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11. Wild Rice Garden
12. Office-cum-lab at Ramachandrapuram Farm

Preface

I am pleased to place before you the Annual Report of the Directorate of Rice Research for the period 2011-12, the seventh report during my tenure as the Project Director.

The year 2011-12 was a landmark year, for agriculture in general and for rice production in particular with the country crossing the magical mark of 100 million tonnes for the first time and as per third advance estimates, rice production is expected to be around 103.41 million tones. This is a matter of great satisfaction to all the stakeholders of rice sector.

The year has also been quite significant for DRR, as four of our scientists have been recognized at the National level for their scientific achievements and also for developing and hosting the "Rice Knowledge Management Portal"- a unique portal acclaimed by many as a model for other crops.

Progress of research during the period under report has been very satisfactory. Two hybrids were released by the Central Sub-committee on Crop Standards and Notification and Release of Varieties (CSCSNRV) and 16 more varieties and 2 hybrids were released by different states. Varietal identification committee identified 10 hybrids and two varieties, both varieties being developed by DRR, for consideration of release. New and improved parental lines have been identified for development of suitable hybrids. Molecular markers for grain and cooking quality traits have been developed. Drought tolerant transgenic BPT5204 lines are under intensive testing. Resource conservation agro-techniques are being aggressively tested and validated. Crop response to climate change has been given higher priority with creation of infrastructure for intensive research under NICRA. New sources, new genes and linked markers for resistance/ tolerance to biotic and abiotic stresses have been identified/developed. Eco-friendly components of IPM like trap crop for yellow stemborer management were validated and found to work well.

Need and demand based four training programmes were conducted. Over 300 FLDs were organized and 245 quintals of breeder seed was produced. Nine externally funded projects were awarded to DRR, during this year by different agencies.

During the period, several additional infrastructural facilities like, renovated auditorium, biotechnology annexe building, wild rice garden, transgenic rice net house Lab cum Farm Office etc. were added. Academic activity encompassed award of five Ph.D. degrees and 24 M.Sc. students completed their research projects and signing of MOUs with two universities. Over 100 research papers have been published in high rated journals and our scientists presented papers and posters in national and international symposia. DRR signed MOU two with companies for production and marketing of our hybrids.

A summary of these activities is presented in this Annual Report which has been condensed as per the recent guidelines issued by the Council.

(B.C. Viraktamath)
Project Director

June 2012
Hyderabad

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अखिल भारतीय समन्वित चावल सुधार कार्यक्रम

नई विमोचित किस्में

- इस वर्ष के दौरान फलस प्रमाणन, अधिसूचना एवं किस्म विमोचन केन्द्रीय उपसमिति द्वारा दो संकर किस्में वी.एन.आर. 202 एवं वी.एन.आर 204 तथा दो संकर किस्में सी.ओ-4 (तमिलनाडू) व सह्याद्री 5 (महाराष्ट्र) राज्यों द्वारा जारी की गयी। इसके अतिरिक्त 16 अन्तः प्रजात किस्में भी जारी की गयीं।
- वर्ष 2011 के दौरान, 44 अन्तः प्रजात वंशक्रम एवं 6 संकर किस्म परीक्षण आयोजित किये गये जिसके लिये कुल 810 प्रयोग देश के 5 क्षेत्र के 27 राज्यों में (46 वित्तीय सहायता प्राप्त एवं 67 स्वैच्छिक केन्द्र) आयोजित किये गये। दो-तीन साल के दौरान विभिन्न प्रयोगों द्वारा सर्वोत्तम कल्चर को पहचाना गया।
- कृषि एवं सहकारिता विभाग द्वारा निर्धारित अन्तः प्रजात किस्मों एवं संकरों के पैतृक वंशक्रमों का प्रजनक बीज उत्पादित किया गया। देश के 38 केन्द्रों में 6828.16 कुन्तल प्रजनक बीज का उत्पादन किया गया जिसमें 242 प्रजातियों तथा पांच संकर किस्मों के पैतृक वंशक्रम सम्मिलित हैं।

शस्य विज्ञान

- चौदह श्रेणियों की उन्नत किस्मों (62 ए.वी.टी-2) कल्चर में नत्रजन की विभिन्न मात्राओं के प्रति अनुक्रिया का अध्ययन किया गया। सामान्य एवं 50% नत्रजन मात्रा पर अच्छी उपज देने वाली किस्मों की पहचान की गयी है।
- अन्तर शस्य प्रणाली एवं खरपतवार प्रबंध के तरीकों का वर्षाधारित ऊपरी भूमि में अध्ययन के अनुसार धान : दलहन का 4:3 अनुपात में विस्थापन तथा पौधे निकलने के 25 दिन बाद हाथ से निराई के साथ पेंडिमिथालिन (0.75 कि.ग्रा. सक्रिय तत्व/हे.) का प्रयोग धान की उपज बढाने में लाभप्रद रहा।
- एरोबिक धान के लिये अनुकूल बुवाई तिथि तथा उपयुक्त किस्मों के अध्ययन के अन्तर्गत पाया गया कि अधिकतम उपज प्राप्त करने के लिये उपयुक्त बुवाई का करता है। एरोबिक धान में वाष्पीकरण हानि (150% सी.पी.ई) के कारण अधिक सिंचाई की आवश्यकता पडती है।
- प्राथमिक पोषक तत्वों से भरपूर संतुलित उर्वरक एरोबिक धान के लिये आवश्यक हैः खरपतवार नाशी पेंडिमिथालिन (1 कि.ग्रा. सक्रिय तत्व/हे. बुवाई के 3-4 दिन बाद) के साथ बुवाई के 15 एवं 30 दिन बाद हाथ से खरपतवार निकालने से खरपतवारों का प्रभावी नियंत्रण हो पाया। एस.आर.आई प्रणाली में रोपाई के 10, 20, 30 एवं 40 दिन बाद चार बार कोनो वीडर द्वारा निराई या ब्यूटाक्लोर के साथ हाथ से निराई करने से अधिक उपज प्राप्त की जा सकती है। रोपित धान में खरपतवार नाशियों (ग्लाइफोसेट, वेनसब्यूरान, मिथाइल+प्रोटाक्लोर) का क्रमवार प्रयोग प्रभावी पाया गया।
- मशीन द्वारा रबी एवं खरीफ के दैरान रोपाई करने से मानव द्वारा कठिन कार्य श्रम निर्भरता एवं लागत कम होने के साथ खरीफ में 2.2-19.6% अधिक उपज प्राप्त हुयी।
- अजैविक खाद (एन.पी.के. तथा सूक्ष्म पोषक तत्वों) के साथ जैविक खाद का प्रयोग करने से 29-41% अधिक उपज प्राप्त हुयी।

मृदा विज्ञान

- तेईसवें वर्ष के अध्ययन के परिणामस्वरूप यह पाया गया कि सिफारिश की गयी उर्वरक मात्रा (100% एन.पी.के जस्ता सल्फर) के साथ 5 टन/हे. पूरक गोबर की खाद का खरीफ धान पर अच्छा प्रभाव पडा तथा साथ ही इससे मृदा में पौषक तत्व उपलब्धता एवं कार्बन स्तर पर सुधार हुआ और मृदा शक्ति में कमी आयी।
- समेकित पोषक तत्व प्रबंध अध्ययन के अन्तर्गत यह पाया गया कि 50% नत्रजन कार्बनिक खाद द्वारा पूर्ति करना 100% सिफारिश की गयी उर्वरक मात्रा के बराबर प्रभावी है।

- स्थान विशेष पर आधारित पोषक तत्व प्रवन्ध वर्तमान में सिफारिश की गयी व्यापक उर्वरक मात्रा या मृदा परीक्षण के आधार पर तय की मात्रा के बराबर तथा किसान द्वारा अपनायी गयी उर्वरक परिपाठी से उत्तम पाया गया।
- लगभग उदासीन, अम्लीय एवं लवणीय मृदाओं में सिखारिश कियेगये एन.पी.के. एवं सूक्ष्म पोषक तत्वों (जस्ता, लोहा, मैंगनीज, बोरान, सिलिकान) के साथ कार्बनिक खादों का प्रयोग करने से धान की उपज एवं पोषक तत्व प्राप्ति में वृद्धि हुयी।
- एक समूह की किस्मों में उपज एवं दाने में सूक्ष्म पोषक तत्वों की मात्रा में सार्थक सहसंबंध नहीं पाया गया। ब्राऊन राइस की तुलना मे मिलिंग (6% पोलिश) करने से 26-81% लोहे एवं 20-78% जस्ते की हानि हुयी।
- खरीफ में कानपुर में 100% वाष्पीकरण तथा हैदराबाद में 150 (सी.पी.ई.) के समतुल्य सिंचाई से एरोबिक धान में 10-27% पानी की बचत हो सकी।
- धान-धान एवं धान-गेहूँ फसल प्रणाली में धान की पुआल का सीधा या हरी खाद या जीवाणु (अम्लीय मृदा में) खाद के साथ प्रयोग करने से फसल उपज, पोषक तत्व प्राप्ति तथा मृदा में कार्बन स्तर में वृद्धि हुयी।
- हाल ही में जारी की गयी अन्तः प्रजात एवं संकर किस्मों मे पोषक तत्व संग्रह एवं प्रयोग हुयी खाद की उपज अनुक्रिया के आधार पर पाया गया कि उन्नत किस्मों एवं संकर धान की अधिकतम उपज के लिये विभिन्न पोषक तत्वों की आवश्यकता का स्तर 16-33 कि.ग्रा. नत्रजन, 5-9 कि.ग्रा. फास्फोरस तथा 15-41 कि.ग्रा. पोटाश प्रति टन दाने की उपज के लिये आवश्यक है।

पादप कार्यिकीः

- पांच किस्मों में अगेती बुवाई करने से बाली निर्माण अवस्था का समायोजन 950 सी.डी.डी. (संग्रहित डिग्री दिवस) एवं 850 सी.एन.पी. (संग्रहित निशा अवधि) पर किया तथा इस में सामान्य समय पर बुवाई की गयी फसल की अपेक्षा दाने की उपज भी अधिक प्राप्त हुयी। निष्कर्षों के अनुसार जल्दी बुवाई करने पर 7 स्थानों (मुख्यतः पूर्वी भारत) पर अधिक उपज प्राप्त हुयी।
- बोरोन (0.4 पी.पी.एम) के प्रयोग से उपज में 9.6% वृद्धि के साथ जैवपदार्थ एवं दाने भरने के प्रतिशत में भी वृद्धि एवं दाना रहित शूकिकाओं में कमी आयी। विभिन्न स्थानों पर तीन प्रविष्टियाँ आई.ई.टी. 22218, आई.ई.टी. 21540 तथा आई.ई.टी. 21519 ने अधिकतम उपज दी।
- छः स्थानों पर 12 आई.ई.टी. प्रविष्टियों एवं तीन मानक किस्मों में से अंजली, सहभागी धान तथा तुलसी सूखे के प्रति सहनशील पायी गयीं।
- अधिक तापमान सहनशीलता के लिये उपयुक्त धान की किस्मों की जाँच पर पाया गया कि आई.ई.टी. 21577, आई.ई.टी. 21415, आई.ई.टी. 21404, बरधान एवं पी.एच.बी-71 में शुष्क पदार्थ की पुनः गतिशीलता अत्यधिक है। सामान्यतः ऐसी लक्षण वाली किस्में अधिक तापमान में भी अच्छा प्रदर्शन करती हैं।

कीट विज्ञान

- कुल 2099 किस्मों का 40 स्थानों पर 188 परीक्षणों में 12 कीटों के प्रति मूल्यांकन किया गया। इसके फलस्वरूप 11 दाता एवं 81 प्रविष्टियाँ एक या एक से अधिक कीटों के प्रति उत्कृष्ट पायी गयीं।
- गालमिज रोधक जीन (जी.एम.-3, जी.एम-4 एवं जी.एम-8) द्वारा प्रदत्त प्रतिरोधिता कीडे की विभिन्न बायोटाइप एवं समष्टि के प्रति प्रभावी पायी गयी।
- नये कीटनाशियों के मूल्यांकन अध्ययन में सल्फोक्साफ्लोर कीटनाशी भूरे फुदके के प्रति मोनोक्रोटोफास के समान या आधिक प्रभावी पाया गया।
- एसीफेट या डाइनोटेफ्यूरान को हेक्साकोनाजोल या ट्राइसाइक्लाजोल के साथ मिलाकर प्रयोग करने से कीटनाशियों की प्रभाविता पर प्रतिकूल प्रभाव नहीं पडा।
- रोपित धान की तुलना में सीधी बुवाई वाले खेत में

पत्ती मोडक कीट का अधिक आक्रमण पाया गया। संकर किस्मों पर दो स्थानों पर तना छेदक का अधिक आक्रमण पाया गया।

- तीन सालों के लगातार प्रयास के फलस्वरूप, तना छेदक के नियंत्रण में जाल फसल के रूप में सुगन्धित किस्म जैसे पूसा बासमती किस्म की रोपाई (मुख्य फसल की 9 पंक्तियों के बाद एक पंक्ति) की पुनः पुष्टि की गयी।
- उन्नीस स्थानों पर तना छेदक, पत्ती मोडक एवं फुदके आदि कीटों एवं उनके प्राकृतिक शत्रुओं की निगरानी की गयी।
- पारिस्थितिक अभियंत्रण के अन्तर्गत पुष्पीय विविधता, एलीवेज, प्रभावी जल प्रबंध तथा मिरिड बग अवयवों के प्रयोग से भूरे फुदके के कीट की संख्या में कमी आयी।
- यद्यपि तना छेदक एवं पत्ती मोडक द्वारा की गयी हानि विभिन्न आचारों में सार्थक रूप से भिन्न थी लेकिन इसका उपज की हानि में प्रभाव नहीं आंका जा सका।
- समेकित कीट प्रबंध से किसान द्वारा अपनायी जाने वाली विधियों की अपेक्षा अधिक उपज प्राप्त हुयी लेकिन इससे लागत खर्च बढ गयी।
- प्रकाश जाल द्वारा कीटों की समष्टि की निगरानी देश भर के 29 स्थानों पर की गयी।

रोग विज्ञान

- पाँच राष्ट्रीय छटनी नर्सरी में 1023 प्रविष्टियों (अग्रिम प्रजनन वंशक्रम एवं नई संकर किस्मों) को विभिन्न रोगों के प्रति 52 स्थानों में मूल्यांकन किया गया।
- कुल 812 जनन द्रव्य प्रविष्टियों की पांच रोगों-झौंका, पर्णच्छद अंगमारी, जीवाणु अंगमारी भूरे धब्बे एवं टुंग्रो के लिये 11 स्थानों में छंटाई की गयी जिसमें पाया गया कि एक्सेसन नं. 463044 और 576993 जीवाणु अंगमारी तथा दुंग्रो के लिए जबकि एक्सेसन नं. 545000 पर्णच्छद अंगमारी एवं भूरे घब्बे के लिये अवरोधी हैं।
- पैरीकुलेरिया ग्रीसिया के खेत में उग्रता निगरानी अध्ययन के अर्न्तगत डिफ्रेंशियल प्रतिक्रिया के अनुसार 5 मुख्य समूह पाये गये। कोयंबतूर तथा घाघराघाट समूह, अलमोडा समूह-2, पोन्नमपेट एवं बारापानी समूह-3, नई दिल्ली समूह-4, अपर शिलांग, नेल्लोर, पट्टांबी, मलन, लोनावला, टीटाबार, खुदवानी, गुडलूर, सी.आर.आर.आई, डी.आर.आर., रायपुर, नवागाम तथा मांड्या समूह-5 में रखे गये।
- जान्थोमोनास ओराइजी पी.वी. के खेत में उग्रता निगरानी अध्ययन के अंतर्गत 22 एन.आइ.एल. के मूल्यांकन फलस्वरूप Xa13 तथा Xa21 को छोडकर एक जीन वाली सभी एन.आई.एल. बीमारी के प्रति संवेदी पायी गयीं ताकि सभी तीन व चार जीन संयोग तथा Xa13 + Xa21 दो जीन संयोग सभी स्थानों पर प्रतिरोधी पाये गये।
- रोग निगरानी परीक्षणों में लीफ एवं नेक ब्लॉस्ट, भूरे धब्बे, पर्णच्छद अंगमारी, शीथरॉट, फाल्समट, बीज विवर्ण एवं झुलसा रोगों का मूल्यांकन किया गया। देर से बुवाई करने पर झौंका एवं जल्दी बुवाई करने पर पर्णच्छद अंगमारी का अधिक प्रकोप पाया गाया।
- नये कवक नाशियों में क्रेसोक्सिम मिथाइल 40% + हेक्साकोनाजोल 8% WG (आर.आई.एल. 068/एफ1 48WG) रोगों की उग्रता कम करने एवं उपज बढाने में सहायक सिद्ध हुये। मूल्यांकन किये गये कवक नाशियों में से टिल्ट एवं नेटिवों दोनों फाल्समट नियंत्रण में समान रूप से प्रभावी पाये गये। इसके बाद एरगन का स्थान है।
- जैव नियंत्रण पदार्थो में टी.एन.ए.यू. के टाल्क तथा द्रवीय (पी.एफ1) पदार्थ झोंके एवं पर्णच्छद अंगमारी नियंत्रण में अधिक प्रभावी पाये गये।
- कवकीय रोगों के लिये 100% नत्रजन मात्रा के साथ प्रतिरोधी किस्मों का प्रयोग या2/3 नत्रजन के साथ संवेदी किस्मों की खेती तथा आवश्यकतानुसार कवकनाशी का छिडकाव करना उपयुक्त पाया गया। झुलसा के लिये प्रतिरोधी किस्म एवं कम नत्रजन का प्रयोग बेहतर पाया गाया।
- उत्पादोन्मुखी सर्वेक्षण में जैविक कारणों का प्रभाव मध्यम से निम्म तीव्रता का रहा। यद्यपि छत्तीसगढ में नेक ब्लास्ट, छत्तीसगढ़, झारखंड व बिहार में भूरा धब्बे, तटीय आंध्र प्रदेश में पर्णच्छद अंगमारी, रायगढ

(महाराष्ट्र), कर्नूल (आ.प्रा.), पल्लाकाड (केरल) में झुलसा, बिहार, हिमाचल प्रदेश, जम्मू काश्मीर एवं झारखंड में फाल्सस्मट का अधिक प्रकोप पाया गया।

अग्रिम पंक्ति प्रदर्शन (एफ.एल.डी.)

- विभिन्न चावल उत्पादन तकनीकियों - उन्नत किस्में, संकर किस्में तथा अन्य शस्य क्रियाओं के लिये इस वर्ष 700 अग्रिम पंक्ति प्रदर्शन आयोजित किये गये। इनमें से 25 उत्कृष्ट तकनीक की पहचान की गयीं। एक राष्ट्रीय कार्यशाला (एफ.एल.डी. को पुनः परिभाषित करना एवं इसके प्रभाव को बढाने के लिये) के दौरान डी.आर.आर में 28 मार्च 2012 को गहन चिन्तन किया गया।

अग्रिम अनुसंधान

फसल सुधार

- स्वर्णा X ओ.निवारा संकरण से प्राप्त विमोचन के लिये चयनित वंशक्रम आई.ई.टी. 21542 (उपज बढाने वाले चिह्नक जीन उपज 2.3, उपज 8.3 तथा जी.डब्ल्यू 81) ने राष्ट्रीय चैक जया से 25%, क्षेत्रीय चैक से 36% तथा संकर किस्मों के.आर.एच-2 से 34% अधिक उपज वृद्धि दर्शायी एवं इसकी अधिकतम उपज 10.65 टन/हे. प्राप्त हुयी।
- एक प्रविष्टि आई.ई.टी.21665 (आर.पी.3644-1-19-5-5) जिसमें 110 दिन की पुष्पण अवधि वांछित सुगंधित धान की गुणवत्ता, झौंका तथा भूरा धब्बा रोगों के प्रति अवरोधिता की, दिल्ली, उत्तराखंड एवं उत्तर प्रदेश के बासमती उगाने वाले क्षेत्रों के लिये पहचान की गयी है।
- इंडिका जापानिका संकरण से प्राप्त दो नये पादप प्रारूप वंशक्रमों - एफ.जी.आर. 21-17 एवं एफ.जी.आर 21-22 में कम कल्लों की संख्या, मजबूत तना, अधिक बायोमास, प्रति बाली अधिक दाने, मध्य पतले दाने वाले लक्षण पाये गये। इन वशक्रमों ने आर.एच-2 को छोडकर अन्य सभी जाँच की गयी किस्मों से अधिक उपज दी।
- बोरो क्षेत्रों के लिये धान की किस्म प्रजनन कार्यक्रम में अग्रिम पीढी की वंशक्रमों को पौध अवस्था में कम तापमान सहनशीलता एवं पुष्पण तथा दाने भरने की अवस्था में अधिक तापमान सहनशीलता के लिये मूल्यांकन किया गया।
- दो पिछेती किस्में आर.पी. 5320 एवं आर.पी. 5312 एवं छः मध्यम अवधि वाली किस्मों (आर.पी. 5194, आर.पी. 4977, आर.पी. 5318, आर.पी. 4975, आर.पी. 4974 एवं आर.पी. 5181) में अधिक उपज एवं फुदका के लिये प्रतिरोधिता पायी गयी।
- आई.ई.टी. 20214, जनन द्रव्य वंशक्रम 2255, टी.आर.एल 21050, मुगद सुगन्धा तथा प्रायोगिक संकर किस्म डी.आर.आर. एच-79 ने मृदा की निम्न फास्फोरस दशा में अच्छा प्रदर्शन किया।
- मूल्यांकन किये गये लगभग 2500 जनन द्रव्य वंशक्रमों में से छः वंशक्रमों ई.1763, आई.सी.352760, आई.सी.350189, आई.सी.466351, आई.सी.577070 तथा आई.सी.576974 ने 15 दिन की अवधि के दौरान अनऐरोबिक दशाओं में 90% अंकुरण दर्शायी।
- पांच सौ परीक्षण संकरण के मूल्यांकन के फलस्वरूप 60 उत्कृष्ट प्रत्यावर्तक एवं 40 अनुरक्षकों की पहचान की गयी।
- विभिन्न तापमान अन्तरालों के अन्तर्गत पांच टी.जी.एम.एस. वंशक्रमों का उर्वरता व्यवहार के लिये मूल्यांकन किया गया।
- स्थानीय परीक्षण में सीधी बुवाई तथा ऐरोबिक दशा के लिये मूल्यांकन की गयी 56 संकर किस्मों में आई.आर. 79156 ए/सी.बी 06-137, ए.पी.एम.एस. 6ए/आर.पी. 4092, ए.पी.एम.एस 6ए/2634-1, ए.पी.एम.एस 6ए/एल 182 नामक संकर उत्कृष्ट पाये गये।
- जीवाण्विक पत्ता अंगमरी के प्रति प्रतिरोधिता के लिए मूल्यांकित 29 अनुरक्षक वंशक्रमों में चार प्रविष्टियाँ उत्कृष्ट पायी गयीं।
- फिनोटाइप की सूचना के आधार पर जननक्षमता पुनरुद्धार लक्षणों की पहचान के लिए आणविक चिह्नक आर.एफ 4, आर.एम 10318, आर.एफ-1 के लिए आर.एम 6100 और आर.एफ 3 के लिए आर.एम. 3873 काफी हद तक याने 80-85 प्रतिशत तक पर्याप्त पाये गये।

- परीक्षित 208 छोटे दानेवाले सुगंधित चावल वंशक्रम में से चार एस.एस.आर चिह्नकों - आर.एम 577, आर.एम 505, आर.एम 89 और आर.एम 22866 ने जीनोटाइप विशिष्ट प्रवर्धक पैटर्न का उत्पादन किया।
- बी.पी.टी. 5204 एवं चिट्टी मुत्यालु के संकरण से प्राप्त एक अग्रिम वंशक्रम छोटा मोटा दाना, मध्यम बौनी, मध्यम अवधि एवं अधिक उपज के साथ अधिक लोहा (3.12 मि.ग्रा./100ग्रा.) एवं अधिक जस्ते (4.0 मि.ग्रा./100 ग्रा.) की मात्रा वाला वंशक्रम पाया गया।
- आर.टी. 206 x जया संकरण से प्राप्त रिक्त समष्टि में जिलेटीनाइजेशन तापमान के लिये qGT-6 नामक एक मुख्य क्यू.टी.एल. (32% प्रभाव) की आर.एम. 276-आर.एम.217 संकेतों द्वारा पहचान की गयी।
- दो जीनों सुक्रोज फास्फेट सिन्थेज एवं शुगर ट्रांस्पोर्टर के लिये अलील माइनिंग के अंतर्गत दाना भरने के लिये इंडल बहुरूपी पायी गयी।
- 28 एस.एस.आर. चिह्नकों का एक समूह की उपज में औज का पता लगाने के लिये पहचान की गयी है।
- (इंडयूसेबल प्रमोटर rd29A के अंर्तगत)ATDREBIA जीन की तीन अलग घटनाओं (बी.पी.टी. 5204 ट्रांसजैनिक) में सूखे के प्रति सहनशीलता का स्तर अधिक पाया गया।
- RNAi बाईनरी वेक्टर कंस्ट्रक्ट जिसमें आर.टी.एस.वी. के सी.पी. 3 (कोट प्रोटीन) को तीन वंशक्रम तयपेई 309, आई.आर.64, बी.पी.टी. 5204 में ट्रान्सफार्म किया गया है।

फलस उत्पादन

- संपदा किस्म में एस.आर.आई विधि (8.16-8.32 टन/हे.) (जैविक या अजैविक खाद) के अंतर्गत सर्वोत्तम प्रबंध क्रियाओं (बी.एम.पी. 6.99 टन/हे.) से अधिक उपज प्राप्त हुयी।
- एरोबिक धान से पानी की बचत होती है लेकिन खरपतवारों की मुख्य समस्या है। प्रयोगों के अंतर्गत पेंडीमिथालिन (1.5 कि.ग्र./हे.) के बाद बिसपाइरीबेक सोडियम (20 ग्रा/हे.) का प्रयोग खरतपवारों की संख्या कम करने एवं उपज बढाने में सहायक सिद्ध हुआ।
- डाइरेक्ट स्पोट सीडेड राइस (SSR) विधियों से चावल उगाने में प्लास्टिक मलचिंग को संसाधन संरक्षण के रूप में पेश किया जा रहा है। रोपिल एवं डाइरेक्ट वेट सीडेड (संतृप्ति नमी की अवस्था में) धान की उपज में कोई सार्थक अंतर नहीं पाया गया। मलचिंग से नानमचिंग की अपेक्षा उपज में 0.26 टन/हे. कमी आयी। मलचिंग में लगभग 35% पानी की बचत हुयी। मलचिंग से मृदा तापमान में वृद्धि एवं खरपतवार वृद्धि में कमी आयी।
- विभिन्न नर्सरी प्रबंध विधियों के अंतर्गत संकर किस्में पी.ए. 6444 की कम बीज घन्नन एवं फास्फोरस का प्रयोग करने से अधिक बीजोद्भिद् ओज पाया गया। उपज बढाने के लिये समेकित पोषक तत्व प्रबंध के अंतर्गत एन.पी.के. की अतिरिक्त मात्रा, नत्रजन को चार बार में प्रयोग करना, तथा पोटाश व बोरान का पी.आई. अवस्था पर प्रयोग से 0.7-0.8 टन/हे. अधिक उपज प्राप्त हुयी।
- एन-0 एवं एन-100 स्तरों पर 15 किस्मों में नत्रजन उपयोग कुशलता के सात सूचकांकों के आधार पर राशी, एम.टी.यू. 1010, वरधान, स्वर्णा तथा बी.पी.टी. 5204 सबसे अधिक कुशल पायी गयीं।
- नाइट्रस आक्साइड उत्सर्जन के एक अलग अध्ययन में उर्वरक प्रयोग के बाद N_2O में कमी आयी। दो विधियों में से पंक्तियों में सीधी बूवाई (WSR) विधि में रोपित धान की अपेक्षा अधिक N_2O फ्लक्स पाया गया।
- सूक्ष्म तत्वों से परिपूर्ण कंपोस्ट (एम.ई.सी.) जैसे खेत में तैयार पोल्ट्री एवं वर्मी कंपोस्ट से के.आर.एच-2 की उपज में वृद्धि हुयी।
- एसिड सल्फेट मृदाओं से प्राप्त पौधे एवं मृदा में पाये जाने वाले नौ जीवाणुज आइसोलेट आइ.ए.ए. उत्पादन के लिये घनात्मक, 4 आइसेलेट ए.सी.सी. के लिये घनात्मक पाये गये जबकि अम्लीय-लवणीय मृदाओं से प्राप्त 5 आइसोलेट पी.ई.जी. द्वारा हुयी पानी की कमी में वृद्धि कर सके। स्वर्णा के बीजों को इन में से कुछ आइसोलेट से उपचार करने पर पी.ई.जी. द्वारा हुई पानी की कमी की अवस्था में अंकुरण और औज में वृद्धी हुई।
- समान रूप से बीज छिडकने के लिये शक्ति चालित

