for re-designing rice crop
4. Designing climate smart rice for mitigation and management of crop response to climate change
5. Selective mechanization for rice cultivation system
6. Resource and use efficiency for maximising yield, profitability and sustainable crop productivity
7. Development of soil health management system for enhanced productivity and sustainability of rice cropping system
8. Sustainable insect pest management in the changed climatic conditions for enhanced productivity
9. Sustainable disease management in the changed climatic conditions for enhanced productivity
10. Innovative strategies for efficient technology transfer and impact assessment

Completion Reports of Externally Funded Projects

"Conversion of elite partial restorers among the rice cultivars into restorers by marker-assisted introgression of major fertility restorer genes, *Rf4* & *Rf3*" Funded by DBT (Dec, 2011 to Nov, 2015)

This project was initiated to develop desirable restorers with the characters of Swarna and Samaba Mahsuri. To improve the fertility restoration, the popular mega varieties *viz*., Swarna, Samba Mahsuri and Improved Samba Mahsuri were crossed with KMR3R and IBL 57 to produce F_1s. These F_1s were backcrossed with recurrent parents to produce back cross populations. The hybrids produced by using converted partial restorers of BC_1F_6 showed 15-20% more spikelet fertility than partial restorers i.e. Swarna, Samba Mahsuri and Improved Samba Mahsuri. It has provided a basis that by transferring fertility restorer gene *Rf3*, fertility restoration percentage has been improved from 15 to 20 % in the partial restorers' *viz*., Swarna, Samba Mahsuri and Improved Samba Mahsuri. Around 200 new restorer lines with good grain and cooking quality of different duration have been developed for hybrid rice breeding programme. The new rice hybrids developed utilizing converted restorers with the characteristics features of Swarna, Samba Mahsuri and Improved Samba Mahsuri has been nominated to AICRIP for multi location testing across the country.

"Marker-assisted recurrent selection for improvement of biotic stress resistance in hybrid rice" Funded by SERB-Fast Track young scientist project (April 2012 to 2015)

One of the interesting method of improving parental lines is genetic male sterility facilitated recurrent selection, which not only broadens the genetic base of parental lines but also helps in pyramiding the desirable genes (Virmani *et al*., 1997). In the present study IR36 genetic male sterile (GMS) restorer population DRCP-102 was utilized for restorer improvement programme. Sterile plants selected from DRCP-102 plants were crossed with donors of *Xa21* for BLB resistance, *Pikh* for blast resistance, *Bph20 & 21* for BPH resistance and *Gm4* for gall midge resistance to produce F_1s. Harvested F_2 seeds from each selected F_1 plants and equal quantity of seed were mixed and subjected to 1st recurrent selection cycle or recombination cycle. Seeds harvested from sterile plants (out crossed) were harvested and bulked to constitute next recurrent selection cycle. In each cycle molecular screening for the target traits with the help of linked markers was undertaken for selecting plants for further recurrent selection cycle. In the same way the population was advanced till 7th recurrent selection cycle and from 5th cycle onwards fertile plants were selected and advanced by two row pedigree method to derive multi stress resistance restorers. The identified multiple stress resistance restorers are under phenotypic evaluation for various biotic stresses to identify potential restorers for hybrid rice breeding.

Development of RNA interference (RNAi) mediated resistance against rice yellow stem borer (DBT) (Nov 2012- Oct 2015)

To silence the key genes of YSB yellow stem borer (*Scirpophaga incertulas*) three candidate genes of YSB were selected for silencing and assessing their effect on control of larval growth and infestation. Bioassays of 5'FAM labeled siRNAs designed from target genes *viz*., Acetylcholinesterase, Cytochrome P450 and Amino peptidase N resulted in reduced larval growth, size, delayed molting and led to mortality. These bioassays were confirmed by the presence of fluorescence in the larval tissue as well as larval gene silencing through qRT-PCR. Using these three gene 21nt siRNA, three ami RNA binary constructs were developed and mobilized in into Taipei and BPT by *Agrobacterium*-mediated transformation method. Transgene integration was confirmed in T_0 plants through molecular approaches and confirmed plants were carry forwarded to T_1 generation and these T_1 are being evaluated their efficacy through insect bioassays.

Identification and molecular mapping of novel neck blast resistance gene (s) from local landraces and introgression lines of Oryza (DBT funded TWINING project) (April 2012 - March 2016)

In this project, extensive screening of 326 introgression lines (ILs) derived from six wild species of Oryza (*viz*. O. glumaepatula, O. glaberrima, O. nivara, O. rufipogon, O. longistaminata and O. barthii) were done and fFour ILs (IL-1, IL-2, IL-3 & IL-4) were selected. These four ILs were screened again through AICRIP for leaf and neck blast resistance. All the four ILs have shown excellent resistance to both leaf and neck blast. IL-1 which is derived from O. glumaepatula, inheritance study showed that, resistance for leaf and neck blast is governed by polygene which suggests the role of QTLs in resistance. Though QTL analysis, two QTLs, i.e qBL3 on chromosome-3, having 53% phenotypic variance and another QTL qBL7 on chromosome-7 with 35% phenotypic variance with LOD >5.0 were identified. The identified QTL's were further validated in alternate populations. Introgression of these QTLs was also being done in to the background BPT-5204 (now it is in BC_2 generation). Through GBS (genotyping by sequencing), SNP markers were developed and used them in fine mapping of qBL3, it resulted in to narrow down the QTL region from 3 Mb to 100 Kb. Through micro array, we specifically identified the genes which are up regulated and found serine threonine kinase was one among those, and is the only gene belongs to resistance mechanisms present in the 100 kb region of qBL3.

Akahanphou is a unique rice landrace collected from Manipur. It was extensively screened for the leaf and neck blast and showed high resistance for leaf as well as neck blast. Resistance gene profiling study with linked markers revealed the presence of Pi38 and Pitp in these unique landrace. Further, inheritance study showed polygenic control of blast resistance. Through QTL mapping, two novel QTLs which confer resistance for both leaf and neck blast resistance i.e, qLNBL-5 (26.23% PV) and qLNBL-7 (25-31 %) present on chromosome-5 and 7 were identified. Identified QTLs were confirmed in alternate populations derived from Akhanaphou. Validation results prove the reliability and reproducibility of the mapping results. The fixed lines (RIL lines) having both QTLs with or without two major reported genes (Pi38 and Pitp). These lines can act as good genetic resources which can be used in introgression of novel QTLs for development of durable blast resistance cultivars.

Metabolic and Molecular profiling of aromatic rice Germplasm of India for gaining insights about Aroma (Aug 2012 to Aug 2015)

It is a network project with 11 centers, (IIRR) Hyderabad – Nodal center, (IICT) Hyderabad, (PAU) Ludhiana, (GBPUA & T) Pantnagar, (NDUA & T) Masodha, (AAU) Nawagam, (TNAU) Coimbatore, (IGKV) Raipur, (IARI) New Delhi, (SVPUA & T) Nagina and (JNKVV) Jabalpur.

Developed the core set of aromatic germplasm and Identified 30 accessions having novel alleles of *badh-2* in the core set which have the different nucleotide variation than the established polymorphisms. Identified 40 accessions having novel alleles of *badh-1* in the core set which have the different nucleotide variation than the established polymorphism. Analyzed alleles of *badh-2* and *badh-1* found that *badh-1* alleles have less variation than the *badh-2*. A – T (Transversion) in exon -2 and 6bp insertion in intron-4 of *badh-2* plays a vital role for accumulation of 2-APin ASG- indigenous accessions. A three base pair deletion in intron-2 of *badh-2* plays vital role in accumulation of 2-APin ASG- Exotic accessions. In Traditional Basmati- indigenous group, in addition to the 8bp deletion exon-7, have 8 bp insertions in intron -4 also associate with 2 AP productions. In Evolved Basmati- indigenous accessions have 43 bp deletions 3' UTR specifically associate with 2AP accumulation. In traditional/evolved-exotic accessions, a SNP, A→G (Transition) at position 5677 was found a major SNP contribute the 2-AP. Identified accessions which does not have 8bp deletion in exon-7 of *badh-2* but still have the 2AP, where in badh-1 allele have common SNP i.e. C/T at position 1172 in *badh-1*, which contribute to the 2-AP. Identified 5 accessions which have novel alleles of *badh-1* play role in

2-AP formation. Twenty four core accessions in that majority belongs-ASG- Indigenous group might have contained other metabolites which cause the aroma. Among the ASG: the *badh-1* sequence variation and 8 bp deletion in exon -7 of *badh-2* may not have correlation to the 2AP values. It appears that there are at least 11 major volatile metabolic compounds which contribute to the aroma. Aroma is best expressed at GI centres than non GI centres.

Molecular marker-assisted introgression of two major blast resistance genes and a major QTL for grain yield under drought stress in rice -DBT(July 2013 to June 2016)

The strategy of marker-assisted backcross breeding coupled with phenotype-based selection was adopted to transfer major blast resistance genes *i.e. Pi1, Pi54* and a major QTL for grain yield under drought stress *i.e. qtl12.1* into the genetic background of elite upland variety Varalu. Marker-assisted foreground selection involving the codominant/functional markers RM224 for *Pi1*, RM206 and Pi54MAS for *Pi54*, while RM511, RM28099, RM28130 and RM28163 for *qtl12.1*, respectively were used for selection of target traits. Polymorphic survey was done among the parents and found 200 polymorphic SSR markers among Vandana NIL and Varalu and 180 SSRs among BPT-LT and Varalu. The identified polymorphic markers were utilized for background selection at BC_1F_1 and BC_2F_1 stages and positive plants having maximum recurrent parent genome (approximately 82-87%) were selected for advancement. The best BC_2F_2 plants having two blast genes and qtl 12.1 in homozygous state were intercrossed to get the both traits in the genetic background of Varalu. The phenotyping and genotyping of obtained IC_1F_2's were done and selected 20 best plants. These plants are being evaluated for yeild as well as blast resistance. The developed lines will be nominated in AICRP trials.

Institutional Activities

Significant events

Transfer of Technology

Revenue Generation

Awards/recognitions

Other Institutional Activities

Personnel

Publications

Training and Deputation

Results Framework Document

Significant Events

1a. IIRR in the Service of Farmers

IIRR has been forging ahead taking all the ICAR Institutions, SAUs and Departments of Agriculture of Telangana and Andhra Pradesh together keeping farmers' first as the motto and farmers welfare being the foremost priority. During 2015-16 IIRR took several steps such as Rythu sadbhavana yatras, Organizing farmers days/meets and implementing Tribal sub plan *etc.,* to interact with farmers and to provide possible technical solutions to improve their livelihood in both the states. Ten Teams each with a group of 8-10 members visited several villages and interacted with hundreds of farmers.

Rythu Sadbhavana Yatra in Telangana and Andhra Pradesh

In view of the seriousness of drought situation prevailing in the Telangana and Andhra Pradesh states, Rythu Sadbhavana Yatras were organized during 5 - 6 October, 2015 in Telangana and 27-29 January 2016 in Andhra Pradesh. Joint multi-crop and multidisciplinary teams comprising of Scientists from ICAR, ICRISAT, PJTSAU, ANGRAU and officials from State Agriculture Departments such as ADAs, DDAs and JDAs covering 150 villages across nine districts of the Telangana and 200 villages across 13 districts of A.P were organized to instill confidence among the farmers. The visit was flagged off from IIRR, Hyderabad by the Directors of IIRR, IIMR, CRIDA, IIOR, PDP and Director (Research) PJTSAU in the morning of 5th October 2015. The visits encouraged the farmers and helped to build the confidence among farming community in all the districts of Telangana and Andhra Pradesh.

The farmers need urgent support from concerned agencies for reclamation, soil testing, and recommendation of suitable crops as per soil mapping. The farmers were facing problems related to bank loans.

Major Issues

- Major concerns of agriculture in these states included mainly the cost of cultivation, non-availability labour, minimum support price. Farmers also felt that development of crop based industry for value addition could be an ideal mechanism for improving farmers' status.
- As the input costs increased, there is a need to introduce crop varieties that can withstand major biotic and abiotic stresses. Supply of good quality seeds, unadulterated pesticides, herbicides, fungicides *etc.* in time should be ensured.
- Government should create storage and marketing infrastructure along with post harvesting processing mechanism to help the farmers.
- Stringent law enforcement is required with reference to exploitation of groundwater because of high investments in digging bore wells. Besides, there must be a mechanism to insist the farmers to follow the scientific agriculture complying with the advises from technical personnel.
- There is an urgent need to train rural youth and provide employment opportunities in agriculture and allied industries and encourage them in maintaining custom hire centres for machinery, workshops for repairing the machinery, rice mills, biofertilizer manufacturing units *etc.*
- School children were targeted to create awareness about pursuing agriculture as a profession in the first instance and to make agriculture as a means of livelihood with higher returns through value addition.
- Establishment of cooperative societies to help the farmers in providing timely inputs, like seeds, fertilizers, pesticides, herbicides, farm machinery *etc.*, is essential for which unity among the farmers and Government support is needed.
- There is need a need to adopt and practice integrated farming system management

Rythu Sadbhavana Yatras in Telangana and Andhra Pradesh

Team of Scientists visited all the districts of Telangana and Andhra Pradesh and discussed with farmers on various issues related to agriculture

approach involving different farming systems like dairying, poultry, cash crops, vegetables, pulses, millets and cereals *etc.*

- ✧ The diagnostic teams suggested the following steps to mitigate the drought stress.
- ✧ Crop diversification, inter cropping, water conservation and rainwater harvesting measures, reclamation of paddy fields, integrated farming systems approach, adoption of micro-irrigation, classification of farmers fields for suitability to crops, supply of acoustic devices *etc.*
- ✧ The agricultural scientists of ICAR and SAUs should realign their research priorities to address the farmer needs in developing high yielding varieties responding to low inputs and with multiple resistances for pests and diseases. Lodging resistant varieties with good dormancy for coastal region.
- ✧ Development of varieties rich in Fe and Zn for supplementing the micronutrients. N & P use efficient varieties for increased input use efficiency.
- ✧ Water saving technologies for areas experiencing moisture stress and Cropping system research.
- ✧ Organic farming for high market demand.
- ✧ Farm mechanization to overcome labour shortages and large scale cultivation.
- ✧ Photosynthetic efficient varieties for increased yields.
- ✧ Strengthening extension activities with FLDs and Farmers Days.
- ✧ Regular interactions with farmers to identify research areas based on farmer priorities.

Farmer-Scientist interaction

Popularisation of cost effective and labour saving rice production technologies was under taken in Chinna Solipet Village of Rangareddy district on 13/08/2015. A farmer- scientist interaction was organized to create awareness about the use of herbicide for weed control, drum seeder under water saving technology and cono weeder for labour saving and drudgery reduction. Dow Agrosciences company has demonstrated the correct application of herbicide and precautions to be taken in the use of herbicide.

Field Day was organized on 2nd and 3rd at Chinna Solipet and Devunigadda villages of Rangareddy district of Telangana to showcase the technologies demonstrated under FLDs. In Devunigadda village, FLDs on 'Labour saving technologies' *viz.*, Use of manual weeders and application of herbicides were demonstrated In Chinnasolipet village, the FLDs on 'Cost Effective Rice Production Technologies', *viz.*, reduced seed rate and effective weed management were demonstrated and sprayers were distributed to beneficiary farmers to promote mutual sharing of resources during *Kharif* 2015. A Farmer-Scientist interaction was organized at both the villages. The farmers posed a lot of questions on pest management which were answered by IIRR scientists. The labour saving and cost effective technologies resulted in reduced cost and labour requirement which were highly appreciated by the beneficiary and other farmers. The interventions demonstrated in FLDs resulted in horizontal spread of technologies that reduced labour and input costs in rice production.

Blight-Out Project

With the collaboration of CSIR-CCMB, IIRR has been very actively poplularizing the Improved

Samba Mahsuri, a BLB resistant variety. Seeds of this variety were distributed to the farmers in Andhra Pradesh, Karnataka, Tamil Nadu, Telangana and Uttar Pradesh. Overall 500 demonstrations were conducted in the BLB endemic areas of these states. The extension information were provided in the form of video films and information brochure in both English, Hindi, Tamil and Telugu languages.

Tribal Sub-Plan

Achievements under ICAR - IIRR TSP 2015-16

- Improved Samba Mahsuri variety seeds has been distributed to 60 farm families in Nalgonda and Ranga Reddy Districts of Telangana.
- New varieties of ICAR-IIRR *viz*., DRR Dhan 42, 43 and 44 were popularized among the tribal farmers of Yellammatanda of Telangana. On 13-07-2015 mini-kits were distributed to the tribal farmers and technical inputs on package of practices were provided. Leaflets in local language about these new varieties were made and distributed.

- The farm families were provided with Zinc Sulphate, leaf colour chart for optimum use of nitrogen, selected herbicides.
- Field level training on sustainable rice production technology.
- For the *rabi* season, all the critical inputs like pesticides, herbicides and fertilizers were procured for 100 farm families.
- Off campus training on vermicompost making, IPM in Rice, safe seed storage and marketing value chains were organized.

Under the National Seed Project (NSP), Tribal Sub Plan (TSP) was implemented in the following districts.

- Chinthapally and Seethampet of Vishkhapatnam and Srikakulam districts during 4-6th Sep, 2015.

Implementation of TSP under Mega Seed Project at Seethammapet, Srikakulam Dist. A.P.

- Dummugudem of Khammam district during 30th Sep to 1st Oct, 2015.
- Bhimili Thanda of Nalgonda district on 29th Nov, 2015.
- Govinda thanda, thurkapally of Nalgonda district on 4th Jan, 2015.
- Narayanpet, Mahabubnagar district for distribution of Drum seeders, power sprayers and tarpaulins on 10th Feb, 2015.

Distribution of Drum Seeders under TSP in Narayanpet, Mahaboobnagar Dist. Telangana

During the visits to those selected villages, tribal farmers were briefed about TSP. Farmers' participatory seed production practices were demonstrated along with varietal / production / protection technologies to improve their income. Inputs like quality seeds, sprayers, drum seeders, cono weeders were distributed to the tribal farmers.

TSP in bheemli thanda, Nalgonda

Registration of Farmers' varieties

A huge number of varieties (gene combinations) evolved in the farmers' fields till systematic plant breeding started by trained Plant Breeders for developing high yielding varieties. Realizing the importance of such farmers' varieties (FVs) for the development of modern crop varieties, the Government of India enacted the "Protection of Plant Varieties and farmers' Rights Act-2001" in which the contribution of the farmers as conserver of such varieties has been acknowledged. There is a provision in the act to register such varieties in the name of the farmers. Being a mega-centre of genetic diversity of rice, India had a large number of farmers' varieties. However, with the spread of High Yielding Varieties (HYV) the total number of such farmers' varieties has drastically reduced. At present also some of the farmers like to cultivate their own traditional varieties for different reasons including assurance against total crop failure due to natural calamities. Such varieties need to be taken up urgently for registration with the PPVFRA for establishment of their legal ownership.

Farmers' Varieties under testing at IIRR Farm

Registration of farmers' varieties started with three farmers' varieties of rice namely Hansraj, Indirasen and Tilakchandan during 2008 and testing of 638 Fvs for registration during 2015-16. So far IIRR facilitated testing of 1900 FVs and registration certificates issued for 700 farmers' varieties.

Farmers' day organized at IIRR

Farmers Day 2015 was organized at IIRR on 7th November 2015. The technologies developed by IIRR and other ICAR Institutes were showcased on this occasion. About 600 farmers from Telangana state participated in the event. Honourable Minister of State Sri Bhandaru Dattatreya, Chief Guest emphasised that Telangana state should be developed as Seed Hub and appreciated the efforts of all the Agricultural Institutes working in Hyderabad. Sri. C. Parthasarathi, IAS, Agri. Production Commissioner (APC) and Secretary, Govt. of Telangana, emphasised the need for helping small and marginal farmers for enhancing the productivity. Smt, V. Usha Rani, IAS, Director General, National Institute of Agricultural Extension Management (MANAGE), informed about various training programmes organised by MANAGE for the benefit of the farming community. All the Directors of ICAR Institutes gave a brief account of their activities and technologies for farmers. Some of the progressive farmers were awarded and the queries raised by the farmers were clarified by the Scientists. There was exhibition of the Latest technologies developed by different institutes were exhibited.

Farmers' day

Innovative Rice Farmers' Meet

Innovative Farmers meet was organized on 29th August 2015 by IIRR. Honourable Union Minister for Labour, Shri Bandaru Dattarreya was the Chief Guest of this function. Shri V. Shobanadreeswara Rao, former Minister of Agriculture, Govt of Andhra Pradesh, Dr I.S. Solanki, ADG (FFC) and Sh. Dusharla Satyanarayana, Founder, Jala Sadhana Samithi were Guests of honour. The Chief Guest felicitated thirty innovative farmers representing all over India for their innovations related to rice cultivation. Innovative farmers made presentation on their innovations followed by interaction with the subject matter specialists for further upscaling and validation. On this occasion a book on "Rice Innovation – 2015" was released along with a "Mobile app on Rice Innovation". More than 200 farmers from all over India participated in this function and witnessed the farmers' innovations in rice cultivation.

Innovative Farmers Meet

1b. Official Events / Meetings

First Director of IIRR

Dr V Ravindra Babu, Principal Scientist and Head, Crop improvement section and Acting Director has taken over the charge as the first Director of Indian Institute of Rice Research Hyderabad on 9th November 2015.

Dr. V. Ravindra Babu, first Director of IIRR

Dr V. Ravindra Babu is a well known rice breeder, having been associated with rice crop for three decades. His research accomplishments include identification of stable salt tolerant genotypes in different crops *i.e.* paddy, wheat, barley, bengalgram, mustard and cotton, and registered four salinity tolerant rice lines IC Nos. 296497 (VRS17), IC296498 (VRS-2), IC 296499 (VRS-11), IC 296500 (VRS-12) with NBPGR. He was associated in evaluating popular rice varieties and hybrids at national level and identified genotypes with high Iron and Zinc and used them in breeding programme for developing varieties with high Iron and Zinc. He developed high zinc variety IET 23832 which was released in 2015.

Institute Management Committee (IMC)

The XIX Institute Management Committee meeting of IIRR was held on 27.05.2015 to discuss and fine tune the requirements of the institute. The meeting was attended by the experts *viz.*, Dr I S Solanki, ADG (FFC), ICAR, New Delhi, Dr Raji Reddy, Director of Research, Prof. Jayashankar Telangana State Agricultural University; Dr B. Dayakar Rao, Principal Scientist, DSR; Dr (Mrs) Mayabini Jena, Principal Scientist and Head, Crop Protection, CRRI, Cuttack, Dr A.K. Singh, Principal Scientist and Head, Division of Genetics and Plant Breeding, IARI, New Delhi; Shri Athmakuri Brahmaiah, Shri M. Vittal Reddy, Farmers' representatives; Shri H Ganesha, Finance & Accounts Officer, IIOR; besides the Project Director, Administrative Officer, Finance & Accounts Officer, IIRR and Heads of various sections of IIRR and convener Dr D. Krishnaveni, Principal Scientist, Plant Pathology, IIRR.