मशीन का प्रारूप तैयार किया गया है। व्यापारिक यांत्रिक निकाई मशीन एरोबिक खेल में एस.आर.आई प्रणाली में अच्छी नहीं पायी गया।

- अधिक तापमान का बाली निर्माण अवस्था में मेगास्पोरोजेनेसिस एवं माइक्रोस्पोरोजेनेसिस के अंर्तगत मादायें 40% तथा नर में 60% बीज बन पाया।
- पानी की कमी की अवस्था में कुछ किस्मों जैसे आई.ई.टी. 22031, अंजली तथा आई.ई.टी. 22034 में तने से खाद्य पदार्थ के बेहतर संचालन फलस्वरूप उपज में न्यूनतम हानि हुयी।
- अध्ययनों के अनुसार सोर्स एवं सिंक की नत्रजन मात्रा को 0-200 कि.ग्रा./हे. तक बढाया जा सकता है। 8-9 टन पैदावार लेने के लिये 6-7 एल.ए.आई. अनुकूल है।
- अ.भा.स.चा.सु.प. सूचना प्रबंध प्रणाली (MIS) का विजुअल बेसिक तथा एम.एस. एस.क्यू.एल इंटरफेस का प्रयोग करके 65 रिलेशनल तालिका 200 संग्रहित प्रक्रिया के द्वारा किया गया।
- फसल वृद्धि के दो अवस्था वाली प्रवृत्ति के लिये सिंचित धान में मौसम परिवर्तन अनुक्रिया के लिये फसल वृद्धि माडल की जाँच की गयी। विभिन्न वर्षा के दौरान मौसम परिवर्तन का शाखीय अवस्था की अपेक्षा बाली वनने की अवस्था पर अधिक प्रभाव पडा।

फसल रक्षण

- आई.एन.आर.सी. 174704 तथा आई.आर-64 म्यूटैंट (आई.ई.टी.20545) में गालमिज प्रतिरोधिता के लिये दो नये जीन स्रोत तथा काव्या में गालमिज प्रतिरोधिता की नयी प्रक्रिया की पहचान की गयी।
- ग्रीन हाउस में मूल्यांकन की गयी 300 किस्मों में से के.ए.यू.एम. 166-2, टी.आर. 2004-029 तथा जनन द्रव्य संख्या 463272, 463328, 545463, 576923 में बी.पी.एच. एवं डब्ल्यू.बी.पी.एच. प्रतिरोधिता पायी गयीं।
- आई.आर.64/ ओ.ग्लेबेरीमा संकरण से प्राप्त सभी 23 BC3F5 वंशक्रम पीले तना छेदक के प्रति अवरोधी पायी गयीं।
- पत्ता मोडक द्वारा क्षतिग्रस्त पत्र क्षेत्र के आधार पर ग्रीनहाउस मूल्यांकन ने दर्ज किया कि टी.एन-१ चेक की तुलना में निम्नांकित चार किस्मों - टी.एन.ए.यू.एल.एफ.आर 831311, एल.एफ 293, डब्ल्यू 1263 (डी.आर.आर) और आर.पी. 4645-688 को क्षति बहुत कम हुई।
- धान की किस्में टी.के.एम-6, अन्नदा, सूरक्षा, तथा रामाकृष्णा में रूट नॉट निमेटोड मिलेडोगाइने ग्रेमिनीकोला के प्रति अवरोधिता पायी गयी।
- विभिन्न स्रोतों से प्राप्त किस्मों का जीवाणुज पत्ता अंगमारी के प्रति रोधिता का नियंत्रित दशाओं में मूल्यांकन कर उत्कृष्ट किस्मों की पहचान की गयी।
- झौंका के लिये जाँच की गयी 2762 वंशक्रमों में से 394 प्रतिरोधी पायी गयीं।
- राइस टुंग्रो रोग के प्रति प्रतिरोधिता (क्यू.आर.टी.वी-7) के एक प्रमुख स्थान को जनन द्रव्य संख्या-7 में 17-19 एम.बी. क्षेत्र के रूप में पहचाना गया।
- आर.टी.वी. के लिये गुणसूत्र 7 पर प्रतिरोधी जीन (क्यू.आर.टी.वी-7) की पहचान की गयी।
- नये कीटनाशियों में से रेनेक्सीपाइर तना छेदक के लिये उपयुक्त पाया गया।
- कवक नाशी संयोग क्रेसोक्सिम मिथाइल 40% + हेक्साकोनाजोल 8% WG(आर.आई.एल.068/एफ1 48 WG) 1 ग्रा/एल तथा 0.75 ग्रा/एल दर पर प्रभावी पाये गये।
- पारिस्थितिक अभियंत्रण के अंतर्गत प्राकृतिक शत्रुओं के रख-रखाव के लिये मेंड पर पाये जाने वाले एस्ट्रेसी परिवार के खरपतवार (अजेरेटम कोनाईजोईड्स, एक्लीप्टा प्रोस्ट्रेटा, एक्मेल्ला, एलिजिनोसा) में लाभकारी कीटों की अधिक विविधता पायी गयी। इन खरपतवारों से फसल पर कोई प्रतिकूल प्रभाव नहीं पडा और लाभदायक कीटों के लिए उपयोगी साबित हुये।
- धान से प्राप्त 16 एण्डोफाइटिक जीवाणु आइसोलेट (आर.ई 4 डी एवं आर.ई 10 एच) 72 घंटे के परीक्षण के दौरान *M. graminicola* में 100% घातक पाये गये।

- ई.पी.एन. की विभिन्न जातियों का प्रयोगशाला में उत्पादन से 6.2-12.8 लाख आई.जे.एस./10ग्रा. माध्यम की प्राप्ति हुयी। विभिन्न ई.पी.एन. आइसोलेट में डी.आर.आर.-ई.पी.एन-1 एवं एच-1 अच्छी पायी गयीं।
- सफेद तना छेदक (डब्ल्यू.एस.बी.) के गिडार को प्यूपा बनने तक बेबी कार्न या धान के तने के टुकडों में पाला जा सकता है। सामान्य अर्ध सिंथेटिक भोजन भी गिडार वृद्धि (1-5 इन्स्टार) के लिये उपयुक्त पाया गया।
- गुलाबी तना छेदक में प्रौढ की बनने एवं संयोग इच्छा की प्रवृत्ति के अंतर्गत सिसामिया इनफरेन्स (पी.एस.बी.) में एक दिन आयु की मादाओं के साथ संयोग से सफलता अधिकतम पायी गयी।
- फाल्सस्मट रोगाणु उस्टिलाजिनौडिया वैरन्स की जैविकी, संवर्धन एवं संक्रमण तकनीक का मानकीकरण किया गया। कवक के 70 आइसोलेट का संग्रह कर इनका आगे अध्ययन किया जा रहा है।

प्रौद्योगिकी हस्तांतरण का अनुसंधान

- उत्तर प्रदेश एवं उडीसा राज्यों के नौ जिलों के 50 गाँव के 245 धान उगाने वाले किसानों से समेकित कीट प्रबंध पर एकत्र जानकारी के अनुसार इस तकनीक को अपनाने वाले अधिकतम किसान (55%) कृषि विज्ञान केंद्रों, कृषि विश्वविद्यालयों एवं राष्ट्रीय संस्थानों के पास रहने वाले हैं।
- धान की खेती में लिंग आयामों के अध्ययन में पाया गया कि स्त्रियाँ खरतपवार निकालने को सबसे कठिन कार्य मानती हैं। सभी सवेंक्षण किये गये गाँवों में एम.जी.एन.आर.ई.जी.ए. योजना के कारण कृषि श्रम व्यय बढ गया हैं।
- दूसरे अध्ययन पंजाब में चावल की टिकाऊ खेती के लिये मुख्य चुनौतियों में जमीन में पानी का गिरता स्तर, बिजली की कमी, श्रम का अभाव, अकार्बनिक खादों से मृदा गुणवत्ता का गिरता स्तर तथा सरकार की प्रतिकूल क्रय नीति हैं।
- सामान्य रूप से कृषि विकास एवं मुख्य रूप से धान की खेती के लिये इ-ज्ञान की रणनीति की व्यवहारिकता का धान के कार्य- कर्ताओं (प्रसार) में इ-तैयारी एवं सूचना साक्षरता से जायजा लिया गया। धान उत्पादन, रक्षण तथा अन्य तकनीकियों पर 18 ई-पाठ्यक्रम तैयार किये गये जो www.moodle.learnrice.in पर उपलब्ध हैं।
- विभिन्न साझेदरों जैसे धान अनुसंधानकर्ताओं, प्रसारकर्मियों, निजी क्षेत्र में कार्यरत पेशेवर कार्यकर्ताओं की भागीदारी की इच्छा का प्ररंभिक विश्लेषण से पता चला कि अधिकतर साझेदार (62.5%) प्रौद्योगिकी के विकास में साझेदारी के इच्छुक हैं।
- उत्तर प्रदेश के वर्षाधारित निचली भूमियों में उपज अंतर एवं चावल उत्पादन में अर्थमितीय समस्याओं के विश्लेषण से प्रथम उपज अंतराल 9.6% तथा दूसरा 20.57% /हे. गणना किये गये। उपज अंतराल (उपज क्षमता एवं वास्तविक उपज के बीच का अंतर) का सूचकांक 1.41 टन/हे. या 28.2% पाया गया। धान उत्पादन में व्यय-आय का अनुपात 1:1.36 है।

All India Coordinated Rice Improvement Programme (AICRIP)

New varieties released

- Two hybrids *viz.,* VNR 202 and VNR 204 from CSCSNRV and two hybrids Sahyadri 5 (Maharashtra) and CO RH4 (Tamil Nadu) from the state were released for cultivation in this year. Besides 16 varieties were also released by different states.

Crop Improvement

- During the year 2011, 44 breeding and varietal trials, 6 hybrid rice trials were conducted as 810 experiments at 46 funded and 67 voluntary centres in 27 states and 2 Union Territories in all the 5 regions of the country. Most promising cultures based on performance in 2-3 years of testing under different trials were identified.
- Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized. A total of 6828.16 quintals of breeder seed (against a target of 5771.80 quintals) of 242 varieties and parental lines of 5 rice hybrids (40.1 quintals) was produced at 38 centres across the country.

Agronomy

- Elite genotypes (62 AVT-2 cultures) belonging to 14 categories were evaluated for their response to varying levels of nitrogen. Promising cultures performing equally well at recommended and 50% recommended dose of N were identified.
- Evaluation of intercropping system and weed management practices in rain fed upland rice showed that by intercropping rice with legume in 4:2 replacement series and weed management through use of pendimethalin (0.75 kg a.i/ha) + hand weeding at 25 days after emergence enhanced rice productivity substantially.
- Studies on suitable varieties and optimum date of sowing for aerobic rice cultivation revealed location specific sowing dates and cultivars that proved highly productive. Aerobic rice required frequent irrigations compensating more than the evaporation losses (150% CPE). Balanced fertilization with all primary nutrients of NPK (N120P60K50) was promising for aerobic rice.
- Integration of herbicide (pendimethalin @ 1 kg a.i./ha at 3-4 DAS) with two mechanical weedings at 15 & 30 DAS was found effective in reducing weed density, weed biomass and thus helped in realizing higher grain yields of aerobic rice. Four times cono-weeding (at 10, 20, 30 and 40 DAT) or butachlor + hand weeding were effective in realizing high yields in SRI. Sequential application of herbicides *i.e.,* pre-planting application of glyphosate fb, combination herbicide (bensulfuron-methyl + pretilachlor) was found promising in transplanted rice.
- Mechanical transplanting not only reduced the human drudgery and labour inputs during both the seasons but also enhanced rice yields by 2.2-19.6% during *kharif*.
- Application of organic matter in addition to inorganic NPK application + micro-nutrients recorded 29-41% higher grain yields.

Soil Science

- The results of 23rd year of long term fertilizer study showed that supplementary application of 5 t/ha FYM along with recommended fertilizer dose (100% NPKZnS) was superior to all the treatments with corresponding increase in nutrient accumulation and improvement in soil nutrient status and organic carbon.
- INM treatments substituting 50% of N with organic sources and reduced NPK dose produced yield levels comparable with 100% RDF.
- Site specific nutrient management (SSNM) was superior to the currently recommended blanket fertilizer dose or the soil test-based recommendation (uniform dose followed) and farmers' fertilizer practice.
- In near neutral, acid and sodic soils, addition of organic manures along with recommended NPK and micronutrients (Zn, Fe, Mn, B, Si) increased rice grain yields and nutrient uptake.
- Grain yield of a common set of cultures and micronutrient content (Fe and Zn) in grain did not show significant correlation. Milling (~6% polishing) resulted in a substantial loss of 26-81% of Fe and 20-78% of Zn as compared to brown rice.
- Irrigation equivalent to 100% cumulative pan evaporation (CPE) at Kanpur in *kharif* season and about 150% CPE in the *rabi* season at Hyderabad in Deccan plateau appeared to be optimum for aerobic rice system saving about 10 – 27% irrigation water.
- Utilization of rice straw as direct use, or in combination with green manure or microbial culture (in acid soils) produced positive response in rice-rice and rice-wheat cropping systems with increase in crop yields, nutrient use efficiency and soil nutrient and organic carbon status.
- Trials on nutrient requirement of recently released varieties and hybrids based on nutrient accumulation and yield response to fertilizer application indicated

that the estimated nutrient uptake requirements for the highest yields of hybrids and HYVs across the locations ranged from 16 – 33 kg N, 5-9 kg P_2O_5 and 15 – 41 kg K_2O per ton of grain production.

Physiology

- Early sowing resulted in adjustment of panicle initiation stage and matched with accumulation of desired cumulative degree days (CDD=950) and cumulative nycto-period (CNP=850) in 5 genotypes and also produced better grain yield than under normal sown crop. Overall results indicated that advancing sowing date resulted in better yields at 7 locations, particularly in eastern region.
- Boron applied @ 0.4 ppm significantly increased grain yield (9.6%) and yield attributes along with biomass by increasing grain filling and reducing spikelet sterility. The entries IET 22218, IET 21540 and IET 21519 gave the highest yield across the locations.
- Screening 12 IET cultures along with three check varieties at six locations identified Sahabagidhan, Anjali and Tulasi to be drought tolerant rice genotypes with reference to yield and other yield parameters under dry spells.
- Screening rice genotypes for high temperature tolerance showed higher dry matter remoblizaton under high temperature in IET 21577, IET 21415, IET 21404, Varadhan and PHB-71. In general, the genotype with high remobilization efficiency performed relatively better under high temperature.

Entomology

- A set of 2099 entries was evaluated against 12 insect pests in 188 tests at 40 locations. The results of these evaluations identified 11 donors and 81 cultures as promising against individual and multiple pests, of which only 3 (3.17%) entries were under retesting.
- Resistance conferred by *gm3*, *Gm4* and *Gm8* genes was effective across biotypes and populations.
- Evaluation of new insecticides showed sulfoxaflor treatments to be significantly superior in their efficacy against BPH and also in yield which was on par with monocrotophos.
- No adverse impact on the efficacy of either acephate or dinotefuran due to their combination with either hexaconazole or tricyclazole or vice versa was noticed confirming the compatibility of the chemicals when used as tank mix in the field.
- Higher leaf folder damage was observed in direct seeded rice as compared to normal transplanted rice. Hybrids recorded higher stem borer damage at two locations.
- Three years of study reconfirmed the efficacy of raising an aromatic rice variety like Pusa Basmati as the trap crop by planting one row for every 9 rows of main crop of any variety was effective in stem borer management.
- The species composition and natural enemies of stem borer, leaf folder and planthoppers was monitored at 19 locations across the country.
- Increasing floral diversity, providing alleyways, effective water management and release of mirid bugs as components of ecological engineering resulted in reduction in BPH population in varying degrees and an increase in mirid bug populations as compared to farmers' practice plots.
- Though the damage due to stem borer and leaf folder was significantly different across the treatments, its impact on yield was not discerning in yield loss estimation studies.
- Integrated pest management resulted in higher grain yield compared to farmers practice, but benefit cost ratio was high in the former or IPM fields.
- Population monitoring of insect pests through light trap collections was carried out at 29 locations across the country.

Pathology

- Five national screening nurseries comprising of 1023 entries of advanced breeding lines and new rice hybrids, were evaluated for their reactions to major rice diseases at 52 locations and promising entries in different trials were identified.
- Of the 812 germplasm accessions screened for resistance against five diseases, *viz.,* blast, sheath blight, bacterial blight, brown spot and tungro at 11 locations, AccNos 463044 and 576993 showed resistance against bacterial blight and rice tungro diseases whereas Acc No 545000 showed resistance against sheath blight and brown spot diseases.
- Field monitoring of virulences of *Pyricularia grisea* revealed five major groups in terms of reaction of the differentials.
- Field monitoring of virulences of *Xanthomonas oryzae* pv. *oryzae* with twenty two near isogenic lines revealed that single gene, except *xa13* and *Xa21*, showed susceptible reactions in most of the locations. All the 3 and 4 genes combinations and among the two genes combination, *xa13* + *Xa21* showed resistant reactions across the locations.
- The disease monitoring trial recorded leaf and neck blast,

brown spot, sheath blight, sheath rot, false smut, grain discolouration and bacterial blight at different locations. Late sowing increased the intensity of leaf blast while sheath blight was more in early planted crops.

- Among the new chemicals evaluated kresoxim methyl 40% + hexaconazole 8% WG at both 1 g/l and 0.75 g/l reduced the severity and incidence of fungal diseases compared to the check and improved the yield compared to the other commercially available fungicides tested across the locations. Both trifloxystrobin 25% + tebuconazole 50% (75 WG) and propiconazole (25 EC) performed at par in reducing the flase smut infected panicles/m^2 and infected spikelets/panicle.
- Among the bio-control products tested, two products *viz.,* talc and liquid (Pf1) from TNAU were found comparatively better than others in reducing the disease intensity of leaf blast and sheath blight.
- For fungal diseases, cultivation of resistant variety along with 100% recommended dose of nitrogen (RDN) treatment was the best followed by cultivation of susceptible variety with 2/3rd RDN and need based spray of fungicide. For bacterial blight of rice, use of resistant variety along with reduced dose of nitrogen was the best for reduction in disease severity and incidence.
- Production oriented survey revealed that the biotic constraints in general were in low to moderate intensities. However, there were severe problems of neck blast in parts of Chhattisgarh, brown spot in parts of Bihar, Chhattisgarh, Jharkhand, sheath blight in coastal Andhra Pradesh, bacterial blight in Raigarh of Maharashtra, Kurnool of Andhra Pradesh and Palakkad area of Kerala and false smut in parts of Bihar, Himachal Pradesh, Jammu and Kashmir and parts of Jharkhand. There was severe black beetle problem in Himachal Pradesh.

Frontline Demonstrations

- For the year 2011-12, 300 FLDs on various rice production technologies like improved varieties, hybrids and other practices were planned and conducted and some promising technologies were identified. A National Workshop & Brainstorming on "Redefining Frontline Demonstrations: Maximising Impacts" was conducted at DRR on 28 March 2012.

Lead Research

Crop Improvement

- IET 21542, an introgressed line of the cross Swarna X *O. nivara* having markers linked to yield enhancing QTLs yld2.3, yld8.3 and gw8.1, identified for release, showed 25% yield advantage over the national check (Jaya), 36% over regional checks, 34% over the hybrid check (KRH2) and with the highest yield of 10.65 t/ha.
- The culture IET 21665 (RP 3644-1-19-5-5) with a flowering duration of 110 days, desirable basmati quality traits, moderately resistant to leaf blast, neck blast and brown spot has been identified for the basmati growing areas of Delhi, Uttarakhand and Uttar Pradesh.
- Two new plant type lines FGR21-17 and FGR21-22, with traits such as low tiller number, sturdy stem, high biomass, high number of grains per panicle, medium slender grains derived from tropical *japonica* and *indica* germplasm, recorded higher grain yield than all the other tested genotypes except KRH2.
- Under breeding varieties for Boro area, advanced generation breeding material is being evaluated under low temperatures at seedling stage and high temperatures during flowering and grain filling stages.
- Two late duration cultures,RP 5320 and RP 5312, and six medium duration cultures (RP 5194, RP 4977, RP 5318, RP 4975, RP 4974 and RP 5181) displayed distinct yield advantage and planthopper resistance.
- IET20214, a germplasm accession 2255, TRL 21050, Mugad Sugandha and experimental hybrid DRRH79 performed well under low soil P condition.
- Of about 2500 germplasm accessions screened, six lines E 1763, IC 352760, IC 350189, IC466351, IC 577070 and IC 576974 recorded more than 90% germination under anaerobic conditions for 15 days.
- Four SSR markers - RM577, RM505, RM89 and RM22866 - produced genotype specific amplification patterns among the 208 short grain aromatic rice genotypes tested.
- One advanced line derived from the cross BPT5204 X Chittimuthyalu with high iron (3.12 mg/100 g) and zinc (4.0 mg/100 g) in brown rice and with short bold grain, semi dwarf stature, medium duration, high yield potential was identified.
- Of the 500 test crosses evaluated, 60 restores, 40 maintainers and 20 promising combinations were identified under hybrid rice programmes.
- Five promising TGMS lines were evaluated under different temperature regimes to find their fertility behavior.
- Of the 56 station trial hybrids along with promising hybrid checks tested under direct seeded aerobic conditions, IR 79156A/CB06-137, APMS 6A/RP 4092, APMS 6A/2634-1, APMS 6A/L 182 hybrids were promising.

- Out of the 29 maintainer lines screened for resistance to bacterial leaf blight, four entries were promising.
- A major QTL, accounting for 32% variance, for gelatinization temperature - qGT-6 - within the marker interval of RM276-RM217 was validated in the RIL populations of the cross RT206 x Jaya.
- Allele mining of two candidate genes sucrose phosphate synthase and sugar transporter showed indel polymorphism to be associated with superior alleles for grain filling.
- A set of 28 EST and hyper variable SSR markers that can predict yield heterosis has been developed.
- Based on the phenotypic data it was found that molecular markers RM6100 for Rf4, RM10318, RM1 and RM3873 for Rf3 were efficient upto 80 to 85% in identifying restorers.
- Three independent events of transgenic BPT 5204 with AtDREB1A gene under strong inducible promoter rd29A in T3 generation showed very high level of tolerance to water stress compared to the control plants.
- RNAi binary vector construct containing CP3 (coat protein) gene of RTSV was used to transform, through *Agrobacterium tumefaciens* medium, three rice genotypes, *viz.,* Taipei309, IR64 and BPT5204 to confer RTV resistance.

Crop Production

- Field experiments showed that the grain yields in SRI, either only with organic manures or those receiving both organic and inorganics, were significantly higher (8.16-8.32 t/ha) than those obtained under best management practices (BMP, 6.99 t/ha) with variety Sampada.
- Studies showed that pre-emergence application of pendimethalin (1.5 kg/ha) followed by post-emergence application of bispyribac sodium (20 g/ha) resulted in lower weed population and biomass and in higher grain yields under aerobic cultivation.
- Plastic mulching is being proposed as resource conservation practice for transplanted and direct spot seeded rice. Studies showed no significant differences in productivity of transplanted and direct wet seeded rice grown with saturation moisture regime. Mulching in rice resulted in 0.26 t/ha lower productivity as compared to that of no mulch crop. The saturation moisture regime of mulched rice resulted in ~35% saving in irrigation water. Mulching enhanced soil temperatures and prevented weed growth.
- Under different nursery management methods, the hybrid PA6444 showed maximum seedling vigor with low density of sowing and application of P. Yield maximizing integrated nutrient management (INM) involving extra dose of NPK, organic manuring, four split applications of N and top dressing of K and B at PI stage contributed to additional yield of 0.7-0.8 t/ha.
- Based on seven nitrogen use efficiency (NUE) indices estimated for 15 genotypes under N0 and N100 levels, Rasi and MTU1010 in early; Varadhan in medium; and Swarna and BPT 5204 in late maturing groups were rated as most efficient.
- In another study, measurements of the emission of nitrous oxide showed that, the N_2O flux ($\mu g/m^2/h$) decreased with time after fertilizer application. Among the two establishment techniques, direct wet sown in rows (WSR) resulted in higher N_2O flux over transplanted rice.
- Application of micronutrient enriched compost (MEC), *i.e.,* field fortified poultry or vermi compost manure resulted in enhanced grain yield of the hybrid KRH2.
- Nine plant and soil colonizing bacterial isolates from acid sulfate soils tested positive for IAA production, four isolates tested positive ACC deaminase activity while five isolates from acid saline soils showed IAA activity and three isolates exhibited ACC deaminase activity while five isolates were able to grow under PEG induced water stress. When seeds of Swarna were treated with some of these isolates, it improved germination and vigor under PEG induced water stress.
- A prototype of power operated broadcasting machine is being improvised for uniform seed distribution. The commercial mechanical weeder for SRI did not perform well when tested in aerobic rice field.
- Effects of high temperature at panicle initiation stage on megasporogenesis and microsporogenesis showed that in female stressed plants the seed set was 40% whereas in male stressed plants the seed set was 60%.
- Investigations on the influence of water stress revealed better mobilization of stem reserves leading to minimal yield loss in some genotypes like IET 22031, Anjali, and IET 22034. under water stress.
- Studies revealed that source and sink size can be increased with increasing nitrogen levels from 0-200 kg/ha. Leaf area index (LAI) of 6-7 was optimum for attaining a yield of 8-9 t/ha.
- AICRIP Management Information System (MIS) package was designed with 65 relational tables, 200 stored procedures and 65 user interfaces using Visual Basic and MS SQL. The system is now operational online.
- Crop growth models for simulating climate change responses in irrigated rice were tested adopting the model to bi-phasic nature of the crop growth. Variations in the panicle phase of growth were shown to be largely a consequence of year-to-year variations in weather, whereas the vegetative phase seemed largely independent of those variations.

Crop Protection

- Two new sources of gall midge resistance, INRC174704 and IR64-mutant (IET20545) likely to carry unidentified genes and a novel mechanism of gall midge resistance in Kavya were reported.
- Of the 300 entries screened in the greenhouse, KAUM 166-2, TR2004-029 and germplasm accessions IC# 463272, 463328, 545463 and 576923 had resistance against both BPH and WBPH.
- All the of 23 BC_3F_5 lines of IR64 / *O. glaberima* showed promising reaction against yellow stem borer with ≤ 6% WE when re-evaluated.
- In greenhouse evaluation in terms of leaf area damage by leaf folder, four entries: TNAULFR831311, LF293, W1263 (DRR) and RP4645-688 recorded significantly lower leaf damage when compared to the check TN1.
- Rice cultivars TKM6, Annada, Suraksha and Ramakrishna, showed resistant reaction to rice root-knot nematode, *Meloidogyne graminicola*.
- Three hundred and forty one cultures from different sources were evaluated for BB resistance under controlled conditions and promising entries with score of 1 or 3 were identified.
- Blast resistant lines were developed by introgressing *Pi1, Pi2* and *Pikh* genes through MAS in the background of Samba Mahsuri and Swarna. Some of the lines even exhibited resistance to multiple diseases.
- A major locus for rice tungro disease resistance (qRTV-7) was identified in 17 -19 Mb region of chromosome 7.
- Field evaluation of newer insecticides against insect pests showed rynaxypyr treatment to be most effective against stem borers and also resulted in the highest grain yield.
- A new formulation of fungicide *viz.,* kresoxim methyl 40% + hexaconazole 8% WG (RIL – 068/F1 48 WG) was evaluated at two concentrations *i.e.,* 1g/l and 0.75 g/l and found to be effective against blast disease at both the concentrations
- Ecological engineering to increase natural enemy fitness examined the weed plants on the rice bunds and found that weeds belonging to the family Asteraceae *viz., Ageratum conyzoides, Eclipta prostrata, Acmella uliginosa* had the maximum diversity of beneficial insects but did not compete with rice crop or did not support pests of rice.
- Of 16 endophytic bacterial isolates from rice evaluated, two isolates (RE4D & RE10H) caused 100% mortality of second stage juveniles of *M. graminicola in vitro* after 72 h of exposure.
- *In vitro* production system developed for different species of EPN could yield 6.2 to 12.8 lakh IJs/10g medium. Among EPN isolates tested, maximum yield was recorded in case of DRR-EPN1 followed by HI (*Heterorhabditis indica*).
- Larvae of white stem borer, *Scirpophaga fusciflua* could be reared on cut pieces of baby corn cob or rice stem until they pupated. A simple semi synthetic diet without any rice component was also found to support larval growth and molting from 1st to 5th instar.
- Adult emergence pattern and courtship behaviour of pink stem borer, *Sesamia inferens* (PSB) showed that mating success rate was the highest with 1 day old females.
- Biology of the false smut pathogen, *Ustilaginoidea virens*, culturing and inoculation techniques are being standardized. Seventy isolates of the fungus have been collected and pure cultures of these are being maintained for further study.

Transfer of Technology

- Information collected from 245 rice farmers in 50 villages of nine districts of Uttar Pradesh and Odisha showed that IPM practices were adopted more (55%) by farmers in villages nearby and adopted by KVKs, agricultural university or other national institutes.
- Study on gender dimensions of rice cultivation showed that farm women perceived weeding as the most drudgerous work. Majority (74%) of the respondents in all the surveyed villages reported that the agriculture labour costs have increased due to implementation of the MGNREGA scheme.
- Another study in Punjab revealed that the major constraints to sustain the rice production in the state are depletion of ground water, power shortage, labour problem, degradation of soil due to excessive application of inorganic fertilizers and the unfavourable procurement policies of the government.
- Feasibility of e-learning strategies for agricultural development in general and rice sector in particular was assessed through estimation of E-readiness and information literacy among rice (extension) workers. A total of 18 e-courses were developed on rice production, protection and other technologies which are available online at www.moodle.learnrice.in.
- The preliminary analysis of the willingness of the various stakeholders like rice researchers, rice extension professionals and professionals working in the private sector to enter into partnership mode revealed that majority of the stakeholders (62.5%) were willing to forge partnerships especially in the technology development activities.
- An econometric analysis of yield gaps and constraints in rice production in rainfed lowland ecologies of Uttar Pradesh showed yield gap I to be 9.6% while yield gap II was 20.6%. The total yield gap which is the difference between the potential yield and the actual yield worked out to be 1.41 t/ha or 28.2% as index of yield gap. The Cost-Benefit ratio in rice cultivation was 1:1.36.

Introduction

Significant achievements during 2011-12

Mandate

Organization and infrastructure facilities

Budget allocation

Cadre strength

Weather and crop season

All India Coordinated Rice Improvement Project (AICRIP) was established in 1965 by the Indian Council of Agricultural Research (ICAR) to organize multi-location national testing programme for varieties and other crop management technologies being developed across the country. In view of the long term need for an institution with twin responsibilities of technology development and evaluation, the AICRIP was redesignated as the Directorate of Rice Research (DRR) in August 1975 with the added mandate of pursuing research on irrigated rice for strengthening and stabilizing rice production in the country. Currently 47 funded and over 90 voluntary centres operate under AICRIP which also forms a part of the mandate. In addition, DRR initiates network projects of immediate importance and coordinates these activities.

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 center 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

Significant achievements

Since 1968, more than 980 rice varieties for various agro-ecologies prevalent across the country have been released through multilocation testing, out of which 60 varieties have been developed by the Directorate. About 27% of these varieties are meant for irrigated area in medium and early (18) duration group, 17% for rainfed shallow lands, 14% for rainfed uplands, 4.6% for irrigated areas in hills, 3.9% for irrigated mid-early, 3.7% for semi-deep water, 2.9% irrigated saline/alkaline soils, 2.6% for scented rice, 2% for deep water and rest for the other rice ecologies. The releases also include 50 rice hybrids. Of the varieties released under AICRIP, 19 are being cultivated in 25 other rice growing countries worldwide. These high yielding varieties and hybrids cover over 80% of the rice area. The Directorate has also developed crop production and protection technologies in association with various cooperating centres and these are adopted by farmers all over the country.

Significant achievements during 2011-12

- Two hybrids VNR 202 and VNR 204 from CSCSNVR and two hybrids Sahyadri 5 (Maharastra) and CO4 (Tamil Nadu) from the state were released for cultivation this year. Besides 16 varieties were also released by different states.
- During the year 2011, 44 breeding and varietal trials, 6 hybrid rice trials were conducted as 810 experiments at 46 funded and 67 voluntary centres in 27 states and 2 Union Territories in all the 5 regions of the country. Most promising cultures identified in 2-3 years of testing under different trials were identified.
- Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized. A total of 6828 quintals of breeder seed - against a target of 5771 quintals - of 242 varieties and parental lines of 5 rice hybrids (40 quintals) was produced at 38 centres across the country.
- Application of organic matter in addition to inorganic NPK application + micro-nutrients recorded 29-41 per cent higher grain yields.
- Site specific nutrient management (SSNM) was superior to the currently recommended blanket fertilizer dose or the soil test-based recommendation (uniform dose followed) and farmers' fertilizer practice.
- Boron application (0.4 ppm) significantly increased grain yield (9.6%) and yield attributes along with biomass by increasing grain filling and reducing spikelet sterility. The entries IET22218, IET21540 and IET21519 gave the highest yield across the locations.
- Resistance conferred by *gm3, Gm4* and *Gm8* genes was effective across biotypes and populations.
- Field monitoring of virulences of *Xanthomonas oryzae* pv. *oryzae* with twenty two near isogenic lines revealed that single gene, except *xa13* and *Xa21,* conferred resistance showed susceptible reactions in most of the locations. All the 3 and 4 genes combinations and among the two genes combination, *xa13* + *Xa21* showed resistant reactions across the locations.
- For the year 300 FLDs on various rice production technologies like improved varieties, hybrids and other practices were planned and conducted.
- IET 21542, an introgressed line of the cross Swarna X *O.*

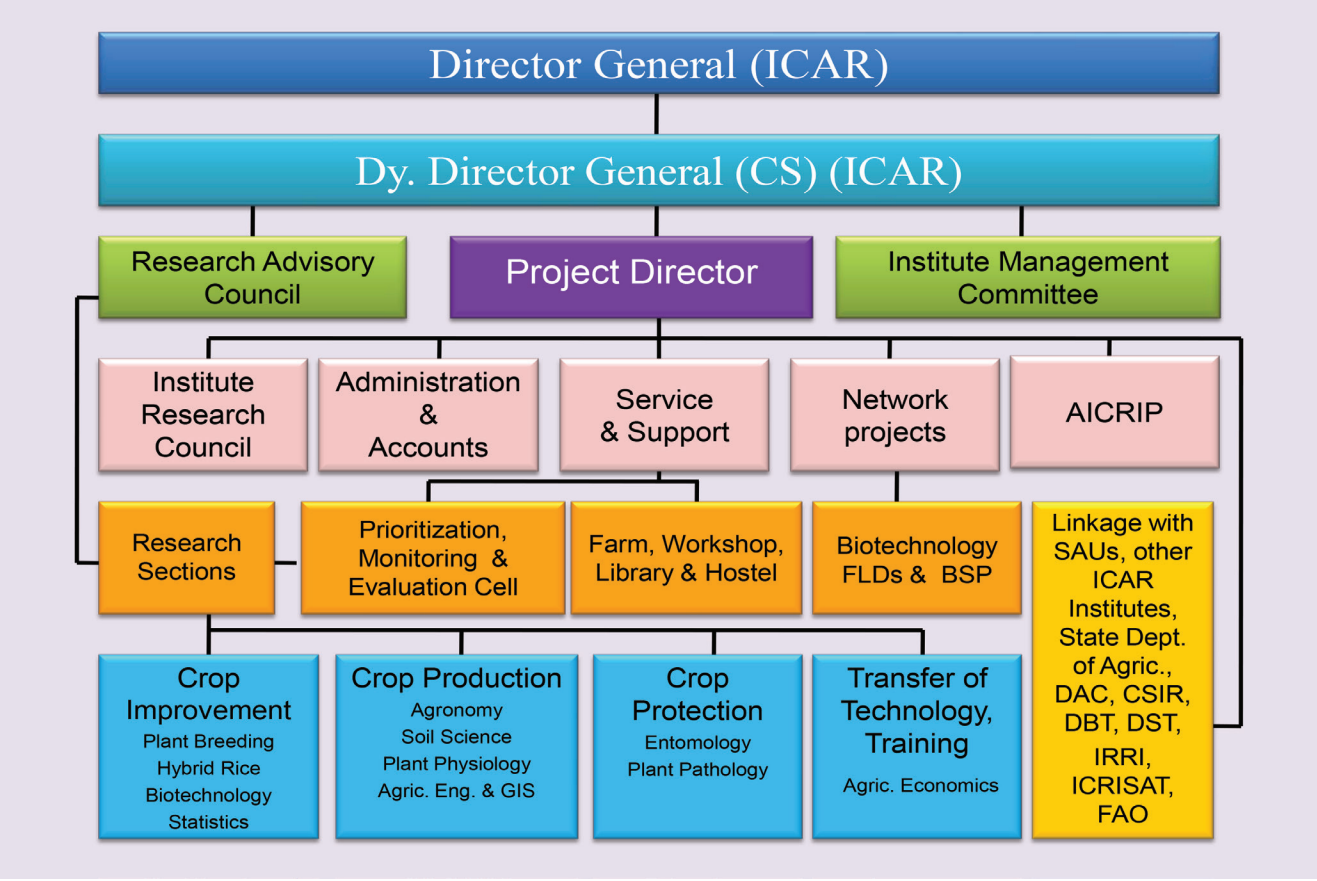
nivara having markers linked to yield enhancing QTLs yld2.3, yld8.3 and gw8.1 was identified for release

- The culture IET 21665 (RP 3644-1-19-5 -5) with a flowering duration of 110 days, desirable basmati quality traits, moderately resistant to leaf blast, neck blast and brown spot has been identified for the basmati growing areas of Delhi, Uttarakhand and Uttar Pradesh.
- Based on seven nitrogen use efficiency indices estimated for 15 genotypes under N0 and N100 levels, Rasi and MTU1010 in early; Varadhan in medium; and Swarna and BPT 5204 in late maturing groups were rated as most efficient.
- A prototype of power operated broadcasting machine is being improvised for uniform seed distribution. The commercial mechanical weeder for SRI did not perform well when tested in aerobic rice field.
- Rice cultivars TKM6, Annada, Suraksha and Ramakrishna showed resistant reaction to rice root-knot nematode, *Meloidogyne graminicola*.
- Field evaluation of newer insecticides against insect pests showed rynaxypyr treatment to be most effective against stem borers and also resulted in the highest grain yield.
- A new formulation of fungicide *viz.*, kresoxim methyl 40% + hexaconazole 8% WG (RIL – 068/F1 48 WG) was evaluated at two concentrations *i.e.,* 1g/l and 0.75 g/l and found to be effective against blast disease at both the concentrations
- IPM practices were adopted by more farmers (55%) in the villages which were nearby and adopted by KVKs, Agril. University or other national institutes.
- Majority (74%) of the respondents in all the surveyed villages reported that the agriculture labour costs had increased due to implementation of the MGNREGA scheme.

Organization and infrastructure facilities

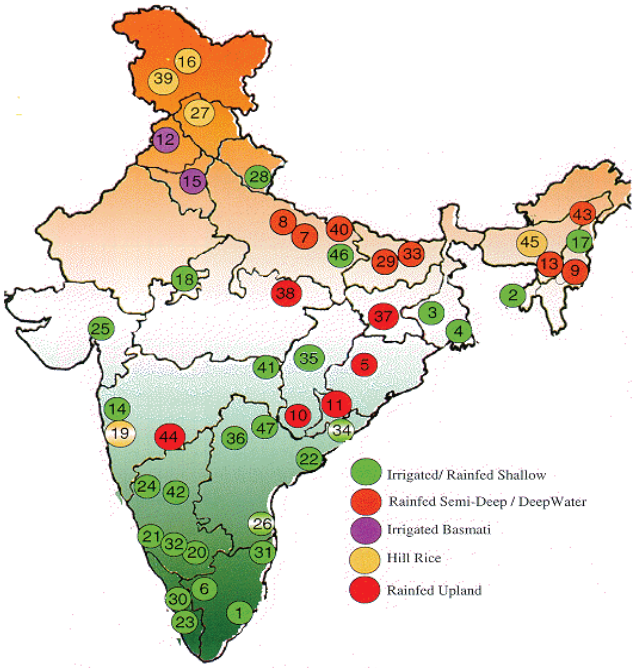
DRR is one of the constituent institutes of the ICAR under direct supervision of the Deputy Director General for Crop Sciences. Following flow diagram provides the detailed organizational plan of the Directorate. For fulfilling its mandate effectively, DRR is organized into four sections and ten units along with centralized service wings and Administration. AICRIP activities are integrated into the mandate with senior most scientists of each discipline acting as the PIs of the programme. Research and institutional activities are planned and guided by Research Advisory Committee and Institute Management Committee while the progress is critically evaluated by the Quinquennial Review Committee once in five years.

Organogram of DRR



The Directorate has well equipped laboratories with state of the art equipments, centrally air cooled greenhouses, bio-safe transgenic greenhouses, growth chambers, well laid out experimental farm and digital enabled library facilities.

DRR also coordinates rice research at 47 funded and over 90 voluntary centres under APCRIP.



AICRIP funded centres conducting rice research under DRR coordination.

Budget allocation

Budget allocation during 2011-12 with actual expenditure.

(Rs. in lakhs)

Centre	Plan		Non-Plan	
	Amount sanctioned	Amount spent	Amount sanctioned	Amount spent
DRR Head quarters	240.00	240.00	1745.42	1745.34
AICRIP Rice	2494.00	2494.0	-	-
Total	2734.00	2734.0	1745.42	1745.34

Cadre strength of Scientists, Technical, Administration and SS grade staff (as on 31-03-2012)

S.No.	Cadre	Sanctioned	Filled	Vacant
1	Scientists (Excluding Project Director)	71	57	14
2	Administration	32	28	04
3	Technical	53	43	10
4	Supporting	17	17	-

Weather and crop season

As per the Indian Meteorological Department (IMD), for the country as a whole, the rainfall for the season (June-September 2011) was 101% of its long period average (LPA). Seasonal rainfall was 107% of its LPA over Northwest India, 110% of its LPA over Central India, 100% of its LPA over south Peninsula and 86% of its LPA over Northeast (NE) India. Monthly rainfall over the country as a whole was 112% of LPA in June, 85% of LPA in July, 110% of LPA in August and 106% of LPA in September. The monsoon set in over Kerala 29 May 2011, 3 days before its normal date of 1 June and covered the entire country by 9 July, 6 days earlier than its normal date of 15 July. The withdrawal of monsoon from west Rajasthan was delayed and it commenced only on 23 September. (Southwest Monsoon – 2011, Status Report, India Meteorological Department)

The annual mean temperature for the country as a whole during 2011 was +0.45^{0}C above the 1961-1990 average, thus the year was ninth warmest year on record since 1901. The year 2010 was the warmest year on record since 1901. (Annual Climate Survey-2011, National Climate Centre, India Meteorological Department, Pune)

The rice production in the country in 2011-12 has crossed the magical figure of 100 million tonnes for the first time. As per the third advance estimates, it is expected to be an all time record of 103.41 million tonnes as against the 95.98 million tonnes produced during the last year (2010-11). (Economic Survey of India 2011-12, Ministry of Finance, Government of India).

Research Achievements

Coordinated Research

Crop Improvement

New varieties/hybrids released

Crop Production

Agronomy

Soil Science

Plant Physiology

Crop Protection

Entomology

Plant Pathology

Crop Improvement

New varieties/hybrids released

Two hybrids *viz.,* VNR 202 and VNR 204 from CSCSNRV and two hybrids Sahyadri 5 (Maharashtra) and CO RH4 (Tamil Nadu) from the state were released for cultivation in this year. Besides 16 varieties were also released by different states. The varieties/hybrids released by Central and State variety release committee during 2011-12 are listed below.

Sl. No	Variety Name	IET No	Designation	Cross Combination	FD (Days)	Eco-System	Grain Type	Yield (kgha)	Reaction to pest / diseases
Central Releases									
1	VNR 2245 (Hybrid)	20716	VNR 204	VNR-F51/ VNR-RB242	90-95	IR	LS	6838	MR-LB.
2	VNR 2355 (Hybrid)	20735	VNR 202	VNR-F51/ VNR-RB 66	100-105	IR	MS	5752	MR-LB, NB,
State Releases									
Maharastra									
3	Ratnagiri –5	--	--	Zina-63/IR-64	85-90	Konkan areas RUP	SS	--	MR-BLB, Bl
4	Shyadri – 5 (Hybrid)	--	--	--	110-115	RSL Konkan region	LS	--	MR-BLB, Bl
5	Karjat-8		Karjat-8	-	110-115	RSL	SS	3500-4000	MR- Bl, NBl, BLB, WBPH, GM.
Odisha									
6	Improved Lalat	21066	CRMAS 2621-7-1	Lalat/IR BB 60	95-100	IR	LS	4500	NB,BS, MR,LB
7	Improved Tapaswini	21070	CRMAS 2622-7-6	Tapaswini/IR BB 60	95-100	IR	SB	4000	--
8	CR Dhan 200	21214	CR 2624-IR5523-01	UPL RI 5/IR 12979-24-1	85-90	Aerobic	SB	4500	LB,NB,BS,
9	CR Dhan 902	18008	CRM 2203-4	CR Basna / Dhan-902	105-110	IR	LS	4500	NB,GMRS,SB
10	CR Dhan 404	19913	CR 662-22-1-1-1-1	IR 31/IR 13246	115-120	RSL	LB	5200	--
11	CR Dhan 100	20148	CR 2340-11	IR31238-350-3-2-1/IR41054-102-2-3-2	75-80	RUP	--	4700	--
12	CR Dhan 503	20214	CR 2282-1-2-5-1	Panikekoa/ Ambika	130-135	DW	--	4600	--
13	CR Dhan 502	20706	CR 2080-169-3-2-5-2	Samsonpolo / Jalanidhi	130-135	DW	MS	4600	LB,NB,SB,SR,
14	CR Dhan 301	19351	CRK 26-1-2-1	IR42/Rahaspan-jar	95-100	IR	LS	4500	Sheath Rot, RTV NB
15	CR Dhan 406	19472	CR 2092-158-3	Jaya / Lunishree	120-125	CS	MS	4100	LB,MTSB
16	CR Dhan 405	21237	CR 2577-1	IR31142-14-1-1-3-2/IR71350	75-80	CS	MS	4600	LB,MTSB

Sl. No	Variety Name	IET No	Designation	Cross Combination	FD (Days)	Eco-System	Grain Type	Yield (kgha)	Reaction to pest / diseases
17	Jyotirmayee	21106	OR 1777-4	Pusa 677-50-103-2-9 /Badami	60-65	RUP	MS	4378	LB, SB, GM1,
18	Hiranmayee	20601	OR 2329-44	OR 1530-8/IR 68181-B-49	100-105	IR	MS	5453	SB, SR, RTV, BLB, BS, GM1,
19	Tanmayee	20262	OR 2339-8	Indravati/kan-chan	110-115	RSL	SB	5240	NB, LB, SB, RTV, BLB, GM1,
20	Nua Achara-mati	19713	Acharamati	Pure line selec-tion of indig-enous aromatic rice collection "Acharmati" from Bhawa-nipatna	100-105	IR	SB	4187	SB, RTV,B LB, GM1, SB, BPH,
Tamil Nadu									
21	CO (R) H-4	--	--	COMS 23A/ CB174 R	130-135	IR	MS	7348	R-Bl, BS: MR-WBPH, GLH, ShR, RTD
Jammu & Kashmir									
22.	Shalimar Rice-2	--	SKAU-341	VL Dhan 221/ K-39	101	Irrigated Low-lands	MB	8000-8500	R-Bl.
23.	Shalimar Rice-3	--	SKAU-382	IR-32429-47-3-2-2/K-438	96	Irrigated Low-lands	MB	7500-8000	R-Bl.
West Bengal									
24.	Puspa	17509	CN B 1259-5-21	Sel. from BG 1731-2	79	RUP	SB	4500-5000	R-Bl, ShBl, ShR, BLB, BS, BPH, MR- RTV, LF, SB
25.	Dhiren (BNKR-1)	17509	CN 1340-76-1-BNK R23-7-1	IR 42/ Patnai 23	116	IR	SB	5000-5500	R- LBl, NBl, BS, ShR, LF

Coordinated Research

During the year 2011, 44 breeding and varietal trials, 6 hybrid rice trials conducted as 810 experiments at 113 locations (46 funded, 67 voluntary centres) in 27 states and 2 Union Territories in all the 5 regions of the country. Eleven private companies participated in conducting hybrid rice experiments. A total of 1082 test entries including 174 checks and 130 experimental hybrids in separate hybrid rice trials were included in multi-location testing. Most promising cultures identified in 2-3 years of testing under different trials are listed in Appendix 1.

Promising entries in INGER Nurseries evaluated during *kharif* 2011

1. International Irrigated Rice Observational Nurseries (IIRON) Module-1: IR 09N533, IR 09A228, AG 7, OM 5629 and B11338F-TB-26 Module-2: PR 31132-B-1-1-1-3-3, IR 05 N 168, CB 01-508, IR 81336-8-2-3-3, PR35238-B-1-1
2. International Rainfed Lowland Rice Observational Nursery (IRLON) IR 09F175,IR 09F162, CT 19298-(100)-1-2-3-1-4MP, NR 1893-17-2-3
3. International Upland Rice Observational Nursery (IURON) CT 15675-7-1-7-1-2-M, IR 07G101, B11577E-MR-B-12-1-1, Vandana, IR 82912-B-B-16
4. International Temperate Rice Observational Nursery (IRTON) K 39-96-1-1-1-2, SKAU-330
5. Green Super Rice (GSR), Weed Tolerant Rice 1, SACG 4, SAGC-02, ZHONGHUA 1, KCD 1
6. International Rice Soil Stress Tolerance Nurseries (IRSSTN) Module-1: AT 401, IR 71895-3R-9-3, IR 55179-3B-11-3, IR 71829-3R-10-3 Module-2: IR 72046-B-R-8-3-1-2, IR 77674-3B-8-2-2-14-4-AJY 2
7. International Heat Tolerance Nursery (IRHTN) CO 18 (ACC 6331), XUE HE (ACC 76826), IR 8866-30-3-1-4-2, BRRI DHAN 48

8. International Rice Blast Nursery (IRBN) IRBL 3-CP4/ RL, AOQINGZHAN, IRBL 5-M/RL, IRBLTA 2-PI/ RL, IRBLZ 5-CA/RL
9. International Rice Bacterial Blight Nursery (IRBBN) IR-BB21, IR-BB66, IR 83265-1-1-13-3-1-26-1-8-1-2-1, IR-BB53 (IR72914-21-1-3)
10. International Rice Brown Plant Hopper Nursery (IRBPHN) IR 84675-7-1-2, IR 06N233, MILYANG 63, BG 367-2

National Seed Project & Breeder Seed Production

Breeder seed production of rice varieties and parental lines of rice hybrids as per the DAC indents was organized at 38 centres across the country, involving 242 varieties and parental lines of 5 rice hybrids. A total production of 6828.16 quintals of breeder seed was achieved against a target of 5771.80 quintals which included 40.10 quintals of breeder seed of parental lines of 5 rice hybrids. At DRR centre, 15 varieties and parental lines of DRRH-2 were included in breeder seed production with a total production of 245.20 quintals against the target of 164.50 quintals (Appendix 2).

Crop Production

Agronomy

Response of rice cultures to nitrogen

- In 259 experiments conducted at 55 locations, elite genotypes (62 AVT-2 cultures) belonging to 14 categories and their response to varying levels of nitrogen were evaluated. Promising cultures were IET 21393, IET 21390, IET 21386 in AVT-2 Early hill; IET 21374, IET 21383 in AVT-2 medium hill; IET 21326 , IET 21320 in AVT -2 Upland hill; IET 21044 in IVT aromatic short grain; IET 21665 in AVT-2 Basmati, IET 21627 in AVT-2 early direct seeded; IET 21278 in AVT-2 very early (transplanted); IET 21401 in AVT-2 early (transplanted); IET 20716, IET 21411 in AVT 2 medium early; none in AVT-2 IM; IET 21449 in IHRT medium slender; none in AVT-2 medium early (aerobic); IET 20884 in AVT-2 Late; none in AVT-2 *boro*.

Cultural management trials

- Intercropping rice with legume in 4:2 replacement series and weed management through pendimethalin (0.75 kg a.i/ha) + hand weeding at 25 days after emergence enhanced productivity substantially in rain fed upland rice.

Experiments on aerobic rice

- Studies on suitable varieties and optimum date of sowing for aerobic rice cultivation revealed that sowing on 1 June (Pattambi), 10 June (Ghagharghat, Parbhani and Pusa), 14 June (Nawgam), 29 June (Arundhatinagar), 2 July (Rajendranagar), 10 July (Hazaribagh) and 20 July (Mandya) was promising for aerobic rice yields. Among the varieties, Param (Arundhatinagar), HB-6129 & PR-1531 (Rajendranagar), NDR-359 (Ghagharaghat), APH-111 (Hazaribagh), KRH-4 (Mandya), Dandi & Gurjari (Nawgam), Parag (Parbhani), PA-6444 (Pusa) and Aishwarya (Pattambi) proved highly productive.

Weed management

- Integration of herbicide (pendimethalin @ 1 kg a.i./ha at 3-4 DAS) with two mechanical weedings at 15 & 30 DAS was effective in reducing weed density, weed biomass and helped in realizing higher grain yields of aerobic rice.
- Based on the three year findings at different locations representing different soil and climatic conditions, use of 10-day old seedlings, and integrated weed management involving four times cono-weeding (at 10, 20, 30 and 40 DAT) or butachlor + hand weeding were effective in realizing high yields in SRI.
- Use of penoxsulam + cyhalofop-butyl @ 120 g a.i/ha was economical and equally effective in controlling weeds as butachlor and bispyribacsodium. Sequential application of *i.e.,* pre-planting application of glyphosate fb. combination herbicide (bensulfuron-methyl + pretilachlor) was promising in transplanted rice.
- In another study, penoxsulam at two test doses was effective at five locations. Carfentrazone-ethyl @ 25 g a.i./ha efficiently controlled sedges and broad leaved weeds and was non-phytotoxic to crop.
- In direct seeded and canal irrigated rice, pretilachlor plus 30 EC, butachlor 50 EC, metamifop 10 EC, either alone or in combination with metsulfuron methyl + chlorimuron ethyl 20 WP were tested.

Farm mechanization

- Results of a new trail initiated this year on integration of selective mechanization for enhancing productivity indicated that mechanical transplanting not only reduced the human drudgery and labour inputs but also enhanced rice yields by 2.2-19.6% during *kharif*.

Micronutrient management

- The trial on management of micronutrients in rice based cropping systems revealed that soil application of organic matter in addition to inorganic NPK application and micro-nutrients gave higher grain yields by 29-41%.

Soil Science

Long term soil fertility management in rice based cropping systems

- The results of 23rd year of study showed that growth of *kharif* rice yield was positive with supplementary application of 5 t/ha FYM along with recommended fertilizer dose (100% NPKZnS) and at par with 100%

RDF or superior with corresponding increase in nutrient accumulation and improvement in soil nutrient status, organic carbon and reduced soil strength.