IMC Meeting at IIRR

Research Advisory Committee (RAC)

The fourth meeting of the Research advisory Committee was held at IIRR on 28th May 2015 under the chairmanship of Dr Darshan Singh Brar Former IRRI breeder (Adjunct Professor, School of Agri Bio-technology), PAU, Ludhiana. The other members include Dr I.S. Solanki, ADG (FFC), ICAR, New Delhi, Dr A. K Singh, Principal Scientist& Head (Division of Genetics & Plant Breeding), IARI, New Delhi, Dr Rabindran, (Professor, Plant Pathology & Registrar, TNAU, Coimbatore, Dr Raji Reddy, Director (Research), PJTSAU, Hyderabad, Dr Randhir Singh, Principal Scientist IIWBR, Karnal, Shri M. Vittal Reddy and Shri. A. Brahmaiah (Farmer

representatives) and Dr R Mahendra Kumar, Principal Scientist and Member Secretary, RAC, IIRR. At the outset Dr Ravindra Babu Director welcomed the Chairman and all the members and presented an overview of IIRR research activities and accomplishments covering crop improvement, crop production, crop protection and transfer of technology and training sections. Dr Mahendra Kumar presented the proceedings of the RAC 2014 and action taken report. This was followed by detailed presentation of research accomplishments of each discipline by respective heads of sections.

RAC meeting

Renovated administrative block was inaugurated by Chairman RAC Dr D.S. Brar, Former IRRI breeder (Adjunct Professor, School of Agri Biotechnology), PAU, Ludhiana.

Dr. D.S. Brar inaugurating Administrative block of IIRR

Institute Research Council (IRC)

Institute Research Council Meeting was organized from June 1-2 and 17 2015 under the chairmanship of Dr V Ravindra Babu, Project Director, IIRR. All the Scientific Staff of IIRR participated in the meeting. The chairman in his opening remarks highlighted the importance of IRC and the sequential system of conducting QRT, ARGM, IMC, RAC and IRC before *kharif* season starts. The chairman welcomed the new Scientists who joined IIRR. This was followed by presentation of the work done during 2014-15 by individual Scientists of each discipline. Each presentation was thoroughly discussed by the members. Nine new projects were approved by the IRC. In his concluding remarks the Chairman emphasized that a) the entries/lines with special traits should be registered with NBPGR and multiplied in alternate years and re-tested by the concerned Scientists. b) Network projects on Hybrid rice, Entomology, Pathology, Biotechnology, Pre-breeding and Direct Seeded Rice can be prepared. The meeting ended with vote of thanks by Dr B Sreedevi Joint Secretary, IRC.

Institute Research Council meeting

Field Institute Research Council (IRC)

Field Institute Research Council (IRC) meeting was organized under the chairmanship of Dr V. Ravindra Babu, Director, IIRR on 6th November, 2015. Chairman and all the members of the IRC visited the field experiments laid out by different scientists of IIRR-Rajendranagar farm during which the scientists appraised the Director on various field trials being conducted. An interim IRC meeting was also conducted for the newly joined scientists on 30th November and 1st December, 2015 in which eight new project proposals were approved.

Scientist visiting Research Experiments during Field IRC meeting

50th Annual Rice Research Group Meetings, 11th – 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 Guests of Honor during the inaugural session.

Inaugural session of 50th ARGM marking Golden Jubilee year of AICRIP

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.

Display of saree made out of paddy straw

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. Eight Publications were released and website for SARR & International Rice Symposium-2015 were e- released.

ICAR-Sponsored Short Courses

1. A ten days short course on, "Transformative approaches in Gender Mainstreaming, Gender Budgeting and Women Empowerment in Agriculture was conducted at IIRR during June 8-17, 2015**.** The participants of the course comprised of SMS-Home Science, Scientists- Agricultural Extension and Assistant Professors representing 8 states of the country. The Chief Guest at the inaugural session was Smt. Renuka Chowdhary, Former Minister of State of Women and Child Development Govt. of India. The objectives of the course were to impart knowledge and skills for application of tools and techniques of Gender analysis, gender mainstreaming, gender budgeting and empowerment of women in agriculture.

Short Course on Women empowerment at IIRR

2. A short course on "Quality Improvement, Bio-fortification and Product Development in Rice for Nutritional and Financial Security of Rice Farmers" was organized during 1st to 10th September 2015. Total 18 participants from different parts of the country participated. Of these, there were 15-men and 03- women.

Short Course on Quality Improvement, Nutrional and Financial Security of Rice Farmers

3. A 10 days short course on "Modern Integrated Crop Breeding Tools - Breeding Management System (BMS)" was organized by Indian Institute of Rice Research (IIRR), Hyderabad from Jan 18th to Jan 27th, 2016. The training was planned in three modules *viz*., statistics module, data management and molecular breeding module, for the understanding of integrated crop breeding tools to carry out breeding/molecular breeding projects in an efficient manner.

Short Course on Modern Integrated Crop Breeding Tools and Breeding Management System at IIRR

Hindi pakhwada

Hindi pakhwada was celebrated from 14-29 September at IIRR. The celebration started by formal inauguration by the Director Dr Ravindra Babu on 14th September continued for a fortnight. In the 15 day long celebrations, various competitions/ activities per training to Hindi language were organized. The valedictory function was organized on 29th September chaired by Dr V Ravindra Babu, Director IIRR, Shri Jaishankar Tiwari Assistant Director, Rajbhasha, Central Hindi Training institute, Hyderabad, was the chief guest. The winners of various competitions were felicitated on this occasion. The chief guest Shri Jaishankar Tiwari remarked that Hindi has certain attractions and the more the people use the language the more they get attracted towards it. Dr Ravindra Babu, Director, emphasized on the constitutional obligations of use of Hindi in the office.

Hindi Pakhwada from 14th-29th at IIRR

ICAR (Crop Sciences) – Industry Meet held

As a part of the ICAR initiative, the ICAR (Crop Sciences) - Industry Meet 2015 - showcasing of ICAR Technologies & Services was organized at the Indian Institute of Rice Research on 5th December, 2015 with the prime objective of forging Public-Private Partnership in Agriculture in general and crop production, in particular. Six other ICAR crop science institutes *viz*., 1) Directorate of Rapeseed - Mustard Research, Rajasthan 2) Indian Institute of Maize Research, New Delhi 3) Directorate of Soybean Research, Indore 4) Sugarcane Breeding Institute, Coimbatore 5) Indian Institute of Oilseeds Research, Hyderabad and 6) Indian Institute of Millets Research, Hyderabad also participated in this meet to showcase their technologies. A total of 65 representatives from private companies and ICAR institutes participated in the meet and took part in subsequent deliberations. Various technologies developed by ICAR *viz*., newly released varieties and hybrids, rice based health care products, Customized leaf colour chart for Nitrogen Management in Rice for Irrigated Rice and Soil health kit, Sugar cane juice powder, Soil moisture indicator, Low cost and liquid formulation of microbial bio control agents, Millet based ready to cook products, *Corcyra cephalonica* Rearing Cage were presented to the industry representatives. Several key issues such as popularization of ICAR technologies and products in local languages, exclusive licensing methodology, adoption of uniform set of procedures and guidelines for licensing and commercialization of technologies were discussed.

Inauguration of ICAR (Crop Sciences) - Industry Meet at IIRR

First IIRR Foundation Day

IIRR celebrated its first Foundation Day on 15th December 2015. Dr V. Ravindra Babu, Director, IIRR, welcomed the staff and the guests. Dr S.V.S Shastry, Founder Joint Co-ordinator, of the then AICRIP was the Chief Guest, Dr Seetharaman Ex. Project Director, DRR and Dr E.A. Siddiq, Ex , DDG (CS) were the other Guests of Honour. Dr T. Longvah, Special Guest NIN, delivered the Foundation lecture on "Nutritional Challenges in India". All the Directors and other representatives of ICAR institutes were also present at the function. Director, IIRR gave a brief account of the achievements and activities taken up at IIRR during the Golden Jubilee year 2015. He also deliberated upon the various outreach activities taken up by the institute for the benefit of farmers. He made a special mention about the new initiatives taken and creation of additional facilities to newly joined scientists at IIRR. Dr S.V.S. Sastry reminisced the initiation of AICRIP coordination with only three scientists. Dr Seetharaman emphasized the need to focus more on the IPM, INM and integrated farming systems research, cost effective technologies and Water saving Drip system for enhancing the productivity. Dr E.A. Siddiq outlined the journey of DRR and mentioned that the hybrid rice research and biotechnology programs were started in a humble way and today these programs have become role models at National and International levels.

Awards were given under three categories for the outstanding contributions of the staff which were named after three doyens of rice research (Prof. E.A. Siddiq award for sincere and dedicated staff, Prof. Seetaraman award for best young scientist, and Prof. S.V.S Sastry award for outstanding Scientist) and 32 scientists were awarded under the above three categories. In addition, 25 Administrative, Technical and Supporting staff were also felicitated for their contributions. Games and cultural programmes were conducted on this occasion and the elders gracing the occasion were felicitated.

First Foundation day of IIRR

Award		Awardees
Prof. E.A. Siddiq Award for Sincere & Dedicated Scientist	:	Dr Chitra Shanker, Dr R. Mahender Kumar, Dr P. Muthuraman, Dr Vidhan Singh, Dr M.S. Prasad, Dr Jhansi Rani, Dr Jhansi Lakshmi, Dr G.S. Laha, Dr K. Surekha, Dr A.S. Hariprasad, Dr C.N. Neeraja, Dr Ch. Padmavathi, Dr L.V. Subba Rao
Prof. S.V.S Shastry Award for Outstanding Scientist	:	Dr R.M. Sundaram, Dr Seshu Madhav, Dr V.P.Bhadana, Dr S.N. Meera, Dr D. Subrahmanyam, Dr Brajendra
Prof. R. Seetharaman Award for Best Young Scientist	:	Dr P. Revathi, Dr P. Senguttuvel, Dr K.B. Kempa Raju, Dr M. Sampath Kumar, Dr B. Nirmala, Dr Jyothi Badri, Dr Suneetha Kota, Dr Prakasam, Dr D. Sanjeeva Rao, Dr Ladha Lakshmi, Dr P.C. Latha, Dr S. Arun Kumar, Dr S.K. Mangrauthia, Dr B. Sailaja
Best Administrative Staff Certificate	:	Ms. Judith Daniel, Mr. R. Udaya Kumar, Ms. Sudha Nair, Ms. Aparna Das, Mr. S. Rama Murthy, Mr. Vidhyanath, Mr. G. Sathyanarayana, Mr. Mohd. Hussain
Best Technical Staff Certificate	:	Mr. U. Chaitanya (PMEC Cell), Mr. M. Vijay Kumar, Mr. E. Nagarjuna, Mr. C. Muralidhar Reddy, Mr. C. Sadhanandam, Mr. Chaitanya (Photographer), Mr. Amudam Srinivas, Mr. B.P. Anjaneyulu , Mr. Shivanarayana, Mr. Ramulu, Mr. Anantha Reddy, Mr. Chiruthkar, Mr. D.S. Vinod Kumar, Mr. S. Narsing Rao, Mr. Janardhan
Best Supporting Staff Certificate	:	Mr. Yadaiah, Mr. Chander, Ms. Susheelamma, Mr. Chandra Kumar

National Rice Group Meeting for Hill Rice

The 3rd National Rice Group Meeting for Hill Rice was held on 27 February, 2016 at the ICAR Research Complex North Eastern Region (ICAR-RC NEH), Umiam, Shillong. About 30 scientists from ICAR-IIRR, Hyderabad, ICAR-RC NEH, Central Agricultural Universities of Shillong and Manipur, Sher- E-Kashmir University of Agricultural Sciences and Technology, Srinagar, Himachal Pradesh Krishi Vishwa Vidyalaya, Palampur and Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora par ticipated in the meeting. Dr S.K. Nachan, Director, RC NEH inaugurated the meeting and Dr Ravindra Babu, Director, ICAR- IIRR chaired the proceedings. The group meeting reviewed the research work on hill rice cultivation being carried out under the All India Coordinated Rice Improvement Project (AICRIP). The group meeting came out with refinements in technology and identified promising entries for cultivation in hill region.

DUS test Guidelines review meeting

Review of DUS Test Guidelines of Rice at IIRR

The first review meeting of the DUS test Guidelines was organized on 2nd December 2015 under the chairmanship of Dr E.A Siddiq at Indian Institute of Rice Research. Dr L. V. Subba Rao, Principal Scientist, and Nodal Officer (DUS) gave a detailed account of DUS test guidelines. The Task force consisted of Dr P. Raghava Reddy, former VC ANGRAU, Dr A.K Singh Principal Scientist and Head, IARI (represented Dr T. Mohapatra, Director, IARI), Dr V. Ravindra Babu. Director, IIRR, Dr L.V. Subba Rao, Principal Scientist and Nodal Officer DUS, Dr Dipal Roy Chowdhury, Joint Registrar, PPV & FRA and Member Secretary of the meeting discussed at length about revising DUS test guide lines and descriptors in rice. The other members associated were Dr B.C Patra, NRRI, Cuttack, Dr M.P Rajanna, ZARS, Mandya, Dr Rakesh Seth, IARI Regional Station, Karnal, Dr P. Anand kumar, Principal Scientist and Head, Crop Improvement Section, IIRR, Dr B Rama Krishna, Nuziveedu seeds. Committee proposed certain amendments.

1c. International Events / Meetings

International Rice Symposium (IRS 2015)

On the occasion of Golden Jubilee celebrations of All India Coordinated Rice Improvement Project (AICRIP), an International Rice Symposium was organized in Hyderabad, during November 18-20, 2015 with the theme 'Rice Science for Global Food and Nutritional Security' to bolster the ongoing thought process to make rice cultivation a profitable endeavour. The event was jointly organised by IIRR Hyderabad, NRRI Cuttack, IRRI Philippines, PJTSAU, ANGRAU and Society for Advancement of Rice Research, Hyderabad.

Inauguration of International Rice Symposium

The programme was inaugurated with *Jyothi Prajwelan* by all the dignitaries. In the Inaugural Session, Dr J.S. Sandhu, DDG (CS), ICAR while delivering welcome address, highlighted the country's remarkable achievements in increasing the rice production, productivity that resulted not only in attaining self- sufficiency, but also to become top ranker in the global rice exports. Shri Bandaru Dattatreya, in his inaugural address complemented IIRR on account of 'Golden Jubilee Year of Celebrations of AICRIP'and its role in the development and release of more than 1050 rice varieties that helped in resolving the difficulties faced by the farming community. Dr Robert Zeigler, 'Guest of Honour' congratulated the staff of IIRR for 50 years of productive and active contribution to the rice research.

Dr A. Padma Raju, 'Guest of Honour' highlighted the prominent role of ANGRAU in rice research & development. Dr David Bergvinson stressed on the utilization of germplasm resources for obtaining substantial genetic gains in rice research. Shri R. Rajagopal, Additional Secretary (DARE) & Secretary, ICAR n his Presidential address reiterated that "No nation can be great without food security" and mentioned that farmers undertake rice cultivation with pride and they are sentimentally attached to it. A brain storming session was conducted for preparing the road map for 2nd Green Revolution in India.

As many as 500 delegates participated in the symposium, including 20 foreign delegates. Many eminent scientists delivered lead lectures on latest developments in rice science and shared their experiences and expertise with the young research scholars, students who also participated in large numbers. In the symposium, a panel discussion on road map for 2nd Green Revolution was organised, four plenary sessions were organised, twelve concurrent sessions were organised in which around 120 oral presentations were made and in the poster sessions, around 450 posters were displayed.

On this occasion, the following publications were released *viz.*, Programme booklet, Abstracts of the presentations (soft version as Pen drive), bulletins on Rice Production Practices in India, Rice Bran oil, Rice; JS Nanda & PK Agrawal, IIRR Newsletter, Mobile applications from RKMP (IIRR + 28 partners, CDAC), Web based expert system for rice varieties, pests and diseases, APRRI – Rice Diseases and their Management (in Telugu) and APRRI – Rice Insect pests and their Management.

Expert Elicitation Workshop on Rice Varietal Adoption

Expert Elicitation Workshop on 'Rice Varietal Adoption in Andhra Pradesh and Telangana states' was organized at ICAR- IIRR on 18 March, 2016. This workshop was organized in collaboration with International Rice Research Institute (IRRI) and Strengthening Impact Assessment of Consultative Group on International Agricultural Research (SIAC) and Michigan State University (MSU). The Expert Elicitation method for rice varietal adoption was validated under the project 'Tracking Improved Varieties in South Asia (TRIVSA)' conducted by IRRI and showed that estimates derived from Expert Elicitation Method were close to estimates derived through traditional household survey method with only a small margin of error.

Expert Elicitation one day workshop on Rice Varietal Adoption in A.P and Telangana

Dr V. Ravindra Babu, Director, IIRR, in his opening remarks appreciated the efforts of IRRI in conducting the Impact assessment of rice germplasm improvement research. Dr Raji Reddy, Director of Research, PJTSAU suggested to identify the tools and methods to regularly monitor the varietal adoption. Experts from both Andhra Pradesh and Telangana states have participated in the workshop and arrived at a consensus on the most popular rice varieties and expressed that these estimates will serve as a feedback for the improvement of rice breeding programme to meet the preferences of the farmers and consumers. The Expert Elicitation Methodology was validated by Ms. Lourdes Velasco, Scientist, Social Sciences Division, IRRI and Dr Debdutt Behura, Agricultural Economist of OUAT. Dr B. Nirmala, Scientist (Agricultural Economics), IIRR coordinated the Workshop.

Green Super Rice Phase II completion work shop

The Green Super Rice Phase II (between November 2012 to Dec. 2015) completion work shop was held during 21-23 November 2015 at IIRR in Hyderabad. 35 participants from different Asian countries namely Bangladesh, Sri Lanka, Philippines, Vietnam, Indonesia, Lao, IRRI and India and one private company BOSHIMA from China participated. The meeting was presided

over by Dr Jauhar Ali, IRRI and GSR project director Dr Zhikang Li of the Chinese Academy of Agricultural Sciences (CAAS). The participants discussed about the achievements made during the project period in their respective countries. Dr V. Ravindra Babu, Director IIRR mentioned that farmer-to-farmer interaction on-farm adaptive trials by GSR varieties farmers in different target locations in India. The participants also discussed about future strategies for next upcoming GSR Phase.

The meeting ended with vote of thanks by Dr V. Ravindra Babu, Director, ICAR-IIRR, Hyderabad. On this occasion, a pylon was erected to signify the Golden Jubilee year of AICRIP which was inaugurated by Shri Bandaru Dattatreya, Hon'ble Minister of State (Independent Charge) for Labour & Employment, Govt. of India.

2. Transfer of Technology

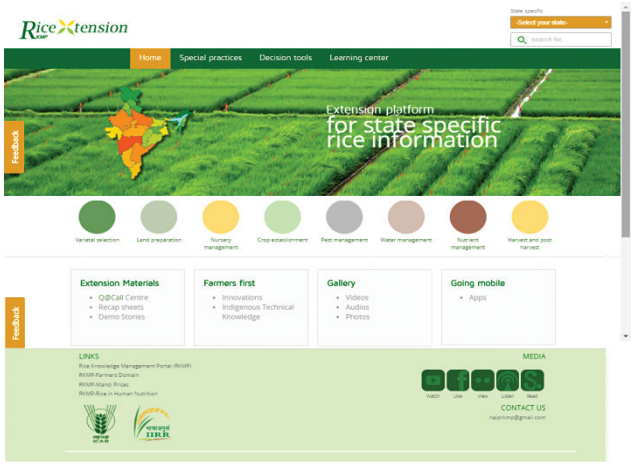
Rice Knowledge Management Portal

RKMP remained as a major source of rice related information in India with 6 of 10 Google searches are directed across the domain to the Portal.

S. No.	Name	Description
1	Rice Vocs App	A ready reckoner for extension professional
2	Rice Crop FAQs	Compendium of Kisan Call Centre Questions on Rice
3	RKMP E-Learning App	With 20 e-courses for the benefit of Extension Professionals
4	Rice Innovations App	Farmers Rice Innovations 2011 & 2015
5	RKMP Extension Tools App	More than 60 ready to use extension methods tool suit

- A network project has been approved under the XII Plan. During the year 2015-16, RKMP in collaboration with C-DAC Hyderabad has developed a series of mobile apps for the benefit of Indian Extension Professionals and Farmers.
- Most of the users expressed their desire to use a series of mobile apps in local languages that are being developed for next two years.
- An extension interface/ platform is developed for extension professionals of the country. Soon it will be launched.

A thorough analysis was done in terms of Contents and Usability of the Rice Knowledge Bank (Content side) along with Web framework of Rice Knowledge Bank (How it works, links, *etc.*). This helped develop insights as to how simplified extension platform of RKMP should be. This will improve the extension professionals' uptake of knowledge in most useful format. SWOT Analysis of RKMP/ Planning for Revisions and RKMP Reorganization of an extension domain was discussed at length. Proposed - Contents and web layout for Extension Interface of RKMP was presented which was followed by general agreement on lay out and content types for extension interface. During this year, an extension platform was developed www.rkmpextension.in and www.riceextension.in. The RKMP Extension Interface will have positive consequences in the uptake of extension material from RKMP.



Rice Check Program

ICAR's concept of 'Farmer First' 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 Rice Check. In continuation with our earlier efforts, this year, the pilot project on innovative participatory extension method (Rice Check) was continued in Telangana state for the second consecutive year involving KVK (Kampasagar, Nalgonda). A discussion group involving 20 farmers were involved in the Rice Check programme. The local extension professionals facilitated the group meetings. The complete track of key checks, practices, adoption of yield contributing factors was undertaken.

Visitors' Services

During the year 2015-16, about 6750 visitors comprising students, extension professionals, scientists, farmers, foreign delegates, policy makers, private input dealers visited IIRR and got acquainted with the ongoing activities and achievements of IIRR.

Organizing Farmers' Day/fair/Exhibition

1. IIRR took active part and exhibited IIRR technologies in the Hitex Seed Congress/ Exhibition held at Hitex – Hyderabad, IIOR Farmers day, IIRR Industry Meet, IIMR Industry Meet at IIMR and Krishi Unnati Mela 2016 at IARI
2. "Nutrition Information Campaign" was organized to create awareness about the nutritional deficiencies and bio- fortified rice under CRP on Bio-fortification in selected crops for nutritional security on 06/02/2015. It was organised in the Banne Baoji Tanda (tribal hamlet) of Deverakonda Mandal of Nalgonda District, Telangana.
3. On the occasion of International Day for Biological Diversity on, May 22, 2015 (to reaffirm our resolve to safeguard the precious, heritage of bio-resources for the future generations) an exhibition stall was put up depicting the various Research, Extension and Training activities of IIRR at Indira Priyadarshini Auditorium, Public Gardens, Nampally, Hyderabad.