Nutrient management

- INM treatments substituting 50% of N with organic sources and reduced NPK dose produced comparable yield levels with 100% RDF
- SSNM was superior to the currently recommended blanket fertilizer dose or the soil test-based recommendation (uniform dose followed) and farmers' fertilizer practice indicating scope for improvement in nutrient use efficiency and economizing fertilizer use.
- In near neutral, acid and sodic soils, addition of organic manures along with recommended NPK and micronutrients (Zn, Fe, Mn, B, Si) increased rice grain yields and nutrient uptakes.
- Several location specific promising cultures for high Fe and Zn content were identified which included NDR-2064 and Kalanamak at Faizabad, BR 2655 at Mandya, BPT 5204 at Titabar, Aghonibora at Bankura and Komad at DRR, Hyderabad. Milling (~6% polishing) resulted in a substantial loss of 26-81% of Fe and 20-78% of Zn as compared to brown rice.
- Irrigation equivalent to 100% cumulative pan evaporation (CPE) at Kanpur in *kharif* season and about 150% CPE in the *rabi* season in Deccan plateau (DRR) appeared to be optimum for aerobic rice saving about 13-27% and 10% irrigation water at Kanpur and DRR respectively without yield loss and improved water productivity. The nutrient uptake was estimated to be 12, 6 and 14 kg NPK/ton grain production at DRR and 18, 7 and 21 kg NPK/ton grain at Kanpur under aerobic system.

Management of crop residues in rice based cropping systems

- Utilization of rice straw alone or in combination with green manure or microbial culture (in acid soils) produced positive response in rice – rice and rice-wheat cropping systems with increase in crop yield, nutrient use efficiency and soil nutrient and organic carbon status.
- Five tons of straw approximately contributed 7-21 kg N, 2-18 kg P_2O_5 and 23-54 kg K_2O to the immediate crop per season and improved soil nutrient status by about 70-130 kg N/ha, 7-28 kg P_2O_5 and 50-100 kg/ha K_2O/ha after four cropping cycles.

Nutrient requirement of recently released varieties and hybrids

- The estimated nutrient requirements for the highest yields across the locations ranged from 16-33 kg N, 5-9 kg P_2O_5 and 15-41 kg K_2O per ton of grain production. Among the test cultures nutrient requirement for hybrids was less compared to HYVs at all the locations suggesting higher use efficiency of hybrids

Physiology

Studies on photothermic indexing

- A set of 21 AVT rice cultures was sown 15 days early and at normal date at 10 geographical latitude regions starting from 10.55^0 to 29.02^0. Early sowing resulted in adjustment of panicle initiation stage and matched with accumulation of desired CDD (950) and CNP (850) in 5 genotypes and also produced better grain yield than under normal sown crop. In general, hybrid yields were superior under the above conditions. Overall results indicated that advancing sowing date resulted in better yields particularly in eastern region.

Influence of boron on spikelet fertility

- Studies conducted at 9 locations showed that Boron application (0.4 ppm) significantly increased grain yield (9.6%) and yield attributes along with biomass by increasing grain filling and reducing spikelet sterility. The entries IET22218, IET21540 and IET21519 gave the highest yield across the locations.

Screening of elite rice cultures for drought tolerance

- Screening of 12 IET cultures along with three check varieties at six locations identified Sahabagidhan, Anjali and Tulasi. The drought tolerance character of rice genotypes with reference to yield and other yield parameters under dry spells was investigated at six centers. Based on the grain yield across the locations IET 21625, IET 22032, IET 21627 and Sahabagidhan can be identified as suitable for upland rainfed conditions. The drought tolerance indices based were more suitable to delineate tolerant and susceptible genotypes. Based on Drought Stress Index (DSI) IET 21625, IET 22032, and Sahabagidhan could be identified as drought tolerant genotypes.

Evaluation of rice genotypes for terminal heat tolerance suitable for future climate

- During *kharif* 2011 a trial to screen rice genotypes for high temperature tolerance was conducted at seven centers with 11 IET cultures, 5 hybrids and 2 released varieties. Post anthesis heat treatments were imposed in field by enclosing the crop with polythene sheets. The temperature increase inside the polyhouse was 3.5 to 5°C higher than ambient temperature. Exposure to high temperature had resulted in significant reduction in grain yield and TDM, HI, 1000 grain weight and increased the number of unfilled grains per panicle across the locations. Based on the grain yield and TDM under high temperature treatments, IET 21404, IET 21577, KRH-2, PB-4 and Varadhan were relatively more tolerant. The dry matter remoblizaton under high temperate was higher in IET 21577, IET 21415, IET

21404 Varadhan and PHB-71. In general the genotype with high remobilization efficiency performed relatively better under high temperature.

Crop Protection

Entomology

Host plant resistance

- A set of 2099 entries (including 1001 breeding lines, 112 hybrids and 904 germplasm accessions and checks) was evaluated in 188 valid tests (46 greenhouse and 142 field tests) against 12 insect pests at 40 locations. The results of these evaluations identified 11 donors (1.2%) and 81 cultures as promising of which only 3 (3.17%) entries were under retesting.

Entries found promising against each of the pests is listed below.

Trial	Pest	Promising entries (source of resistance)
PHS& PHSS	BPH & WBPH	KAUM 166-2, KAUM 168-1, KAUM 173-1, KAUM 172-1 and RP Bio 4918, RP 2068-18-3-5, RP5211-16, RP5211-40
GMS	Gall midge	JGL 17974*(*Gm8*); JGL18799, JGL18256, JGL18816 (*Gm1*+ *gm3* +*Gm11*)
GMSS	Gall midge	COGR-1,COGR-3,INRC15888; INRC17470 (new gene)
LFST	Leaf folder	CO43, Ptb12, W1263 (CBT), ADT46, IC115737, SB319
GEMP	Multiple pests	IC 462381, IC 577036 and IC 864036
MRST	Multiple pests	CR 3005-230-5, CR 2711-76, CR3005-77-2, CR 3006-8-2
NSN -1	Multiple pests	IET Nos. 22163, 22069, 22096, 22137, 22225, 21692, 21625, 22081
NSN-2	Multiple pests	IET Nos 22416, 22425, 22436, 21883, 22298, 22300, 22301, 22303, 22309, 22311, 22313, 22317, 22476, 22488, 22489,22492, 21725, 22637, 22662, 22676, 22684, 22687, 22692, 22813, 22763
NSN H	Multiple pests	IET Nos 21745, 21375, 21378
NHSN	Multiple pests	ITE Nos. 22406, 22375, 22389, 22402

Insect biotype studies

- **Gall midge biotype trial** (GMBT) wherein the standard set of 17 differentials carrying all the 11 known resistance genes and those with unknown genes and checks was evaluated at 16 locations and Gall midge population monitoring (GMPM) trial aimed to quantify variation in virulence in the pest populations at three locations confirmed the prevailing status of biotypes with some minor and major changes and a few exceptions. Resistance conferred by*gm3, Gm4*and *Gm8* genes was effective across biotypes and populations. Further, development of virulence against *Gm2* gene at Cuttack and against *Gm11* at Sakoli, and also loss of virulence against *Gm1* at Sakoli were noted this year.

Chemical control studies

- **Insecticide evaluation trial** (IET) was carried out at 36 locations with an objective of screening newer insecticide formulations for efficacy against major insect pests of rice and consequent impact on grain yield. The standard check treatment of monocrotophos performed better than the newer insecticide formulations against stem borer, leaf folder and GLH, and registered the highest grain yield among the treatments. However, sulfoxaflor treatment was significantly superior against BPH and also yielded on par with monocrotophos. The newer insecticide formulations did not have any adverse impact on spider populations in the field but mirid bug populations were significantly low in the sulfoxaflor treated plots compared to other treatments including control.
- **Pesticide compatibility trial** (PCT) was carried out with the objective of evaluating the compatibility of newer insecticide and fungicide formulations as tank mix against major insect pests and diseases of rice and consequent impact on grain yield, at 15 centres. No significant differences in the performance of the two newer insecticide formulations in their efficacy when applied alone or in combination with fungicides were observed. The insecticide fungicide combination treatments yielded better than insecticide alone. Hence, the results revealed that there was no adverse impact on the efficacy of either acephate or dinotefuran due to their combination with either hexaconazole or tricyclazole or vice versa confirming the compatibility of the chemicals when used as tank mix in the field.

Ecological studies

- **Influence of rice cultivation practices on rice pests** (IRCP) studies at four locations compared direct seeded rice with normal transplanted rice, and nested within the hybrids with varieties, in terms of pest incidence. Among the rice cultivation practices, only leaf folder damage was high in direct seeded rice as compared

to normal transplanted rice across three locations. Hybrids recorded higher stem borer damage at two locations. Direct seeded rice recorded higher yield at two locations while transplanted rice recorded higher yield at one location, whereas no significant difference was noted in one location. Strangely, at all the locations, varieties out yielded hybrids except at Rajendranagar.

- **Trap crop for stem borer management** (TCSB), carried out at six locations during 3rd year showed, dead heart damage at Karjat and Pusa and white ear damage by stem borer at Raipur, Pusa and Ghagharaghat were significantly lower in the main treatment where trap crop was grown along with main crop. The total grain yield was also higher in treatment with main crop + trap crop as compared to main crop only at Raipur and Ghagharaghat. Stem borer incidence *per se* was low at Rajendranagar throughout crop growth. Need based application of insecticide had significantly reduced the damage and gave higher yields.

Biocontrol and biodiversity studies

- **Monitoring of pests and natural enemies** (MPNE) was carried at 19 locations in *kharif 2011*. Stem borer composition and its natural enemies were reported from 9 centres. Composition of species of leaf folder was reported from 5 centres. The plant hopper ratios and population of its natural enemies were reported from three centres. The extent of infestation and parasitisation of gall midge was reported from three locations.
- **Ecological engineering for management of planthoppers** (EEMP) was conducted at three locations with the objective of managing hoppers through increased natural enemy fitness through space management, increasing floral diversity, alleyways, effective water management and release of mirid bugs. It resulted in reduction in BPH population in varying degrees and an increase in mirid bug populations as compared to farmers practice.

Integrated pest management

- **Yield loss estimation trial** (YLET) was conducted at four locations. Though the damage was significantly different across the treatments, impact on yield was not much evident. Regression analysis revealed a significant negative relationship between yield and DH at 65 DAT and DL at 50 DAT ($r^2 = 0.9439$) only at Ludhiana.
- **Integrated pest management special** (IPMS) was conducted only at two locations on experimental farm itself. At Chinsurah, though higher grain yield was obtained in IPM block than in farmers practice block, benefit cost ratio was high with farmers' practice (FP). At Ranchi also significantly higher yield was obtained in IPM block as compared to FP.
- **Population monitoring of insect pests through light trap collections** was carried out at 29 locations across the country and yellow stem borer, gall midge, brown plant hoppers were the main pests reported.

Plant Pathology

- A total of 14 trials were conducted at 52 locations on host plant resistance, field monitoring of virulence in major pathogens, and disease management. Five national screening nurseries comprising of 1023 entries of advanced breeding lines and new rice hybrids, were evaluated for their reactions to major rice diseases at 52 locations. Promising entries in different trials are listed below.

Ent. No.	IET No.	Resistant to
NSN 1		
502	21346	Bacterial blight, Sheath blight, sheath rot, brown spot & rice tungro virus disease
1303	21411	Leaf blast, neck blast and rice tungro virus disease
1418	22107	Bacterial leaf blight, sheath blight and rice tungro virus disease
1423	22117	sheath blight, brown spot and rice tungro virus disease
1430	22137	Leaf blast, neck blast and sheath blight
1908	22168	Sheath rot, brown spot and rice tungro virus disease
1706	22203	Leaf blast, neck blast and bacterial leaf blight
1711	22226	Bacterial leaf blight, brown spot and rice tungro virus disease
1721	22243	Bacterial leaf blight, brown spot and rice tungro virus disease
NSN 2		
801	22298	Neck blast, bacterial leaf blight and sheath blight
816	22311	Neck blast, sheath blight and rice tungro virus disease
NSN-H		
3505	21742	Leaf blast, neck blast, sheath blight and brown spot
3204	21768	Leaf blast, sheath blight and brown spot

NHSN		
HRT-MS-09	21826	Leaf blast, neck blast and bacterial leaf blight,
IHRT-ME-04	22343	Neck blast, bacterial leaf blight and sheath rot
IHRT-ME-34	22370	Leaf blast, sheath blight and sheath rot,
IHRT-M-03	22381	Bacterial leaf blight, sheath blight and sheath rot,
IHRT-M-05	22382	Neck blast, sheath blight and sheath rot
IHRT-M-08	22384	Neck blast, bacterial leaf blight and sheath blight
IHRT-M-20	22394	Leaf blast, bacterial leaf blight, sheath blight and sheath rot
IHRT-M-21	22395	Leaf blast, neck blast, bacterial leaf blight and sheath blight
IHRT-M-26	22400	Leaf blast, sheath blight and sheath rot
DSN		
16	CB 05-022	Leaf blast, bacterial leaf blight, sheath rot and rice tungro virus disease
13	CB 05-031	Neck blast, sheath blight, sheath rot and brown spot
14	CB 07-103	Bacterial leaf blight, sheath blight and sheath rot
19	CB 09-123	Sheath blight, sheath rot, brown spot and rice tungro virus disease
20	CB 09-153	Bacterial leaf blight, sheath blight, sheath rot and brown spot
50	HPR 2745	Leaf blast, Neck blast and brown spot
65	RP 4321-1842	Sheath blight, sheath rot and rice tungro virus disease
38	RP Biopatho -2	Leaf blast, bacterial leaf blight, sheath blight and sheath rot
39	RP Biopatho -3	Leaf blast, neck blast, and brown spot
40	RP Biopatho -4	Leaf blast, neck blast, sheath blight and sheath rot
34	RP Patho -10	Leaf blast, sheath blight and sheath rot
35	RP Patho -11	Leaf blast, neck blast, bacterial leaf blight, sheath blight, brown spot, sheath rot and rice tungro virus
36	RP Patho -12	Leaf blast, neck blast, bacterial leaf blight, sheath blight and sheath rot
29	RP Patho -5	Leaf blast, sheath blight, brown spot and sheath rot
31	RP Patho -7	Leaf blast, brown spot and rice tungro virus
32	RP Patho-8	Neck blast, bacterial leaf blight, sheath blight and sheath rot
33	RP Patho-9	Leaf blast, sheath rot and brown spot
21	TNRH 192	Leaf blast, sheath blight, sheath rot and rice tungro virus

Germplasm screening

- A total of 812 germplasm accessions were screened in *kharif* 2011 for resistance against five diseases, *viz*., blast, sheath blight, bacterial blight, brown spot and tungro at 11 locations in the country. The Accession numbers like 463044, 576993 and 545000 showed resistance against two diseases. The Acc. Nos. 463044 and 576993 showed resistance against bacterial blight and rice tungro diseases whereas Acc. No. 545000 showed resistance against sheath blight and brown spot.

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

- The experiment was conducted at 20 locations with different dates of sowing. The nursery included 61 cultivars consisting of international differentials, RILs, donors, NILs and commercial cultivars. Cluster analysis of *P. oryzae* reactions on the selected genotypes revealed that all these locations formed five major groups. Group one consisted of Coimbatore and Gagharaghat and both are identical in nature. Group two consisted of only Almora. Group three Ponnampet and Barapani. Group four consisted of New Delhi only. The remaining locations *viz.,* Upper Shillong, Nellore, Pattambi, Malan, Lonavala, Titabar, Khudwani, Gudalore, CRRI, DRR, Raipur, Rajendranagar, Nawagam and Mandya were in group five. There was a considerable variation in reaction at locations within each group.

Field monitoring of virulences of *Xanthomonas oryzae* pv. *oryzae* (Bacterial leaf blight)

- The trial consisted of twenty two near isogenic lines (IRBB lines) with different bacterial blight resistance genes and their combinations and different checks. The trial was conducted at 19 different hot spot locations across the country. Most of the single genes except *xa13* and *Xa21* showed susceptible reactions in most of the locations. All the 3 and 4 genes combinations and among the two genes combination, *xa13* + *Xa21* showed resistant reactions across the locations.

Disease observation nursery

- The trial was conducted at 10 centres. The intensity of different diseases varied in across locations with varieties, cultivation practices, climatic conditions and sowing time. The different diseases recorded were leaf and neck blast, brown spot, sheath blight, sheath rot, false smut, grain discolouration and bacterial blight. Late sowing increased the intensity of leaf blast while sheath blight was more in early planted crop.

Evaluation of new fungicides for location specific diseases

- New chemicals were evaluated against leaf blast, neck blast, node blast, sheath blight, brown spot, leaf scald and glume discoloration. Kresoxim methyl 40% + hexaconazole 8% WG (RIL – 068/F1 48 WG) reduced the severity and incidence compared to check. A concentration of 1 g/l reduced the disease severity and incidence of the diseases and improved the yield compared to the other commercially available fungicides tested across the locations.

Evaluation of biocontrol agents and formulations against rice diseases

- A trial was conducted to select better strains of *Pseudomonas fluorescens* and its formulation and to maintain the biodiversity of rice ecosystem at eleven centres. Though, all the biocontrol products were not on par with the check chemical fungicides, some significantly reduced the disease severity of blast and sheath blight. Two products, talc and liquid (Pf1) from TNAU were found comparatively better than others in reducing the disease intensity of leaf blast and sheath blight.

Evaluation of fungicides against false smut

- The trial was conducted at 20 hot spot locations across India with three chemicals *viz*., propiconazole, kresoxim methyl and trifloxystrobin 25% + tebuconazole 50% at three different growth stages *viz*., booting, 50% PE and 100% PE. Spraying at 50% PE stage was most effective in reducing both infected panicles/m^2 and infected spikelets/panicle. Among the chemicals tested, propiconazole and trifloxystrobin 25% + tebuconazole 50% performed on par followed by kresoxim methyl.

Integrated disease management (IDM)

- IDM trail on leaf blast and neck blast was conducted at three locations (Ghagharaghat, Khudwani and Malan); on leaf blast, sheath blight and bacterial leaf blight at Chiplima; on bacterial leaf blight at Pusa; on sheath blight at Pondicherry; on brown spot at Faizabad and on false smut and bacterial leaf streak at Karaikal. The trial was conducted under natural disease development conditions at seven locations and under artificial inoculated conditions at two locations. Cultivation of resistant variety along with 100% RDN treatment was the best followed by cultivation of susceptible variety with 2/3rd RDN and need based spray of fungicide for management of fungal diseases. For bacterial blight of rice, use of resistant variety along with reduced dose of nitrogen was the best for reduction in disease severity and incidence.

Production oriented survey (POS)

- POS was conducted by 24 centres in 18 states. The climatic conditions were more or less normal throughout India. However, there were drought or drought like situations in some places in Bihar and Chhattisgarh, delayed rainfall in parts of Gujarat, excess rainfall at the time of harvest in parts of Maharashtra and a cyclone called '*Thane'* damaged rice crops in Cuddalore and Villipuram districts of Tamil Nadu. In addition to major hybrid rice growing states like Haryana, Jharkhand and Maharashtra, many farmers in the state of Gujarat, Himachal Pradesh, Madhya Pradesh, Tamil Nadu and Uttar Pradesh cultivated different rice hybrids. Some of the farmers in Bihar, Telengana region of Andhra Pradesh and Andaman and Nicobar islands are also growing hybrids. The biotic constraints in general were in low to moderate intensities. However, there were severe problems of neck blast in parts of Chhattisgarh, brown spot in parts of Bihar, Chhattisgarh, Jharkhand, sheath blight in coastal Andhra Pradesh, bacterial blight in Raigarh of Maharashtra, Kurnool of Andhra Pradesh and Palakkad area of Kerala and false smut in parts of Bihar, Himachal Pradesh, Jammu and Kashmir and parts of Jharkhand. There was severe black beetle problem in Himachal Pradesh.

Technology Transfer

Frontline demonstrations (FLDs) on rice

- For the year 2010-11, 300 FLDs on various rice production technologies like improved varieties, hybrids and other practices were planned and conducted in 16 states and six rice ecosystems of the country. In total 25 promising technologies have been identified from FLD programme. A National workshop & brainstorming on "Redefining Frontline Demonstrations: Maximising Impacts" was conducted at DRR on 28 March 2012.

Research Achievements

Lead Research

GEY - Genetic enhancement of yield and stress tolerance

GEQ - Genetic enhancement of quality for domestic and export purpose

ABR - Application of biotechnology tools for rice improvement

RUE - Enhancing resource and input use efficiency

SSP - Sustaining rice system productivity

CCR - Assessing and managing crop response to climate change

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

HRP - Host-plant resistance against pathogens and its management

IPM - Integrated pest management

TTI - Training, transfer of technology and impact analysis

GEY – Genetic Enhancement of Yield

GEY 01

Redesigning the indica rice plant type from the tropical japonica and wild rices (T. Ram)

Nine FGR lines developed by introgressing traits such as low tiller number (6-8), high number of grains per panicle (350-400), medium slender grains (test weight >20gm), sturdy stem, high biomass derived from tropical *japonica* and *indica* germplasm were evaluated along with four high yielding varieties and three hybrids as checks. Two FGR lines FGR21-17 and FGR21-22 recorded grain yield comparable to the hybrids KRH2, PA6444 and PHB71.

A new recessive BLB resistance gene was identified in the introgressed lines from *O. rufipogon*. Other selected introgressed lines showed varying degrees of blast resistance. RTV resistance in some accessions of *O. rufipogon* (acc.106087, 104760 and 106477) was detected.

The line with new recessive BLB resistance gene introgressed from *O. rufipogon* into BPT5204 showing 19% higher yield than BPT 5204 with same cooking quality has been nominated to AICRIP trials for evaluation

(Ram et al. 2011 Plant Breeding 136(6): 715-718).

GEY 02

Breeding varieties for *boro* (L.V. Subba Rao)

Two row breeding material of F5 generation (n=206) is being evaluated in *rabi* 2012 for their performance under low temperatures at seedling stage and high temperatures during flowering and grain filling stages. Twenty two crosses were made using *boro* germplasm and high yielding varieties. Over 300 germplasm accessions received from NBPGR and typical *boro* locations are being evaluated in *rabi* 2012. Of these, 85 germplasm accessions were found to be tolerant to cold and have been transplanted in the main field for further evaluation. Bulk selections of F_3 generation are being evaluated during 2011-12 for cold tolerance at vegetative stage and heat tolerance at grain filling stage at ideal locations (BHU, Varanasi; RAU, Pusa; RARS, Titabar and RRS, Chinsurah). Plants tolerant to cold during nursery (survival capability) and heat during flowering are selected for *boro* cultivation.

GEY 03

Breeding for planthopper resistance (G. Padmavathi)

Standard seed box screening tests for BPH resistance in F_2 populations derived from crosses involving different donors and susceptible parents (Samba Mahsuri and Sona Mahsuri) revealed presence of a single dominant gene in the donor MTU 1064 (3R:1S), single recessive gene in CB05-022 (1R:3S), duplicate dominant genes in CR 2712-2, derived from land race Dobanumbari, (15R:1S), two complementary genes in another derived line CR 2711-114 (9R: 7S), one dominant and one recessive gene in IC 319435 (13R:3S) and minor genes in IC 347611conferring BPH resistance.

Screening of another set of F_2 populations against WBPH revealed resistance to be governed by a single dominant gene in MTU 1064 (3R:1S), one dominant and one recessive gene in CR 2712-2 (13R:3S), a single recessive gene in CR 2711-114 (1R:3S), duplicate dominant genes in IC 347611 (15R:1S) and by minor genes in CB 05-022.

Based on yield components as well as field resistance to planthoppers at the hot spot location (Maruteru) during *kharif* 2011, 24 lines were selected among the 70 advanced lines derived from nineteen F_6-F_8 populations. Based on station yield trials, two late duration cultures (RP 5320 and RP 5312) and six medium duration cultures (RP 5194, RP 4977, RP 5318, RP 4975, RP 4974 and RP 5181) with distinct yield advantage were identified.

Field screening at Maruteru against combined populations of BPH & WBPH

GEY 04

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

One hundred forty genotypes including hybrids were screened along with checks Rasi, MTU-1010, Improved Samba Mahsuri, DRRH 3 (hybrid) for their performance under low-P conditions during *rabi* 2011. On the basis of their overall growth and other attributes, promising hybrids and varieties were identified. Some of the genotypes *viz*., IET20214, germplasm accession 2255, TRL 21050 and Mugad Sugandha performed better than Swarna known to have tolerance to low P.

During *kharif 2011,* eight hybrids and their parental lines were screened for low P tolerance. It was observed that all the hybrids were better in one or the other attributes as compared to their parental lines and could accumulate more biomass through plant height, tiller numbers and panicle length either individually or in combination. DRRH 79 was the best performer under low P followed by DRRH 3 and DRRH 2. Breeding for enhanced PUE has been initiated with nine crosses during *rabi* and some more crosses during *kharif* involving Swarna, Rasi, MTU 1010, NDR 359, Improved Samba Mahsuri and IR 64 and advancing generations or involving three way crosses. Pup 1 locus has been identified to play a major role in P uptake by plants. However, reported markers for this locus had some problems in resolution and hence new primers were designed to overcome this. Now all the six markers are working and can identify genotypes possessing Pup1.

DRRH 79 (hybrid) 4th line from the left with better growth in P-deficient condition.

GEY 05

Breeding rice varieties for conservation agriculture (K. Suneetha)

Evaluation of breeding lines and varieties for conservation agriculture identified promising lines like Sabita with weed suppressiveness and early seedling vigor; RP5219-9-6-7-3-2-1-1 and RP 5214- 38-14-9-5-2-1-B with desirable plant type and higher yield; S-166 with thick and dark green leaves, higher number of grains per panicle; Aathira, Swarna Prabha, Kalinga III, IET 22051 (RP5125-2-4) and B 644F-MR-6-0-0 for their desirable plant type, higher yield and RP5129-17-8-3-2, RP5214-57-26-9-6-3-2-B for root characteristics.

Screening for anaerobic germination

A screening methodology for seed germination under anaerobic condition was standardized wherein the rice seeds of diverse genotypes after checking viability were sown in germination trays with soil. These trays were immersed in 40 cm deep water in larger zinc trays for 15 days providing anaerobic condition. Entries were scored after 15 days for germination. Among the 2500 germplasm accessions screened, six lines E 1763, IC 352760, IC 350189, IC466351, IC 577070 and IC 576974 recorded more than 90% germination.

The promising genotypes identified were utilized in hybridization to generate segregating populations. F_2 generation was evaluated under direct seeding. A total of 1500 F2 populations derived from the crosses (1) IR 64/ Sabita (RP 5291), (2) IR 64 x IR 79906-B-5-3-3 (RP 5292), (3) IR 64 x CR 691-58 (RP 5293), (4) IR 64 x B 644F-MR-6-0-0 (RP 5294) and (5) IR 79906-B-5-3-3 x Sabita (RP 5295) were evaluated under direct seeded condition and 378 superior segregants (SPS) from the above mentioned crosses were selected which will be evaluated in two row pedigree under direct seeded condition.

GEY 06

Development and evaluation of three line rice hybrids (B.C. Viraktamath)

During *kharif* 2011, six experimental hybrids nominated from DRR were tested in AICRIP trials. Seven hundred entries were grown in the source nursery and 350 test crosses were made. Of the 500 test crosses evaluated, 60 restores and 40 maintainers and 20 promising combinations were identified. In a station trial, of the 48 hybrid combinations evaluated, six promising ones were identified. Hybrid seed of 15 experimental hybrids was produced by barrier isolation method and 12 CMS lines were multiplied. The nucleus seed of the parental lines of DRRH-2 *viz*., IR 68897A (70 kg), IR 68897B (100 kg), DR 714-1-2R (50 kg); DRRH-3 *viz*., APMS 6A (130 kg), APMS 6B (150 kg) and RPHR 1005 (100 kg) were produced.

Promising maintainer lines	Promising restorer lines
CPK 8454-5	BK-39-179
CT 18172-2-7-2-1-4-3M	BK-49-42
CR 2624-IR55423-101	BK-49-76
CHAITE-6	BK-49-77
IR 77298-14-1-2	BK-52-104
IR 77509-22-2-3-3-1	RP-4075-345-132
IR 81366-124-1-2-2	IR 82355-5-2-6
IR 77032-47-2-3-3	IR 82571-544-2-3

GEY 07

Exploitation of inter sub-specific heterosis in rice (A.S. Hari Prasad)

Twenty five promising genotypes were identified from the available breeding material and crosses were attempted between these promising lines. Five promising TGMS lines were evaluated under different temperature regimes to find their fertility behavior. Around 350 test crosses, 150 paired crosses and 25 varietal crosses were made for further evaluation. Of the 500 test crosses evaluated, 20 promising test crosses were identified for further evaluation. Two hundred single plant selections were made from the breeding materials in various segregating generations.