Media Coordination and Kisan Call centre

Approximately 20 scientific talks on various aspects of rice production Technologies were delivered by the resource faculty of IIRR and broadcasted by AIR, Hyderabad Kendra. IIRR is part of Kisan Call centre program and the question related to rice from the farmers through toll free non 1551 were answered. Five of the Scientists delivered rice related program in the private televisions' (Telugu) Channel.

Production of Video films and Extension Literature

A 15 minutes video film on the production technology of Improved Samba Mahsuri was produced and dubbed in English, Telugu, Tamil, Kannada and Hindi. The video film is telecasted through Doordarshan and private cable television channels to help the rice farmers in the BLB endemic areas.

An extension brochure about the production technology of improved samba mahsuri was printed in English, Telugu and Tamil languages and distributed to the farmers in the BLB endemic areas. Efforts are on to print it in kannada and Hindi languages.

3. Revenue Generation

An amount of Rs. 1,23,51,100 was received through testing of varieties and hybrids, contractual services for the evaluation of breeding lines for quality, diseases increases, insects and also assessing the efficiency of new molecules / chemicals.

Revolving Fund

Under the National Seed Project (NSP) ICAR s provided revolving fund for strengthening seed production activities to produce quality seed. IIRR actively involved in production of quality seed in research farms and supplying it to Pvt. Seed companies, Govt. seed agencies and to farmers. The receipts have generated an amount of Rs. 17,05,581 for the financial year 2015-16.

4. Awards and Recognitions

IIRR receives ISO 9001 : 2008 certificate

✧ Integrated Quality certification Pvt Ltd certified that the quality management system of Indian Institute of Rice has been assessed and conforms to the quality management systems ISO 9001 : 2008. It is certified that the scope of research, development and extension of technologies to enhance rice productivity, resource and input use efficiency without adverse effects on the environment. The certificate is valid from 26-5-2015 to 25-5-2018.

Dr V. Ravindra Babu receiving ISO 9001 : 2008 Certificate

Dr Brajendra Senior Scientist (Soil Science) nominated to FAO panel on soils

✧ It is a Honour to IIRR, Hyderabad that the Food and Agricultural Organization (FAO) of the United Nations has nominated Dr Brajendra, Senior Scientist, Soil Science) IIRR as one of the 27 top global soil experts to the panel of Intergovernmental Technical Panel on Soils (ITPS). The main function of the Intergovernmental Technical Panel on Soils is to provide scientific and technical advice on global soil issues, primarily to the GSP, UNFAO, and in relation to specific requests submitted by global or regional institutions.

Dr Brajendra with ITPS Panel at UNFAO

Dr Shaik N. Meera received Lal Bahadur Shastri Out-standing Young Scientist Award 2014

✧ Dr Shaik N. Meera, Senior Scientist received prestigious' Lal Bahadur Shastri Outstanding Young Scientist Award 2014' of ICAR. The award was presented during the 87th Foundation Day Celebrations and Award Ceremony of ICAR held at Patna. Dr Meera received the awards for his contribution in developing innovative extension methods He received an award amount of 1.00 lakh in cash and a citation and a project for three years with budgetary provision of 30.00 lakh and 5.00 lakh for foreign training.

Dr SN Meera receiving young scientist Award

Dr Divya Balakrishnan received ICAR Jawaharlal Nehru Award for Outstanding Doctoral Research in Agricultural and Allied Sciences 2014

✧ **Dr Divya Balakrishnan** carried out marker assisted backcross breeding for transferring blast resistance *genes viz., Pi1, Pi2 Pi33* and *Pi54* to popular but susceptible rice varieties *viz.*, ADT43, BPT5204 and Improved White Ponni and received ICAR Jawaharlal Nehru Award for Outstanding Doctoral Research. Award consists of 50,000/-in cash plus a citation and a gold medal. Dr Divya obtained her Ph. D from Centre for Plant Breeding and Genetics, TNAU.

Dr Divya Balakrishnan receiving Jawaharlal Nehru Award for her Outstanding Doctoral Research

Dr L.V. Subba Rao received Seedsmen Award constituted by NSAI, New Delhi and Seedsmen Association of A.P.

✧ Under the category of scientist for his valuable contributions to the Seed Sector in the country. He received the award during 20th Annual General Meeting on 9th September 2015, Hyderabad.

Dr L.V. Subba Rao receiving Seedsmen Award

Dr L.V. Subba Rao received International Agricultural Science Award constituted by Association for the Advancement of Biodiversity Science" during 2015

✧ L.V. Subba Rao received "International Agricultural Science Award" and Conferred "Fellow of the Association for the Advancement of Biodiversity Science" by Association for the Advancement of Biodiversity Science for his outstanding contribution to the science of Biodiversity during International Symposium on Biodiversity, Agriculture, Environment and Forestry,2015

Dr L.V. Subba Rao receiving International Agricultural Science Award

✧ **Dr Ch. Padmavati,** Principal Scientist (Entomology) was awarded as the Fellow of Plant Protection Association of India at the 'Conference on National Priorities in Plant Health Management' held during 4-5 February, 2016 at SV Agricultural College, Tirupati (AP).

Awards	Recipients
Dodla Raghava Reddy Medal-2014; Plant Protection Association of India.	Dr P. Ananda Kumar
Outstanding Woman Scientist Award from G.K.V. Society, Agra (U.P)	Dr B. Nirmala, Dr Divya P Syamaladevi Dr Suneetha Kotta, Dr D. Ladhalakshmi
Outstanding woman scientist achievement from Science and Technology society for integrated rural improvement and National conference on GRISAS- 2015	Dr Suneetha Kotta
Young scientist award from G.K.V. Society, Agra (U.P)	Dr K.B. Kemparaju, Dr V. Prakasam
Young Scientist Award by Society of Bio-Technology, Allahabad, UP, 2016.	Dr V. Prakasam
Felicitation Award 2016 by SVFD and Society of Extension Professional.	Dr Shaik N Meera
Agri-Innovation Award by GVK Society; Outstanding investigator award by SER Society; Distinguished Scientist award by SHIATS; Young Scientist award by Society for URE, 2015	Dr Brajendra

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

5. Other Institutional Activities

Distinguished visitors

Mrs Renuka Chowdary MP Rajyasabha visited IIRR

Mrs Renuka Chowdary MP Rajyasabha and Member of Parliamentary Committee (Agriculture) visited IIRR on 8th June 2015. She has visited rice museum, other IIRR facilities, inaugurated training programme on 'Transformative approaches in Gender Mainstreaming, Budgeting and Women Empowerment in Agriculture', interacted with IIRR scientists and participated in the planting of saplings.

Mrs Renuka Chowdary's visit to IIRR

Dr David Bergvinson Director General ICRISAT, Hyderabad visited IIRR

Dr David Bergvinson the Director General of ICRISAT had made a maiden visit to IIRR on 18th May 2015 on the occasion of Golden Jubilee year celebrations. He had visited IIRR research farm, museum and interacted with the Scientists. He had extended his help in popularizing the IIRR technologies, village adoption programmes and improving facilities in IIRR farm at ICRISAT.

Dr D. Bergvinson, DG, ICRISAT visits IIRR

IIRR Team receives Sports Medals

IIRR team consisting of Dr M.N. Arun and Dr R. Mahender Kumar got gold medal (1st position) in table tennis men's team event for the first time in the ICAR – Inter-Institutional Tournament (South Zone) held at ICAR- CIFT, Kochi during 25-29, May 2015.

ICAR Southern Zones Sports Meet

IIRR woman's team consisting of Dr K. Surekha and Dr G. Padmavati got gold medals (1st position) in both the singles and doubles table tennis event. In the woman high jump event Dr P. Revathi got silver medal (2nd Position). In the overall score points, IIRR got 23 points and placed in the sixth position in the south zone meet.

IIRR Team with Sports Medals

ICAR-Inter Zonal Final Sports Meet

ICAR-Inter Zonal Final Sports Meet held on 8-12th February, 2016 was held at CAZRI, Jodhpur. IIRR Team consisting of Dr R. Mahender Kumar, Dr M. N. Arun Kumar, Mr. C. Muralidhar Reddy, Mr. B. Ramesh, Dr K. Surekha, Dr G. Padmavathi par ticipated Table Tennis events. Mr. R. Udaya Kumar was the Chief-De-Mission. Dr K. Surekha and Dr G. Padmavathi won the Gold in Womens' Doubles and Dr K. Surekha won Silver in Singles events.

IIRR Team with Inter zonal Sports Medals

Medical Camp by Care Hospitals

A medical Camp was organized by the recreation club of IIRR and the specialists from Care Hospital including general physician and Cardiologist participated in the Camp and examined the IIRR staff for blood Pressure, diabetes and hear t problems. The Doctors gave consultancy based on the problems and nearly 150 staff members participated in the camp.

Health Camp by Care Hospital

Exposure trip of the Philippines rice achiever awardees to IIRR

A 15 member delegation from the Philippines visited IIRR on 23rd June 2013 under the Philippines-IRRI partnership program on the Food staple sufficiency program The delegation consists of the Philippines rice achievers mostly affiliated to the government of Philippines. They were exposed to the achievements, on-going programmes and future plan of work of IIRR. The delegates visited Rice museum, glass houses and the laboratories and interacted with the Director and the heads of the sections.

Rice Achiever Awardees of Philippines visit IIRR

Yoga day celebrated

Recreation Club of IIRR conducted a programme on YOGA to sensitize about Yoga and its importance in commemoration of first "International Yoga Day – June 21" at IIRR. Dr Debnath, Medical Doctor of NAARM and Yoga practitioner Dr Mahabir Singh (Retd Head of Extension, IIRR) were chief guests of the day. Dr Debnath stressed on the importance of Yoga followed by demonstration of the Aasanaas and Pranayama.

Yoga day at IIRR

Dr Mahbir Singh informed about daily yoga routine and keeping mental and physical fitness of the body by regular practice. All the staff members participated in the programme and the programme ended with vote of thanks by Dr R. Mahender Kumar (Chairman IIRR recreation club).

World Environment day 5-6-2015

World environment day was celebrated in IIRR and planting of saplings was done at various places in the Institute premises.

World Environment day

Swatcha Bharath Abhiyan

Swachh Bharat Abhiyan activities are being regularly carried out by Indian Institute of Rice Research every week on Saturday from 3-4 PM. The Director and all the IIRR Staff are actively participating in this activity. As a part of this activity, the office premises were thoroughly cleaned by the IIRR staff. The collected waste material will be converted into vermicompost. Planting of saplings was also taken up during Swatcha Bharath activity at various places in the premises.

Women in Agriculture Day Celebrated

Women in Agriculture Day was celebrated at ICAR-IIRR on December 4, 2015 to signify the important contributions of Women in agriculture. A series of activities were organized on this occasion.

Dr V. Ravindra Babu, Director felicitated all the Women Scientists and Women Farm workers of the Institute and highlighted the significant role played by them in research and farm activities. Dr K. Manorama and Dr K. Aparna, PJTSAU deliberated upon Women, Hormones and Food Plans to reiterate the importance of healthy eating for healthy lifestyles. A set of team building games were organized for farm workers. The program was coordinated by Dr Amtul Waris and Dr B. Nirmala.

World Soil Day

World Soil Day was celebrated at IIRR, Hyderabad on 5th December, 2015. Thirty farmers from three villages *viz*., Kondagadapa (Mothkur Mandal), Thukkapuram and Thimmapuram (Atmakur Mandal) of Nalgonda district participated in this function. Dr V. Ravindra Babu, Director, IIRR stressed the importance of soil in food production and human well-being and the maintenance or enhancement of soil resources for food, water, and energy security. On this occasion, soil health cards were distributed to thirty farmers by the Director. The farmers thanked IIRR scientists for collecting soils, analysing and giving recommendations on fertilizer use and felicitated Dr V. Ravindra Babu, Director, IIRR for the soil testing services extended to their villages.

Soil Health card distribution to farmers on World Soil day at IIRR

KVK, Kampasagar

Soil day was celebrated at KVK, Kampasagar, Nalgonda district, Telangana state. Soil samples from Miryalguda and Tripuraram mandals of Nalgonda district were received from KVK Kampasagar, Nalgonda district, analyzed and soil health cards were distributed to 250 farmers. The function was graced by Dr Raji Reddy, Director of Research, PJTSAU, and scientists from IIRR and KVK Kampasagar.

Distribution of Soil Health cards to farmers at KVK Kampasagar

Jai Kisan Jai Vigyan Week celebrated

Indian Council of Agricultural research celebrated 'Jai Kisan Jai Vigyan' week from 23-29 December 2015 to commemorate the birth anniversaries of former Prime Ministers Shri Atal Bihari Vajpayee and late Shri Chaudary Charan Singh. The celebration was organised keeping in view their immense contribution for promoting use of science for the welfare of farmers. Dr V Ravindra Babu, Director, IIRR briefed about the importance of the programme and discussed about different schemes like Front line Demonstrations, Tribal Sub-Plan, Tribal Sub-Plan under National Seed Project, Visit of scientists to villages, Mera Gaon Mera Gaurav programme, Production Oriented Survey, Drought mitigation team visit to distressed villages, Popularisation of SRI method of Rice Cultivation, Soil testing and Distribution of Soil Health Cards taken up under this programme.

IIRR celebrated Jai Kisan Jai Vigyan week

Asia Pacific Weed Science Society conference delegates visit IIRR

The delegates of the 25th Asia Pacific Weed Science Society conference held in PJTSAU Hyderabad during 13-16 October, 2015 visited Agronomy field Experiments *viz*., comparative performance of new post-emergence herbicides against weeds in Aerobic rice and their effect on succeeding crop, new herbicide molecules for weed control in Direct seeded Rice and transplanted Rice, greenhouse gas emissions from rice fields, use of sensors for water application and Phosphorus sick plots conducted in the Research Farm, IIRR on 15-10-2015.

Delegates of Asia Pacific Weed Science Society

Womens' Day

ICAR-IIRR celebrated International Women's Day on 8th March, 2016 at the SVS Shastry Auditorium, IIRR. This year's International Women's Day theme was "Planet 50-50 by 2030: Step It Up for Gender Equality". The guest of honour of the function was Dr KBRS Visarada, Principal Scientist, ICAR- IIMR and chief guest was Mrs. Meghana Musunri, Founder and Chairperson, Fountainhead Global School, Hyderabad. The guests delivered inspiring lectures on the role and importance of women in the society.

Womens' day celebrated at IIRR

Workshop on Relaxation and Meditation Techniques

A three day workshop on "Heartfulness Guided Relaxation Technique for Stress Free Life: Learn to Meditate" was organized for the staff

members of IIRR by Sri Ramachadra Mission, Hyderabad during 18-20 January, 2016 at SVS Shastry Auditorium, IIRR. Scientific, technical, administrative and farm staff have actively participated in the programme to learn the relaxation techniques.

IIRR organized ICAR Institute Biosafety Officers (IBOs) interaction meeting

ICAR-IIRR organized ICAR Institute Biosafety Officers (IBOs) interaction meeting was held on 17 February, 2016. Dr Micheal Wach of ILSI, Washington delivered the guest lecture. IBOs of ICAR institutes situated in Hyderabad attended the meeting along with scientific staff.

Institute Biosafety Officers Meeting

Interaction Meeting of CBM and IIRR Scientists on Food Security Projects

An interaction meeting of Canadian Baptist Missonaries (CBM) and IIRR scientists was held on 11 March, 2016 at IIRR to discuss the status of projects related to food security at IIRR. Dr Stefan Cherry, Greg Mattews and Dr Suraj Kumar of CBM and Drs. V. Ravindra Babu, R. M. Kumar, L. V. Subba Rao, K. Surekha and B. Nirmala of IIRR participated in the discussion.

ICAR-IIRR participates in Krishi Unnati Mela - 2016

ICAR-IIRR participated in the 'Krishi Unnati Mela- National Agriculture Fair' organized at ICAR-IARI, Pusa, New Delhi during 19-21 March, 2016. The mega event was organized by the Ministry of Agriculture and Farmers' Welfare, Government of India in which Indian Council of Agricultural Research was a major partner and facilitator. The National Fair was inaugurated by Hon'ble Prime Minister, Shri Narendra Modi. IIRR technologies, varieties and hybrids along with the best practices were displayed as posters and exhibits. The IIRR stall was visited by the farmers from across the country and familiarized with IIRR activities, latest rice varieties/hybrids and management practices.

Krishi Unnati Mela

Nutrition Information Campaign

ICAR-IIRR organized 'Nutrition Information Campaign' to create awareness on the nutritional deficiencies and importance of bio-fortified rice under 'CRP on Bio-fortification in selected crops for nutritional security' on 6 February, 2016 in the tribal hamlet of *Banne Baoji Tanda* in Deverakonda Mandal, Nalgonda District, Telangana in association with Action for Rural Development Society, Devarakonda. Dr V. Ravindra Babu, Director, IIRR, Dr Amtul Waris, Principal Scientist, IIRR, Dr B. Nirmala, Scientist, IIRR and Dr T. Supraja, Assistant Professor (Food and Nutrition), PJTSAU, Hyderabad par ticipated in the campaign. The team explained the importance of bio-fortified rice in overcoming micronutrient deficiencies and simple diagnostic techniques to identify the nutritional deficiency symptoms. The team also explained input saving technologies in rice production for higher productivity.

Dr V. Ravindra Babu at Nutrition Information Campaign in Devarakonda, Nalgonda Dist.

Independence day and Republic day

68th Independence day was celebrated on 15th August and 67th Republic day on 26th Jan at IIRR. Dr V. Ravindra Babu, Director, IIRR hoisted the national flag and highlighted 50 years achievements of IIRR. On this occasion, games and sports competitions were organized for all the staff members of IIRR. In addition to these competitions, separate spor ts meet was conducted for various ICAR Institutes *viz*., IIOR, IIMR, NBPGR, PDP, NAARM situated in Rajendranagar area of Hyderabad. The sports events include Table Tennis, Shuttle, Kabaddi, Volleyball. The Directors of the various ICAR Institutes also participated in the celebrations and prized were distributed to the winners of different competitions.

Independence day and Republic day celebrations at IIRR

Ayudha Pooja

Ayudha Pooja was performed in connection with DUSSERA festival at IIRR Farm ICRISAT, Workshop and farm at IIRR on 21st October 2015.

Ayudha Pooja

Vigilance Awareness Week

Vigilance awareness week was observed in IIRR during 26-31 October 2015. A pledge was administered to all the staff on 26th October and vigilance banners were displayed at prominent spots in the institute. Various events such as debate, essay writing on moral values and ethics, ideas and methodology to prevent corruption in institutes were conducted. A lecture was delivered by Sri Anil Bihari SAO (retd), IIOR, Hyderabad during the closing ceremony.

Vigilance Awareness Week Observed

Personnel (2015-16)

Scientific Staff

S. No.	Name	Designation	E-mail	Remarks
1	Dr V. Ravindra Babu	Director	director.iirr@icar.gov.in	1-4-2015 to 8-11-2015 Director (A); 9-11-15 onwards Director
Plant Breeding				
2	Dr T. Ram	Principal Scientist	t.ram2011@yahoo.com	
3	Dr L.V. Subba Rao	Principal Scientist	lvsubbarao1990@gmail.com	
4	Dr Mohibe Azam	Principal Scientist	azam@gmail.com	
5	Dr G. Padmavati	Principal Scientist	padma_gpv@yahoo.co.in	
6	Dr G.S.V. Prasad	Senior Scientist	varaprasad.gogineni@gmail.com	Superannuated on 30-4-2015
7	Dr V.P. Bhadana	Senior Scientist	vp_pb@yahoo.co.in	Left on promotion to NIAB in Feb. 2016
8	Dr Gireesh. C	Scientist	giri09@gmail.com	
9	Dr Suneetha K	Scientist	ponnukota@yahoo.com	
10	Mr. Abdul Fiyaz	Scientist	---	
11	Dr Jyothi Badri	Scientist	jyothi_rishik@yahoo.com	
12	Dr D. Sanjeeva Rao	Scientist	sraodurbha@gmail.com	
Hybrid Rice				
13	Dr A.S. Hari Prasad	Principal Scientist	hariprasad34@gmail.com	
14	Dr P. Senguttuvel	Scientist	senguttuvel@gmail.com	
15	Dr P. Revathi	Scientist	revathi.ponnusamy@gmail.com	
16	Dr K.B. Kemparaju	Scientist	kbkemparaju@gmail.com	
Biotechnology				
17	Dr P. Ananda Kumr	Principal Scientist	polumetla@hotmail.com	joined on 29-4-2015
18	Dr S.M. Balachandran	Principal Scientist	balasena@yahoo.com	
19	Dr C.N. Neeraja	Principal Scientist	cnneeraja@gmail.com	
20	Dr R.M. Sundaram	Principal Scientist	rms_28@rediffmail.com	
21	Dr M. Seshu Madhav	Principal Scientist	sheshu24@gmail.com	
22	Dr Satendra K Mangrauthia	Scientist	skmdrr@gmail.com	
23	Dr Divya P Syamaladevi	Scientist		
24	Dr Kalyani Kulkarni	Scientist	kalyaniaau@gmail.com	
Agronomy				
25	Dr R. Mahendra Kumar	Principal Scientist	kumarrm213@gmail.com	
26	Dr B. Sreedevi	Principal Scientist	sreedevi.palakolanu@gmail.com	
27	Dr Mangal Deep Tuti	Scientist	mangal.iari@gmail.com	Joined on 6-7-2015
28	Mr. Soumya Saha	Scientist	saha.soumya5@gmail.com	Joined on 9-4-2015
Physiology				
29	Dr S.R. Voleti	Principal Scientist	voletisr58@rediffmail.com	
30	Dr D. Subrahmanyam	Principal Scientist	subbu_desiraj@msn.com	
31	Dr P. Raghuveer Rao	Senior Scientist	prrao2005@yahoo.co.in	
Soil Science				
32	Dr K. Surekha	Principal Scientist	surekhakuchi@gmail.com	

S. No.	Name	Designation	E-mail	Remarks
33	Dr M.B.B. Prasad Babu	Senior Scientist	mbbprasadbabu@gmail.com	
34	Dr DVK Nageswar Rao	Principal Scientist		Joined on 25-5-2015
35	Dr Brajendra	Principal Scientist	braj_2222@rediffmail.com	
36	Dr P.C. Latha	Senior Scientist	lathapc@gmail.com	
37	Dr Bandeppa	Scientist		Joined on 10-4-2015
Computer Applications in Agriculture				
38	Dr B. Sailaja	Senior Scientist	saila_r@yahoo.com	
Agricultural Engineering				
39	Dr T. Vidhan Singh	Principal Scientist	vidhan_singh@yahoo.com	
Entomology				
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Abhilash Kumar V, CH. Balachiranjeevi, S. Bhaskar Naik, R. Rambabu, G. Rekha, K. R. Madhavi, G. Harika, S. Vijay, K. Pranathi, S. K. Hajira, A. Srivastava, H. K. Mahadevaswamy, M. Anila, A. Yugander, J. Aruna, A. S. Hari Prasad, M. S Madhav, G. S. Laha, B. C. Viraktamath, S. M. Balachandran, P. Senguttuvel, B. Kemparaju, V. Ravindra Babu, R. M. Sundaram, M. S. Prasad (2016). Marker-assisted introgression of the major bacterial blight resistance gene, Xa21 and blast resistance gene, Pi54into RPHR-1005, the restorer line of the popular rice hybrid, DRRH3. *J. Plant Biochem. Biotechnol*. PP: DOI 10.1007/s13562-016-0352-z.