Restorer line improvement	
KMR-3 x TJ 17	Tropical Japonica lines
RPHR-1096 x TJ 154	
RPHR-1096 x TJ 212	
RPHR-612 x HP-74	ARC landrace derivatives
RPHR-612 x HP 290	
GQ-102 x HP 194	

GEY 08

Hybrids for aerobic and salinity / alkalinity conditions (P. Senguttuvel)

Seven hybrid parental lines were screened for salinity tolerance at germination and seedling stage with NaCl salt solution. It was found that the germination ability and seedling phase screening differed in their outcome. Screening of 56 station trial hybrids along with promising hybrid checks under direct seeded aerobic conditions showed that IR 79156A/CB06-137, APMS 6A/RP 4092, APMS 6A/2634-1, APMS 6A/L 182 were promising under water limiting conditions.

Field evaluation of 63 genotypes under three water regime treatments identified five promising aerobic lines (AR11-1-IR 82310-B-B-67-2, AR11-04-IR 82639-1, AR11-05-IR 79915-1, AR11-08-IR 78913-1 and AR11-21-B644F-MR-6-0-0). Of the 28 test entries of 37th IURON tested for yield and yield components, four entries *viz.,* IR 83106-B-B-1, IR 82912-B-B-16, IR 88628-B-B-15, B11577E-MR-B-12-1-1 were promising.

A promising aerobic line

GEY 09

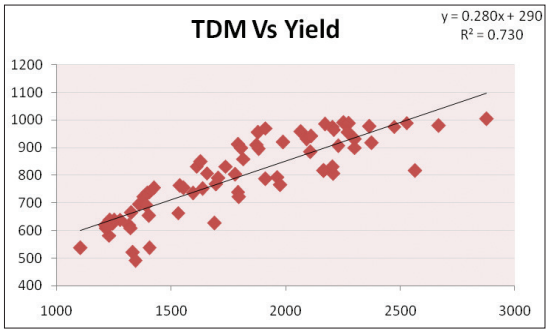
Development of CMS lines with higher outcrossing (K.B. Kemparaju)

For genetic improvement of maintainers and out crossing ability of male sterile line improvement fresh crosses (APMS-6B x DRR-6B, APMS-6B x IR 79156B, APMS-6B x DRR-13B, DRR-6B x APMS-6B, IR 79156B x APMS-6B, DRR-13B x APMS-6B,) were attempted between poor stigma exsertion (APMS-6B & IR 68897 B) and high stigma exsertion (DRR 6B, IR 79156 B & DRR 9B) B-lines. Six F_2 populations were available for the study of stigma exsertion trait. Recording of phenotypic observation is under progress in field for F_2 population (436 plants each) of cross combinations *viz.,* APMS-6B x DRR-6B, APMS-6B x IR 79156B. Parental polymorphism is under progress for the stigma exsertion.

GEY 10

Increasing the yield potential in irrigated rice: Manipulating source and sink sizes (P. Raghuveer Rao)

Three varieties (Akshayadhan, Varadhan, DRR Dhan 38) and three hybrids (KRH-2, PA-6201, PHB-71) were grown under different nitrogen levels to manipulate the source and sink sizes and to note their influence on physiological parameters, biomass, yield and yield attributes. The results revealed that source and sink size increased with increasing nitrogen levels from 0-200 kg/ha. Among the genotypes tested, source and sink sizes were the highest in hybrids as compare to high yielding varieties (HYV). Leaf area index (LAI) of 6-7 was optimum for attaining a yield of 8-9 t/ha. Crop growth rate (CGR) increased with increase in N level and hybrids had better CGR than HYVs. Photosynthetic rate, stomatal conductance and transpiration rate increased with increase in N level. Photosynthetic rate and transpiration rate were also high in hybrids with PHB-71 recording the highest values. Varadhan had high water use efficiency in terms of A/T and IWEU ratios. A/Ci ratio *i.e.,* carboxylation efficiency or activity of RUBP carboxylase was found to be higher in hybrids as compared to high yielding varieties. Correlation studies revealed that yields can be increased in irrigated ecology by improving the biomass.



Correlation between total dry matter and grain yield

GEQ – Genetic Enhancement of Quality

GEQ 01

Genetic enhancement of quality rice varieties (N. Shobha Rani)

One of the cultures from this programme, IET 21665 (RP 3644-1-9-5-5) has been identified for release for the basmati growing areas of Delhi, Uttarakhand and Uttar Pradesh. This culture has a flowering duration of 110 days, with desirable basmati quality traits, moderately resistant to leaf blast, neck blast and brown spot. Five entries recording more than 5% yield advantage over the best check are nominated to IVT Basmati trial during *kharif* 2011.

The genetic diversity analysis based on data generated by 70 EST-SSR markers classified all six traditional Basmati accessions in one cluster and evolved Basmati in another group.

Forty basmati and 40 aromatic short grain lines along with 426 advanced non-basmati cultures were evaluated for 15 physico-chemical characters to identify the promising elite material with desirable quality traits.

Twenty seven basmati pyramided lines in the background of Taroari Basmati, Vasumathi and Basmati 386 were evaluated in BC1F8 generation, of which 79 SPS and 12 bulks were made after screening for quality, plant type and presence of *Xa21* and *xa13* genes. Thirty two BC1F1 were positive for *Xa21*, *Pikh* and *Pi2* in BLB blast convergence programme.

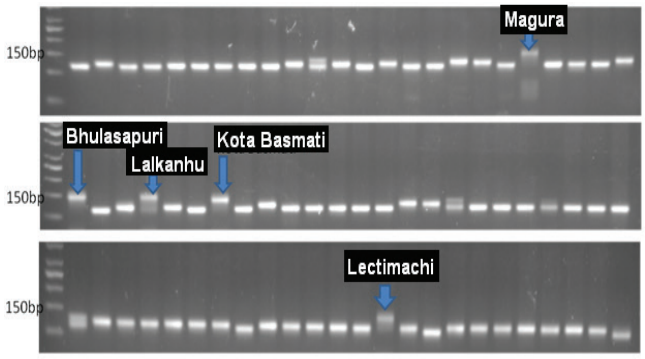
DRR initiative on soft rice

A set of 73 genotypes at DRR and 45 genotypes at Titabar were evaluated under normal and late transplanted situations. These have an average of 11.68% amylose, 5.65 ASV, 58.67 mm gel consistency, 68% milling, 61% head rice recovery, with completely opaque grains. Other physico-chemical properties that contribute to their instant cooking nature are being studied. These soft rices are predominantly land races are semi-tall to tall statured and photoperiod sensitive.

GEQ 02

Genetic enhancement of aromatic short grain rices (G.S.V. Prasad)

During 2011, 208 short grain aromatic rice genotypes were characterized for 49 phenotypic traits including morphological (19 traits), cooking and eating qualities (16), agronomic (9) and pest-disease resistance (5). Further, genetic diversity was scored using 56 polymorphic SSR markers dispersed across the 12 chromosomes. Cluster analysis performed individually for phenotypic traits, genotypic traits and by combining both revealed lower level of correlation between phenotypic and genotypic clustering. Four SSR markers namely RM577, RM505, RM89 and RM22866 produced genotype specific amplification patterns and could be used for DNA fingerprinting.



The SSR marker RM89 amplified 5 genotype specific 150bp amplicon among 208 short grain aromatic rice genotypes tested.

Nine hundred ninety single plant selections were made in 16 crosses in 2 row pedigree nursery. Four hundred sixty two plants were selected in 15 F_2 populations. Promising crosses included RP4926 - Swarna/RAU 3041, RP5084 - Sona/Malaysia, RP5095 - Swarna/Sonachoor, RP5100 - Swarna/RAU 3041//Swarna/KB 13, RP5098 - Swarna/Kalanamak 2, RP5087- IR 64/Lectimachi A, RP4927 - Swarna/Dubraj, RP4928 - Swarna/Nagri, RP5079 - Sona/KB 13, RP5221-Rasi/Heerakani.

Seventy four new crosses were attempted and F_1s raised in *rabi* 2012.

GEQ 03

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

One hundred and sixty eight lines with reported high iron (Fe) and zinc (Zn) content were evaluated at four locations. One advanced line derived from the cross BPT 5204 X Chittimuthyalu with short bold grain, semi dwarf with high yield potential (>4.5t/ha) and medium duration with high Fe (3.12 mg/100 gm) and Zn (4.0 mg/100 g) in brown rice was identified with good quality characters *viz*., good HRR (67.5%), intermediate ASV (5.01), AC (24.05%) with mild aroma.

During *kharif* 2011, about 250 lines from F_7 generation and another 6 fixed lines were selected for high Zn content on the basis of phenotypic acceptability. Depending upon the grain type, duration and grain yield one entry is being nominated to AICRIP during *kharif* 2012. Another 960 lines from F_3 generation involving about 48 crosses were also selected from the segregating populations.

Genetic studies revealed non-additive gene action in inheritance of high Fe and Zn content as a trait. PR 116 and Madhukar were the two parents with good *gca* effects for Zn content. Based on significant *sca* effects, the crosses *viz.,* Swarna × Madhukar, IR64 × Chittimuthyalu, IR64 × Suraksha and PR116 × Chittimuthyalu could be used to exploit heterosis for grain Fe, Zn and yield in F_1 generations. The association studies revealed that grain Fe or Zn content had no correlation with grain yield.

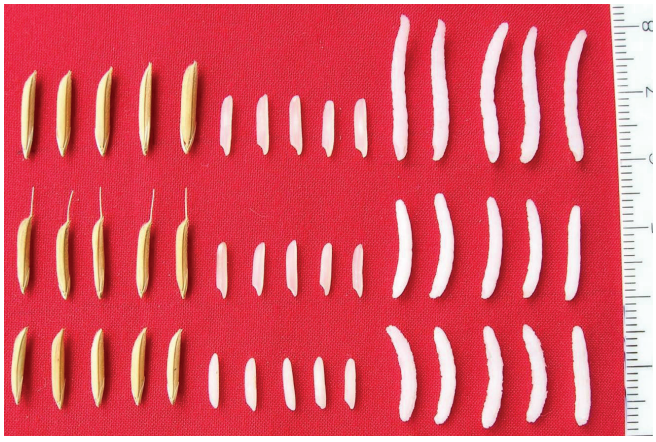
Based on the candidate genes associated with Fe and Zn metabolism information as derived from rice genome sequence, several microsatellite markers were designed and mapped in $F_{2:3}$ of two mapping populations *viz*., BPT 5204/Chittimuthyalu and BPT 5204/Ranbir Basmati. Eight loci associated with Fe and Zn metabolism across chromosomes 3, 4, 5, 6, 8 and 12 were identified in two donors and two loci from chr 3 and one locus from chr 4 common in both donors.

An attempt was also made to identify SSR markers associated with high content of Fe and Zn in grain and metabolism using the F_2 progeny mapping population from the cross between Swarna and Madhukar. One of the markers, SC129 appeared to be associated with both Fe and Zn content.

GEQ 04

Molecular markers for quality traits (M. Seshu Madhav)

A major QTL for gelatinization temperature (GT) - qGT-6 - identified earlier, was validated in the RIL population (250 individuals) derived from the cross RT206 x Jaya. Presence of qGT-6 within the marker interval of RM276-RM217 explained 32.0% phenotypic variance at a LOD score of 12.95. One major QTL was identified (qAC-6) for amylose content (AC) within the marker interval of RM204 and RM276 on chromosome 6, which explained 9% of the phenotypic variation in the RIL population developed from IR42 X IR65 cross. Another QTL for Gel consistency (GC), was identified (qGC-8) on chromosome 8 within the intervals of RM3395 and RM22866 on chromosome 8, which explained 4% of phenotypic variation.



A simple PCR based marker system targeting SNP in second exon of the QTL GS3 for kernel length and also kernel elongation was developed

(*Ramkumar et al. 2011. Mol. Breed 27:129-135*)

ABR – Application of Biotechnology tools for Rice improvement

ABR 01

Yield enhancing genes from wild rice (N. Sarla)

Several of the advanced generation introgression lines (ILs) from Swarna - *O. nivara* and KMR3 - *O. rufipogon* crosses have been evaluated against biotic and abiotic stresses and as restorers to develop hybrids and for overall yield performance. After 3 years of testing in IM trials of AICRIP, IET21542 (Swarna x *O. nivara* BC2F8 IL) was identified for release in the states of Maharashtra, Tamil Nadu and West Bengal. Another IL, IET22493 was promoted to AVT-L. Nine ILs out of 14 entered in NSASN trials were promoted to CSTVT and AL&ISTVT. IET 21943 and IET 21944 were promoted to second year of CSTVT. IET 21940 was promoted to 2nd year of AL&ISTVT.

Several of these ILs were identified for allele mining for drought and salinity tolerance traits. One of the Swarna x *O. nivara* IL - 4918-230S was identified as BPH resistant and is being tested for multiple resistance. From the same cross, IET 21542 showed least damage to stem borer. Twenty ILs were resistant to BLB and 87 ILs to blast in glass house screening.

Seven hybrids gave significantly high yield in replicated field trials out of 36 crosses using 6 CMS lines and 6 KMR3 ILs.

Two mapping populations were developed and F2 phenotyping data of one and F4 phenotyping data of another dense x lax panicle cross showed wide variation. So extremes were identified for selective genotyping. 40 SSR markers polymorphic between dense and loose panicle plants were identified.

One gene *Os11Gsk* (glycogen synthase kinase involved in Brasinosteroid biosynthesis pathway) from *O. rufipogon* was identified as candidate gene for high yield in KMR3IL 50-7 based on transcriptomics and real time expression data.

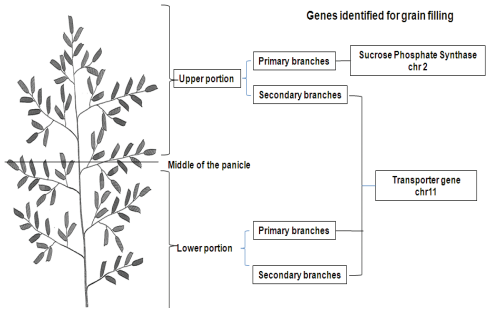
(*Sudhaker et al. 2012. Funct. Integ. Genom 12:277-289*)

IET 21542, an introgressed line of the cross Swarna X *O. nivara* having markers linked to yield enhancing QTLs *yld2.3, yld8.3* and *gw8.1* and identified for release showed 25% yield advantage over the national check (Jaya), 36% over regional checks, 34% over the hybrid check (KRH2)and with the highest yield of 10.65 t/ha.

ABR 02

Identification of genes for grain filling (C.N. Neeraja)

Grain filling (GF) was characterized in 70 genotypes comprising improved varieties and landraces grown during *kharif* 2008; 2009 and 2010 at DRR and *kharif* 2011 at CRRI, Cuttack. Principal component analysis of the number of spikelets, number of filled grains and grain filling percentage on upper half – primary and secondary; lower half – primary and secondary in this set of genotypes identified the contrasting genotypes for their grain filling pattern across the panicle suggesting the involvement of different sets of genes or differential control of same set of genes during grain filling process.



Allele mining of two candidate gene based markers *viz*., sucrose phosphate synthase gene on chromosome 2 and sugar transporter gene on chromosome 11 showed indel polymorphism to be associated with superior alleles

(*Subhaker Rao et al. 2011. Mol. Breed. 28:683–691*)

ABR 03

Molecular basis of yield heterosis and WA-CMS trait in rice (R.M. Sundaram)

A set of 52 EST and genomic SSR markers along with SSR markers targeting $(GATA)_n$ motifs were reported earlier to be informative for preliminary characterization of genetic diversity in parental lines and for prediction of heterosis. These markers were validated in 47 restorers and twelve elite CMS lines. Based on the analyses, a set of genetically divergent lines were identified for developing hybrids. All the combinations produced heterotic hybrids confirming the utility of the informative markers for heterosis prediction. Based on these analyses, a set of 28 EST and hyper-variable genomic SSR markers have been identified which could be immediately used for calculation of parental genetic divergence and prediction of heterosis. In the second part of the study, based on previous reports, targeting the mitochondrial genomic region between 156-205 kb, a set of 44 primer pairs was designed for amplification of the entire region. However, only 33 out of 44 gave amplification in both A and B lines. Interestingly, two primer pairs (i) RMT156F

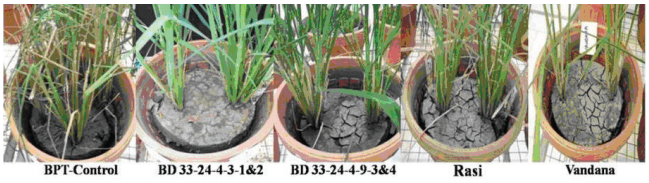
and RMT159R and (ii) 1.5-2F and 1.5-2R in the genomic region between 155-160 bp displayed amplification of an allele in the maintainer lines, restorer lines and varieties, while the CMS line did not show any amplification.

ABR 04

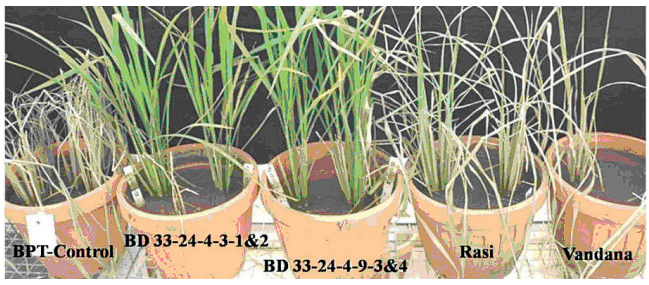
Transgenic rice for biotic and abiotic stress tolerance (S.M. Balachandaran)

Three events of Bt transgenic rice with *Cry1Ac* gene in the background of IR64 were advanced to T4 generation and bioassayed against yellow stem borer (YSB) which showed good level of resistance both at vegetative and reproductive stages.

Three independent events of transgenic BPT 5204 with *AtDREB1A* gene under strong inducible promoter rd29A were advanced to T3 generation by screening through PCR. Selected homozygous plants were subjected to drought stress experiment. A very high level of tolerance to water stress compared to the control plants was detected. Re-watering after two days resulted in complete recovery of transgenic plants but controls could not recover. Physiological parameters such as chlorophyll content (CC), relative water content (RWC), proline content (PC) and ion leakage (EC) were also studied with transgenic plants in both stressed and unstressed conditions. All these parameters clearly indicated that transgenic rice lines performed very well under water stress conditions.



Performance of transgenic BPT5204 with *AtDREB1A* gene under inducible promoter rd29A (2nd and 3rd pots) along with checks, after withdrawal of water for three weeks (top) and two days after re-watering (bottom).



ABR 05

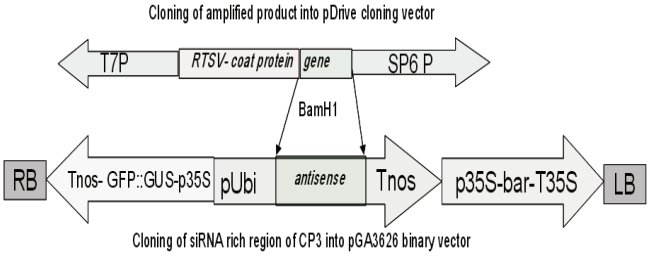
Suppression of rice tungro virus and sheath blight through RNA interference (S.K. Mangrauthia)

RNAi binary vector construct containing CP3 (coat protein) gene of RTSV was used to transform, through *Agrobacterium tumefaciens* medium, three rice genotypes, *viz.,* Taipei309, IR64 and BPT5204. About 250 putative transformed lines were established in T0 using Basta selection and PCR analysis.

In a similar approach against the sheath blight causal fungus *Rhizoctonia solani,* two of the pathogen genes *viz*., polygalacturonase and beta-tubulin were amplified, cloned and sequenced (sequences submitted to NCBI database; accession Nos. JN620498, JN620496 and JN620497). 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.

Molecular diversity analysis based on ORF I, II and IV sequences from different RTBV isolates across India revealed distinct divergence into two groups: one consisted isolates from Hyderabad, Cuttack, and Puducherry and another from Chinsurah and Kanyakumari. Nevertheless, comparison of sequence data of isolates across the globe brought out the distinctness of Indian isolates from those of non-Indian isolates.

Mangauthia et al. 2012. Virus Genes (Online)



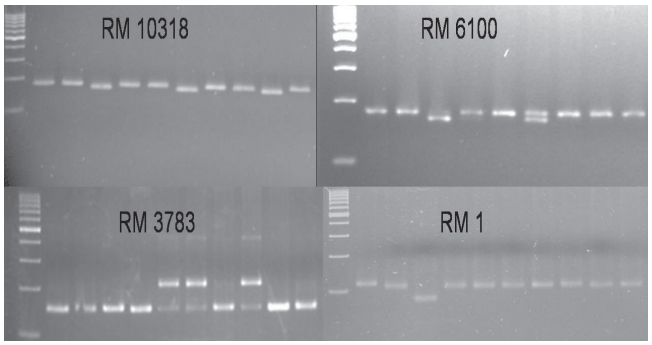
ABR 06

Molecular breeding for parental line improvement in hybrid rice (P. Revathi)

To identify relative role of *Rf4*, *Rf3* and wide compatibility *S5* gene in spikelet fertility, eighteen restorer lines with different combination of *Rf4*, *Rf3* & *S5* genes were crossed with six CMS lines namely IR 58025A, IR 68888A, IR 68897A, Pusa5A, APMS 6A, IR 79156A and F_1s seeds were produced. During next season F_1s were evaluated for pollen, spikelet fertility and grain yield heterosis. In comparison of phenotypic data with molecular screening results indicated that *Rf4* and *Rf3* genes are important for fertility restoration of WA-CMS, whereas *S5* neutral allele was not influencing the fertility restoration of WA-CMS and at the same time the presence of *Rf4*, *Rf3* & *S5* genes alone or in combination not directly influencing the grain yield. Although all the CMS lines derived from WA source, restorer lines performance varied with the different CMS lines, therefore diversifying CMS lines may help in increasing the level of heterosis.

Around 100 breeding lines were screened for the presence of fertility restorer genes *Rf4* located on chromosome 10 and *Rf3* located on chromosome 1 using linked molecular markers

RM6100 for *Rf4* and RM10318, RM1 RM3873 for *Rf3* gene. Amplification pattern of different SSR markers are presented in the following figure. These lines were crossed with CMS line APMS6A to produce F_1 seeds. F_1s were evaluated for pollen and spikelet fertility. Based on the phenotypic data, it was found that molecular markers are possessing 80 to 85 percentage efficiency in identifying fertility restoration trait.



Amplification pattern of breeding lines for the presence of *Rf4* & *Rf3* genes

Other Research Related Activities

Maintenance breeding

Nucleus seed production of 32 varieties (annexure xx) developed and released from DRR was undertaken through progeny row testing (PRT) during *kharif* and *rabi* seasons.

Mega seed project

Under Mega-Seed Project 1100 quintals of quality seed of 11 DRR released varieties were produced in participatory mode involving more than 20 farmers in 15 villages/*tandas*.

Characterization and evaluation of germplasm

Agro-morphological characterization (20 Characters) of 812 germplasm accessions received from NBPGR was carried out and the same set was multiplied and dispatched to 30 centers for multilocation evaluation for agro-morphological characterization (at 8 centers) and against biotic stresses (at 22 hot spot locations).

Establishment of national rice resource database (ENRRD)

As per the primary objective 3286 germplasm accessions including 15 accessions of wild species were characterized for 30 qualitative and quantitative characters in *kharif*. The same accessions are being deposited with NBPGR for preservation.

DUS tests in rice

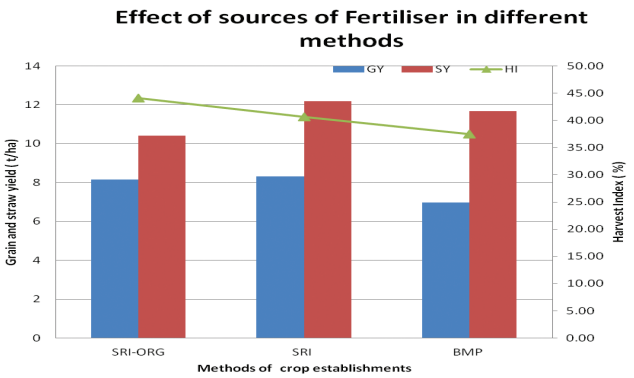
Third set of 26 candidate varieties received from PPV & FRA were evaluated against 53 reference varieties. In addition 17 VCKs / Extant varieties, 66 Farmers varieties, and 15 candidate varieties from second set were also grown and evaluated.

RUE - Resource Use Efficiency in Rice

RUE 01

System of rice intensification (SRI): potential and sustainability (R. Mahendra Kumar)

Field experiments showed that the grain yields in SRI, either only with organic fertilizers or those receiving both organic and inorganics, were significantly higher (8.16-8.32 t/ha) than those obtained under best management practices (BMP, 6.99 t/ha) with variety Sampada. The amount of water applied in SRI was lower by 36-44% compared to BMP due to reduced number of irrigations. High water saving was obtained with SRI organics.



The modifications like direct or row seeding introduced in SRI in order to save labour cost, did not give satisfactory grain yields due to lodging of the crop.

Evaluation of 12 varieties of different duration groups under SRI and normal planting conditions revealed that high tillering genotypes performed better.

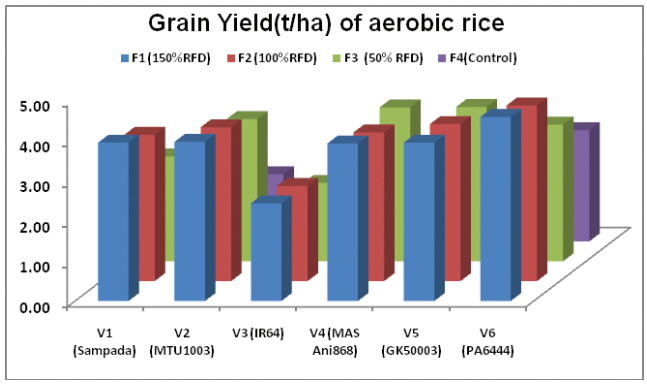
(Kumar RM et al. 2011. Oryza, 48: 233-237)

RUE 02

Agronomic management for aerobic rice (B. Sreedevi)

Aerobic rice, a water saving technology, is either grown as direct-seeded upland crop without flooding or in favourable lowlands with access to supplementary irrigation. Field studies during *kharif* showed that hybrid DRRH3 recorded the highest grain yield with 25 x 10 and 30 x 10 cm spacing and with the seed rate of 30 kg/ha and 35 kg/ha. In another study, 150% recommended fertilizer dose (RFD-120-60-50 NPK) recorded significantly higher grain yield across six genotypes tested. Pre-emergence application of pendimethalin (1.5 kg/ha) followed by post-emergence

application of bispyribac sodium (20 g/ha) resulted in lower weed population and biomass and in higher grain yields.



Grassy weed domination in aerobic rice

RUE 03

Plastic film mulching cultivation of rice for resource conservation (B. Gangaiah)

A field study was made to assess the effect of plastic mulching (no mulch, black and white plastic mulch) on resource conservation and productivity of transplanted and direct spot seeded rice in factorial RBD with six replications. Saturation moisture was maintained in all the treatments. In mulched plots all N was applied as basal. For comparison, traditional transplanted rice with standing water was included as the control. The results indicated no significant differences in productivity of transplanted and direct wet seeded rice grown with saturation moisture regime. However, direct seeded rice had a yield penalty of 0.76 t/ha over transplanted rice with standing water regime (5.68 t/ha). Mulching in rice resulted in 0.26 t/ha lower productivity as compared to that of no mulch crop. This reduction in productivity could be ascribed to basal application of entire N in this treatment. The saturation moisture regime of mulched rice using 36 cm water resulted in ~35% saving in irrigation water over flooded rice (55 cm) during August-November. Mulching enhanced soil temperatures (at both 15 & 30 cm), prevented weed growth. Mulching increased productivity of direct seeded rice, as compared to that in transplanted rice.

Grain yield (t/ha) of rice crop under different treatments

Mulching	Method of establishment		Mean
	Trans-planted	Direct seeded	
No mulch	5.35	4.82	5.08
Black mulch	4.69	4.86	4.78
White mulch	4.72	5.00	4.86
Mean	4.92	4.89	
Transplanted flooded	5.68		
CD (P=0.05)	Planting methods	Mulches	Inter-action
	NS	0.19	0.27

SSP – Sustaining Rice System Productivity

SSP 01

Integrated nutrient and crop management to realize potential yields (K.V. Rao)

With the objective of developing integrated input and crop management strategies to maximize productivity, an experiment was conducted in *kharif* with three improved cultures (PA 6444, Varadhan and MTU 1010). Using Oryza 2000 crop growth model, potential yields, of these genotypes were estimated to range from 9.7-10.4 t/ha under the conventional transplanted rice system. Under different nursery management the hybrid PA6444 showed maximum seedling vigor with low density of sowing and application of P. The test cultures differed in their response to nutrient management with significant interaction effects of nursery and nutrient management. Yield maximizing integrated nutrient management (INM) involving extra dose of NPK, organic manuring, four split application of N and top dressing of K and B at PI stage contributed to additional mean yield of 0.7 – 0.8 t/ha in case of hybrid and MTU 1010. Nursery and nutrient management treatments also influenced nutrient uptake and N and P use efficiency of the hybrid tested.

Influence of seedling vigor and nutrient on rice productivity, *kharif* 2011

Treatments	Seedling vigor (g/5H)	GY (t/ha)	PFP (kg/ha)	Nutrient uptake (kg/ha)		
				N	P_2O_5	K_2O
Hybrid nursery	2.6	8.7	-	199	57	156
SRI	2.2	8.3	-	188	52	135
Normal	1.5	8.1	-	177	52	140
P enriched	2.6	8.6	-	198	55	152
CD (0.05)	-	NS	-	13	NS	NS
PA6444 - RDF	2.7	8.7	37.8	187	51	146
- INM	-	9.5	25.7	213	55	157
Varadhan - RDF	1.8	8.3	36.1	173	54	133
- INM	-	8.2	22.2	192	55	149
MTU 1010 - RDF	2.1	7.6	33.0	179	54	139
- INM	-	8.3	22.4	199	56	150
CD (0.05) - Nu	-	0.6	-	15	NS	NS
Interaction	-	1.2	-	29	NS	NS

RDF–120:50:60 kg NPK /ha; INM–VC (5t/ha)+180:90:100 kg NPK/ha+ B (0.2%).

SSP 02

Improving nitrogen use efficiency (NUE) in irrigated rice (K. Surekha)

A set of 15 genotypes, under three duration groups, was field evaluated in two seasons at two 2 N levels (N0 and N100 kg/ha) to identify rice genotypes efficient in N use and response. During *kharif* 2010, grain yield was significantly higher (by 42%) at N100 compared to N0. During *rabi* 2010-11 also, grain yield was significantly higher at N100 compared to N0 by 58%. Based on NUE indices such as agronomic efficiency (AE), physiological efficiency (PE), internal efficiency (IE), recovery efficiency (RE), partial factor productivity (PFP), harvest index (HI), nitrogen harvest index (NHI), N requirement per kg grain, productivity rate, N uptake rate per day, grain yield and total N uptake, the genotypes were ranked and based on their mean ranks, the genotypes were ranked duration wise. During *kharif*, Varadhan was ranked first followed by PA6444, Rasi and Jaya. Whereas, during *rabi*, MTU1010 ranked first followed by Varadhan, Anjali and Rasi. In both the seasons, Prasanna occupied the last position. Based on crop duration, Rasi and MTU1010 in early; Varadhan in medium; and Swarna and BPT 5204 in late maturing groups occupied number one position among the tested genotypes in *kharif* and *rabi*, respectively.

Promising genotypes for high nitrogen use efficiency based on NUE indices

Early duration (110-120)	Medium duration (125-135)	Late duration (>145)
***Kharif* - 2010**		
Rasi	Varadhan	Swarna
MTU 1010	PA 6444	BPT 5204
Annada	Jaya	Mahsuri
***Rabi* - 2010-11**		
MTU 1010	Varadhan	BPT 5204
Anjali	PHB 71	Swarna
Rasi	DRRH 2	Mahsuri

SSP 03

Assessment of soil quality for optimum rice productivity (Brajendra)

Two field experiments were conducted in *kharif* and *rabi* seasons of 2011 in a deep black clayey vertisol (*Typic Pellustert*) with a soil pH of 8.07; containing 1.24 % organic matter; available N at 191 kg/ha; P at 25 kg/ha; K at 389 kg/ha and sulphur at 8 kg/ha to compare the performance of two rice genotypes (hybrid KRH2 and Krishnahamsa) with application of micro-nutrient enriched compost (MEC), *i.e.,* field fortified poultry or vermi compost manure. Soil levels of the micronutrients Zn and Cu were high and Fe and Mn status was low. Results showed that the hybrid KRH-2 out yielded the high yielding variety Krishnahamsa in all the treatments of enriched composts and in control. Very high soil microbial biomass (µg C/g soil dry weight) was recorded in all the MEC plots compared to control and RDF. Soil enzyme assays for alkaline phosphatase in all the MEC plots were highly skewed. Higher soil dehydrogenase activity was recorded in all the MEC plots compared to control and fertilized plots.

At site fortification of vermicompost with micro-nutrients

SSP 04

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

Plant and soil colonizing microorganisms from various environments were isolated and studied for their efficacy in enhancing water and nitrogen use efficiency of rice. Indigenous free living and endophytic nitrogen fixing bacteria were isolated by their ability to grow on nitrogen free media. The bacteria isolated are *Azospirillum* (10 isolates), *Herbaspirillum* (3 isolates), *Glucanoacetobacter* (15 isolates), and *Azotobacter* (2 isolates). Eight bacterial cultures demonstrating the ability to convert nitrate to ammonium have also been isolated. Fifty bacterial isolates, unique in morphology were selected from trytic soy agar plates of acid sulfate (ASU) and acid saline (ASA) soils and tested for different plant growth promoting activities like indole acetic acid (IAA) production, aminocyclopropane carboxylic acid (ACC) deaminase activity leading to reduced ethylene production and the capacity to grow under PEG induced water stress conditions. Nine isolates from acid sulfate soils tested positive for IAA production, four isolates tested positive ACC deaminase activity. From acid saline soils five isolates showed IAA activity and three isolates exhibited ACC deaminase activity while five isolates were able to grow under PEG induced water stress.

In-vitro studies with 8 isolates for their ability to improve germination and vigor index of Swarna seeds indicated two isolates to increase vigor index (VI) and non stress and under PEG induced water stress conditions.

Effect of bacteria on vigor index (VI) of Swarna with or without PEG stress

Treatments Isolate / PEG	Source of isolation	PGPR activity	Control (No PEG)	PEG 15%	PEG 20%
			VI	VI	VI
Control (No inoculation)	-	-	2281	1630	1389
Isolate 1	ASA	IAA production	2040	1492	1277
Isolate 2	ASA	ACC deaminase	2290	2220	2087
Isolate 3	ASA	ACC deaminase	2410	2035	1530
Isolate 4	ASU	ACC deaminase	2410	1920	2317
Isolate 5	ASA	IAA production	2130	1872	1670
Isolate 6	ASA	IAA production	2250	2057	1810
Isolate 7	ASU	ACC deaminase	1393	1110	1458
Isolate 8	ASU	ACC deaminase	1981	2190	1910

SSP 05

Selective mechanization of rice cultivation (T. Vidhan Singh)

Mechanical transplanter, drum seeder, manual transplanting and broadcasting were tested for their performance and grain yield of rice. The modified drum seeder developed at DRR with a row to row spacing of 25 cm was used for sowing pre-germinated seed. A prototype of power operated broadcasting machine was evaluated and its performance was not so encouraging due to non-uniform rate of seed dispensing. This prototype is being improvised for uniform seed distribution. The commercially available power operated weeder was tested in *rabi* season and the performance was encouraging. The commercial mechanical weeder for SRI when tested under aerobic rice did not perform well. Conceptual prototype of the weeder is under development.

Power operated weeder under test

SSP 06

AICRIP database management system (B. Sailaja)

A very large number of trials are being conducted at many locations every year under AICRIP. This project is aimed at digitizing and online processing of various AICRIP activities by centralized database concept and through web enabled interactive pages. AICRIP Management Information System (MIS) package was designed with 65 relational tables, 200 stored procedures and 65 user interfaces using Visual Basic and MS SQL and was hosted at http://www.aicrip-intranet.in. The database was updated with real time data of AICRIP 2011. The centers (funded and voluntary), discipline wise cooperators, trials and seed dispatch details were entered successfully into the database. User names and passwords were communicated to each center and real time data on trials was received from different centers (20%). Seed receipt and crop condition forms were modified to suit the requirements of different disciplines. Independent analysis and report modules of statistical designs (RBD and Split-plot) were validated with the data of 2011 and modified according to the requirement of different disciplines. Production Oriented Survey (POS) form was modified and divided into 4 sub-forms *viz.,* district details, management parameters, availability of inputs and biotic constraints. Socio-economic data formats were designed to integrate with www.aicrip-intranet.in.

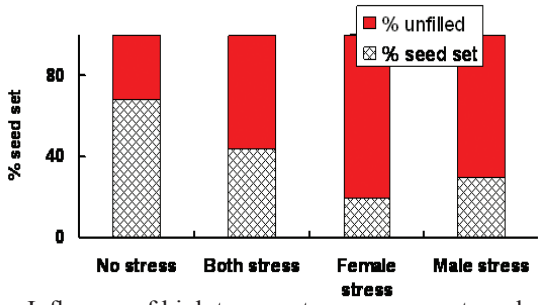
CCR - Assessing and Managing Crop Response to Climate Change

CCR 01

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

A field experiment was conducted with 16 rice genotypes to study the impact of high temperature during grain filling. The results revealed adverse influence of high temperature on the processes of water relations and photosynthesis and also the yield attributing characteristics. The number of unfilled grains also significantly increased. However, the TDM was not affected. A significant amount of carbon was remobilized from the stems and leaf sheath supplementing the carbon obtained through the photosynthesis. Carbon remobilization was studied by estimating the stem weight at flowering and at maturity. The TDM reduction was higher and lower remobilization efficiency was observed in IET 21404, PA-6201 and Akshayadhan. Membrane thermostability in the boot leaves examined at 60 and 90 days. Triguna had higher relative injury (55.8% & 60.5%) throughout while lower relative injury was observed in the IET 20905 (37.22%) at 60 and IET 20915 (33.93%) at 90 days respectively.

Impacts of high temperature at panicle initiation stage on megasporogenesis and microsporogenesis also were studied. In general, a rise in temperature of 3.5^0 C was observed to result in an additional loss of 24% seed set compared to normal situation. The results also showed that in female stressed plants the seed set was 40% (equivalent of 24% is 9.6%) whereas in male stressed plants the seed set was 60% (equivalent of 24% is 14.4%). Genotypic variation existence was also observed in this study, which might be useful to develop temperature tolerant genotypes.



Influence of high temperature on per cent seed set

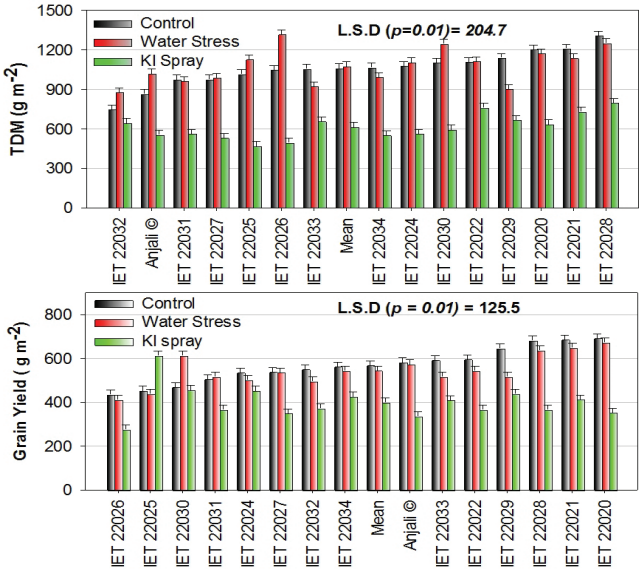
Make shift heat tunnel in the field

CCR 02

Influence of post-anthesis water stress on stem carbohydrate reserve mobilization in rice (D. Subrahmanyam)

Field experiments were conducted to investigate the influence of water stress on stem carbon remobilization with 15 genotypes during *rabi* and 18 genotypes during *kharif*. Additionally, pot culture experiment was conducted to investigate the influence of water stress on the leaf photosynthetic characteristics. A marginal reduction in grain yield was noticed in some genotypes (IET-22031, Anjali, and IET 22034) under water stress suggesting better mobilization of stem reserves into grains. During *kharif*, PHB-71, PA-6201, DRR dhan-39 Rasi, and KRH-2 recorded marginal increase (<10% increase) in grain yield under water stress. KI spray @ 0.3% significantly reduced the grain yield due to complete inhibition of leaf photosynthesis. IET-22024 recorded minimum reduction in grain yield (15% over control) while DRR Dhan-39 and Shanti registered a small increase in yield during *kharif*.

The pot culture experiment showed significant reduction in photosynthesis rate, stomatal conductance, transpiration rate, and greater difference between leaf temperature and air temperature under water stress. However, the internal CO_2 concentration, transpiration efficiency (A/T) and intrinsic water use efficiency (WUE) were not significantly influenced by the stress. Leaf position significantly (P<0.01) influenced stomatal conductance, transpiration rate whereas Ci was not influenced. The interactions between variety x treatment and leaf position x treatment were also found to be significant.



Influence of post-anthesis water stress on total dry matter production and grain yield of different genotypes during *rabi* 2011

CCR 03

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

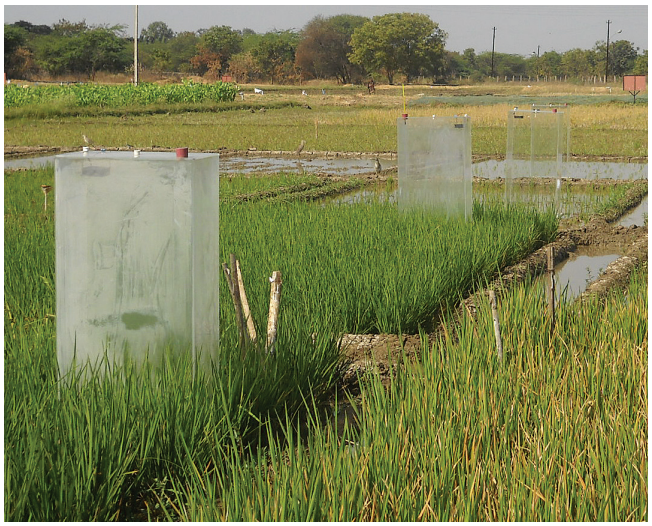
The results of the study on the effect of different sources of nitrogenous fertilizers (Urea, DAP and Ammonium sulphate) and cultivars (DRRH2, Varadhan and MTU 1075) on the yield of rice and nitrogen use efficiency in *rabi* 2010-11 have shown no significant differences between the three cultivars tested. Of the three N fertilizers tested, ammonium sulphate recorded significantly higher grain yield of 7 t/ha as compared to 6 t/ha obtained with urea and 5 t/ha with DAP. Nitrogen use efficiency (NUE) significantly differed with the N fertilizer used. Ammonium sulphate recorded the highest NUE of 55 kg grain/kg N applied followed by urea (51 kg grain/kg N applied) and DAP (42 kg grain/kg N applied).

The results of the study on the effect of rice establishment techniques {direct wet sown in rows (WSR) and transplanted (TPR)} with staggered sowing at monthly intervals from July 2011 onwards on rice yield, NUE and N_2O flux, have shown that yields of the July 2011 sown crop were the highest with 5.90 and 4.98 t/ha in WSR and TPR, which decreased with sowings in the subsequent months. WSR matured a week earlier and gave (3-18%) higher yields than TPR crop owing to higher number of panicles/hill. There was severe occurrence of blast in rice crop sown from September to November 11 as the low night temperatures were congenial for the occurrence of the disease. The N uptake and nitrogen use efficiency (NUE) following the trend of grain yield were highest in July sowing (Total N uptake 112 & 106 kg N/ha and NUE 49 and 42 kg grain/kg N applied in WSR & TPR).

Measurements of the emission of nitrous oxide have shown that, the N_2O flux ($\mu g/m^{2/}h$) decreased with time after fertilizer application. Among the two establishment techniques, WSR resulted in higher N_2O flux over TPR.

Effect of staggered monthly sowings/plantings on productivity and NUE of rice

Sowing / Planting	Grain Yield (t/ha)		Total N uptake (kg/ha)		NUE (kg grain/kg N applied)	
	WSR	TPR	WSR	TPR	WSR	TPR
Jul-11	5.90	4.98	111.9	105.5	49.2	41.5
Aug-11	3.83	3.47	87.7	81.1	31.9	28.9
Sep-11	1.30	1.20	44.5	43.3	10.8	10.0
Oct-11	0.64	0.62	30.8	30.1	5.3	5.1
Nov-11	3.36	3.07	81.8	81.1	28.0	25.6



Closed chambers for collection of nitrous oxide samples

CCR 04

Crop growth models for simulating climate change responses in irrigated rice (S. Ravichandran)

Annual crops often exhibit S-shaped growth patterns and logistic equation has long been used to describe those patterns. However, a curious growth pattern was observed for irrigated rice. There was a slowing down in growth as the reproductive organs developed and a marked upswing in growth after flowering. Thus, the crop has two phases of logistic growth: the vegetative growth followed by the reproductive growth. These two are nearly equal phases of growth, with about half of the first phase of vegetative growth preceding reproductive growth.

In view of these empirical observations, a Logistic Model was fitted separately to the vegetative and to the reproductive phase. When the curves were summed, the combined curve gave a good description of the time course of above-ground dry matter, capturing the pause in growth and its resumption. The overall pattern of growth could be seen to be the result of this bi-phasic nature of the crop. Variations in the panicle phase of growth were shown to be largely a consequence of year-to-year variations in weather, whereas the vegetative phase seemed largely independent of those variations.

To explore the temperature-yield relationship over time, the sample was split into two time periods of equal length, 1950–1977 and 1978–2005. The non-linear relationship between yield and temperature observed between 1950 and 1977 was similar to the one observed between 1978 and 2005. The critical threshold when temperatures become harmful is rather robust over time. The temperature-yield relationship across sub-samples was similar. Because of technological changes, average yields in the more recent sample are about twice those in the earlier sample. Yield growth increases gradually with temperature up to 29–32°Celsius, depending on the crop, and then decreases sharply.

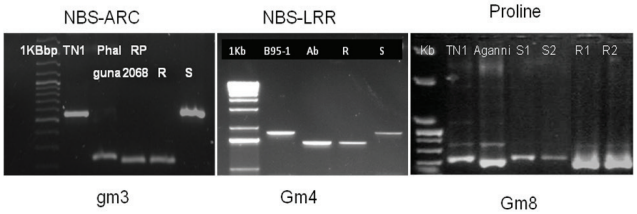
HRI – Host-Plant Resistance against Insect Pests and its Management

HRI 01

Host-plant resistance to gall midge (J.S. Bentur)

Two new sources of gall midge resistance, INRC174704 and IR64-mutant (IET20545) were identified. Nature and genetics of resistance and molecular allelism tests suggested possibility of having new resistance genes in these donors.

Differential gene expression studies involving suppressive subtraction hybridization based cDNA library and microarray analyses followed by realtime validation of candidate genes suggested gall midge resistance in Suraksha with *Gm11* to be akin to plant response to pathogens, while resistance in Kavya with *Gm1* gene was of a novel type. Susceptibility involved more complex gene interplay.



Gene specific markers for *gm3*, *Gm4* and *Gm8* genes developed

Rawat et al. 2012. Funct. Int. Genom. 12:249-264
Rawat et al. 2012. Rice (Online)

HRI 02

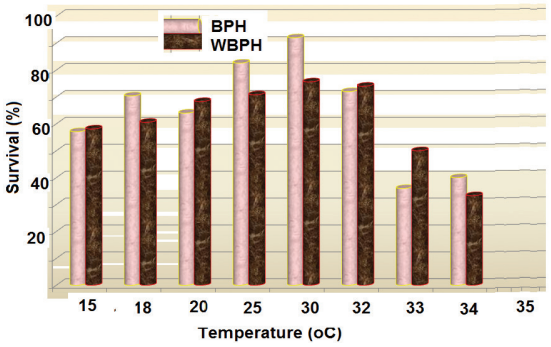
Host-plant resistance to brown planthopper (BPH) and white backed planthopper (WBPH) (V. Jhansi Laxmi)

Over 3000 entries consisting of advanced breeding lines and germplasm accessions were evaluated against BPH in greenhouse and 60 entries were promising with low damage score below 5.0. Similar evaluation against WBPH identified 41 as promising. KAUM 166-2, TR2004-029 and germplasm accessions IC# 463272, 463328, 545463 and 576923 had resistance against both the planthoppers.

Studies revealed that wild rices have the tolerance mechanism against planthoppers. Nymphal survival was comparable with that on susceptible check but at the same time the wild rices could withstand the hopper populations without any damage to the plant. Hoppers excreted less quantity of honeydew on wild rices as compared to the susceptible check.

Some of the weeds found near the rice field were tested for their suitability for the survival and development of BPH and WBPH. While WBPH could survive and complete life cycle on *Echinochloa crusgalli* and *Chloris barbata*, BPH could not do so on any of the weeds tested.

Development of BPH and WBPH at 9 constant temperatures and 60% RH revealed 25-30° C to be the most favourable temperature range for both the insects.



Survival of nymphs of BPH and WBPH at different constant temperatures

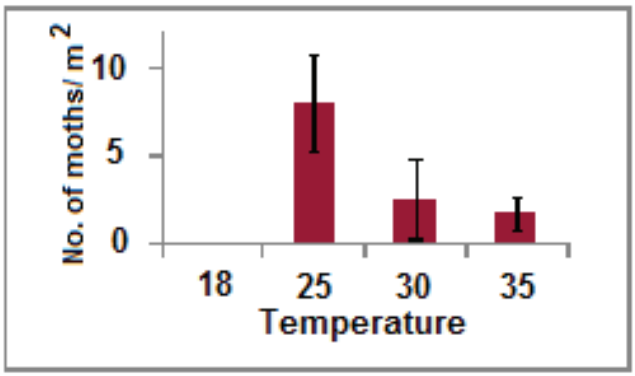
HRI 03

Host-plant resistance to yellow stem borer (YSB) (A.P. Padmakumari)

Biology of YSB moth on 6 rice varieties under caged condition was studied by releasing neonate larvae at booting stage. None of the released larvae could develop into adults. But 22.5 to 100% larvae survived in the stubbles in 5-7th instar. White ear (WE) damage in the varieties ranged from 8-80%. Negative correlation was observed between white ear damage and grain weight. Re-evaluation of 23 BC_3F_5 lines of IR64/*O. glaberimma* showed all the lines with ≤ 6 % WE.

Adult emergence from stubbles could be observed only under controlled conditions when stubbles were uprooted from the field and incubated between 25-35^{0}C temperature and 60 ±5% RH. No emergence was observed at 18^{0}C. At a constant temperature of 25^{0}C nearly 8 moths/sq.m. emerged over a span of 5-22 days. With the increase in temperature there was a decrease in the emergence of adult moths from the stubbles. This indicated the potential of stubbles as a source of YSB for the next season.

Population growth rates of YSB were recorded from two varieties PB1 and BPT 5204. A single unparasitized egg mass pinned at maximum tillering stage under caged conditions could cause a damage of 6.4- 7.3% DH/sq.m. The number of pupae developed from a single egg mass was very low due to high mortality rate.

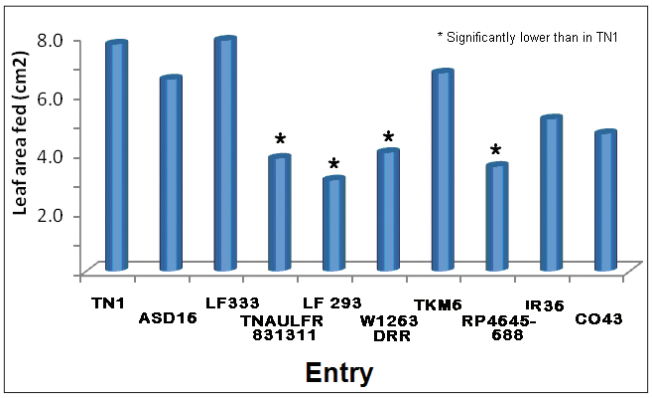


HRI 04

Host-plant resistance to leaf folder (Ch. Padmavathi)

Field screening of 112 entries under augmentative release of leaf folder adults revealed that 10 entries were promising with less than 5% damaged leaves *viz.,* PTB12, SB319 (TN1/W1263), CO43, ADT46, GEB24, TKM6, IC115737 and three breeding lines. Twenty entries with low damage in the field screening were screened in greenhouse using 30-day plants and exposing to a single third instar larva for 48 hrs for feeding. Entries were assessed in terms of leaf area damage with ImageJ program. TNAULFR831311, LF293, W1263 (DRR) and RP4645-688 recorded significantly lower leaf damage when compared to the check TN1.

Studies on the development of rice leaf folder in 20 low damage entries and TN1 revealed that the larval survival ranged from 24 to 92% on different entries. Lowest larval survival of 24% was observed on TKM 6, followed by Choorapundy (28%) and IC115737 (32%). Weights of pupae developed from different entries ranged from 15.1 to 19.9 mg per pupa. Lowest number of adults emerged from IC115737 (12%) followed by RP 4645-688 (13%) while highest from TN1 (89%) followed by Aganni (72%).



HRI 05

Host-plant resistance to nematodes (J.S. Prasad)

Among eight rice cultivars tested in field conditions, maximum root population of rice root nematode *Hirschmanniella* spp. was observed in case of TN1, followed by Suraksha and Phalguna.

Rice cultivars TKM6, Annada, Suraksha and Ramakrishna, showed resistant reaction to rice root-knot nematode, *Meloidogyne graminicola.*

HRP – Host-Plant Resistance against Pathogens and its Management

HRP 01

Resistance to bacterial leaf blight (BLB) (G.S. Laha)

Three hundred and forty one cultures from different sources were evaluated for BB resistance under controlled conditions. The promising entries with a score of 1 or 3 are being evaluated for broad spectrum resistance using multiple isolates of the pathogen.

Genetic variability of 54 isolates of *Xanthomonas oryzae* pv. *oryzae* collected during 2010 was studied with Jel-1 (F) and Jel-2 (R) primer (based on the repetitive element *IS1113*). The PCR product was visualised on ethidium bromide stained gel.

Promising lines with BLB resistance
Cisadane, IR 83265-1-1-13-1-1-27-3-10-1-1-1, IR 83265-1-1-13-1-1-6, IR 83265-1-1-13-1-1-6-1-1-1-1-1, IR 83265-1-1-13-3-1-26-1-8-1-2-1, IR 83265-1-1-13-40-1-10-1-1-1-1, IR 83265-1-1-13-40-1-10-1-1-1-1-1, CB-00-15-64 and CRR 650-B-195-1-B
IET # 22119, 22841, 22289, 21786, 21801, 22842, 21405, 21415, 22491, 22514, 22715, 22726, 22432, 22433, 21840, 22465, 22471, 22476, 22477, 22478, 22479, 22483, 22492, 22493, 22515, 22516, 22517, 22533, 22541, 22542, 22549, 22550, 22583, 22584, 22585, 22600, 22601, 21937, 22728, 22791, 22793, 22323, 22379, 22380 and 22384

(Ram T et al. 2011. Plant Breed. 130: 715-718)

HRP 02

Host plant resistance to RTV (D. Krishnaveni)

From the earlier studies, the major locus for rice tungro disease resistance (qRTV-7) was identified in 17 -19 Mb region of chromosome 7. Seven primers targeting four candidate genes showed differential expression under real time PCR condition.