Agarwal S, Mangrauthia SK*, and Sarla N (2015). Expression profiling of iron deficiency responsive microRNAs and gene targets in rice seedlings of Madhukar x Swarna recombinant inbred lines with contrasting levels of iron in seeds. *Plant and Soil*, 396: 137-150.

Akhilesh Singh K, Kemparaju K. B, Virupaxagouda Patil, Rahul Priyadarshini, Pranitha Koradi, Durga Khandekar, Jayaramulu K, Sheshu Madhav M, Lalitha Shanthi M, Pawan Khera, Manisha Barthwal, Subba Rao, L. V, Hariprasad A. S, K. Ulaganathan and Vinay Shenoy V (2015). Stigma exsertion trait in rice (*Oryza Sativa* L.) And comparison of two Phenotyping methods. *International Journal of Current Research* 7(03):13123-13135.

Amitha Mithra, S. V, M. K. Kar, T. Mohapatra, S. Robin, N. Sarla, M. Seshashayee, K. Singh, A. K. Singh, N. K. Singh and R. P. Sharma. 2015. DBT propelled national effort in creating mutant resource for functional genomics in rice. *Current Science,* 110 (4), 543-548.

Amtul Waris (2015) Farm women's empowerment for sustainable rural and community development. *Ind. J. Sci. Res. and Tech.* 3(4):3-5.

Amtul Waris (2015) Training for capacity building of extension personnel for improving efficiency of knowledge transfer to farming communities. *Agriculture Update* 10 (3): 23-28.

Amtul Waris (2016) Farm Tourism an innovative income earning opportunity for farm women. *Rashtriya Krishi* 10(2): 53-55.

Amtul Waris (2016) Women in agriculture: Key developments under eleventh five year plan and thrust areas of the twelfth plan. *International Journal of Home Science Extension And Communication Management* (3) 1:45-49.

Amtul Waris, B. Nirmala and S. Arun Kumar (2016) Gender gap and female workforce participation in agriculture in Andhra Pradesh, India. *Afr. J. Agric. Res.*11 (9):769-778

Arun K. Singh#, Revathi Ponnuswamy#, Krishnaveni Donempudi and Satendra K. Mangrauthia* (2016) The differential reaction of rice hybrids to Tungro virus by phenotyping and PCR analysis. *Journal of Phytopathology*: 1-8. (# these authors contributed equally).

Arun Kumar Singh, Pulin Borah, Revathi Ponnuswamy*, Debojit Sarma, Ashutosh Roy and G. N. Hazarika. 2016. Identification of fertility restorers among Assam rice cultivars by phenotyping and molecular screening approaches. *Indian J. Genet*., 76(1): 10-17.

Aruna Sri Yadav., Subba Rao L.V., Lavanya K., Surender R., Chiranjeevi M., Chaitanya U., and Suneetha K. (2016)Characterization of rice (Oryza sativa L.) germplasm for physico-chemical quality. *Progressive Research an International Journal*.Vol 11(Special II): 677-679.

Aruna, J., Vijay Kumar, S., Rambabu, R., Ramesh, S., Madhavi, K. R., Abhilash, V., Laha, G.S., Krishnaveni, D., Ladhalakshmi, D., Prakasam, V., Ravindra Babu, V. and M. S. Prasad. (2015). Variability in Aggressiveness of Rice Blast (P. oryzae) Isolates originating from resistant and susceptible cultivars. *Journal of Rice Research* 8(1): 82-83.

Augustine SM, Cherian AV, Syamaladevi DP*, Subramonian N* (2015) Erianthus arundinaceus HSP70 (EaHSP70) Acts as a key regulator in the formation of anisotropic interdigitation in sugarcane (Saccharum spp. hybrid) in response to drought stress. *Plant Cell Physiol*. 56(12): 2368-80.

Augustine SM, JA Narayan, DP Syamaladevi, C Appunu, M Chakravarthi, V Ravichandran, Narendra Tuteja, N Subramonian (2015) Overexpression of EaDREB2 and pyramiding of EaDREB2 with the pea DNA helicase gene (PDH45) enhance drought and salinity tolerance in sugarcane (Saccharum spp. Hybrid*) Plant Cell Reports* 34(2):247-63.

Augustine SM, JA Narayan, DP Syamaladevi, C Appunu, M Chakravarthi,V Ravichandran, N Subramonian (2015) *Erianthus arundinaceus* HSP70 (EaHSP70) overexpression increases drought and salinity tolerance in sugarcane (Saccharum spp. Hybrid) *Plant Science* 232:23-34.

Augustine SM, JA Narayan, DP Syamaladevi, C Appunu, M Chakravarthi,V Ravichandran, Narendra Tuteja, N Subramonian (2015) Introduction of Pea DNA Helicase 45 into sugarcane (Saccharum spp. Hybrid) enhances cell membrane thermostability and upregulation of stress-responsive genes leads to abiotic Stress tolerance. *Molecular Biotechnology* 57(5):475-88.

Azam M.M. 2015. Rice Riche- Rice Bran Oil based Pain Relieving Gel. *Journal of Rice Research,* 8(1): 81

Balachiranjeevi CH, Bhaskar Naik S, Abhilash V, Akanksha S, Viraktamath BC, Madhav MS, Hariprasad AS, Laha GS, Prasad MS, Balachandran SM, Neeraja CN, Satendra Kumar M, Senguttuvel P, Kemparaju KB, Bhadana VP, Ram T, Harika G, Mahadeva swamy HK, Hajira Sk, Yugander A, Pranathi K, Anila M, Rekha G, BVN Kousik M, Dilip kumar T, Swapnil RK, Archana Giri and Sundaram RM (2015). Marker-assisted introgression of bacterial blight and blast resistance into DRR17B, an elite, fine-grain type maintainer line of rice. *Molecular breeding* 35:151, DOI 10.1007/s11032-015-0348-8.

Balachiranjeevi CH, Bhaskar Naik S, Abhilash V, Mahadeva Swamy HK, Harika G, Hajira SK, Hari Prasad AS, Laha G S, Madav MS, Archana Giri, Sundaram RM (2015). Development of host plant resistance in an elite maintainer line DRR17B for Bacterial Blight and Blast through marker assisted backcross selection. *International Journal of Scientific Research.* 4(8): 27-30.

Balachiranjeevi CH, Bhaskar Naik S, Abhilash V, Mahadeva Swamy HK, Harika G, Hajira Sk, Pranathi K, Anila M, Dilip Kumar T, Rekha G, Hari Prasad AS, Laha GS, Madav MS, Archana Giri and Sundram RM (2015). Improvement of an elite maintainer line DRR17B for Bacterial blight and gall midge resistance through marker assisted selection. *Annals of Plant and Soil Research*, 17: 605-608.

Bhaskar Naik S, Balachiranjeevi CH, Abhilash Kumar V, Rekha G, Harika G, Pranathi K, Mahadeva Swamy Hk, Anila M, Hajira Sk, Yugander A, Hariprasad AS, Madhav Ms, Laha Gs, Balachandran Sm And Sundaram RM (2015). Marker-assisted improvement of Akshayadhan for bacterial blightand gall midge resistance. *Annals of Plant and Soil Research,* 17: 269-272.

Bhaskar S, Balachiranjeevi, Abhilash V, Harika G, Laha GS, Prasad MS and Sundaram RM (2015). Introgression of bacterial blight and blast resistance the elite rice variety, Akshayadhan through marker-assisted backcross breeding. *International Journal of Current Research* 7: 18943-18946.

Bimolata W, Kumar A, Reddy SK, Sundaram RM, Laha GS, Quresh IA and Ghazi IA (2015). Nucleotide Diversity Analysis of Three Major Bacterial Blight Resistance Genes in Rice. *PLoS One* DOI:10.1371/journal.pone.0120186

Chakravarthi M, Syamaladevi DP*, Harunipriya P, Augustine SM, Subramonian N* (2016) A novel PR10 promoter from Erianthus arundinaceus directs high constitutive transgene expression and is enhanced upon wounding in heterologous plant systems. *Mol Biol Rep* 43(1):17-30.

Divya, D., Bhaskar Naik, S., Sundaram, R.M., Laha, G. S. and Bentur J.S. (2015). Marker-assisted pyramiding of bacterial blight and gall midge resistance genes in Samba Mahsuri and study of their interactions. IJSR - International Journal of Scientific Research 4(6): 591-594.

Duan C-G, Wang X, Tang K, Zhang H, Mangrauthia SK, Lei M, Hsu C-C, Hou Y-J , Wang C, Li Y, Tao WA, and Zhu JK (2015). MET18 Connects the Cytosolic Iron-Sulfur Cluster Assembly Pathway to Active DNA Demethylation in Arabidopsis. PLoS Genetics, 11(10): e1005559.

Hajira SK, Sundaram RM, Laha GS, Yugander A, Balachandran SM, Viraktamath BC, Sujatha K, Balachiranjeevi CH, Pranathi K, Anila M, Bhaskar S, Abhilash V, Mahadevaswamy HK, Kousik M, Dilipkumar T, Haria and Rekha G (2016). A Single-Tube, Functional Marker-Based Multiplex PCR Assay for Simultaneous Detection of Major Bacterial Blight Resistance Genes in Rice, *Xa21, xa13* and *xa5*. *Rice Science* 23(3); published online.

Haritha G., T. Sudhakar, Dinesh Chandra, T. Ram, B. Divya, N. Sarla. 2016. Informative ISSR markers help identify genetically distinct accessions of *Oryza rufipogon* for use in yield improvement. Rice Science 23(5):1

Harshvardhan N. Zala, Tejas C. Bosamia, Yogesh M. Shukla, Sushil Kumar and Kalyani S. Kulkarni. Genome modifications in crops employing engineered nucleases *Agricultural Reviews*. 10.18805/ar.v0iof.9629.

Himanshu Patel, Brajendra, Vijay Pal Bhadana, Suneetha Kota, Mahadevaswamy, Rajkamal Patel, Madan Prasad Paikara, Gulab Chand and V. N. Mishra. (2016) Phosphorous acquisition by rice. *Asian Journal of Bio science* 11 (1): 206-211.

Jeer, Jeer M., Telugu, U. M., Voleti, S. R. and Padmakumari, A. P. 2016. Soil application of silicon reduces yellow stem borer, Scirpophaga incertulas (Walker) damage in rice. *Journal of Applied Entomology Version of Record* DOI: 10.1111/jen.12324.

Kanakachari, M., Solanke, A.U., Prabhakaran, N., Ahmad, I., Dhandapani, G., Jayabalan, N. and Kumar, P. A. 2015. Evaluation of suitable reference genes for normalization of qPCR gene expression studies in Brinjal (*Solanum melongena* L.) during Fruit Developmental Stages. Applied Biochemistry and Biotechnology 10.1007/s12010-015-1884-8.

Kaushal K., S.M. Balachandran, K Ulaganathan, A.K.Singh, R. Priyadarshi and V. Shenoy (2015). Auxin to improve green plant regeneration of rice anther culture. *Intl J Agri Crop Sci*. 8 (1): 15-26.

Keshavulu K, Krishnasamy V, Sundaram RM, Sultana R, Rajendrakumar P, Madhav MS, Subbarao LV and Chin-Wo SR (2015) Assessment of Genetic Diversity of Elite Indian Rice Varieties Using Agro-Morphological Traits and SSR Markers. *American Journal of Experimental Agriculture* 6: 384-401.

Kiran, B., Mohan Kumar Varma Rajendra Krishna, G. V., Mohan Kumar Varma, C Vinay Shenoy, Maheshwari Parveda, Kavi Kishor, P. B. and Kalmeshwer Kalmeshwer Gouda p Subba Rao, L. V. (2016) Response to direct selection for grain yield in oryza sativa IR58025b x oryza meridionalis ng., mapping population under irrigated and stress conditions interspecific population of mapping population *International Journal of Current Research* 8(1): 25053-25061.

Kiranmayi SL, K Manorama, VGNT Venkata, K Radhika, C Cheralu, N Sarla. 2015. Identification of markers associated with iron and zinc concentration in recombinant inbred lines of brown rice. *Indian Journal of Genetics and Plant Breeding* 74 (4), 423-429.

Kola VSR, Renuka P, Padmakumari AP, Mangrauthia SK, Balachandran SM, Babu VR, and Madhav MS (2016). Silencing of CYP6 and APN genes affects the growth and development of rice yellow stem borer, *Scirpophaga incertulas*, *Frontiers in Physiology*, 7: 20.

Kondamudi R, K. N. Swamy, Y. Venkateswara Rao, T. Vishnu Kiran, K. Suman,D. Sanjeeva Rao, P. Raghuveer Rao, D. Subrahmanyam, N. Sarla, B. Ramana Kumari, S. R. Voleti. (2016) Gas exchange, carbon balance and stomatal traits in wild and cultivated rice (Oryza sativa L.) genotypes. *Acta Physiol Plant* 38:160.

Kota S., S. S. Singh, A. M. Singh, T. Mohapatra, A. K. Ahlawat, P. Brajendra, and B. N. Mandal.2015. The Variation and Stability Analysis of Starch Pasting Properties among New Plant Type (NPT) Wheat Derivatives. *J. Agr. Sci. Tech.*, 17: 1887-1902.

Krishnamurthy S.L., S.K. Sharma, D.K. Sharma, P.C. Sharma, Y.P. Singh, V.K. Mishra, D. Burman, B. Maji, B.K. Bandyopadhyay, S. Mandal, S.K. Sarangi,R.K. Gautam4, P.K. Singh, K.K. Manohara, B.C. Marandi, D.P. Singh, G. Padmavathi, P.B. Vanve, K.D. Patil, S. Thirumeni, O.P. Verma, A.H. Khan, S. Tiwari, M. Shakila, A.M. Ismail, G.B. Gregorio and R.K. Singh. 2016. Analysis of Stability and G × E interaction of Rice Genotypes across Saline and Alkaline Environments in India. *Cereal Research Communications*. 44(2): 349–360.

Kulkarni KS, Zala HN, Bosamia TC, Shukla YM, Joshi CG, Kumar S, Fougat RS, Narayanan S and Patel MS (2016). De novo transcriptome sequencing to dissect candidate genes associated with pearl millet-downy mildew (Sclerospora graminicola Sacc.) interaction. *Front. Plant Sci.* 7:847.

Kumar, S., Parekh, M.J., Patel, C.B., Zala, H.N., Sharma, R., Kulkarni, K.S., Fougat, R.S., Bhatt, R.K. and Sakure, A.A. (2015). Development and validation of EST-derived SSR markers and

diversity analysis in cluster bean (*Cyamopsis tetragonoloba*). *J. Plant Biochem. Biotechnol.* 25(3): 263-269

Lima JM, M Nath, P Dokku, KV Raman, KP Kulkarni, C Vishwakarma, S. P. Sahoo, U. B. Mohapatra, S. V. Amitha Mithra, V. Chinnusamy, S. Robin, N. Sarla, M. Seshashayee, K. Singh, A. K. Singh, N. K. Singh, R. P. Sharma and T. Mohapatra. (2015) Physiological, anatomical and transcriptional alterations in a rice mutant leading to enhanced water stress tolerance, *AoB Plants doi: 10.1093/ aobpla/plv023*.

Madhu Babu Pulagam, Praveen V, Sai Sravanthi M, Sanjeeva Rao D, Surekha K, Sundaram R M, Ravindra Babu V, Neeraja C N (2015) Association of OsYSL9 gene with high iron and zinc content in rice grains and identification of elite rice lines. *International Journal for Tropical Agriculture* 33 (4): 3031-3036.

Mahender Kumar R., M.D.Tuti, B.Sreedevi, K.Surekha and V.Ravindra Babu (2016). Rice Agronomy: Towards improving productivity and sustaining health. *SATSA Mukhapatra-Annual Technical Isuue* 20:15-25.

Mahender Kumar, R., V. Ravindra Babu, , L.V. Subba Rao, K.Surekha, Ch. Padmavathi, M.S. Prasad, N. Somasekhar, A.S. Rama Prasad and Vinod Goud. (2015). Grain Quality Parameters of Cultivars as Influenced by SRI Vs Normal Method of Rice Cultivation. *Journal of Rice Research* 8(2):28-35.

Malathi P, Krishnaveni D and Mangrauthia SK* (2015). Sequence Divergence of Coat Protein Gene among Indian and non-Indian Isolates of Rice Tungro Bacilliform Virus. Journal of Rice Research, 8:63-70.

Malathi S, Divya B, Sukumar M, A Krishnamraju Y V Rao and Sarla N. 2016.Genetic characterization and population structure of Indian rice cultivars and wild genotypes using core set markers. 3Biotech 6:95.

Malay K. Bhowmick, M. C. Dhara, S. K. Bardhan Roy, K. Surekha and R. Mahender Kumar. 2015. Effectiveness of Chemical Fertilizers with and without Bio-organic Materials in Transplanted Rice. *Journal of Rice Research.* 8(2): 58-63.

Manimaran P, Reddy MR, Rao TB, Mangrauthia SK, Sundaram RM and Balachandran SM (2015). Identification of cis-elements and evaluation of upstream regulatory region of a rice anther-specific gene, *OSIPP3*, conferring pollen-specific expression in *Oryza sativa* (L.) ssp. indica. *Plant Reproduction*. 28: 133-142.

Nagendra Reddy B, V. Jhansi Lakshmi, T. Uma Maheswari, A. Ramulamma and GR Katti (2016) Identification of resistant sources to brown planthopper N*ilaparvata lugens* (Stal.) (Delphacidae: Homoptera). *Progressive Research – An International Journal, 11 (1) : 5-8*

Nirmala B, Amtul Waris and P. Muthuraman (2015). Technology Dissemination Approaches for Bridging Rice Yield Gaps on Small Farms .*Indian Res. J. Ext. Edu.* 16 (1): 128-133.

Nirmala B. (2015) Hybrid rice seed production in Telangana and Andhra Pradesh states of India: a situation analysis. *International Journal of Agriculture Sciences*, Volume7 (14): 883-886.

Nirmala Devi G., G. Padmavathi, Suneetha Kota and V. R. Babu (2015) Genetic Variability, Heritability And Correlation Coefficients Of Grain Quality Characters In Rice (*Oryza Sativa* L.). *SABRAO Journal of Breeding and Genetics*. 47 (4): 424-433.

Nirmala Devi G., G.Padmavathi, V. Ravindra Babu and KavitaWaghray. 2015. Proximate Nutritional Evaluation of Rice (*Oryza Sativa* L.). *Journal of Rice Research*. 8(1): 23-32.

Nirmala Devi G., V. Ravindra Babu, G. Padmavathi and T. Sunitha. 2015. Genetic Diversity in Grain Quality Traits of Rice Genotypes. Journal of Rice Research. 8(1). 6-14.

Nithya, N., Geetha, R. and Prakasam, V. (2015) Alleviation of the adverse effects of salinity stress in rice var. PMK-4 (*Oryza sativa.*) by seed biopriming with salinity tolerant *pseudomonas fluorescens. Annals of Plant and Soil Research* 17(SI):190-193.

Okonkwo C.C., Azam M.M., Ezeji T.C. and Qureshi N. 2016. Enhancing ethanol production from cellulosic sugars using Scheffersomyces (Pichia) stipites. Bioprocess Biosystems Eng., 39:1023 1032.

Padmavathi Chintalapati, Gururaj Katti, P Raghuveer Rao and NV Krishnaiah. 2016. Neo-nicotinoid induced resurgence of rice leaffolder, *Cnaphalocrocis medinalis* (Guenee). *Pest Management Science (Pesticide Science)* 72 (1): 155-161.

Padmavathi Chintalapati, Katti Gururaj, Sailaja Vallabuni and Prasad Yenumulag. 2015. Physiological Age Status of Female Adults and Off-Season Survival of Rice Leaffolder, *Cnaphalocrocis medinalis* in India. *Rice Science*, 22(5): 237-244.

Palaniswamy H, Syamaladevi DP*, Mohan C, Philip A, Petchiyappan A, Narayanan S*(2016) Vacuolar targeting of r-proteins in sugarcane leads to higher levels of purifiable commercially equivalent recombinant proteins in cane juice. Plant Biotechnol J. 14(2):791-807.

Parekh, M.J., Kumar, S., Zala, H.N., Fougat, R.S., Bosamia, T.C., Kulkarni, K.S., and Parihar, A. (2015). Development and validation of novel fibre relevant EST-SSR markers and their utility in revealing genetic diversity in diploid cotton (*Gossypium herbaceum* and *G. arboreum*). *Industrial Crops and Product* 83:620-629.

Prakash C.R, Sreedevi B, Mahbooba Asra and Dwivedi R.S, 2015, Feature Selection for Urban Land-Cover Classification using Landsat-7 ETM+ Data *International Journal of Advanced Remote Sensing and GIS* 4(1): 1229-1238

Prakash C.R., Mahbooba Asra, J.Venkatesh, B.Sreedevi, 2015, Monitoring Urban Land-Cover Features Using Resourcesat LISS-III Data *International Journal of Advanced Remote Sensing and GIS* 4(1): 1064-1069

Pranathi K#, Viraktamath BC, Neeraja CN, Balachandran SM, Hariprasad AS, Koteswara Rao, P, Kulkarni SR, Senguttuvel P, Hajira SK, Balachiranjeevi CH, Bhaskar Naik S, Abhilash V, Anila M, Mahadevaswamy HK, Rekha G, Madhav MS, Revathi P, Harika G, Dilip T, Kemparaju B and Sundaram RM# (2016). Comparative analysis of sequences of mitochondrial genomes of wild abortive male sterile (WA-CMS) and male fertile lines of rice, development of functional markers for WA-CMS trait and their use in assessment of genetic purity of seeds of WA-CMS lines. *Molecular Breeding* 36:21 (published online: DOI 10.1007/s11032-016-0445-3; # these authors contributed equally).

Prasanth VV, KR Basava, MS Babu, SK Mangrauthia, S Neelamraju. 2016. Field level evaluation of rice introgression lines for heat tolerance and validation of markers linked to spikelet fertility. *Physiology and Molecular Biology of Plants*, 1-14.

Pushpalatha Ganeshan, Ajay Jain, Brajendra Parmar,A.R Rao, K. Sreenu, Pragya Mishra, Sudhakar Mesapogu, D. Subrahmanyam. T. Ram. N. Sarala and Vandana Rai (2016) Identification of salt tolerant rice lines among interspecific BILs developed by crossing *oryza sativa x O. rufipogon and O. sativa x O. nivara. Australian J. Crop Sciences 10(2)*: 220-228

Rahul Priyadarshi, A. S. Hari Prasad, Akhilesh Kumar Singh, K. Ulaganathan, Vinay Shenoy (2016). Comparative analysis of effectiveness of wide compatibility (*wc*) trait between improved maintainer line having *wc* and *eui* genes and maintainer line with *eui* and without *wc* genes in rice (*Oryza Sativa* L.). *Environment & ecology* 34 (4b): 214.

Rahul Priyadarshi, Akhilesh Kumar Singh, Durga Khandekar, Pranitha Koradi, Demudunaidu P, Pawan Khera, Hari Prasad A. S, Ulaganathan K & Vinay Shenoy (2015). SSR-BASED molecular profiling of selected donors of wide compatibility, elongated uppermost internode, stigma exsertion and submergence tolerance traits and parental lines of commercial rice (*O. Sativa* L.) Hybrids. *International Journal of Agricultural Science and Research* (IJASR) 5(2): 67-92.

Rahul Priyadarshi, Hari prasad A.S, Akhilesh Kumar Singh, Ulaganathan K And Vinay Shenoy (2016). Comparative analysis of effectiveness of wide compatibility (WC) trait between improved maintainer line having *WC* and without *WC* gene in rice. *Green Farming* Vol. 7 (5).

Rajkumar, Jyothi Badri*, VP Bhadana, C. Priyanka, N. A. Ansari, Susmita Dey and D. Srinivasa Chary (2015) Genetic Divergence Studies for Yield and its Components in Rice. Journal of Rice Research. 8 (1): 33-40.

Raksha, I. Sreenivasa Rao and Shaik N.Meera (2015). Development of an attitude Scale to measure attitude of Extension Personnel towards use of ICTs in Agricultural Extension System. *Indian Journal of Social Research.* 56 (6): 1051-1055.

Raksha, I. Sreenivasa Rao and Shaik N.Meera (2015). Perceived Utility of Information and Communication Technologies in Agricultural Extension System. *Indian Journal of Extension Education.* 51(3&4):133-138

Raksha, Sreenivasa Rao and N.Meera Shaik (2015). e-readiness of Agricultural Extension Personnel with the use of ICTs in Agricultural Extension Systems. *Journal of Extension Systems (International).* Vol 31 (2): 1-10

Raksha, Sreenivasa Rao and Shaik N.Meera (2015). Development of e-readiness Index in Agricultural Extension System. *Journal of Communication Studies*. Xxxiii: 95-99.

Rama Devi, S.J.S., Kuldeep Singh, B. Umakanth, B. Vishalakshi, P. Renuka, K. Vijay Sudhakar, M. S. Prasad, B. C. Viraktamath, M. S. Madhav. Development and identification of novel rice blast resistant sources and their characterization using molecular markers. *Rice Science*, 2015, 22(6): 300-308

Ramkumar G, Madhav MS, Rama Devi SJS, Umakanth B, Pandey MK, Prasad MS, Sundaram RM, Viraktamath BC and Ravindra Babu V (2016). Identification and validation of novel alleles of rice blast resistant gene *Pi54*, and analysis of their nucleotide diversity in landraces and wild *Oryza* species. *Euphytica* 209(3):725-737

G.Ramkumar, M S. Madhav*, S.J.S. Rama Devi, M.S. Prasad, V.Ravindra Babu (2015). Nucleotide variation and identification of novel blast resistant alleles of Pib by allele mining strategy. *Physiol Mol Bio Plants*. 21(2):301-304.

Rao DVKN and Lakshmanan R. (2015). Low intensity sampling based predictive model for actual soil volume. *Current Advances in Agricultural Sciences*, 7(1), 24-28.

Ravindra Babu V, G.S. Varaprasad, T. Ram, L.V. Subba Rao, G. Padmavathi, Vijai Pal Bhadana, Suneetha Kota, Jyothi Badri and U. Chaitanya. 2014. Rice research in India Society for scientific development in Agriculture and tech. *Progressive Research* (conf.Spl): 3-7.

Renu Singh, Yashi Singh, Suchit Xalaxo, S. Verulkar, Neera Yadav, Shweta Singh,Nisha Singh, K.S.N. Prasad, K. Kondayya, P.V. Ramana Rao, M. Girija Rani, T. Anuradha, Y. Suraynarayana, P.C.Sharma,S.L.Krishnamurthy,S.K.Sharma,J.L. Dwivedi, A.K. Singh, P.K. Singh, Nilanjay, N.K. Singh, Rajesh Kumar, S.K. Chetia,T. Ahmad, M. Rai, P. Perraju, Anita Pande, D.N. Singh, N.P. Mandal, J.N. Reddy,O.N. Singh, J.L. Katara, B. Marandi, P. Swain, R.K. Sarkar, D.P. Singh, T. Mohapatra,G. Padmawathi, T. Ram, R.M. Kathiresan, K. Paramsivam, S. Nadarajan,S. Thirumeni, M. Nagarajan, A.K. Singh, Prashant Vikram, Arvind Kumar,E. Septiningshih, U.S. Singh, A.M. Ismail, D. Mackill, Nagendra K. Singh (2016) From QTL to variety-harnessing the benefits of QTLs for drought, flood and salt tolerance in mega rice varieties of India through a multi-Institutional network. *Plant Science* 242:278-287.

Revathi P , Dinesh Chandra, Ram Deen, Arun Kumar Singh, Sohanvir Singh, Moti Lal, V.P. Bhadana, T. Ram (2015). Marker assisted selection for S5 neutral allele in inter-subspecific hybridization of rice. *Molecular Plant Breeding* 6(1): 1-7

Ruchi Agarrwal, Ayyagari Phani Padmakumari, Jagadish S. Bentur and Suresh Nair (2016) Metabolic and transcriptomic changes induced in host during hypersensitive response mediated resistance in rice against the Asian rice gall midge. *Rice* 9:5

Sailaja B, SR Voleti, S Gayatri, D. Subrahmanyam, R Nagarjuna Kumar, P. Raghuveer Rao and Shaik N.Meera (2015). *Vulnerability of Rice Yields under Changed Climate Conditions. International Journal of Agricultural Statistical Sciences* 11 (2): 523-526

Sailaja B, Subrahmanyam D, Neelamraju S, Vishnukiran T, Rao YV, Vijayalakshmi P, Voleti SR, Bhadana VP, and Mangrauthia SK* (2015). Integrated Physiological, Biochemical, and Molecular Analysis Identifies Important Traits and Mechanisms Associated with Differential Response of Rice Genotypes to Elevated Temperature. *Frontiers in Plant Science*, 6:1044.

Sakthivel, K., Gautam, R. K., Manigundan, K., Singh, P. K., Laha, G. S. Velazhahan, R. (2015). Isolation and molecular characterization of rice bacterial blight pathogen *Xanthomonas oryzae* pv. *oryzae* from Andaman Islands, India. *Pl. Dis. Res*. 30(2): 136-141.

Sampathkumar M, Chitra Shanker, Ch Padmavathi and Gururaj Katti (2015). Binary sex attractant blends for caseworm, *Nymphula depunctalis*. *Indian Journal of Plant protection*, 43(3): 364-365.

Satish L., A.S.Rency, P. Rathinapriya, S.A. Ceasar, S. Pandian, R. Rameshkumar, T. Bhaskar Rao, S.M.Balachandran and M. Ramesh. (2015). Influence of plant growth regulators and spermidine on somatic embryogenesis and plant regeneration in four Indian genotypes of finger millet (Eleusine coracana (L.) Gaertn). *Plant Cell Tiss Organ Cult*. DOI 10.1007/s11240-015-0870-8.

Senguttuvel P., K. Thiyagarajan, C. Vijayalakshmi, S.Geetha, J.R. Kannanbapu Brajendra, B.C. Viraktamath, VP. Bhadana, Sravan Raju, LV. Subbarao, G. Padmavathi and V. Ravindra

babu. (2015) Prediction of combining ability and heterosis in three line rice Hybrids for salinity tolerance. *Annals of Plant and Soil Research 17* (Special Issue): 438-441.

Singh, V.K., Nain, V., Sharma, P., Rao, K.R.S.S., Birah, A., Gupta, G.P. and Kumar, P. A. (2015)Enhanced toxicity of purified *Bacillus thuringiensis* Cry1Ac δ-endotoxin. *Current Trends in Biotechnology and Pharmacy* 9: 97-106.

Somasekhar, N. and Prasad, J.S. (2015). Plant parasitic nematodes. *National Journal of life Sciences.* 12(3)74-80 (special issue)

Sri Chandana B, JS Bentur, Ch V Durga Rani, G Thappeta, KN Yamini, N Arun Prem Kumar, Md. Jamaloddin, G Swathi, V Jhansi Lakshmi, K Vasantha Bhanu and P Satyanarayana. (2015) Screening of rice genotypes for resistance to brown planthopper biotype 4 and detection of BPH resistance genes International Journal of Life Sciences, Biotechnology and Pharma Research 4(2): 90-95.

Srikanth B, I. Subhakara Rao, S. Zehra Moiz, K.N. Swamy, K. Surekha, D. Subrahmanyam, L.V. Subba Rao, P. Vijayalakshmi, S.R. Voleti, C.N. Neeraja. Physiological and Molecular characterization of three rice genotypes with differential nitrogen use efficiency. *Asian Journal of Bioscience* (2016), 11(1): 162-171.

Srikanth, I. Subhakara Rao, K. Surekha, D. Subrahmanyam, S.R. Voleti, C.N. Neeraja. Enhanced expression of *OsSPL14* gene and its association with yield components in rice (*Oryza sativa*) under low nitrogen conditions. *Gene* (2015), 576: 441-450.

Srikanth, I. Subhakara Rao, K.N. Swamy, P. Vijayalakshmi, K. Surekha, S. Zehra Moiz, M. Lakshmi Narasu, M.S. Archana Giri, S.R. Voleti, C.N. Neeraja. Physiological and molecular analysis of GQ-25, a promising genotype for Nitrogen use efficiency. *Progressive Research- An International Journal* (2015), 10 (Spl-II):651-656.

Subba Rao L.V., G.Kumar,R.Mahendhra Kumar and K.Keshavulu 2015 Effect of system of rice intensification (sri)on growth parameters, Yield attributes and yield in rice genotypes *Annals of Plant and Soil Research* 17 (Special Issue): 411-416 (2015).

Subbarao L.V., Lavanya K, Padma C, Chiranjeevi M, Chaitanya U, Surender R, Jayasree B, Shiva Prasad G, Suneetha K and Dipal R Chowdhury. 2015. Assessment of Genetic Divergence in Farmers' Varieties of Rice [*oryza sativa L.*] from the Eastern Region of India. *Annals of Plant and Soil Research* 17 (5): 424-427.

Suneetha Kota, Senguttuvelu P., V. P. Bhadana, L.V. Subba Rao, U. Chaitanya, Aruna Sri Yadav, Brajendra and V. Ravindra Babu. 2015. Character association and estimates of genetic parameters in transplanted and direct seeded experiments of Rice. *Annals of Plant and Soil Research* 17(5): 424-427.

Supta Sarkar, Aparna Kuna, Azam MM*, M Sowmya, E. Suneel Kumar, 2015. Sensory and consumer evaluation of iron fortified rice, Oryza, 52(3): (231-236)

Surekha K., R. Mahender Kumar and B. C. Viraktamath. 2015. Organic Rice Farming: Opportunities for Quality Seed Production and Soil Health Improvement. SATSA Mukhapatra - *Annual Technical Issue* 19: 1-18.

Surekha, K., R. Mahender Kumar and Ch. Padmavathi. 2015. Evaluation of Crop Establishment Methods for their Productivity, Nutrient Uptake and use Efficiency under Rice-Rice System. *Journal of Rice Research*. Volume 8: Issue No. 1:41-47.

Surekha, K., R. Mahender Kumar, M. D. Tuti and V. Ravindra Babu. 2016. Efficient Nutrient Management Practices for Sustaining Soil Health and Improving Rice Productivity. SATSA Mukhapatra - Annual Technical Issue 20: 26-38.

Susmita Dey, Jyothi Badri*, V. Prakasam, V. P. Bhadana, K.B. Eswari, G. S. Laha, C. Priyanka, Aku Rajkumar and T. Ram (2016) Identification and agro-morphological characterization of rice genotypes resistant to sheath blight. *Australasian Plant Pathology*. 45: 145–153

Syamaladevi DP*, Meena SS, Nagar RP (2016) Molecular understandings on 'the never thirsty' and apomictic Cenchrus grass. *Biotechnol Lett*. 38(3):369-76.

Talla, SK, M Panigrahy, S Kappara, P Nirosha, N. Sarla, R Ramanan. 2015. Cytokinin delays dark-induced senescence in rice by maintaining the chlorophyll cycle and photosynthetic complexes. *Journal of Experimental Botany* 67 (6), 1839-1851.

Thalapati, S, H Guttikonda, ND Nannapaneni, PB Adari, CS Reddy, N. Sarla. (2015). Heterosis and combining ability in rice as influenced by introgressions from wild species *Oryza rufipogon*

including qyld2. 1 sub-QTL into the restorer line KMR3. *Euphytica* 202 (1): 81-95.

Valarmathi Pandian, Rethinasamy Velazhahan, Seetharaman Suresh, Sabariappan Robin, Ramalingam Rabindran and Govind P. Rao. (2015) Subgroup level identification of rice orange leaf phytoplasma and its natural transmission through zigzag leafhopper (*Recilia dorsalis*) in India. Phytopathogenic Mollicutes, 5(2): 107-112.

Valarmathi, P. and Rabindran, R. (2015) Nested PCR assay for detection of Rice Orange Leaf phytoplasma in the Zigzag leafhopper vector, *Recilia dorsalis* (Motschulsky): a first report. *The Ecoscan*, 9(3&4): 837-839.

Valarmathi, P., Kumar, G., Robin, S., Manonmani, S., Dasgupta, I. and Rabindran, R. (2015) Evaluation of virus resistance and agronomic performance of rice cultivar ASD 16 after transfer of transgene against *Rice tungro bacilliform virus* by backcross breeding. *Virus Genes*, DOI 10.1007/s11262-016-1318-x.

Vijaya Sudhakara Rao Kola, P. Renuka, Maganti Sheshu Madhav* and Satendra K. Mangrauthia * (2015) Key enzymes and proteins of crop insects as candidate for RNAi based gene silencing. *Frontiers in Physiology* 6: 119

Vijayalakshmi P., T. Vishnukiran, B. Ramana Kumari, B. Srikanth, I. Subhakar Rao, K.N. Swamy, K. Surekha, N. Sailaja, L.V. Subbarao, P. Raghuveer Rao, D. Subrahmanyam, C.N. Neeraja, S.R. Voleti (2015) Biochemical And physiological characterization for nitrogen use efficiency in aromatic rice genotypes *Field Crops Research* 179: 132–143.

Yugander, A., Ladhalakshmi, D., Prakasham, V., Mangrauthia, S. K., Prasad, M. S., Krishnaveni, D., Madhav, M. S., Sundaram, R. M. and Laha, G. S. (2015). Pathogenic and Genetic Variation among the Isolates of Rhizoctonia solani (AG 1-IA), the Rice Sheath Blight Pathogen. *Journal of Phytopathology* 163: 465-474.

Yugander, A., Ladhalakshmi, D., Srinivas Prasad, M. and Laha, G. S. (2015). Evaluation of selected plant extracts against *Xanthomonas oryzae* pv. *oryzae* causing bacterial blight of rice. *World Journal of Pharmaceutical Research* 4(10): 1555-1561.

Srivastava A, Sharma U and Chitra Shanker (2015) New report of *Chrysonotomyia* species (Hymenoptera: Eulophidae: Entedoninae), larval parasitoid on the rice hispa, *Dicladispa armigera* (Oliver) (Coleoptera: Chrysomelidae) in Himachal Pradesh. Journal of Rice Research, 8(2): 83-84.

Pravallika K, Umamaheshwari T, Sampathkumar M, Sunil V and Chitra Shanker. (2015). Functional Response of the assassin bug, *Rhynocoris marginatus* on three lepidopteran pests, Indian Journal of Plant Protection, 43 (4): 429-433.

Technical Bulletins

Azam MM, Amtul Waris and V. Ravindra Babu (2015) Rice bran oil: Nutritional and Health Benefit. Technical Bulletin Number.

Katti, G., Anitha, K., Somasekhar, N., Laha, G. S., Sarath Babu, B and Varaprasad, K. S. (Editors) (2016). Plant Health Management for Food Security: Issues and Approaches. Plant Protection Association of India, NBPGR Regional Station, Rajendranagar, Hyderabad, Telengana State, 230 p.

Laha, G. S., Sailaja, B., Srinivas Prasad, M., Ladhalakshmi, D., Krishnaveni, D., Singh Ram, Prakasam, V., Yugender, A., Kannan, C., Valarmathi, P. and Ravindra Babu, V. 2016. Changes in rice disease scenario in India: An analysis from Production Oriented Survey. Technical Bulletin No. 91. ICAR- Indian Institute of Rice Research (IIRR), Rajendranagar, Hyderabad-500 030, Telangana, India, 95pp.

Shaik N.Meera, S. Arun Kumar, P Muthuraman and V Ravindra Babu (2015). A Brief Report on Frontline Demonstrations on Rice 2014-15. Indian Institute of Rice Research, Hyderabad. P.76.

Shaik N.Meera, S. Arun Kumar, P. Muthuraman, U Chaitanya, Brajendra and V Ravindra Babu (2015). "Rice Innovations 2015", ICAR- Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500 030.

Sreedevi B, PC Latha, P Hemasankari, T Ram, V Jhansi Lakshmi, D Krishnaveni and Brajendra 2015. Agronomic Management of rice based cropping systems in sulfur deficient soils. IIRR Technical bulletin No 85/2015 PP 57.

Technical / Popular Articles

Amtul Waris (2015) Is Rice cultivation losing out labour to other crops? ICAR-IIRR Newsletter13 (4)10.

Amtul Waris (2015) Rice in Dreams heralds success, ICAR-IIRR Newsletter13 (2)12.

Amtul Waris (2015) Socio-religious significance of rice, ICAR-IIRR Newsletter13(3)8-9.

Amtul Waris (2016) Vyavasayamlo mahilalu: samasyulu mariyu vyuhalu Vyvasayam 8(3).

Gangaiah B., B. Sreedevi, Subbalakshmi Lokanadhan, M.D.Tuti, Soumya Saha, P.Senguttuvel, R.Mahender Kumar and V.R. Babu 2015. Climate resilient management practices in rice based cropping systems. IIRR News Letter Vol. No.1 2016. p 12.

Gangaiah B., Martijn Gipmans, Jagmeet Bal. V. Ravindra Babu. R.Mahender Kumar, M.B.B.Prasad Babu. Florian Meler, Dainiel Thylmann, Sebastian Schulze, Nils Langeand Torsten Rehl (2015). Supporting sustainable development of Rice cultivation in India. Ag balance™ Study on the Socio-economic and ecological impacts of Transplanted (TPR) and Direct wet seeded rice (DWSR) cultivation in Andhra Pradesh. Joint effort of IIRR & BASF collaborative studies – pp 86.

Jhansi Lakshmi V., Anupama Chapke, LV Subbarao, PM Chirutkar, GR Katti and V Ravindra Babu 2015. Rice germplasm lines resistant to rice brown planthopper DRR Newsletter 13 (3): 6.

Kalyani M. Barbadikar, Phule Amol S., M. Seshu Madhav, P. Senguttuvel, D. Subrahmanyam, S. M. Balachandran, P. Ananda Kumar. 2016. Water scarcity: Driving force for root studies in rice. ICAR-IIRR News letter, 14 (1):7.

Latha, P.C., Prasad Babu, MBB, Sreedevi, B, Chandrakala, C and Prasad Babu, K.V. 2015. Quorum quenching activity of a Rhizobium sps isolated from the rice rhizosphere. IIRR Newsletter, 13(2):11.

Mangrauthia SK, Malathi P, Krishnaveni D, Balachandran SM, Brajendra, and Babu VR (2015) Development of Rapid Diagnostic Kit for Identification of Rice Tungro Disease. IIRR News Letter. April issue.

Mangrauthia SK, Sailaja B, Prasanth VV, Swamy KN, Sarla N, Voleti SR, Subrahmanyam D, and Bhadana VP (2015), Genes encoding cell wall integrity protein, iron-sulphur cluster binding-protein, and fertility restorer homologue protein contribute to heat stress tolerance in rice. IIRR News Letter, Volume 13 (2), P. 9.

Nirmala B. 2015 Comparative advantage of India in rice exports. IIRR News letter. Vol 13(3) p.9.

Nirmala B. 2015 Trends in India's Rice Consumption. IIRR Newsletter Vol 13(4) p.10.

Padmavathi G., P.V. Satyanarayana, K.Vasantha Bhanu, V. Jhansilakshmi, V.P. Bhadana, M. Tahseen, G.S.V. Prasad and V Ravindra Babu. 2015. Potential sources of resistance to planthoppers identified in greenhouse and field screening. IIRR Newsletter 13 (1): 12.

Prasad MS, Ratna Madhavi K, Rambabu R, Vijay Kumar S, Aruna J, Abhilash Kumar V, Laha GS, Prasad GSV, Sundaram RM, Madhav MS , Ram T and Ravindrababu V (2015). Evaluation of blast and bacterial blight resistant MAS lines in multi environment. IIRR newsletter 13: 13.

Ravindra Babu V., G. Padmavathi, L.V. Subba Rao, G.S.V. Prasad, T. Ram, V.P. Bhadana, K. Suneetha, Jyoti badri and A.S. Hari Prasad, May 2015. Vari sagulo melaina nuthana vangadamulu (in Telugu). *Annadata*. Pp 48.

Sailaja B, AP Padma Kumari, D Krishnaveni, S Gayathri and Shaik N.Meera (2015). Web based Expert System for Rice Varieties, Pests and Diseases. IIRR Newsletter. Vol 13 (3). July-September 2015.

Sreedevi B., Chandulal Thakur, P.Senguttuvel, A.Sandhyarani, B. Dhanunjayareddy, R. Mahenerkumar and V. Ravindrababu 2015. Energy dynamics of herbicidal weed control in aerobic rice. IIRR News Letter Vol. No.1 2016.p 8-9.

Sreedevi B., P.C. Latha, P. Hemasankari, T. Ram, V. Jhansilakshmi, D. Krishnaveni and Brajendra (2015) Agronomic management of rice based cropping systems in sulfur deficient soils. Technical Book No.85/2015.IIRR, Rajendranagar, Hyderabad- 500030.

Sreedevi, B. Latha, P.C., Ram, T., Somasekhar, N., Kumar, R.M., Senguttuvel, P., Sandhya Rani, and Ramamurthy, V. (2015). Weed management in aerobic rice to increase productivity. *IIRR Newsletter*, 13(2) 9-10.