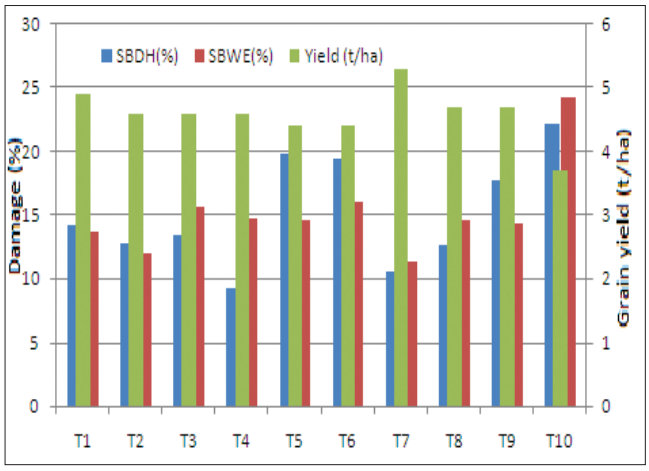
Eight entries of the 38 introgressed lines from wild rice scored 1 when screened for RTD resistance. These are: IRGC-80434, IRGC-8379-6, TRP-32, TRP-36-1, TRP-46, TRP-63 (BPHR), TRP-64-2, TRP-69-4.

IPM – Integrated Pest Management

IPM 01

Chemical control of insect pests in IPM (G. Katti)

A field experiment was conducted to screen newer insecticides *viz.,* a new formulation of sutathion-triazophos 40 EC @ 300 and 500 g a.i./ha and sulfoxaflor 24 SC @ 75 and 90 g a.i./ha along with the checks hostathion-triazophos 40 EC @ 300 and 500 g a.i./ha, rynaxypyr 20 SC @ 30 g a.i./ha, acephate 75 SP @ 500 g a.i./ha, monocrotophos 36 WSC @ 500 g a.i./ha and untreated control for their efficacy against insect pests in rice during *kharif* 2011. Stem borer incidence was the lowest in rynaxypyr treatment. Sutathion-triazophos at both the doses showed lower white ear damage but dead heart damage was relatively high. All the treatments were significantly superior to the control. Yield differences were also significant and rynaxypyr showed the highest yield of 5.3t/ha. The next best treatments were sutathion triazophos @ 300 g a.i./ha (4.9t/ha) followed by acephate and monocrotophos (4.7t/ha). Overall, rynaxypyr 20 SC @ 30 g a.i./ha was the best treatment in terms of low pest damage and high yield followed by sutathion triazophos @ 300 g a.i./ha.



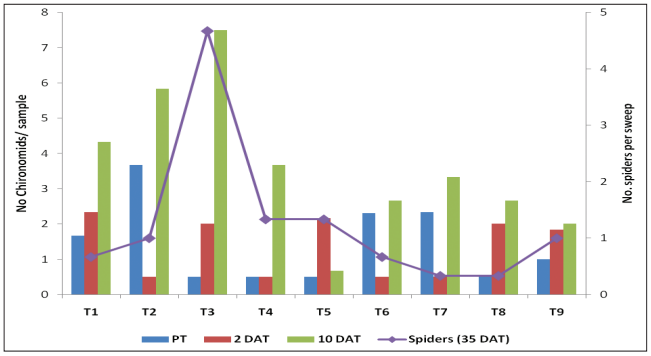
Efficacy of newer insecticides against insect pests and grain yield

IPM 02

Arthropod biodiversity of irrigated rice ecosystem and its functional significance (Chitra Shanker)

Aquatic samples examined from rice contained mainly Daphnia, chironomids, ceratopogonid and culicids larvae on the lower trophic level with damsel fly and dragon fly naiads, *Micronecta* sp., *Notonecta* sp., Pleids, hydracarina on the second trophic level as predators. *Micraspis univittata* was the prevalent species in Maruteru. *Scirpohaga fusciflua* was the white stem borer species from Pattambi, Moncompu and Kaul.

Plots applied with phosphocompost showed higher abundance of chironomids which also corresponded with higher abundance of spiders. Treatment with micronised zinc oxide spray at active tillering phase had the least species richness as indicated by Margelef index (24.1) when compared to other treatments.



Ecological engineering to increase natural enemy fitness examined the weed plants on the rice bunds for the presence of beneficial fauna and the suitability of the weed species. Nearly 99 per cent of the beneficial fauna recorded were common to rice crop and weeds. Weeds belonging to the family Asteraceae *viz.*, *Ageratum conyzoides*, *Eclipta prostrata*, *Acmella uliginosa* had the maximum diversity of beneficial insects with Shannon's diversity index of 1.80, 1.04 and 0.85 respectively and can be considered for growing on rice bunds/field margins to enhance abundance and diversity of beneficial fauna. These weeds did not compete with rice crop and did not support pests of rice.

IPM 03

Plant parasitic nematodes of rice (J.S. Prasad)

White tip nematode infection was observed in seeds of Pankhari and Gurjari varieties collected from Nawagam, Gujarat. Total nematode population was higher in SRI plots compared to the conventional irrigated plots

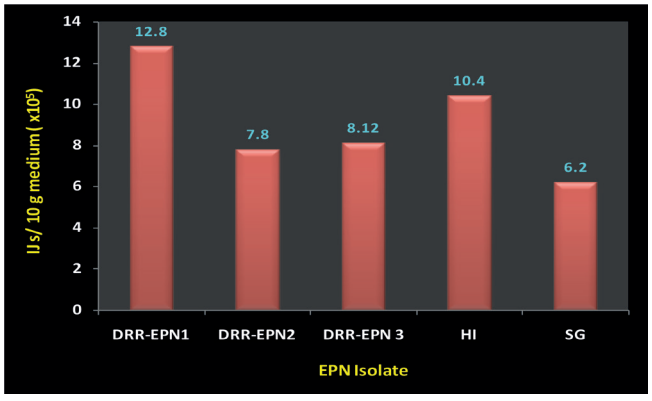
Five *Gluconacetobacter* spp. isolates and 21 other endophytic bacteria were isolated from rice rhizosphere. Of 16 endophytic bacterial isolates evaluated from rice two isolates (RE4D & RE10H) caused 100% mortality of second stage juveniles of *M. graminicola in vitro* after 72 h of exposure.

Three DNA sequences of ITS regions of ribosomal genes pertaining to three rice parasitic nematodes *viz., Meloidogyne incognita* isolate Drr-Mi1, *Meloidogyne graminicola* isolate Drr-Mg1 and A*phelenchoides besseyi* isolate Drr-Ab1 (Acc. Nos. JF949755.1, JF949754.1 & JF932290.1) were deposited in NCBI Gene bank.

IPM 04

Entomopathogenic nematodes (EPN) in rice IPM (N. Somasekhar)

EPN sprayed on rice stubbles after harvest in field could locate and infect the stem borer larvae inside the stubbles. Interactions between EPN and PPN (plant parasitic nematodes) in rice revealed that concomitant inoculation of EPN (*S. glaseri*) and PPN (root-knot nematode *M. graminicola*) resulted in reduced gall formation by the later. *Heterorhabditis* sp. was detected in soil samples from Vyara, Gujarat. Among EPN isolates tested, *Steinernema glaseri* and *Oscheius* sp. showed better survival (85-90%) in synthetic polymer based preparation when stored under refrigeration or at room temperature. A modified NGM agar medium was standardized for *in vitro* culturing of *Oscheius* sp in petri dishes which yielded more than 1 lakh nematodes per dish. Yield of infective juveniles *in vitro* production system on Bedding's method, ranged from 6.2 lakh to 12.8 lakh IJs/10g medium. Among EPN isolates tested, maximum yield was recorded in case of DRR-EPN1 followed by HI (*Heterorhabditis indica*).



IPM 05

Biology and rearing of rice white stem borer, Scirpophaga fusciflua Hampson (M. Mohan)

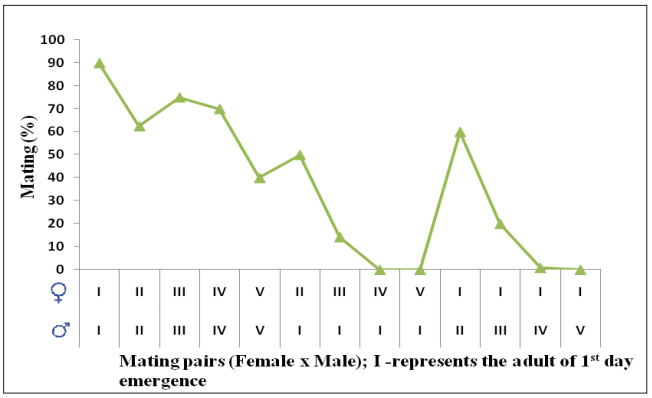
White stem borer (WSB) moths collected from the rice field and light traps from different locations in Kerala have been identified as *Scirpophaga fusciflua* Hampson. It belongs to the family Pyralidae and sub family Schoenobiinae. Larvae of WSB were reared on cut pieces of baby corn cob or rice stem until they pupated. In baby corn, the larval growth was relatively fast as compared to rice stem. Larvae successfully pupated only inside a rice stem. A simple combination of semi synthetic diet without any rice component was found to support larval growth and molting from 1st to 5th instar. However pupation did not occur despite attaining critical weight by 5th instar larva, propably due to lack of proper physical/environmental condition. Direct contact with water or high surrounding moisture content for 5th instar larva seems to be essential for normal pupation.

Well developed WSB larvae on semi-synthetic diet

IPM 06

Semiochemical approaches to IPM (M. Sampath Kumar)

Adult emergence pattern and courtship behaviour of pink stem borer, *Sesamia inferens* were studied in order to identify the time at which pheromone glands of females secrete as such information is pre-requisite in isolation and identification of biologically active components. Peak male moth emergence (ca. 50%) was noticed during 20.00 hrs while females emerged, around 22.00 hrs. After 2 to 4 hrs of emergence female moths assumed calling postures and also exhibited a range of behavioural patterns such us antennal rotation, wing vibration/fluttering chiefly in the scotophases between 22-23 hrs and 0 to 0.30hrs. Mating took place between 0.45 hrs and lasted for 1.35 ± 0.20 hours. After mating, males and females moved apart and the decoupling mechanism ended the courtship behaviour. A series of experiments revealed that mating success rate was the highest with one day old females (90%) and it decreased in five day old females (40%). Unmated 5 day old females laid unfertilized eggs.



Influence of age of female and male moths on mating success

IPM 07

Chemical control of fungal diseases (M.S. Prasad)

A new formulation of fungicide *viz*., kresoxim methyl 40% + hexaconazole 8% WG (RIL – 068/F1 48 WG) at two concentrations *i.e.,* 1 g/l and 0.75 g/l was evaluated along with commercially available popular fungicides like hexaconazole 5 SC 2 ml/l, propiconazole 25 EC 1 ml/l, tricyclazole 75 WP 0.6 g/l and carbendazim (12%) + mancozeb (63%) 1.5 g/l against blast disease. The test chemical at both the concentrations reduced the severity and incidence compared to the check. At higher concentration it was found superior to other commercial fungicides tested. Another new molecule pyridine tested separately was effective as preventive @ 0.5 g/l against blast.

Of the 2762 rice lines evaluated on uniform blast nursery beds for resistance against leaf blast, 394 were found resistant.

Blast resistant lines were developed by introgressing *Pi1, Pi2* and *Pikh* genes through MAS in the background of Samba Mahsuri and Swarna. Some of the lines even exhibited resistance to multiple diseases.

Performance of blast resistance gene *Pi1* introgressed lines through MABB in the background of BPT5204 and Swarna in UBN

IPM 08

Chemical control of bacterial leaf blight (G.S. Laha)

Efficacy of three chemicals *viz.,* isotanil, alliete and kocide to control bacterial blight was tested at three dosages under glass house using TN1 as test plants. The plants were inoculated with DX-020 isolate of the pathogen after treatment with the chemicals. Three days after inoculation, the plants were again sprayed with the respective chemicals. Third spraying was done 10 days after the 2nd spraying. Observations on lesion length were taken 7 days after the final spray. None of the chemicals was very effective. Only isotanil at higher dose (1.25 ml/l) was moderately effective in reducing the lesion length.

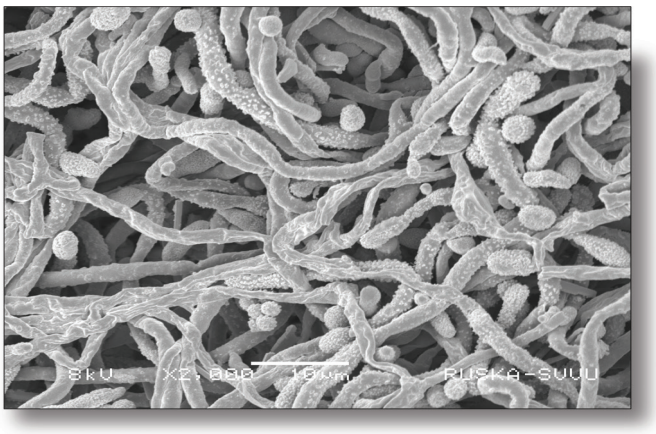
IPM 09

Biology of false smut disease of rice (D. Ladha Lakshmi)

Seventy isolates of the false smut pathogen, *Ustilaginoidea virens* were collected, isolated using potato dextrose agar medium and are being maintained as pure cultures. Twelve ISSR markers were selected to study the variation among the isolates. Scanning electron microscopy study revealed that the chlamydospores are globose to irregularly round in shape with prominent spines on its surface with the diameter of 4 to 6 µm. The chlamydospores germinate by germ tube, which become septate and form conidiophores which bears primary conidia at the tapering apex

The pathogen was mass multiplied on different cereals of which bajra and ragi proved most suitable.

Among the fungicides tested against the pathogen, trifloxystrobin 25% + tebuconazole 50% (75 WG) at 0.02%, 0.04%, 0.06% concentrations and propiconazole (25 EC) at 0.05%, 1% and 1.5% were effective in inhibiting the fungal growth.



TTI – Training, Transfer of Technology and Impact Analysis

TTI 01

Awareness, perception and constraints in IPM adoption (Mangal Sain)

Information collected from 245 rice farmers in 50 villages of nine districts of Uttar Pradesh and Odisha showed that IPM practices were adopted more (55%) by farmers in villages nearby and adopted by KVKs, agricultural university or other national institutes. Most of the respondents were not aware of the toxic effects of pesticides and relied on local input dealers for information on pest and disease management. Lower awareness was attributed to the non-adoption of IPM practices. Results of this project were similar to those conducted earlier in Andhra Pradesh.

TTI 02

Gender dimensions in rice cultivation and labor migration and livelihoods (Amtul Waris)

A study has been initiated to identify indicators for measuring the empowerment of women in rice-based cropping systems of Andhra Pradesh with a sample size of 120 farmers and farm women. Indicators examined were: i) Women's role in decision making related to rice-based cropping systems with sub-dimensions of gender activity profile ii) Access to productive resources iii) Control over income including the access and control dimensions iv) Individual leadership and status in the community, socio-political profile of women's position and v) Time allocation for farm activities.

The study showed that weeding was perceived by farm women as most drudgerous work in agricultural activities. Majority (74%) of the respondents in all the surveyed villages reported that the agriculture labour costs had increased due to implementation of the MGNREGA scheme.

TTI 03

Sustainable rice production practices: problems and prospects (P. Muthuraman)

A study on sustainability of rice production practices was carried out in the rice growing areas of Punjab. The major constraints were depletion of ground water, power shortage, labour problem, degradation of soil due to excessive application of fertilizers and unfavourable procurement policies of the state. The government of Punjab encouraged farmers to take up *kharif* rice from June onwards in order to save the water and also to opt SRI or aerobic rice and growing green manure crops before *kharif* to rejuvenate the soil fertility. The seeds of green manure crops were distributed at subsidized rate to the farmers and to enhance the efficiency of bore wells the traditional pumps were replaced with modern submersible pumps.

TTI 04

Applications of E-Learning in Agriculture (Shaik N. Meera)

Present research focused on e-readiness and information literacy among rice (extension) workers and tried to assess the feasibility of e-learning strategies for agricultural development in general and rice sector in particular. A total of 18 e-courses were developed on rice production, protection and other technologies which are available online at www.moodle.learnrice.in. Based on the suggestions received from the experts, the online version of e-learning platform is also converted into offline version. A methodology has been developed and applied for assessing the learnability and usability of the e-learning platform.

TTI 05

Partnerships: Impact and implications for the rice sector (S. Arun Kumar)

Willingness of the various stakeholders like rice researchers, extension professionals and professionals working in the private sector to enter into partnership mode was probed using survey tools. The data was collected from the scientists of CRRI and other researchers from ICAR institutes and SAUs.

The preliminary analysis of the results revealed that majority of the stakeholders (62.5%) were willing to forge partnerships especially in the technology development activities. There was a gap in the willingness of the researchers to forge partnership in the areas of technology dissemination (37.5%). Lack of mutual trust and egoism among the partners are reported as some of the major inhibiting factors for public-private research/ extension projects in the rice sector.

TTI 06

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

Studies undertaken in rainfed lowland ecologies of Uttar Pradesh, revealed a considerable yield gap. The average yield of the farmers was 3.59 t/ha while the potential yield realized at research station was 5 t/ha (for variety Jalamagna) and the yield in the demonstration plot was 4.52 t/ha. Yield gap I which is the difference between the potential yield and the potential farm yield was 9.6%, while yield gap II, which is the difference between the potential farm yield and actual yield, was 20.6%. The total yield gap which is the difference between the potential yield and the actual yield worked out to be 1.41 t/ha and the index of yield gap was found to be 28.2%. The net returns obtained were Rs.10, 600/ha. The Cost-Benefit ratio in rice cultivation was 1:1.36. Submergence, pests and diseases, weed infestation and imbalanced use of fertilizer were the major constraints in realizing the potential yield in the study area.

Project Completion Reports

DBT funded project on

Improving the Livelihoods of SC & ST Farmers through Rice Technology Interventions (2008-2011)

Salient achievements

- A comprehensive document on beneficiary farmers and their livelihoods was prepared.
- Technological interventions like varietal demonstrations of rice, groundnut, red gram, green gram and cowpea; seed production of rice; IPM in rice and groundnut, drum seeder demonstration, products of biotechnology, mass multiplication were identified through PRAs and group discussions.
- An area of 211 acres was covered and 193 farmers were directly benefitted by the technological interventions made. 68 case studies of beneficiary farmers who got sustainable income enhancement were documented.
- The net incomes of the farmers adopting various technologies have increased and the adoption rates of the technologies were found to be at rise.
- Exposure visits were organized to hybrid seed production facility at DRR. In addition farmers were taken to agri-expos and field days at different locations besides distributing soil health cards.
- Two training programmes were conducted for the beneficiary farmers on various aspects of technological interventions. Under entrepreneurship development activities, 350 kg of *Trichoderma* and 150 *Trichogramma* cards were mass produced and distributed.
- Beneficiary farmers (148) of *Trichoderma* have reported less incidence of fungal diseases in various crops in the treated fields (upto 2%), yield increase up to 4-5% and in case of *Trichogramma* reported 25-30% reduction in chemical fertilizers, less incidence (5%)of stem borer in treated fields and increased yield up to 5%.
- Through entrepreneurship development activities of the project 15 young and enterprising SC/ST farmers were trained for the mass multiplication of products of biotechnology like *Trichoderma* and *Trichogramma*.

DBT funded project on:

Identification of molecular markers linked to quality parameters in rice, their validation and utilization in marker-assisted selection (2008-2011)

Salient achievements

- A major new QTL (qGT-6) for gelatinization temperature on chromosome 6 in the marker interval RM276-RM217 explaining 30.7% phenotypic variance at a LOD score of 10.95 was identified.
- A common QTL for both Kernel length (KL) and Kernel breadth (KB) explaining 6% phenotypic variation was identified within the marker interval of RM 8226 and RM 217 on chromosome XX and another QTL (qKB-8) for kernel breadth explaining 11.2% phenotypic variance on chromosome 8 within the markers RM5493-RM447 and a QTL (qKE-3) on chromosome 3 explaining 8.2% phenotypic variation were identified.
- One QTL for amylose content (AC) (qAC-6) within the marker interval of RM 204 and RM 276 on chromosome 6 explaining 9% of the phenotypic variation and sharing locus with qGT-6 was reported.
- A QTL (qGC-8) explaining 4% of phenotypic variation in gel consistency was identified on chromosome 8 within the marker interval of RM 3395 and RM 22866.
- A simple PCR based marker system (DRR-GL) targeting SNP in second exon of *GS3* gene associated kernel length and kernel was developed to overcome problems with use of earlier reported CAPS marker SF28.
- By selecting the genomic region from the *BAD2* gene responsible for aroma SSR marker ARSSR-3 was developed.

Institutional Activities

Technologies assessed and transferred

Patents and registrations

Revenue generation

Academic activities

Awards/recognitions

Linkages and collaborations

Significant events

Infrastructure developed

Personnel

Publications

Appendices

Technologies Assessed and Transferred

Training programmes

During 2011-12, four structured training programs were organized on various aspects of Rice Production Technologies (RPTs) like Molecular Breeding for Rice Improvement, BT Rice evaluation and deployment strategy, SRI and Hybrid rice. In all 85 participants from SAU's, ICAR, Public & private institution, subject matter specialists from state departments of agriculture were trained. Additionally, 150 progressive farmers from Odisha and Andhra Pradesh were trained in unstructured one day courses sponsored by Agri Biotech Foundation, Hyderabad, INTERFACE Agricultural Technologies, Hyderabad, WALAMTARI, Hyderabad and CARD, New Delhi.

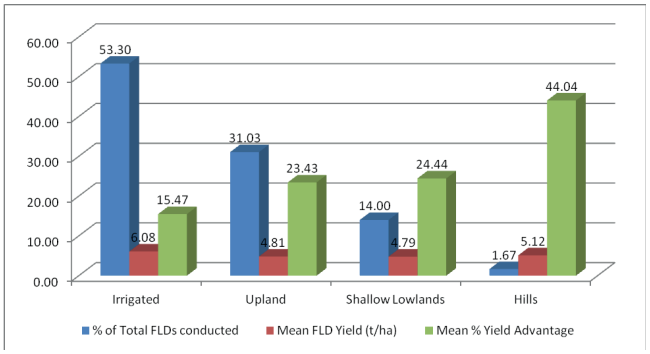
Name of the Training Programme	Dates and duration	No. of Participants	Sponsored by
Molecular Breeding for Rice Improvement	17-30 Aug, 2011 14 days	16	National Agricultural Innovative Project (NAIP), New Delhi
Winter School on BT Rice evaluation and deployment strategy	7-27 Sept, 2011 21 days	27	Indian Council of Agricultural Research (ICAR), New Delhi
System of Rice Intensification (SRI)	28 Sept to 5 Oct, 2011, 8 days	23	Directorate of Extension (DOE), New Delhi
Hybrid Rice Production Technology (HRPT)	29 Oct - 5 Nov, 2011	19	Directorate of Extension (DOE), New Delhi

On farm trial with DRR rice varieties at national level

The on farm evaluation programme has resulted in creating awareness about various IPM practices along with popularization of Improved Samba Mahsuri with BLB resistance. Apart from that, performance of DRR varieties like DRRH 3, Akshayadhan, Varadhan, Sampada, DRR Dhan 38 and DRR Dhan 39 were popularised through demonstrations in the various farmers' fields in different states like Andhra Pradesh, Gujarat, Karnataka, Tamil Nadu, Chattisgarh and Uttar Pradesh. As a part of Tribal Sub-plan Activities to improve the livelihoods of the tribal farmers of Andhra Pradesh, seeds of Krishnahamsa, DRR Dhan 38, DRR Dhan 39 and Sampada were distributed to 30 farmers of Rajapeta Tanda, Kothakota.

Frontline demonstrations (FLDs) on Rice

A cafeteria of rice technologies was demonstrated in 300 FLDs covering 16 states and four major rice ecosystems of the country during the year. About 53% of the total FLDs were conducted in irrigated ecosystems, 31% in rainfed uplands, 14% in shallow lowlands and 2% under Hill Ecosystems. In irrigated ecosystem mean yield of 6.1 t/ha where in shallow lowlands 4.8 t/ha and in rainfed uplands 4.8 t/ha were obtained. Mean yield advantage in irrigated ecosystem was 15.5% while in uplands and in shallow lowlands it was 23.4% 24.4%, respectively. In all, 25 promising technologies have been identified from 14 states.A comprehensive database has been developed on FLDs conducted in the last two decades which is available at http://www.fld.rkmp.co.in.



Ecosystem - wise break up of FLDs conducted, mean yields and yield advantages

Farmers' Day

A Farmers' day was organized on 15 November 2011 at Nallavelli village, Nagar Kurnool Mandal, Mahaboobnagar District, Andhra Pradesh, in association with KVK, Palem (ANGRAU) to showcase the IPM interventions. Posters on various rice IPM interventions undertaken and other related activities were displayed and extension material in Telugu on various important topics of rice production technology were displayed and distributed to the farmers.

Another Farmers' Day was organized by DRR on 17 November, 2011 at Veerareddypalle village of Sirivella Mandal, Kurnool district, Andhra Pradesh to upscale the adoption of Improved Samba Mahsuri in which more than 300 farmers participated in this function.

DRR participation in farmers' fair/exhibition

DRR participated in following state and national level Agri-expos and displayed various rice production technologies farmers various parts of the country were acquainted with the latest rice related technologies.

CRIDA: Farmers Day at Gunegal Farm organised by CRIDA on 21-Sep-2011.

Eastern Zone Regional Agricultural Fair, Feb 21-23, 2012: sponsored by Department of Agriculture and Cooperation organised by Central Rice Research Institute, Cuttack.

Rural Technology Mela, NIRD: during 25 - 28, February 2012, at Rajendranagar, Hyderabad.

Pusa Krishi Vigyan Mela, 1-3 March, 2012: organized by IARI, New Delhi.

Kisan Call Centre

DRR is the part of Kisan Call Centre programme of Government of India (coordinated by MANAGE, Hyderabad).

Mass Media Coordination

About ten scientific talks on various aspects of Rice Production Technologies were delivered by DRR Scientists and broadcasted by AIR Hyderabad.

Visitor's services:

Over 2300 visitors comprising students, farmers, extension officials from various parts of the country and 40 foreigners from various countries visited DRR.

Among the most notable was the Hon'ble Minister of State for Agriculture and Food Processing Industries, Govt. of India. Sh. Charan Das Mahant who visited DRR on 19 Sept, 2011.

Rice Knowledge Management Portal (RKMP)

Vision 2025 document of DRR envisages bridging the yield gap by improving the access to the rice knowledge amongst the rice stakeholders. Accordingly a flagship initiative is undertaken in under Rice Knowledge Management Portal-RKMP (funded by NAIP). First 'extension' centric semantic portal in Indian Agriculture is built and launched in the presence of Hon'ble Prime Minister of India on 16th July 2011. The portal URL is http://www.rkmp.co.in. RKMP now serves as an information highway for sharing rice knowledge across the country. It has several global firsts in terms of comprehensiveness and utility. Built on web 2.0 standards, this portal caters to location specific information needs of many stakeholders in local languages. With about 20 platforms, more than 13,000 pages of content, 3000 minutes of audio, 50 video clips, this is the first comprehensive agricultural portal of the country. Wherever Internet connectivity is not there, offline CDs and brochures/ flyers are prepared and distributed. Various capacity building activities and publicity activities were planned and executed.