Sruthi K,Senguttuvel P, Beulah P, Eshwari B, Naganna P, Sravan Raju N, Revathi P, Kemparaju KB, HariPrasad AS, Suneetha K, Kalyani MB, Sreedevi B, Bhadana VP, Sundaram RM, Madhav MS, Ananda Kumar P, SubbaRao LV, Padmavathi G, Mahender Kumar R, Subrahmanyam D, Brajendra and V Ravindra Babu. 2015. Early seedling vigour and associated traits in rice (Oryza sativa L). IIRR newsletter Vol 13 (4).

Surekha K. 2016. Multi variety Green Manuring Technique to Improve Rice Productivity in Alkaline soils. In: IIRR Newsletter. Research Articles. January - March 2016. Vol. 14 (1): pp 10.

Books & Book Chapters

Arun K. Shanker and Chitra Shanker. 2016. Abiotic and Biotic stresses in plants – Recent advances and Future Perspectives, Intech Open Science, pp 754. http://dx.doi.org/10.5772/60477.

Gururaj Katti, Anitha Kodaru, Nethi Somasekhar, G.S. Laha, B. Sarath Babu and K.S. Varaprasad (Eds.). 2016. Plant health management for food security-issues and approaches. Plant Protection Association of India, NBPGR Regional Station, Hyderabad. Published by Daya Publishing House, New Delhi. Pp. 230.

Gururaj Katti. 2016. Mealy bugs – Rice. Pp 239-245 in Mealybugs and their Management in Agricultural and Horticultural crops (M. Mani, C. Shivaraju eds.), DOI 10.1007/978-81-322-2677-2_1.

Krishnaveni, D., Ladhalakshmi, D., Laha, G.S., Prakasam, V., Asma Jabeen, Mangrauthia SK and Srinivasprasad, M. 2014. Role of Natural Products in Disease Management of Rice. In: Sustainable crop disease management using natural products. Eds., Sangeetha, G., Kurucheve, V and Jayaraj, J. CABI, U.K. p389-402.

Prasad JS, A.P.Padmakumari, N Soma Sekhar and G Katti.2016. Entomopathogenic nematodes as a component in rice pest pest management: A journey from lab to land. 2016. Chapter 14 pp 199-212. In Plant Health management for food security Issues and approaches Eds: Gururaj katti, Anitha Kodaru, Nethi Soma Sekhar, GS Laha, B Sarath Babu and KS Vara Prasad. Published by Daya publishing house A division of Astral International PVT. LTD .New Delhi. 230 pp ISBN 978-93-5124-761-6.

Prasad, J.S., Padmakumari, A.P., Somasekhar, N. and Katti, G. (2016). Entomopathogenic Nematodes as a Component in Rice Pest Management: A Journey from Lab to Land. In: *Plant health management for food security* (eds. Katti, GK, Anitha, K, Somasekhar, N., Laha, GS, Sarathbabu, B and Varaprasad, KS.), Astral International Pvt ltd. New Delhi. pp 199-212.

Ravindra Babu V., Jyothi Badri, P Aruna Sri Yadav, Vijai Pal Bhadana, C Priyanka, LV Subba Rao, G Padmavathi, C Gireesh and T Ram (2015) Genealogical Atlas of High Yielding Rice Varieties Released in India. ICAR-Indian Institute of Rice Research (ICAR-IIRR), Rajendranagar, Hyderabad-500030, Telangana, India. Technical Book No. 86/2015, 198 pp.

Ravindra Babu V., T Ram, C Gireesh, LV Subba Rao, G Padmavathi, GSV Prasad, VP Bhadana, Suneetha Kota, Jyothi Badri, MM Azam, D Sanjeeva Rao, Kumaraswamy Manthri, P Aruna Sri Yadav, S Srikanth, E Nagarjuna, TL Acharyalu, N Shobha Rani, U Prasad Rao and J Ramakrishna Rao (2015) 50 Years of AICRIP-Varietal Testing ICAR-Indian Institute of Rice Research (ICAR-IIRR), Rajendranagar, Hyderabad-500030, Andhra Pradesh, India. Technical Book No. 87/2015, 344 pp.

Reddy, D.V. R., Kumar, P. A., Kumar P. L., Loebenstein, G. and Rao, C.K. 2015. Genetically Engineered Crops in Developing Countries, Studium Press, Houston, USA.

Shabir Hussain Wani, Saroj Kumar Sah, Mohammad Anwar Hossain, Vinay Kumar, Sena M. Balachandran. (2016). Transgenic Approaches for Abiotic Stress Tolerance in Crop Plants. In: Advances in Plant Breeding Strategies: Agronomic, Abiotic and Biotic Stress Traits. (Eds.) Jameel M. Al-Khayri, Shri Mohan Jain, Dennis V. Johnson, pp 345-396. ISBN: 978-3-319-22517-3.

Shaik N. Meera (2016). Impact Acceleration with Digital Technologies: Strategic Ideas for Extension Systems. *In:* Advances in Agricultural Extension. Ed. S Venku Reddy and M Suryamani. BS Publications, Hyderabad. P. 287-303.

Sreevathsa R., Solanke, A. U. and Kumar, P. A. 2015. Biotechnology for insect pest management in vegetable crops. In: Recent Advancements in Gene Expression and Enabling Technologies in Crop Plants (Eds). K. Azhakanandam, A. Silverstone, H. Daniell and M.R. Davey, Springer, New York, pp. 313-387.

Sreevathsa, R. Pattanayak, D. and Kumar, P. A. 2015. Impact of genetically engineered insect resistant crops in developing countries. In: Reddy, D. V.

Trainings attended and organized

Trainings attended		
Name of the Scientist	**Name of Trainings/ Workshop participated**	**Venue & Dates**
Dr K. Surekha	Science Administration and Research Management	August 17th - 28th, 2015 at ASCI, Hyderabad.
Dr P Revathi	A six days training programme on "Analysis of experimental data" using SAS software.	Aug 17th to 22nd, 2015 at NAARM.
	A CAFT 21 days training programme on "Advances and accomplishments of innovative resistance breeding techniques in crop improvement.	January 27th - Feb 17th, 2016 at Tamil Nadu Agricultural university (TNAU), Coimbatore.
Dr Nageswara Rao DVK	DST Sponsored programme on Science Administration and Research Management.	August 17th - 28th, 2015 at Administrative Staff College of India, Hyderabad.
	International workshop on "Time series satellite data processing for understanding Space-Time Dynamics".	November 26th-27th, 2015. Birla Institute of Technology, Ranchi.
	Multiple Crop Modelling to improve Resource Use Efficiency in Agriculture under Changing Climatic Conditions.	December 3rd-23rd, 2015 at PJTSAU, Hyderabad.
	Training Workshop on "Geospatial Analysis in Agriculture and Data Requirement for ICAR-Geo-portal".	March 29th-30th, 2016 at NAARM, Hyderabad.
Dr Divya P Shyamaladevi	Short course on Transformative Approaches in Gender Mainstreaming, gender budgeting and Women Empowerment in Agriculture organized.	June 8th - 17th, 2015 at IIRR, Hyderabad.
	Training Workshop on Monitoring confined field trials of regulated GE plants under UNEP/GEF Supported PhaseII capacity building project on biosaftey.	June 3rd - 4th 2015, organized by Ministry of Environment, Forest and Climate Change at NAARM, Hyderabad.
Dr Hari Prasad AS	A Management development programme on leadership development (a Pre- RMP Programme).	November 30th to Dec 11th, 2015 conducted by NAARM, Hyderabad.
Dr Kalyani Kulkarni	Quality Improvement, biofortification and product development in rice for nutritional and financial security of rice farmers	September 01st - 10th, 2015 at ICAR-IIRR, Hyderabad
	National workshop on Current Trends on Bioinformatics in Agriculture.	September 22nd - 24th, 2015 at ICAR-NAARM, Hyderabad.
Dr Kemparaju K. B.	Rice Breeding Course.	March 7th-18th, 2016 at IRRI, Philippines
Dr Latha P.C.	IVth Short Course on "Metagenomics- Role of Next Generation Sequencing and Bioinformatics".	October 26th- November 4th, 2015 at Anand Agricultural University, Anand, Gujarat.
Dr Satendra K Mangrauthia	21 days CAFT training program on "Functional Analysis of Pathogenicity Genes of Plant Pathogens".	January 02-22nd 2016 at ICAR-IARI, New Delhi.
	Two Workshops and Trainings of Intuitional Biosafety Officers (IBOs) organized by ICAR, BCIL and ILSI Research Foundation.	May 27-28th and September 23rd, 2015.
Dr Sundaram RM	DBT sponsored training workshop on confined field trials of GM crops. (conducted by BCIL)	May 25th -26th 2016 at NASC complex, New Delhi
	A workshop conducted by BCIL-ABSPII on "Dossier preparation for GM crops.	February 25th, 2016 at NASC complex, New Delhi.
Training Organized		
Dr L V Subba Rao	Two day Training Programme on "Characterisation of Rice Varieties for DUS testing "for Co- Nodal Officers of DUS test centres.	May 8-9th, 2015 at IIRR Hyderabad

Deputations Abroad

- Dr Shaik N Meera was deputed to Bangladesh for participation in the GSR workshops (6-10 September 2015)
- Dr Shaik N Meera was deputed to Tokyo, Japan for IGAD pre-meeting and 7th RDA Plenary Meeting (February 28 – March 3, 2016)
- Dr Shaik N Meera, Dr B. Sailaja and Dr S. Arun Kumar were deputed to IRRI, Los Banos, Philippines for visiting an extension platform already built and tested for launching the extension platform of RKMP (9-12, February 2016)
- Dr V. Ravindra Babu, Dr R.M. Kumar and Dr Shaik N Meera were deputed to IRRI, Los Banos, Philippines to participate in the Inception Meeting of GSR Phase III project (29-3-2016 to 2-4-2016)
- Dr P. Brajendra was deputed as Member, Intergovernmental Technical Panel on Soils (ITPS), UNFAO, Rome, Italy (14-09-2015 to 18-09-2015 and 14-03-2016 to 18-03-2016)
- Dr Chitra Shanker deputed to IRRI Philippines on invitation from IRRI to attend the Rice Doctor mobile application and translational workshop for India from 10-01- 2015 to 15-01-2015)
- Dr B. Kemparaju deputed to IRRI to attend under ICAR-IRRI project 8 (New source of resistance to biotic stress and wild rice introgression) and 11 (Increasing the yield potential in rice) (6-03-2015 to 07-04-2015)
- Dr K. Suneetha was deputed to IRRI under ICAR-IRRI project 8 (New source of resistance to biotic stress and wild rice introgression) and 11 (Increasing the yield potential in rice) (14-04-2015 to 08-05-2015)
- Dr Jyothi Badri was deputed to IRRI to attend the Molecular Breeding Course under ICAR-IRRI Collaborative project 8 (New source of resistance to biotic stress and wild rice introgression) and 11 (Increasing the yield potential in rice) (26-10-2015 to 11-11-2015).

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation Report in respect of RFD 2014-2015 of RSCs i.e. Institutes

Name of the Division: Crop Science

Name of the Institution: ICAR – Indian Institute of Rice Research

RFD Nodal Officer of the RSC: Dr Ch. Padmavathi

S. No.	Objective (s)	Weight	Action (s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achieve-ments	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achieve-ments, if applicable
							Excel-lent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw Score	Weighted Score		
1	Identification & validation of technologies for different ecologies under AICRIP	36	Development of improved varieties suited to diverse agro ecologies	Varieties/ hybrids identi-fied for release	No.	15	19	16	13	10	7	19	100	15	118.8	Aggressive efforts of IIRR scientists & AICRIP co-operators resulted in release of more number of varie-ties/hybrids
			Organizing multi-disciplin-ary multi-location trials	Entries evalu-ated	No.	14	1260	1050	840	630	420	1169	95.67	13.39	111.3	Efforts of AICRIP co-operating centers led to more nominations
				Management practices identi-fied	No.	7	11	9	7	5	3	9	90	6.30	100.0	**NA**
2	Genetic en-hancement for yield, quality and resistance for sustainable rice production	27	Evaluation of genetic mate-rial for crop improvement programme	Breeding/ germplasm lines &experimental hybrids evalu-ated	No.	13	700	580	460	340	220	590	90.08	11.71	101.7	NA
				Lines identified for unique traits	No.	10	10	9	8	7	6	9	90	9	100.0	NA

			Seed production programme to ensure quality seed availability	Breeders seed produced	MT	3	720	600	480	360	240	650	94.17	2.83	108.3	NA
				Truthfully labelled seed produced	MT	1	75	60	45	30	15	70	96.67	0.97	116. 7	Collaborative efforts of IIRR with Blight out project supported by CSIR-CCMB to popularise improved samba Mahsuri among 4 states *viz*., AP, Telangana, Tamilnadu & Karnataka resulted in more TFL seed production in collaboration with farmers
3	Development and dissemination of appropriate crop production & protection technologies for maximizing yield	17	Development of new technologies	Production/protection technologies tested	No	11	37	31	25	19	13	33	93.33	10.27	106.5	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	133.3	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	81.27	0.81	82.5	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	100.0	**NA**
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	June 30, 2014	July 2, 2014	Juluy 4, 2014	July 7, 2014	July 9, 2014	June 30, 2014	100	2		**NA**
*	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	99.4	100	2		**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	0	0		**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	90	0.9		**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: 90.58

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

Appendix 1

Promising Entries in Varietal Trials, *Kharif* 2015

S. No.	IET No. Designation	Source Trial	Cross combination	Yield (kg/ha)	FD (Days)	GT	Remarks	Suitable for
1	23565 OR 2380-2	AVT 1-RSL	Mahanadi/ RAYADA-B3	5009	130	LB	MR-LB, BLB, ShB, BS, ShR	Rainfed Shallow Lowland areas in Karnataka
2	23052 CR 3607-12-1-2-1-1	AVT 1-SDW	Gayatri / Sudhir // Varshadhan	3784	136	SB	MR-LB, NB, BLB, ShB, BS, ShR	Rainfed Lowland areas in Andhra Pradesh
3	23596 CR 3836-1-7-4-1-1	IVT-DW	CRLC 899/ AC.38700	3828	134	SB	MR-BLB, ShB, ShR	Rainfed Lowland areas in Odisha
4	23601 CR 3835-1-7-2-1-1	IVT-DW	CRLC 899/ Warda2	4048	129	LB	-	Rainfed Lowland areas in Assam
5	23594 CR 2687-3-3-1-1-3	IVT-DW	CRLC 899/ AC.38606	3295	132	LB	MR-BLB, ShR	Rainfed Lowland areas in Assam
6	23949 MTU 1159	AVT 2-E TP	MTU 1010/ MTU 1081	5539	87	LS	MR-LB, BLB, BS	Irrigated areas in Karnataka
7	23957 GNV 11-09 (PR 35887-1-21-2-1)	AVT 2-E TP	ISH 58/ MATATAG 6	5758	91	MS	MR-LB, BLB	Irrigated areas in Binar and Karnataka
8	23392 BAU/IRRI 496 (IR 838614-673-B)	AVT 2-E TP	IR 78875-131-B-1-2/IR 64	5391	91	LS	MR-BLB, BS, GM1	Irrigated areas in Bihar
9	23356 RP 5125-17-6-3-2-1(IR 84898-B-B)	AVT 2-E TP	IR 78877-208-B-1-1/IR 78878-53-2-2-2	5944	92	LB	MR-LB, BS	Irrigated areas in Bihar, Odisha and Karnataka
10	23976 MTU 1160	AVT 2-E TP	Samba Mahsuri/ Azucena	5411	87	LS	MR-LB, BS	Irrigated areas in Bihar and Karnataka
11	23979 IR 83832-90-3-2-3	AVT 2-E TP	Introduction from IRRI	5750	91	LS	MR-LB	Irrigated areas in Bihar, Karnataka and Puducherry.
12	24075 ***VNR -212 (Hybrid)***	AVT 2-E TP	-	6371	89	LB	MR-LB, BS	Irrigated areas in Punjab
13	23354 RP 5125-12-5-3-B (IR84898-B-B)	AVT 2-E TP	IR 78877-208-B-1-1/IR 78878-53-2-2-2	5536	93	LB	MR-LB, BS, ShR	Irrigated areas in Harayana, Bihar, Madhya Pradesh and Karnataka
14	23951 NP 7008	AVT 2-E TP	NP 7009/Mahsuri	5726	879	SB	MR-LB, BS	Irrigated areas in Bihar and Karnataka

S. No.	IET No. Designation	Source Trial	Cross combination	Yield (kg/ha)	FD (Days)	GT	Remarks	Suitable for
15	23996 RP 5571-49-21-9 -5-3-1-2	AVT 2-E TP	IR 06L164/ BP234E-MR-11	5613	89	LB	MR-LB, BS, ShR	Irrigated areas in Bihar, Madhya Pradesh and Karnataka
16	24082 ***HRI-183 (Hybrid)***	AVT 2-E TP	-	6145	90	LB	MR-LB, BLB, BS	Irrigated areas in Haryana and Tamil Nadu
17	24103 ***XRA-27934 (Hybrid)***	AVT 2-IME	-	6341	97	LB	MR-LB, BS	Irrigated areas in Bihar
18	23216 TM 07278	AVT 2-IME	WGL 32100/ Swarna	5664	96	MS	MR-LB, BS	Irrigated areas in Bihar
19	24122 ***XRA -27936 (Hybrid)***	AVT 2-IME	-	6477	96	MS	MR-LB, BS	Irrigated areas in Rajasthan
20	24146 ***NK-16520 (Hybrid)***	AVT 2-IM	-	6312	102	LB	MR-LB, BLB, BS	Irrigated areas in Bihar and Chhattisgarh
21	24142 ***KPH-467 (Hybrid)***	AVT 2-IM	-	6012	124	SB	MR-LB, BS, ShR	Irrigated areas in Chhattisgarh
22	23272 MTU 1155	AVT 2-IM	MTU 1001/ Annada	5770	108	MS	MR-LB, NB, BLB, BS, ShR	Irrigated areas in Odisha and. Chhattisgarh
23	23666 OR 2542-12	AVT 2-IM	Gouri/ IR 65629-22-1	5712	108	LB	MR-LB, BLB, BS, ShR	Irrigated areas in Bihar
24	24143 ***MEPH-114 (Hybrid)***	AVT 2-IM	-	6208	101	LS	MR-LB, BLB, BS	Irrigated areas in Bihar
25	24565 Pusa 1718-14-2-150	AVT 1-BT	PB 1121 / SPS 97 // PB 1121 *3	4289	108	ELS	MR-BLB, BS, RTD	Trait (BLB resistance) validated.
26	24566 Pusa 1718-19-8-152	AVT 1-BT	PB 1121 / SPS 97 // PB 1121 *3	4506	111	ELS	MR-BLB	Trait (BLB resistance) validated.
27	24570 Pusa 1637-12-8-20-5	AVT 1-BT	Pusa Basmati 1 / IRBL 9-W // Pusa Basmati 1*3	4207	109	ELS	MR-LB, BS, RTD	Trait (Blast resistance) validated.
28	24573 Pusa 1728-23-33-31-56	AVT 1-BT	PB 6/ Pusa 1460 / PB 6*3	3987	118	ELS	MR-BLB, BS, ShR	Trait (BLB resistance) validated.
29	24576 Pusa 1884-3-9-175	AVT 1-BT	Pusa 1726 / Pusa 1727	4510	109	ELS	MR-LB, BS	Trait (Blast resistance) validated.

S. No.	IET No. Designation	Source Trial	Cross combination	Yield (kg/ha)	FD (Days)	GT	Remarks	Suitable for
30	23879 R 1656-1146-5-513-1	AVT 1-ASG	Swarna/ Jira Shankar	5234	109	MS	MR-BS	Promising in Tripura, West Bengal, Chhattisgarh, Maharashtra and Karnataka
31	23782 NDRK 50043	AVT 1 –AL & ISTVT	NDRK 5081/ NDRK 50003	3214	99	SB	MR-BS	Promising in Haryana
32	23784 CSR 11-117	AVT 1 –AL & ISTVT	CSR 11/MI48	2816	99	SB	MR-LB, BS	Promising in Haryana
33	24003 RCPR 8 (IR 84899-B-179-16-1-1-1)	AVT 2-AEROB	IR 78877-208-B-1-1/ IRRI 132	3299	99	SB	MR-LB, BS, RTD	Promising in Bihar and Chhattisgarh
34	24028 ***KPH 272 (Hybrid)***	AVT 2-AEROB	-	3785	98	MS	MR-LB, BS, RTD	Promising in Bihar and Tamil Nadu
35	24006 ***NPH 8899 (Hybrid)***	AVT 2-AEROB	***NPS 8001A / NP 1001R***	4208	107	MS	MR-BPH	Promising in Tamil Nadu
36	24010 RAU 1484-Aer-04	AVT 2-AEROB	OG 6709-7/APO	2576	97	SB	MR-LB, BS, ShR, RTD	Promising in Bihar
37	23829 R- RHZIH-7	AVT 2-BIOFORT	IR 681444/HMT	3950	99	SS	MR-LB, BS, RTD, BPH	Promising in Madhya Pradesh
38	23824 R- RHZ-2	AVT 2-BIOFORT	Poornima/ Annada	3771	90	LB	MR-GM1	Promising in Punjab, Telangana and Karnataka
39	23832 RP 5886-HP 3-IR80463-B39-3	AVT 2-BIOFORT	IR 73707-45-3-2-3/ IR 77080-B-34-3	4068	97	LS	MR-LB, BLB, ShR	Promising in Karnataka
40	23494 NPH 8899 (Hybrid)	IVT-BORO		5667	138	SB	-	Promising in Assam
41	23544 Tamphaphou (CAU R1)	AVT 1-U (H)	Leimaphou / BR-1	2149	109	LB	R-FM, MR-ShB	Promising in Manipur and Meghalaya (Low elevation)

Appendix 2

Variety-wise Breeder Seed Production *Kharif* 2015 (As Per DAC Indent)

Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized at 42 centers across the country, involving 240 varieties and parental lines of 6 rice hybrids. A total production of 5412.92 quintals of breeder seed was achieved against a target of 5191.28 during *kharif* 2015. At DRR centre, 16 varieties and parental lines of DRRH-3 were included in breeder seed production with a total production of 240 quintals against the target of 136.60 quintals.

Hybrid/Variety	Quantity Allotted (Quantity in Quintals)	Quantity Produced (Quantity in Quintals)	Produced By
Abhishek (IET - 17868) (RR-272-829)	55.15	35	CRURRS, Hazaribagh
ADT(R)- 45 (IET 15924)	6.5	6.5	TRRI, Aduthurai
ADT-37	11	10.8	TRRI, Aduthurai
ADT-39	5	5	TRRI, Aduthurai
ADT-43 (IET-14878)	6	5.8	TRRI, Aduthurai
Ajit	10	-	RRS, Chinsurah
Akshayadhan (IET 19367)	0.7	1	IIRR, Hyderabad
Amara (MTU 1064)	5.5	3	ANGRAU
Anjali (IET-16430, RR-347-166)	1.1	4.5	CRURRS, Hazaribagh
Annada	10.5	10.5	NRRI, Cuttack
Bahadur (IET - 13358)	0.5	0.5	RARS, Titabar
Bamleshwari	55	55.2	IGKV, Raipur
Basmati CSR 30 (IET-14720, Yamini)	16.6	26.6	CSSRI, Karnal
Basmati Kasturi (IET 8580)	1	1	IIRR, Hyderabad
Basmati Type 3 (Punjab Basmati 3)	16.5	16.5	PAU, Ludhiana
Basmati-370	4	6	RRS, Kaul
Bhadra (MO-4)	3	3.73	RRS, Moncompu
Bharani (NLR 30491)	3	-	ANGRAU
Bhogavati	1	10.1	ARS, Radhanagari
Bhuban (IET 7804)	1	1.2	OUAT, Bhubaneshwar
Birsa Vikas DHAN -110	2	3	BAU, Ranchi
Birsa Vikas DHAN-109	21	3	BAU, Ranchi
Birsamati	3	4	BAU, Ranchi
BPT-3291 (Sonamasuri)	35.5	-	ANGRAU
BR-2655	3.5	4	UAS, Bangalore
Chandrahasini (IET - 16800)	64	64.2	IGAU, Raipur
Chandrama (IET9354,10419)	25	30	RRLRRS, Gerua
Chenab (SKAU-23)	1	1	SKUAT, Khudwani
CR Boro Dhan-2	20.5	21	NRRI, Cuttack
CR Dhan 500 (IET 20220)	3.2	10	NRRI, Cuttack
CR Dhan-10 (IET 18312)	20.7	21	NRRI, Cuttack
CR Dhan-501	21.7	-	NRRI, Cuttack

Hybrid/Variety	Quantity Allotted (Quantity in Quintals)	Quantity Produced (Quantity in Quintals)	Produced By
CR Dhan-505	0.5	0.5	NRRI, Cuttack
CR Dhan-601	21.5	21.5	NRRI, Cuttack
CR Dhan-70 (IET-11904)	0.3	0.2	NRRI, Cuttack
CR Sugandh Dhan-3 (IET 18395)	3	3	NRRI, Cuttack
CR-1014	0.3	3	NRRI, Cuttack
CSR- 60	10.5	-	CSSRI, Karnal
CSR-36	6	12.8	CSSRI, Karnal
Danteshwari (IET NO. 15450)	43	45	IGAU, Raipur
Daya (OR-131-13-13)	0.5	0.5	OUAT, Bhubaneshwar
Dhanrasi (IET 15358)	0.3	1	IIRR, Hyderabad
Dharitri (IET-6272)	7.2	5.4	NRRI, Cuttack
Dhiren	5	2	RRS, Chinsurah
DRR Dhan 41	10	5	IIRR, Hyderabad
DRR Dhan 44	10	80	IIRR, Hyderabad
Early Samba (RNRM-7)	0.5	1	PJTSAU, Hyderabad
Erramallelu (WGL 20471)	10	10	PJTSAU, Hyderabad
Gajapati (IET-13251)	0.5	0.5	OUAT, Bhubaneshwar
Gayatri (IET-8022)	5.2	11.4	NRRI, Cuttack
Geetanjali (IET-17276)	12.6	15	NRRI, Cuttack
Gitesh	20	20	RARS, Titabar
Giza-14	0.5	1	SKUAST, Chatha
Gontra Bidhan-1 (IET 17430)	47.5	50	BCKVV, Nadia
Gontra Bidhan-3	0.5	15	BCKVV, Nadia
Govind	3.5	10	GBPUAT, Pantnagar
GR-11	0.5	1	GAU, Nawagam
Gurjari	0.5	1	GAU, Nawagam
HBC-19 (Tarwadi)	1.1	-	RRS, Kaul
HKR 44	0.1	-	RRS, Kaul
HKR 47	3	12	RRS, Kaul
HKR-127 (HKR-95-222)	2.5	8	RRS, Kaul
HKR-147	6	-	RRS, Kaul
HPR 2143	8	6.5	RWRC, Malan
HPR-1068	8	1.2	RWRC, Malan
HPR-1156 (IET-16007)	5	2.2	RWRC, Malan
IET 22984 (RCPL-1-412)	2	-	Barapani
IET 23193 (CRL 74-89-2-4-1)	2	5	RRLRRS, Gerua
IET-19972 (SJR-5)	2	4	SKUAST, Chatha
IET-23189 (CR 2713-35)	2	-	NRRI, Cuttack
IET 23409 (MTU 1153)	10	-	ANGRAU

Hybrid/Variety	Quantity Allotted	Quantity Produced	Produced By
	(Quantity in Quintals)		
IET-23420 (RP 533-41-2-3-IR-83383-B)	6	-	Indian Institute of Rice Research,
IET-23832 (RP 5886 HP3 IR 80463-B39)	1.5	1.5	Indian Institute of Rice Research,
IET-24780 (CR 2829-PLN-37)	5	-	NRRI, Cuttack
IGKVR-1 (IET 19569)	6	18	IGAU, Raipur
IGKVR-2 (IET 19795)	5	5.1	IGAU, Raipur
IGRKVR-1244 (IET 19796)	1.5	10.2	IGAU, Raipur
Imprioved Pusa Basmati-1 (IET - 18990)	18	21	Iari Regional Station, Karnal
IMPROVED SAMBA MAHSURI	33.1	65	Indian Institute of Rice Research,
INDIRA AEROBIC-1	5	6	IGAU, Raipur
INDIRA BARANI DHAN-1 (RF-17-38-70)	6	9.9	IGAU, Raipur
INDIRA RAJESHWARI	2	-	IGAU, Raipur
INDRA (MTU1061)	5	3	ANGRAU
Indrayani (IET - 12897)	21.5	40	ARS, Vadgaon
Intan	1.5	1.5	ARS, Mugad
IR-36	86.7	92.4	IGAU, Raipur; JNKVV Jabalpur; DSR, Mau
IR-50	0.5	-	TNAU, Coimbatore
IR-64	150	157.5	IGAU, Raipur; JNKVV Jabalpur; Dsr, Mau
IR-64 (DROUGHT)	16	50	Indian Institute of Rice Research,
JALDI DHAN 13 (PNR-591-18)	0.5	-	RRS, Chinsurah
JALDI DHAN-6 (IET 14359)	3	0.6	NRRI, Cuttack
JALDUBI (IET - 17153)	0.6	1.2	IGAU, Raipur
JARAVA(IET 15420)	1	1	Indian Institute of Rice Research,
JAYA	15	15	GAU, Nawagam, Indian Institute of Rice Research,
JGL 11470 (JAGITYAL MAHSURI)	2	2.5	PJTSAU, Hyderabad
JGL 1798	8.5	10	PJTSAU, Hyderabad
JOGESH (OR-1519-2) (IET-15169)	10	1	OUAT, Bhubaneshwar
JYOTHI	6.6	6.6	KAU, Pattambi
KARJAT-184	1.2	3.4	RARS, Karjat
KARJAT-2	2.1	5.1	RARS, Karjat
KARJAT-3	4.3	18.5	RARS, Karjat
KARJAT-5	2.7	6	RARS, Karjat
KARJAT-6	1	2.6	RARS, Karjat
KARJAT-7	4.5	6.2	RARS, Karjat

Hybrid/Variety	Quantity Allotted	Quantity Produced	Produced By
	(Quantity in Quintals)		
KARMA MAHSURI (IET 19991)	66.5	66.6	IGAU, Raipur
KETEKIJOHA (IET-18669)	15	15	AAU, Jorhat
KHANDAGIRI	5	5	OUAT, Bhubaneshwar
KHITISH (IET-4094)	20	18.1	NRRI, Cuttack; RRS, Chinsurah
KMD-2 (ABHILASH)	1.25	1.5	ARS, Mugad
KRANTI (R-2022)	12	12	JNKVV, Jabalpur
KRISHNA HAMSA	0.5	1	Indian Institute of Rice Research,
LALAT (IET-9947)	36	39	OUAT, Bhubaneshwar
LUIT (IET-13622)	15	15	AAU, Jorhat
LUNASAMPAD (IET 19470)	1	1	NRRI, Cuttack
LUNASUWARNA (IET 18697)	1	1.5	NRRI, Cuttack
LUNISREE	2	5.1	NRRI, Cuttack
MAHAMAYA (IET-10749)	118	120	IGAU, Raipur
MALAVIYA SUGANDH 4-3 (HUR-4-3)	7	4	BHU, Varanasi
MALAVIYA SUGANDH-105 (HUR-105)	4.5	5	BHU, Varanasi
MALVIYA DHAN-2 (HUR-3022)	4	3.1	BHU, Varanasi
MANASWINI (IET 19005)	50	50	OUAT, Bhubaneshwar
MANDAKINI (OR 2077-4)(IET 17847)	33	33	OUAT, Bhubaneshwar
MARUTERU SANNALU (MTU 1006, IET 14348)	1.5	-	ANGRAU
MASURI	5	5	AAU, Jorhat; Indian Institute of Rice Research
MO 21 (PRATIKSHA)	1.5	2	RRS, Moncompu
MRUNALINI (OR 1898-18) IET 18649	20	17	OUAT, Bhubaneshwar
MTU 1010	423	410	ANGRAU; PJTSAU, Hyderabad
MTU 1031 (THOLAKARI)	0.6	2	ANGRAU
MTU 1032 (GODAVARI)	0.6	2	ANGRAU
MTU 1075 (IET 18482)	5	3	ANGRAU
MTU 7029	360	300	ANGRAU; PJTSAU, Hyderabad
MUGAD SIRI-1253	0.5	0.25	ARS, Mugad
NARENDRA DHAN 3112-1 PRAKHAR (IET 19335)	11.5	15	NDUAT, Faizabad
NARENDRA DHAN-359 (NDR-359)	16.5	25	NDUAT, Faizabad
NARENDRA DHAN-97	1.5	5	NDUAT, Faizabad

Hybrid/Variety	Quantity Allotted	Quantity Produced	Produced By
	(Quantity in Quintals)		
Narendra Lalmati (IET 21051)	1	1.25	NDUAT, Faizabad
Narendra Usar Dhan 2008 (IET-18699)	5	10	NDUAT, Faizabad
Narendra-8002 (IET-15848)	22.5	22.3	NDUAT, Faizabad
Naveen	150	115	RRLRRS, Gerua; NRRI, Cuttack
NDR 2064 (IET 17475)	4.5	10	NDUAT, Faizabad
NDR 2065 (IET 17476)	7	12.5	NDUAT, Faizabad
Nellore Mahsuri (NLR 34449)	25.25	25.25	ANGRAU
NLR 145	5	5	ANGRAU
Nua Chinikamini (IET 18394)	0.6	2.7	NRRI, Cuttack
Nua Kalajeera (IET 18393)	3	1	NRRI, Cuttack
Pankaj	2	-	OUAT, Bhubaneshwar
Pant Dhan 18 (IET 17920)	5	10	GBPUAT, Pantnagar
Pant Dhan-10 (IET- 8616)	1	2.5	GBPUAT, Pantnagar
Pant Dhan-11 (IET - 9620)	0.5	3	GBPUAT, Pantnagar
Pant Dhan-12 (IET-10955)	3	10	GBPUAT, Pantnagar
Pant Dhan-19 (IET 17544)	0.5	10	GBPUAT, Pantnagar
Pant Dhan-24	10	27	GBPUAT, Pantnagar
Pant Dhan-43	5	-	GBPUAT, Pantnagar
Pant Sugandh Dhan-15 (IET 14132)	1	12	GBPUAT, Pantnagar
Pant Sugandh Dhan-17 (IET 17263)	1	2.5	GBPUAT, Pantnagar
Pardhiva (NLR 33892)	3	3	ANGRAU
Parijat (IET-2684)	7	15	OUAT, Bhubaneshwar
PAU-201	7	7	PAU, Ludhiana
Phalguni (IET 18720)	20.5	-*	NRRI, Cuttack
Phule Radha	4.5	7.4	ARS, Radhanagari
Phule Samrudhi	1.5	40.50	ARS, Vadgaon
PKV HMT	121	60	ZARS, Sindewahi
Pooja (IET-12241)	8.7	30	NRRI, Cuttack
Poornima (IET-12284)	15.5	24.6	IGAU, Raipur
PR-111	7	7.5	PAU, Ludhiana
PR-113	9.1	10	PAU, Ludhiana
PR-114	17	17	PAU, Ludhiana
PR-115	2.5	5	PAU, Ludhiana
PR-116	2.5	6	PAU, Ludhiana
PR-118	17.5	18	PAU, Ludhiana
PR-121	10	16	PAU, Ludhiana
PR-122	8.1	9	PAU, Ludhiana
PR-123	11	12	PAU, Ludhiana
PR-124	25	30	PAU, Ludhiana
PR-128	2	-	PAU, Ludhiana
Prabhat (MTU 3626)	20	3	ANGRAU
Pratikshya (IET-15191)	159	160	OUAT, Bhubaneshwar
Punjab Basmati-2	0.5	5	PAU, Ludhiana
Pusa 1592	14	14	IARI Regional Station, Karnal

Hybrid/Variety	Quantity Allotted	Quantity Produced	Produced By
	(Quantity in Quintals)		
Pusa 6 (PUSA 1612)	1.5	1.5	IARI Regional Station, Karnal
Pusa Basmati 1121 (PUSA SUGANDH 4)	121	138	IARI Regional Station, Karnal; BEDF, New Delhi; Dsst & IARI, New Delhi
Pusa Basmati-1 (IET 10364)	41	41	IARI Regional Station, Karnal; Dsst & IARI, New Delhi
Pusa Basmati-1509	122	139	IARI Regional Station, Karnal; BEDF, New Delhi; Dsst & IARI, New Delhi
Pusa Basmati-6 (IET 18005)	37	44	IARI Regional Station, Karnal; Dsst & IARI, New Delhi
Pusa Sugandh-2 (IET-16310)	4.5	5	IARI Regional Station, Karnal
Pusa Sugandh-3 (IET-16313)	1.6	4.00	IARI Regional Station, Karnal
Pusa Sugandh-5 (IET-17021)	50	43	IARI Regional Station, Karnal; BEDF, New Delhi; Dsst & IARI, New Delhi
Pusa-44	36.5	40	IARI Regional Station, Karnal
Rajendra Bhagvati	15.5	-	RAU, Pusa
Rajendra Kasturi	6	6	RAU, Pusa
Rajendra Mahsuri-1	72	100	RAU, Pusa
Rajendra Suwasini	6	6	RAU, Pusa
Rajendra Sweta	61.5	80	RAU, Pusa
Rajshree (IET-7970)	0.5	1	RAU, Pusa
Rani Dhan (IET-19148)	109	118	OUAT, Bhubaneshwar
Ranjeet (IET - 12554)	17	20	AAU, Jorhat
Rashmi (JR-201)	50	50	JNKVV, Jabalpur
Rasi (IET 1444)	1.5	3	IIRR, Hyderabad
Ratnagiri-1	1	1	ARS, Ratnagiri
Ratnagiri-24 (IET-19812)	7	7	ARS, Ratnagiri
Reeta (IET-19969)	3.5	3.5	NRRI, Cuttack
RNR 2354	10	10	PJTSAU, Hyderabad
RP-2421 (IET-11242)	2	2.68	RWRC, Malan
Sabita (IET-8970)	7.5	7.5	RRS, Chinsurah
Sadabahar	0.6	5	CRURRS, Hazaribagh
Sahbhagi Dhan	200	200	CRURRS, Hazaribagh
Samalei (Iet-3350)	1.1	-	OUAT, Bhubaneshwar
Samba Mahsuri	127.5	102	PJTSAU, Hyderabad; DSR, Mau; ANGRAU; PRDF, Gorakhpur
Samba Mahsuri Sub 1	20	-	NRRI, Cuttack; DSR, Mau
Samleshwari	36	38.4	IGAU, Raipur
Sampada (IET 19424)	33	33	IIRR, Hyderabad
Sarala CR-260-77 (IET-10279)	0.3	2.4	NRRI, Cuttack
Sarjoo-52	13	50	NDUAT, Faizabad
Satabdi (IET-4786)	65	75	NRRI, Cuttack; RRS, Chinsurah

Hybrid/Variety	Quantity Allotted	Quantity Produced	Produced By
	(Quantity in Quintals)		
Savitri (IET - 5897) (CR 1009)	5.5	15.5	NRRI, Cuttack
Sidhanta (ORS 102-4) (IET-15296)	10	0.5	OUAT, Bhubaneshwar
Srikakaulam Sannalu (RGL 2537)	5	5	ANGRAU
Surendra (IET-12815)	1	1.5	OUAT, Bhubaneshwar
Sushk Samrat	6	4	NDUAT, Faizabad
Swarana-Sub 1 (IET-20266)	396	446	AAU, Jorhat; NRRI, Cuttack; PRDF, Gorakhpur, RRS, Chinsurah
Tanu	3	10	UAS, Bangalore
Tejaswani (OR 1912-22)	20	18	OUAT, Bhubaneshwar
Tellahamsa	1.5	1.5	PJTSAU, Hyderabad
Thunga	3.5	-	UAS, Bangalore
TKM-13 (IET 22565)	4	-	TRRI, Aduthurai
Uma	7.05	9.01	RRS, Moncompu
Upahar (OR 1234-12-1) (IET 17318)	20	17	OUAT, Bhubaneshwar
Utkal Prava (OR-1030)	2	4	NRRI, Cuttack
Vallabh Basmati-22 (IET 19492)	1.1	-	SVBAUA & T Meerut
Vandana (RR-167-982)	5	4.4	CRURRS, Hazaribagh
Varadhan (IET 18940)	3	3	IIRR, Hyderabad
Varshadhan (IET-15296)	29	37	NRRI, Cuttack
Vasundhara (RGL 2538)	15	15	ANGRAU
Vijetha (MTU 1001)	190	80	ANGRAU
Vivek Dhan-62 (IET-14621)	1	1.5	VIHA, Almora
VL Dhan 65	1	1.55	VIHA, Almora
VL Dhan 85 (IET-16455)	1.35	2.25	VIHA, Almora
VL Dhan 86 (IET-16863)	1.05	1.75	VIHA, Almora
Waangal Samba (WGL 14)	2	3	PJTSAU, Hyderabad
Waangal Sannalu (IET 18004)	45	45	PJTSAU, Hyderabad
Total	**5185.4**	**5342.22**	

Parental Lines of Hybrids:

Name of the Producing centre	Name of hybrid	Actual allocation as per BSP-I	Production
IIRR, Hyderabad	**DRRH-3 (IET -19543)**		
	A-Line	0.50	0.10
	B-Line	0.15	0.15
	R-Line	0.15	0.15
UAS, Bangalore	**KRH 2**		
	IR 58025A	1.02	20.00
	IR 58025B	0.34	30.00
	KMR - 3R	0.25	7.70
GBPUAT, Pantnagar	**PANT SHANKAR DHAN-1**		
	A-Line	0.20	0.65
	B-Line	0.10	1.81
	R-Line	0.10	0.04
RARS, Karjat	**SAHYADRI-1**		
	A Line	0.15	1.00
	B Line	0.05	0.20
	R Line	0.05	0.20
	SAHYADRI-2		
	A Line	0.15	0.50
	B Line	0.05	0.20
	R Line	0.05	0.20
	SAHYADRI-3		
	A Line	0.20	0.50
	B Line	0.07	0.20
	R Line	0.10	0.30
JNKVV, Jabalpur	**JRH-8**		
	A-Line	0.50	0.50
	B-Line	0.10	0.10
	R-Line	0.10	0.10
	JRH-5		
	A-Line	0.50	0.50
	B-Line	0.10	0.10
	R-Line	0.10	0.10
CRRI, Cuttack	**Ajay**		**-**
	A-Line	0.30	1.35
	B-Line	0.05	0.45
	R-Line	0.05	0.65
	Rajya Laxmi		
	A-Line	0.30	1.65
	B-Line	0.05	0.60
	R-Line	0.05	0.70
	Total (Hybrids)	**5.88**	**70.70**
	Grand Total	**5191.28**	**5412.92**

Appendix 3

List of Externally funded projects sanctioned during 2015-16

S. No.	Title of the Project	PI and co PIs	Funding Agency
1	CRP on Hybrid Technology"	Dr A. S. Hari Prasad, Dr P. Senguttuvel, Dr P. Revathi, Dr K.B. Kemparaju	ICAR
2	ICAR – "Incentivizing Research in Agriculture" Project IV entitled "Molecular analysis of resistance/tolerance to different stress in rice, wheat chickpea and mustard including sheath blight complex genomics"	Dr R.M. Sundaram	ICAR
3	. ICAR – Incentivizing Research In Agriculture", Project III entitled "Genetic modification to improve biological nitrogen fixation for augmenting nitrogen needs for cereals".	Dr R.M. Sundaram	ICAR
4	DBT project entitled "Mass Production and field release techniques of two bio-control agents through novel Approaches for management of Rice Pests"	Dr Chitra Shankar	DBT
5	ICAR Extramural Research Project on "Pre-breeding to broaden the genetic base of rice for yield enhancing traits, heterotic yield QTLs and brown planthopper resistance by utilizing wild species and land races"	Dr G. Padmavathi, Dr Gireesh, Dr P. Revathi	ICAR
6	ICAR Project on "Molecular cross-talk between defence pathways in rice: from antagonism to synergism" (CN#8730).	Dr M. S. Prasad & Dr G S Laha	ICAR
7	CRP – Molecular Breeding	Dr R.M. Sundaram	ICAR
8	SERB Project "Enhancing growth in rice through re-engineering genes in rice"	Dr Divya P Syamaladevi	SERB

Appendix 4

List of On-going externally funded projects during 2015-16

S. No	Title of the Project/Schemes	Name of PI	Funding Agency
1	CRP-Biofortificaton	Dr V Ravindra Babu & Dr C N Neeraja	ICAR
2	Seed Production and seed technology research in Rice (NSP)	Dr LV. Subba Rao	ICAR
3	DUS Tests in Rice(PPV&FRA)	Dr LV. Subba Rao	PPV&FRA
4	CRP-Agrobiodiversity	Dr L V Subba Rao	ICAR
5	ICAR Network Project for Transgenics in crops : Rice (Transgenic Component)	Dr S.M. Balachandran	ICAR, GOI
6	ICAR Network Project for Transgenics in crops : Rice (Functional genomics Component- Iron and Zinc)	Dr N. Sarla	ICAR
7	Establishment of National Rice Resource Data base	Dr L.V. Subba Rao	DBT
8	BMGF "Stress tolerant rice for poor farmers in Africa and South Asia" STRASA	Dr T. Ram	IRRI
9	BMGF "Green Super Rice (GSR) for poor farmers in Africa and South Asia"	Dr V. Raindra Babu	IRRI
10	Marker assisted breeding of abiotic stress tolerant rice varieties with major QTLs for drought, submergence and slat tolerance	Dr T. Ram	DBT
11	ICAR seed project on Seed Production in Agricultural Crops (MEGA SEED)	Dr LV. Subba Rao	ICAR
12	National Initiative on Climate resilient agriculture	Dr S.R. Voleti	ICAR

S. No	Title of the Project/Schemes	Name of PI	Funding Agency
13	Identification of candidate genes for enhanced water use efficiency in rice through activation tagging	Dr S.M. Balachandran	DBT
14	"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
15	Real time rice pest surveillance programme (NICRA-NCIPM)		
16	Investigations on System of Rice Intensification (SRI) for water saving and yield optimization in irrigated ecosystem	Dr R. Mahender Kumar	Ministry of Water resources
17	Molecular and functional characterisation of yield enhancing QTL from wild ricce	Dr N. Sarla	DBT
18	Enhancing scope of marker assisted selection using genomics technologies (En MAS)	Dr Sheshu Madhav	CSIR
19	Marker assisted introgression of different traits to develop new generation climate adapted varieties	Dr T. Ram	DBT
20	Evaluation of new herbicide molecules (Rice Co-Herbicide) for its efficiency in Transplanted Rice	Dr B. Sreedevi	Rice-Co
21	Evaluation of new herbicide molecules (Rice Co-Herbicides) for its efficiency in Direct Seeded Rice	Dr B. Sreedevi	Rice-Co
22	Evaluation of new fertilizer product "Geofert" An Agro-Nano Technology product in transplanted rice	Dr R. Mahender Kumar	Geofert
23	Evaluation of "Metal Glyainates" in Paddy	Dr R. Mahender Kumar	AMSRI Chemicals Ltd
24	Common basis of defense induction in rice and mustard against sucking and gall insect pests	Dr A.P. Padmakumari	NFBSFARA
25	Modeling network of gene responses to abiotic stress in rice	Dr D. Subramanyam	NFBSFARA
26	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
27	Marker-assisted introgression of Pup1 into elite rice varieties	Dr R.M. Sundaram	DBT
28	Effect of foliar and root application of silicate SiO2 in rice	Dr R. Mahender Kumar	Geolife Agritech India Pvt. Ltd., Mumbai
29	Marker Assisted Improvement of Popular maintainer and restorer lines of rice tolerance to abiotic stresses	Dr P. Senguttuvel	DBT
30	CSIR-800 (Blight Out) project on Popularisation of RP Bio-226.	Dr L.V. Subba Rao	CSIR
31	Development of sheath blight disease resistant transgenic rice: Resistant tests in PR protein- expressing transgenic rice and discovery of new RNA silencing strategy	Dr S.M. Balachandran	DBT
32	Exploiting amiR technology to target viral genes for curtailing the tungro virus infection in rice	Dr S.K. Mangrauthia	DBT
33	Novel Genetic Stocks: Multi-parent advanced generation inter crossess (MAGIC) among diverse genotypes to facilitate gene discovery for various traits in rice	Dr G. Padmavathi	IRRI

Appendix 5

Funded AICRIP centers with staff positions during 2015-16

S. No.	State	Centre	Staff
1	Andhra Pradesh	Maruteru	9
2	Telangana	Rajendranagar	6
3	Andhra Pradesh	Ragolu	1
4	Telangana	Warangal	3
5	Assam	Jorhat/Titabar	7
6	Bihar	Patna	5
7	Bihar	Pusa	4
8	Chhattisgarh	Jagdalpur	4
9	Chhattisgarh	Raipur	5
10	Gujarat	Nawagam	5
11	Gujarat	Navasari	3
12	Haryana	Kaul	6
13	Himachal Pradesh	Palampur/Malan	5
14	Jammu & Kashmir	Khudwani	4
15	Jammu & Kashmir	R.S.Pura (Chatha)	4
16	Jharkhand	Kanke/Ranchi	4
17	Karnataka	Mandya	5
18	Karnataka	Gangavati	4
19	Karnataka	Brahmavar	2
20	Karnataka	Mugad	1
21	Karnataka	Ponnampet	2
22	Kerala	Moncompu	4
23	Kerala	Pattambi	7
24	Madhya Pradesh	Rewa	5
25	Maharashtra	Karjat	5
26	Maharashtra	Sakoli	2
27	Maharashtra	Tuljapur	2
28	Manipur	Imphal (Wangbal)	4
29	Meghalaya	Upper Shillong	4
30	Odisha	Chiplima/Sambalpur	6
31	Odisha	Jeypore	1
32	Puducherry	Kurumbapet	3
33	Punjab	Ludhiana	5
34	Rajasthan	Kota	2
35	Tamil Nadu	Aduthurai	4
36	Tamil Nadu	Coimbatore	7
37	Uttar Pradesh	Nagina	1
38	Uttar Pradesh	Kanpur	2
39	Uttar Pradesh	Ghaghraghat	4
40	Uttar Pradesh	Varanasi	4
41	Uttar Pradesh	Faizabad (Masoda)	5
42	West Bengal	Bankura	2
43	West Bengal	Chinsurah	5
44	Uttaranchal	Pantnagar	6
45	Tripura	Agarthala/ Arundhutinagar	3

Appendix 6

List of projects with PIs and Associates

S. No	Project Code	Project Title	PI & CO-PIs
Crop Improvement Division			
Plant Breeding			
1	GEQ/CI/ BR/8	Enhancing nutritional quality of rice through bio-fortification	**Dr V. Ravindra Babu,** Dr L.V. Subba Rao, Dr B. Sreedevi, Dr K. Surekha, Dr C.N. Neeraja, Dr G. Padmavathi, Dr D. Sanjeeva Rao, Dr T. Longvah (NIN)
2	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.	**Dr T. Ram,** Dr G.S. Laha, Dr Jhansi Lakshmi, Dr A. P. Padmakumari, Dr B. Sreedevi, Dr D. Krishnaveni, Dr Satendra Kumar Mangrauthia, Dr Ladha Lakshmi
3	GEY/CI/ BR/9	Breeding varieties for Boro areas	**Dr L.V. Subba Rao,** Dr V. Ravindra Babu Dr Ch. Padmavathi, Dr M. Srinivas Prasad Dr R. Mahendra Kumar
4	GEY/CI/ BR/20	Development of value added rice based products for different uses	**Dr M.M. Azam ,** Dr D. Sanjeeva Rao, Dr Amtul Waris
5	GEY/CI/ BR/16	Breeding rice varieties for resistance to planthoppers	**Dr G Padmavathi,** Dr V Jhansi Lakshmi, Dr M. Seshu Madhav, Dr P.V. Satyanarayana
6	GEY/CI/ BR/14	Breeding rice for enhanced phosphorous use efficiency	**Dr VP Bhadana,** Dr T. Ram, Dr G.S.V. Prasad, Dr D. Subrahmanyam, Dr R.M. Sundaram, Dr P. Brajendra, Dr R. Mahender Kumar
7	GEQ/CI/BR/21	Breeding for Quality Improvement of Rice through Conventional and Molecular Approaches	**Dr K. Suneeta,** Dr V. Ravindra Babu, Dr D. Sanjeeva Rao, Dr G.S. Laha, Dr P. Senguttuvel, Dr M. Srinivas Prasad Dr R.M. Sundaram, Dr M. Seshu Madhav
8	GEY/CI/ BR/19	Germplasm screening and identification of genes for developing resistance to sheath blight in rice	**Dr Jyothi Badri,** Dr V.P. Bhadana, Dr Suneetha Kota, Dr M. Sheshu Madhav, Dr V. Prakasham
9	GEY/CI/ BR/22	Introgression and identification of novel genes for biotic and abiotic stress tolerance from wild species into cultivated rice	**Dr C. Gireesh,** Dr T. Ram, Dr Jyothi Badri, Dr K. Suneetha, Dr P. Senguttuvel, Dr G. Padmavathi
10	GEY/CI/ BR/23	Breeding high yielding rice lines possessing multiple biotic stress resistance/tolerance through conventional and molecular approaches	**Mr R. Abdul Fiyaz**
11	GEQ/CI/BR/18	Investigation into starch properties and chalkiness on rice cooking quality	**Dr D. Sanjeeva Rao** Dr V. Ravindra Babu
Hybrid Rice			
12	GEY/CI/ HY/7	Exploitation of inter sub-specific heterosis in rice (*Oryza sativa* L.)	**Dr A.S. Hari Prasad,** Dr K.B. Kemparaju, Dr P. Senguttuvel, Dr R.M. Sundaram
13	GEY/CI/ HY/10	Development of parental lines and Hybrids with tolerance to salinity and suitability to aerobic situations	**Dr P. Senguttuvel,** Dr A.S. Hari Prasad, Dr P. Revathi, Dr K.B. Kemparaju, Dr Suneetha Kota, Dr G. Padmavathi, Dr B. Sreedevi, Dr D. Subbramanyam, Dr N. Somasekhar, Dr R.M. Sundaram, Dr Sheshu Madhav, Dr V.P. Bhadana, Dr Mahender Kumar, Dr Brajendra
14	GEY/CI/ HY/12	Development of superior restorers for WA-CMS system and Identification of new restorer (*Rf*) genes in rice by conventional and molecular approaches	**Dr P Revathi,** Dr P. Senguttuvel Dr Satendra K Mangrauthia, Dr Jyothi Badri, Dr Divya Balakrishnan Dr M.S. Prasad, Dr V. Jhnasilakshmi, Dr T. Ram

S. No	Project Code	Project Title	PI & CO-PIs
15	GEY/CI/ HY/11	Development of CMS line with good agronomic base and higher out crossing ability.	**Dr K.B. Kemparaju,** Dr A.S. Hari Prasad Dr P Senguttuvel, Dr P. Revathi, Dr V.P. Bhadana, Dr R.M. Sundaram, Dr M. Sheshu Madhav
Biotechnology			
16	ABR /CI/ BT/12	Root biology of rice grown under irrigated and aerobic conditions	**Dr P Ananda Kumar,** Dr M. S. Madhav Dr M.B.B. Prasad Babu, Dr P. Senguttuvel
17	ABR/CI/ BT/9	Genetic improvement of rice against biotic and abiotic stresses through transgenic approach	**Dr S.M. Balachandran,** Dr A.P. Padmakumari, Dr Ch. Padmavathi, Dr D. Subrahmanyam, Dr S.K. Mangrauthia
18	ABR/CI/ BT/6	Identification of genes for grain filling in rice (*Oryza sativa* L.)	**Dr C.N. Neeraja,** Dr S.R. Voleti, Dr L.V. Subba Rao, Dr S.M. Balachandran, Dr M. Sheshu Madhav
19	ABR/CI/ BT/10	Genomic studies on grain yield heterosis and WA-CMS trait in rice	**Dr R.M. Sundaram,** Dr S.M. Balachandran, Dr A.S. Hariprasad, Dr P. Revathi, Dr M.S. Madhav
20	ABR /CI/ BT/11	Identification of SNP haplotypes in starch synthesizing genes and their association to the various quality characters	**Dr M. Sheshu Madhav,** Dr R.M. Sundaram, Dr K. Sanjeev Rao, Dr K. Suneetha
21	ABR /CI/ BT/13	Candidate gene identification for manipulating growth related genes in rice through computational and expression studies	**Dr P.S. Divya,** Dr S.M. Balachandran Dr D. Subrahmanyam
22	ABR /CI/ BT/14	Exploring RNAi Technology for Management of Rice Diseases	**Dr Satendra Kumar Mangrauthia,** Dr P. Anand Kumar ,Dr S.M. Balachandran, Dr G.S. Laha ,Dr D. Krishnaveni, Dr P. Revathi, Dr V. Prakasam, Dr Kalyani Kulkarni
23	ABR /CI/ BT/15	Molecular and functional characterization of useful root traits in rice	**Dr Kalyani Kulkarni,** Dr M. Seshu Madhav Dr D. Subrahmanyam, Dr P. Senguttuvel Dr S. M. Balachandran, Dr P. Anand Kumar, Dr Divya P. S.
National Professor			
24	NP/1	Development of chromosome segment substitution from elite x wild species crosses for mapping of yield enhancing QTLs/genes in rice"	**Dr N Sarla** Dr Divya Balakrishnan
25	ABR/ NP/2	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.)	**Dr Divya Balakrishnan,** Dr N. Sarla, Dr G. Padmavathi, Dr Jyothi Badri
Crop Production Division			
Agronomy			
26	RUE/CP/ AG/14	Strategic research on enhancing water Use efficiency and productivity in irrigated rice system	**Dr R. Mahender Kumar,** Dr V. Ravindra Babu, Dr L.V. Subba Rao, Dr K. Surekha, Dr P.C. Latha, Dr Ch. Padmavathi, Dr N. Somasekhar, Dr M. Sreenivasa Prasad, Dr P. Raghuveer Rao, Dr P. Muthuraman, Dr B. Nirmala, Dr B. Sailaja, Dr T. Vidhan Singh, Dr B. Sreedevi, Dr Shaik N. Meera, Dr Sheshu Madhav, Dr Senguttuvel, Dr D. Subrahmanyam, Dr D.V.K. Nageswar Rao, Dr M.B.B. Prasad Babu
27	RUE/CP/ AG/13	Improved Agro-techniques for sustainable aerobic rice based cropping systems	**Dr B. Sreedevi,** Dr T. Ram, Dr N. Soma Sekhar, Dr R. Mahender Kumar, Dr B. Jhansirani, Dr C. Kannan, Dr V. Ramamurthy (NBSSLUP), Dr P. Senguttuvel

S. No	Project Code	Project Title	PI & CO-PIs
28	SSP/CP/AG/15	Sustainable intensification of rice-maize system through conservation agriculture	**Dr Mangal Deep Tuti,** Mr Soumya Saha Mr. Bandeppa, Dr T. Vidhan Singh Dr R. M Kumar, Dr B. Sreedevi, Dr B. Nirmala
29	SSP/CP/AG/16	Development of sustainable agro-techniques for direct seeded rice	**Mr. Soumya Saha,** Dr Mangal Deep Tuti, Mr. Bandeppa, Dr T. Vidhan Singh, Dr R.M. Kumar
Soil Science			
30	SSP/CP/SS/11	Assessment and improving nitrogen use efficiency in irrigated rice	**Dr K. Surekha**, Dr V.P. Bhadana, Dr S.R. Voleti, Dr C.N. Neeraja, Dr R. Mahender Kumar
31	CCR/CP/ SS/10	Impact of changing temperatures on nitrogen dynamics and use efficiency in rice	**Dr M.B.B. Prasad Babu** Dr P.C. Latha
32	SSP/CP/SS/14	Heavy metals assessment in soils, grains and Water samples of rice growing areas	**Dr Brajendra,** Dr K. Surekha, Dr P.C. Latha, Dr M.B.B. Prasad Babu, Dr S.N. Meera
33	SSP/CP/SS/13	Utilization of plant growth promoting micro organisms for improving nitrogen and water use efficiency in rice	**Dr P.C. Latha,** Dr M.B.B. Prasad Babu Dr B. Sreedevi
34	SSP/CP/SS/15	Microbial population dynamics in different rice establishment method in relation to nutritional availability and acquisition.	**Dr Bandeppa,** Dr P.C. Latha, Dr K. Surekha, Dr Kalyani Kulkarni, Dr M.D. Tuti
Plant Physiology			
35	CCR/CP/ PP/11	Evaluation of genotypic variation in leaf photosynthetic efficiency and its associated factors in rice	**Dr D Subrahmanyam,** Dr S.R. Voleti, Dr V.P. Bhadana
36	CCR/CP/ PP/9	Physiological studies on Heat tolerance due to ambient and Elevated carbon dioxide in rice	**Dr S.R. Voleti,** Dr P.R. Rao, Dr B. Sailaja, Dr N. Somasekhar, Dr P.C. Latha, Dr K. Surekha, Dr Chitra Shanker, Dr D. Krishnaveni, Dr Shaik N. Meera, Dr M.Vanaja (CRIDA)
37	GEY/CP/ PP/12	Physiological studies for improving ideotype breeding in rice	**Dr P. Raghuveer Rao**, Dr A.S. Hariprasad, Dr V.P. Bhadana
Agricultural Engineering			
38	RUE/CP/ ENG/6	Selective mechanization in rice cultivation	**Dr T. Vidhan Singh,** Dr R. Mahender Kumar, Dr B.Nirmala
Computer Applications			
39	TTI/ CP/CA/3	Delineation of rice growing ecologies using spatial technologies and crop models	**Dr B. Sailaja,** Dr D. Subrahmanyam, Dr Shaik N Meera, Dr B. Nirmala
Crop Protection Division			
Entomology			
40	IPM/ CPT/ ENT/3	Chemical control of rice insect pests as a component of rice	**Dr Gururaj Katti,** Dr V. Jhansi Lakshmi Dr A.P. Padmakumari, Dr Chitra Shanker
41	IPM/CPT/ ENT/21	Botanicals for sustainable management of major pests of rice	**Dr B Jhansi Rani,** Dr Chitra Shanker, Dr M.S. Prasad, Dr M.M. Azam, Dr M. Sampath Kumar
42	HRI/CPT/ ENT/11	Assessment of host plant resistance to rice planthoppers and their management	**Dr V. Jhansi Lakshmi**, Dr D. Sanjeeva Rao
43	IPM/ CPT/ ENT/22	Investigations on Nematodes of Importance to Rice Cultivation	**Dr N. Soma Sekhar,** Dr A.P. Padmakumari, Dr G. Katti, Dr V. Prakasam, Dr P.C. Latha, Dr M. Sheshu Madhav
44	HRI/ CPT/ ENT/23	Insect-plant interactions with special reference to rice pests – yellow stem borer and gall midge	**Dr A.P. Padmakumari,** Dr S.R. Voleti, Dr T. Ram, Dr C.N. Neeraja, Dr K. Suneetha

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45	IPM/ CPT/ ENT/13	Arthropod biodiversity of irrigated rice ecosystems, its functional significance and use in biological control	**Dr Chitra Shanker** ,Dr Gururaj Katti, Dr B. Jhansi Rani, Dr M. Sampath Kumar
46	HR1/CPT/ ENT/19	Assessment of host plant resistance to leaf folder and its management	**Dr Ch Padmavathi,** Dr L.V. Subba Rao, Dr N. Sarla, Dr M. Sampath Kumar
47	IPM/CPT/ ENT/24	Bioecology and Management of Emerging Insect and Mite pests of rice	**Dr Y. Sridhar,** Dr Jhansi Rani, P.S. Dr M. Sheshu Madhav, Dr C. Gireesh Dr Sanjeeva Rao, Dr S. N. Chavan
48	IPM/CPT/ ENT/20	Semiochemical approaches to manage rice pests with special emphasis on sex pheromones	**Dr M. Sampath Kumar,** Dr Ch. Padmavathi, Dr G.R. Katti
49	IPM/CPT/ ENT/25	Development of Entomopathogenic Nematodes (EPN) for Biointensive Integrated Pest Management In Rice	**Mr. Satish** N. Chavan, Dr N. Somasekhar Dr Gururaj Katti, Dr A.P. Padmakumari
Plant Pathology			
50	HRP/CPT/ PATH/15	Assessment of host plant resistance to rice blast disease and its management	**Dr M.S. Prasad,** Dr V. Prakasam, Dr S.M. Balachandran, Dr M.S. Madhav, Dr Divya Balakrishnan
51	HRP/CPT/ PATH/13	Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice	**Dr G.S. Laha,** Dr D. Krishnaveni, Dr R.M. Sundaram, Dr T. Ram, Dr S.K. Mangrauthia, Dr D. Ladha Lakshmi
52	HRP/CPT/ PATH/14	Assessment of host plant resistance and development of diagnostic tools for rice tungro virus disease	**Dr D. Krishnaveni,** Dr G.S. Laha, Dr Chitra Shanker, Dr C.N. Neeraja, Dr S.K. Mangrauthia, Dr D. Ladhalakshmi
53	HRP/CPT/ PATH/20	A consortia approach to the biological management of diseases in rice	Dr C. Kannan, Dr M. Srinivas Prasad, Dr D. Krishnaveni, Dr G.S. Laha, Dr V. Prakasam Dr D. Ladhalakshmi, Dr P.Valarmathi, Dr Chitra Shanker, Dr P.C. Latha and Dr B. Sridevi
54	HRP/CPT/ PATH/19	Epidemiology and management of False smut disease	**Dr D. Ladhalakshmi,** Dr G. S. Laha, Dr M. S. Prasad, Dr D. Krishnaveni, Dr V. Prakasam, Dr Satendra Kumar Mangrauthia, Dr Suneetha Kota
55	HRP/CPT/ PATH/18	Characterization and management of *Rhizoctonia solani* causing sheath blight of rice	**Dr V. Prakasam,** Dr M.S. Prasad, Dr G.S. Laha, Dr Ladha lakshmi, Dr Jyothi Badri
56	HRP/CPT/ PATH/21	Host plant resistance to Brown spot disease of rice and its management	**Dr P. Valarmathi,** Dr M.S. Prasad, Dr D. Ladhalakshmi, Dr V. Prakasam, Dr Divya Balakrishnan
Transfer of Technology & Training			
57	TTI/TTT/ EXT/8	Sustainable rice production practices: Problems and prospects	**Dr P. Muthuraman,** Dr Shaik N Meera, Dr S. Arun Kumar, Dr B. Nirmala
58	TTI/ TTT/ EXT/10	Gender Dimensions in Rice Sector: Dissemination of climate resilient rice production technologies to farmers and farm women in selected villages of Ranga Reddy District of Telangana State	**Dr Amtul waris,** Dr R. Mahender Kumar, Dr S. N. Meera, Dr S. Arun Kumar, Dr B. Sreedevi, Dr K. Surekha, Dr Brajendra, Dr B. Nirmala, Dr V. Jhansi lakshmi
59	TTI/ TTT/ EXT/12	Maximizing the impact of rice technologies through ICT applications	**Dr S.N. Meera**, Dr S. Arun Kumar, Dr Amtul Waris, Dr Chitra Shanker, Dr D. Krishnaveni, Dr B. Sailaja, Dr P. Brajendra, Dr P. Muthuraman, Dr P. Senguttuvel
60	TTI/ TTT/ EXT/13	Effectiveness of farmers field school in dessimenation of IPM strategies in rice	**Dr P. Jeyakumar,** Dr P. Muthuraman, Dr S. Arunkumar and Dr Chitra Sankar

S. No	Project Code	Project Title	PI & CO-PIs
61	TTI/TTT/ ECON-3	IPR - Competition interaction in Indian rice seed sector – Emerging scenario-implications for enhancing quality seed use.	**Dr P.A. Lakshmi Prasanna ,** Dr L.V. Subba Rao, Dr A.S. Hari Prasad, Dr SN. Meera, Dr B. Nirmala, Dr S. Arun Kumar, Dr Amtul Waris
62	TTI/TTT/ EXT/9	An Exploratory study on public-private-partnerships: Impact and implications for the rice sector	**Dr S. Arun Kumar,** Dr Shaik N Meera, Dr P. Muthuraman
63	TTT/ECON/2	Training, transfer of technology and impact analysis of Socio-economic impact assessment of rice production technologies	**Dr B. Nirmala,** Dr P. Muthuraman, Dr Amtul Waris, Dr R.M. Kumar, Dr A.S. Hari Prasad, Dr Vidhan Singh

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