Patents and registrations

Gene Sequences submitted to NCBI database

S. No.	Gene Bank Accession No.	Description	Contributors
1	HM149530	Rice tungro spherical virus isolate Cuttack CP3 gene, partial cds	Mangrauthia, S.K., Malathi, P., Agarwal, S., Ramkumar, G., Krishnaveni, D., Neeraja, C.N., Madhav, M.S., Ladhalakshmi, D., Balachandran, S.M. and Viraktamath, B.C.
2	HM627634	Rice tungro spherical virus isolate Puducherry CP3 mRNA, partial cds	Mangrauthia, S.K., Malathi, P., Agarwal, S., Ramkumar, G., Krishnaveni, D., Neeraja, C.N., Madhav, M.S., Ladhalakshmi, D.,Balachandran, S.M. and Viraktamath, B.C.
3	HM149529	Rice tungro spherical virus isolate Kanyakumari CP3 gene, partial cds	Mangrauthia, S.K., Malathi, P., Agarwal, S., Ramkumar, G., Krishnaveni, D., Neeraja, C.N., Madhav, M.S., Ladhalakshmi, D., Balachandran, S.M. and Viraktamath, B.C.
4	JN620497	Rhizoctonia solani strain RPR endo-polygalacturonase-like mRNA, partial sequence	Sailaja, B., Laha, G.S., Ladhalakshami, D., Malathi, P., Singh, J., Maganti, S.M. and Mangrauthia, S.K.
5	JN620498	Rhizoctonia solani strain RNR beta-tubulin mRNA, partial cds	Sailaja, B., Laha, G.S., Ladhalakshami, D., Malathi, P., Singh, J., Maganti, S.M. and Mangrauthia, S.K.
6	JN620496	Rhizoctonia solani strain RNR endo-polygalacturonase-like mRNA, partial sequence	Sailaja, B., Laha, G.S., Ladhalakshami, D., Malathi, P., Singh, J., Maganti, S.M. and Mangrauthia,S.K.
7	HM149532	Rice tungro bacilliform virus isolate Cuttack hypothetical protein gene, partial cds	Mangrauthia, S.K., Brahma, U., Malathi, P., Biswal, A.K., Krishnaveni, D., Balachandran, S.M., Reddy, C.S. and Viraktamath, B.C.
8	HM149531	Rice tungro bacilliform virus isolate Puducherry hypothetical protein gene	Mangrauthia, S.K., Brahma, U., Malathi, P., Biswal, A.K., Krishnaveni, D., Balachandran, S.M., Reddy, C.S. and Viraktamath, B.C.

Revenue generation

An amount of Rs. 19,91,840 was received towards the contractual changes for the evaluation of elite breeding lines for quality, diseases, insects and also assessing the efficacy of new molecules.

A sum of Rs. 2,80,000 was generated as course fee for M.Sc. Bioteh Projects for students.

Testing Fees

Forty entries including 5 varieties and 35 hybrids from 16 centres were submitted to variety testing generating a revenue of Rs. 24 lakhs.

DRR Technologies commercialized

Two hybrids, DRRH 2 & DRRH 3 were commercialized with two private companies (Shakthi Seeds Pvt. Ltd. and JK Agri. Genetics Ltd., Hyderabad) for an upfront payment of Rs. 8,00,000 during 2011-12.

Non-disclosure and Business Engagement Agreement was signed on 8 June, 2011 between DRR and Huntin Organics for commercialization of Mass Production of *Bacillus thuringiensis* (Bt) biopesticide facilitated by FICCI, New Delhi.

Material transfer agreements (MTAs)

Since the constitution of ITMU, the procedure for exchange of seed materials has been well established at DRR. It was decided that DRR scientists would route/exchange the seed materials after filling DRR-MTA form through ITMU. Individual requests for import/export to NBPGR or exchange of seed material with any other agencies would not be entertained without ITMU permission.

During 2011-12 six MTAs have been signed for exchange of seed materials and Rs. 3,700 received as PPH charges.

Academic activities

Fifty nine students from Osmania University, Hyderabad; JNTU and Central University Hyderabad; AN University, Guntur; ANGRAU, Hyderabad are pursuing their Ph.D. under the guidance of DRR scientists and five students were awarded doctoral degrees during the year. About 24 students were trained by DRR scientists for M.Sc. Biotechnology project work.

Ph.D. degrees awarded during 2011-12:

Name	Guide	Discipline & University	Title
Mr. V.S.A.K. Sama	B.C. Viraktamath	Genetics, Osmania University, Hyderabad	Identification, tagging and mapping of new resistance gene(s) against the Asian Rice Gall midge *Orseolia oryzae* in Rice varieties
Mr. Madan Mohan	M.S. Prasad	Biotechnology, JNTU, Hyderabad	Molecular characterization of pathogenic variability of *Pyricularia grisea* (Rice blast fungus)
Ms. Nidhi Rawat	C.N. Neeraja	Genetics, Osmania University, Hyderabad	Identification and characterization of differentially expressed genes in rice involved in rice-gall midge interactions
Mr. Deepak Kumar Sinha	J.S. Bentur	Genetics, Osmania University, Hyderabad	Identification and characterization of differentially expressed genes in the Asian rice gall midge *Orseolia oryzae* involved in insect-plant interactions
Mr. I. Sudharshan	N. Shobha Rani	Botany, Osmania University, Hyderabad	Study of genetic diversity based on agro-morphological physico-chemical and molecular markers in reference collection of rice varieties

Awards / Recognitions

- **DRR** got ***Best DUS Test Centre Award*** for the maintaining large number of reference collection of varieties (RCV) and also for promotion of registration of varieties at Foundation Day programme of the PPVFRA organized at NBPGR, New Delhi on 11 Nov, 2011.
- **DRR** received '***Excellence Award'*** for application of '***Geospatial Technology in Agriculture'*** for the project 'Spatial Rice Decision Support System for Rice Crop Management' organized by India Geospatial Forum 2012 during 7-8 Feb, 2012 at Gurgaon.
- **Dr. R.M. Sundaram** - Lal Bahadur Shastri Outstanding young Scientist Award-2010.
- **Dr. N. Sarla** - Panjabrao Deshmukh Outstanding Woman Scientist Award-2010.
- **Dr. J.S. Bentur** - Rafi Ahmed Kidwai Award for outstanding research in Agricultural Sciences-2010.
- **Dr. Sampath Kumar** - Gold medal for best Ph. D. Thesis by TNAU, Coimbatore.

Linkages and collaboration in India and abroad

DRR signed MOU with CCMB for collaborative research project on "Improving incomes of rice farmers through cultivation of bacterial blight resistance rice variety Improved Samba Mahsuri" on 6 March 2012.

AICRIP Centres

List of funded AICRIP centres along with staff positions during 2011-12 is given in Appendix 3.

Sports Awards

DRR participated in the ICAR Zonal Sports Meet of South Zone held in Hyderabad during 27 Feb to 01 Mar, 2012 and won the following medals:

Medals	Event	Staff
Gold	Chess	Ms. Sudha Nair
	Table Tennis (Doubles)	Dr. Surekha & Ms. Rekha Rani
	Badminton (Doubles)	Dr. Chitrashanker & Ms. K. Kouslaya
Silver	Table Tennis (Doubles)	Dr. G. Padmavathi & Ms. Sudha Nair
	Shot put	Ms. U. Rama
	High jump	Dr. P. Revathi
Bronze	200 metres Running	Dr. P. Revathi
	Long Jump	Dr. P. Revathi

Externally funded projects:

Forty externally funded projects are currently being handled at DRR as on April 2012, with a total budget outlay of 3009.99 L which are listed in Appendix 4.

Significant Events

Meetings

Institute Management Committee (IMC)

The XVI Institute Management Committee (IMC) meeting of DRR was held on 09 May, 2011 Under the Chairmanship of Dr. B.C. Viraktamath, Project Director. The members expressed satisfaction over the research priorities to be included in the draft and suggested to identify 5-6 major programmes covering the entire gamut of rice research for the next five years. The IMC approved the proposal of renovation of old library hall in the CTC and guest rooms in Jaya Hostel (2 suits + 8 rooms).

Research Advisory Committee (RAC)

The Research Advisory Committee (RAC) meeting of the Directorate was held during 10-11 May, 2011 under the chairmanship of Dr. P. Raghava Reddy, Former VC, ANGRAU, Hyderabad. The RAC has critically reviewed the ongoing research programs and made valuable suggestions for improvement in future. The following thrust areas for the XII plan were identified by the RAC:

- Genetic enhancement of yield, quality and nutrition with stability.
- Developing and optimizing water saving technologies.
- Improving soil health, resource and input use efficiency.
- Coping with adverse effects of climate change.
- Selective mechanization to ensure timely operations in the background of shortage of labour and water.
- Stabilizing yields through integrated pest management.
- Innovative approaches involving ICTs for accelerated technology transfer.

Institute Research Council (IRC)

The Institute Research Council (IRC) meetings were held during 23 to 26 May, 2011 under the Chairmanship of Project Director, Dr. B.C. Viraktamath. Experts were invited from different organizations to participate in the IRC meetings and offer their suggestions for the improvement of the programmes. After thorough discussion new research projects were approved. Ongoing and new projects for 2011-12 are listed in the Appendix 5.

Institutional Biosafety Committee (IBSC)

IBSC meeting of DRR was held on 28 March 2012.

Quinquennial Review Team (QRT)

ICAR has constituted QRT for DRR to review the progress during 2007-2011 with Dr. B. Mishra, former V.C., SKUAT, Jammu as Chairman.

Innovative Rice Farmers Meet

Innovative Rice Farmers Meet was organized by Directorate of Rice Research, Hyderabad on 02 August 2011. This was the second such meet organized by ICAR after the first one held at Suttur, Mysore District, Karnataka. The meet was graced by Sh. Vadde Sobhanadreeswara Rao, Former Minister of Agriculture, Govt. of Andhra Pradesh, Dr. K.D. Kokate, DDG (Extension), ICAR; Dr. S.K. Datta, DDG (CS), ICAR. Kokate A folder "DRR in the service of Farming Community" and a book "Rice Innovations" edited by Drs. Shaik N. Meera, S. Arun Kumar, Mangal Sain and B.C. Viraktamath were released during the meet. Farmers have shared their experiences under different categories *viz*., innovations on varietal selection, innovative methods/ practices in rice cultivation, innovations in water, pest, disease, weed management and innovative farm machinery / post harvest technology and value addition. Selected farmers from all over India were honored for their innovations under different categories.

हिन्दी गतिविधियाँ

तिमाही बैठकों का आयोजनः हिन्दी कार्यान्वयन की स्थिति की जायजा लेने के लिए निम्नांकित तिथियों में चावल अनुसंधान निदेशालय की राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन किया गयाः (1) 13.7.2011 (2) 30.8.2011 और (3) 23.1.2012

हिन्दी कार्यशालाओं का आयोजनः इस निदेशालय के सभी वर्ग के कर्मचारियों में हिंन्दी में काम करने में होनेवाली झिझक को दूर करने के लिए निम्नांकित दिनों को हिन्दी कार्यशालाओं का आयोजन किया गयाः (1) 21.9.2011 और 27.1.2011

डी.आर.आर. समाचार का प्रकाशन : अप्रैल, 2011, जुलाई, 2011 और अक्तूबर, 2011 अंकों का प्रकाशन किया गया।

हिन्दी सप्ताह का आयोजन : इस निदेशालय द्वारा 14 सितंबर, 2011 से 22 सितंबर, 2011 तक हिन्दी सप्ताह का आयोजन किया गया । इस अवसर पर 14 सितंबर को कार्यकारी निदेशक एवं प्रधान वैज्ञानिक डॉ. जे.एस.प्रसाद द्वारा कार्यक्रम का उद्घाटन किया गया। डॉ. डी. वेंकटेश्वर्लु ने स्वागत भाषण दिया। इस सिलसिले में अनेक प्रतियोगिताओं का आयोजन किया गया जिनमें वैज्ञानिक पोस्टर प्रस्तुतीकरण भी सम्मिलित है। 22 सितंबर, 2011 को परियोजना निदेशक डॉ. बी.सी. विरक्तमठ की अध्यक्षता में समापन समारोह संपन्न हुआ। प्रो. जयकिशन, उस्मानिया विश्वविद्यालय इस समारोह के मुख्य अतिथि थे। मुख्य अतिथि के करकमलों द्वारा प्रतियोगिताओं के विजेताओं को पुरस्कार वितरित किये गये। सुश्री वनिता ने उपस्थित वैज्ञानिकों और कर्मचारियों को धन्यवाद ज्ञापित किया।

World Food Day

World Food Day was organized on 18 October 2011 to create awareness about the state of the world's hungry and malnourished. In order to focus on this years' theme, Food Prices-Crisis to Stability an open house discussion was held among the scientists. A guest lecture on 'Phytosterols an essential functional ingredient for CVD risk reduction in India' was delivered by Dr. Xxx.

Women in Agriculture Day

Women in Agriculture Day was celebrated on 5 Dec, 2011. On this occasion, Dr. Indu Sharma, Director, Directorate of Wheat Research, Karnal, Hissar addressed the staff and traced the progress of professional women in the field of agriculture. An eye-camp was organized especially for the farm labour of DRR in collaboration with an NGO-Vision Springs.

Vigilance awareness week

Vigilance Week was observed from 31 October- 5 November, 2011.

Workshop, Summer Institute, Trainings

Molecular Breeding for Rice Improvement

A national training course on "Molecular Breeding for Rice Improvement" was conducted under National Agricultural Innovation Project (NAIP) of ICAR during 17-30 August, 2011 in order to train NARES crop breeders and biotechnologists with the basic knowledge and skills related to molecular markers and transgenics along with genomics. A total of 16 participants attended the training course. The course consisted of both theoretical lectures and practical (hands-on) exercises followed by an interactive debate/ session with experts on the emerging topic "GMOs and their public acceptance".

Winter School on Bt rice evaluation and deployment strategy

An ICAR sponsored Winter School on "Bt rice evaluation and deployment strategy" was organized at the Directorate during 7-27 Sept, 2011 with a view to sensitize and train rice scientists with the basic knowledge and skills related to development and deployment of Bt rice. Dr. S.M. Balachandran, Principal Scientist (Biotechnology) organized the Winter School as the Course Director with the support of Drs. J.S. Bentur, A.P. Padmakumari, M. Mohan, S.K. Mangrauthia and P. Muthuraman as Course Coordinators. Twenty four participants from 11 states covering different ICAR institutes and agricultural universities attended the Winter School.

System of rice intensification (SRI)

A Model Training Course on System of Rice Intensification sponsored by the Directorate of Extension (DOE), New Delhi was organized at the Directorate from 28 September to 5 October, 2011. Twenty three participants from eleven states were trained in this program.

Hybrid Rice Production Technology

The Directorate of Extension, New Delhi sponsored model training course on "Hybrid Rice Production Technology" was organized by this Directorate's Centre of Excellence for Training in Rice from 29 October - 5 November 2011. The main aim of this training was to develop confidence among the trainees, by equipping them with knowledge and skills on hybrid rice production technology. Nineteen participants from 11 states were trained in this program.

47th Annual Rice Group Meetings

Directorate of Rice Research organized the 47th Annual Rice Research Group Meeting during 7-9 April, 2012. Dr. Swapan Kumar Datta, DDG (Crop Sciences), ICAR was the chief guest. About 450 rice researchers from India and abroad actively participated in the three- day meet. The results of research work of the last year were reviewed and new programmes were chalked out for the next year. Eight new rice varieties and ten hybrids were identified and recommended for submission to the central committee. Seven technical bulletins prepared by DRR were released during the Meetings.

The recommendations of the workshop are as follows:

Varietal Improvement

- The Varietal Identification Committee recommended ten hybrids and two varieties.

Agronomy

- Identified ten promising cultures for low N (50% recommended dose) fertilization *i.e.,* IET 21393 (Early hill, Irrigated), IET 21375 (Medium hill, Irrigated), IET 21326 (upland hill, direct seeded), IET 21044 (aromatic short grain), IET 21669 (basmati), IET 21278 (very early, transplanted), IET 21401 (early, transplanted), IET 21405 (medium early, transplanted), IET 21519 (irrigated medium, transplanted), and IET 21449 (IHRT medium slender).
- Developed technology for enhancing rain fed upland rice productivity by 60% by intercropping it with soybean/ cowpea/urdbean in 4:2 replacement series and weed management through pendinethalin (pre-emergence) + hand weeding at 25 days after sowing.
- Established that by manipulating non-monetary inputs of sowing time and variety selection, aerobic rice realizable yields could be enhanced substantially.
- Improved rice yields (2-20%) coupled with exclusion of human drudgery and minimized labour costs in mechanical transplanting as compared to manual transplanting proved the utility of mechanization in rice culture beyond doubt.
- Herbicides penoxsulam + cyhalofop-butyl @ 120 g/ha in transplanted rice and penoxsulam + cyhalofop-butyl or penoxsulam or carfentrazone-ethyl or metamifop in direct seeded rice were found effective for managing weeds.
- In rice-based cropping systems, *rabi* crops grown after direct seeded rice with mulch gave higher yields.

Soil Science

- Addition of organic manures along with recommended NPK and micronutrients (Zn, Fe, Mn, B, Si), increased the crop productivity and nutrient uptake of rice in near neutral and acidic soils of Mandya, Pattambi and Ranchi and in both wheat and rice in sodic soils in IGP.

- TKM-9 and Aghonibora at Karaikal, MTU 1061 and 1064 at Maruteru, Aghonibora at Titabar and HKR 127 at Kaul were most promising with regard to partitioning of zinc and iron. About 22-54% and 22-48% of Zn and Fe, respectively were translocated to the grain. Organic manuring along with micronutrient application improved grain nutrition of Fe and Zn.
- Regulated irrigation equivalent to 100-150% of cumulative pan evaporation (CPE) and nutrient application of 120-180 kg N, 60 kg P_2O_5 and 50-100 K_2O maximized productivity of aerobic rice in Indo Gangetic plains and Deccan Plateau region.

Plant Physiology

- For mid-early genotypes, critical levels of CDD and CNP were estimated. KRH-2, PA-6201, PA-6444, IET-22218 met the required CDD and CNP under early planting situation. The entry IET 20924 of 2010 performed better for second consecutive year and is suggested for genetic stock registration.
- Advancement of sowing date by 15 days in general had resulted in higher RUE. However, in IET 20524 RUE was not affected by change in sowing date. The entries KRH-2 and IET 22225 showed maximum positive response to the advancement of sowing date.
- Boron application @ 0.4 ppm irrespective of locations increased yield. IET-22218, IET-21540 and IET-21519 responded positively to boron application.
- Based on the yield and drought stress indices, IET 21625, IET 22032 and Sahabagidhan were identified as relatively tolerant to drought.
- IET 21577, IET 21415, Varadhan and PHB-71 showed high remobilization efficiency under terminal heat stress.

Entomology

- Host plant resistance studies identified one culture JGL 17974, carrying *Gm8* gene, as promising against gall midge consistently for two years.
- One of the germplasm accession INRC 174704 was found promising against gall midge and is likely to carry a novel gene for resistance.
- Insecticides like acephate or dinotefuran could be mixed or combined with fungicides hexaconazole or tricyclazole without any adverse effects.
- Results of three years of testing confirmed that growing trap crop of any aromatic rice variety like Pusa Basmati 1 resulted in reduced stem borer damage in the main crop. This concept may be promoted to FLD for on farm validation.

Plant Pathology

- Germplasm accession # 463044 and 576993 showed resistance against bacterial blight and rice tungro diseases whereas Acc No 545000 showed resistance against sheath blight and brown spot diseases.
- One culture from Coimbatore CB 09-153BLB, five cultures from DRR *viz*., RP Biopatho -2, RP Biopatho -4, RP Patho -11, RP Patho -12, RP Patho -5 and RP Patho-8 recorded multiple disease resistance and could be registered with NBPGR and the seed samples made available for further use.
- The combination product of kresoxim methyl 40% + hexaconazole 8% WG @1 g/l was effective in reducing the severity and incidence of leaf blast, sheath blight and brown spot.

Seminars and Workshops

- Dr. Karuppan Chetty, ICRISAT, Hyderabad gave a talk on Agri-Business Incubators on 28 Oct, 2011.
- Dr. Surendra K. Chikara, Managing Director, Xcelris Genomics delivered a lecture on "Deciphering the role of Transcriptomes in plants" on 5 Jan, 2012.
- Dr. Ravi Shanker, IIS, Bangalore gave a Seminar on "How to use Science direct tool for downloading research papers" on 17 Jan, 2012.
- Dr. Malali Gowda, Centre for Cellular and Molecular Platforms, Bangalore delivered a Lecture on "Next generation genomics" on 14 Mar, 2012.

Distinguished visitors

Name & Affiliation	Dates
Dr. K.K. Jena, Scientist, IRRI, Philippines	19-07- 2011
Dr. Peter Eckes, President, BASF, Germany	27-07-2011
Dr. Mike Thomson, IRRI, Philippines	22-08-2011
Dr. R.C. Chowdhury, Chairman, PDRF, Gorakhpur	26-08-2011
Dr. K. Krishnaiah, Former Project Director, DRR	07-09-2011
Dr. P. Anand Kumar, Director, NRCPB, New Delhi	12-09-2011
Dr. Raj Kamal Bhatangar, Group Leader, Insect Resistance, ICGEB New Delhi	12-09-2011
Dr. K.V. Rao, Professor, Osmania University	17-09-2011
Sh. Charan Das Mahant, MOS (Agriculture and Food Processing Industries), Govt. of India, New Delhi	19-09-2011
Dr. S.K. Datta, DDG (CS), ICAR	20-09-2011
Dr. K. R. Kranthi, Director, CICR, Nagpur	21-09-2011
Dr. T.M. Manjunath, Former Director, Monsanto Research Centre, Bengaluru	22-09-2011
Dr. Karuppan Chetty, ICRISAT, Hyderabad	28 -10-2011

Training Programme/Winter schools attended

1. **Dr. P. Revathi** (Scientist, Breeding) attended at Molecular Breeding Training programme at ICRISAT from 7-18 October.
2. **Dr. T. Vidhan Singh** (Senior Scientist, Ag. Engineering) attended NAIP training at PAU, Ludhiana from 14-23 November.
3. **Dr. Ladhalakshmi**, Scientist (Plant Pathology) attended the National Symposium on Molecular approaches for management of fungal diseases of Crop Plants at IIHR, Bangalore on 27-30th December, 2010.

Deputations Abroad

1. **Dr. Vanadana Rai**, Sr. Scientist has undergone training under Norman Borlaug fellowship programme at Purdue University, USA from 15 August to 15 October, 2011.
2. **Dr. N. Shobha Rani**, Pr. Scientist and Dr. Suneetha Kota, Scientist participated in the 3rd International Network for quality Rice Symposium at Bangkok, Thailand.
3. **Dr. R.M. Sundaram,** Sr. Scientist (Biotechnology) was deputed to avail Jawaharlal Nehru Fulbright post doctoral Indo-US Fellowship at Dr. Pamela Ronald's Laboratory, University of California-Davis, Davis, California, USA for a period of 12 months from 5.12.2011 onwards.
4. **Dr. Gouri Sankar Laha,** Sr. Scientist has undergone training in the Norman Borlaug International Agricultural Science Technology Fellowship programme - 2011 in the field of "Molecular Plant Pathology at IOWA State University, USA for a period of three months from 3.12.2011.
5. **Dr. T. Ram,** Principal Scientist participated in the partnership development group meeting on Status of BPH Resistance in rice for Asia during 28-30 November 2011 at IRRI, Los Banos, Philippines.
6. **Dr. J.S. Bentur,** Principal Scientist participated in the partnership development workshop on BPH during 23-25 November 2011 and Workshop on "Global Rice Science Partnership climate adapted varieties on 28-30 November 2011 at IRRI, Los Banos, Philippines.
7. **Dr. Shaik N. Meera,** Sr. Scientist attended the workshop on ICT and mobile phone application for small scale rice farmers at IRRI, Philippines from 7-9 December 2011.
8. **Dr. G. Padmavathi,** Pr. Scientist attended 12th SABRAO Congress held at Bangkok, Thailand during 13-16 Jan 2012.

Infrastructure developed

Farm Office-cum-Field Lab at Ramachandrapuram farm, ICRISAT

A newly developed farm Office-cum-field laboratory at DRR farm, Ramachandrapuram, ICRISAT, Hyderabad was inaugurated by Dr. S.K. Datta, DDG (CS), ICAR, New Delhi on 20 Sept, 2011. The function was presided over by Dr. William D. Dar, Director General, ICRISAT who emphasized the importance of partnership between ICRISAT and ICAR and congratulated Dr. S.K. Datta, Dr. B.C. Viraktamath and other staff of DRR for developing the new Farm office facility.

Biosafety Screen House

A newly constructed Biosafety Screen House at the Directorate was inaugurated by Dr. B.C. Viraktamath, Project Director, DRR on 4 June 2011. The total area of the screen house is 600 m^2 which is divided into six independent tanks. It has been constructed at the total cost of Rs.15 lakhs with generous financial support from the International Rice Research Institute (IRRI), Philippines and the Department of Biotechnology, Govt. of India. The facility can accommodate about 10,000 rice plants and would help to screen/evaluate the plants generated from molecular and transgenic breeding programs in real time field situation, under containment conditions as stipulated by the DBT/RCGM.

Wild Rice Garden

A newly developed Wild Rice Garden was inaugurated by Dr. B.C. Viraktamath, Project Director, DRR on 4 June 2011at DRR Farm Ramachandrapuram, ICRISAT, Hyderabad. Wild rices are rare precious genetic resources and are a goldmine of several useful traits for enhancing yield, fortifying against several biotic and abiotic stresses. Maintenance of wild rices requires a contained facility since regeneration, grain filling and grain shattering have to be considered in maintenance. In view of this, the Garden was built with an outlay of Rs. 15 lakhs, where all the available wild species of rice will be maintained.

Biotech Annexe

A Biotech Annexe with two floors was inaugurated by Dr. S.K. Datta, DDG (CS), ICAR on 19 Jan, 2012. The cost of the building was Rs. 117 L. The Annexe will house facilities for genomics, gene cloning, RNAi and rice quality and nutrition laboratories.

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as on 31/03/2012

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Publications:

Research Articles

Akkareddy SV, Vemireddy LR, Puram V, Rao R, Sridhar S, Jayaprada M, Anuradha G, Lakshmi BS, Prasad H, K Reddy, Hari Prasad AS, Siddiq EA (2011). Molecular mapping of QTLs for Drought related traits at seedling stage under PEG induced stress conditions in rice. American J Plant Sci, 2, 190-201.

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APPENDICES

Appendix 1 : List of promising advanced breeding lines.

Rainfed Uplands:

Very Early – Direct Seeded (90-100 days)	
Varieties:	IET 22744 (CRR 617-B-47-3), IET 222020 (CRR 451-1-B-2-1), IET 22032 (CRR 505-14-B-D1-RR1-B)
Early – Direct Seeded (101-110 days)	
Varieties	IET 22822 (MAULS-15), IET 22817 (MAULS-21), IET 22824 (CR 2994-5-3-2-1-1-1)

Rainfed Shallow Ecosystem:

Varieties:	IET 21974 (CR 2459-12-8), Good Quality, MR-WBPH; IET 21996 (CR 2683-15-5-3-1-1), MR- ShBl, BS; IET 22418 (CR 2676-4-2-1-1-1)

Rainfed Lowland Ecosystem:

Semi Deep Water (41-75 cm)	
Varieties	IET 21341 (OR 2331-14), Good Quality, R-NBl, MR-ShBl, BS, GMB1; IET 21347 (CR 2547-62-316), Good Quality; IET 21852 (CR 2304-5-7-2-3-1), IET 21855(OR 2309-19)
Deep Water (76-120 cm)	
Varieties	IET 21719 (CR 2682-4-2-2-2-1), R-NBl, MR-RTV, GMB1; IET 21716 (CR 2683-28-45-1-5), R-NBl, MR-RTV
National Semi Deep Water Screening Nursery (NSDWSN)	
Varieties	IET 22664 (CR 2389-11-2-1-1), MR-WBPH; IET 22674 (CR 2986-3-1-2-1-1)

Irrigated Ecosystem:

Very Early – Transplanted (upto 110 days)	
Varieties	IET 22833(CAUR-3), R-RTV; IET 22830 (CRR 451-193-3-1)
Early – Transplanted (100-115 days)	
Varieties	IET 21630 (CR 2707 (IR 84898-B-CRA-185-16-1-1-1), Good Quality, Promising in Tamil Nadu; IET 21637 (KJT 1-11-15-23-26-22), Good Quality, Promising in Tamil Nadu; IET 22752 (Gontra Bidhan 3); IET 22763 (RP5219-9-6-7-3-2-1-1), MR-GMB4; IET 22764 (NLR 400024
Hybrids	IET 21777 (US314), Good Quality, MR-LBl
Mid – Early (121-130)	
Varieties	IET 22096 (UPR 3425-11-1-1), Good Quality; IET 22095 (UPR 3413-8-2-1), R-LBl, IET 22121 (R 1535-1382-1-1667-1), Good Quality; IET 21515 (NDR 370133), Good Quality; IET 22568 (UPRI 2009-9), MR-ShR, GMB1; IET 22563 (KMP 149), MR-BS, GMB1; IET 22594 (R 1527-947-1-78-1), tolerant to drought in Rain out shelter,
Hybrids	IET 21404 (RH-1531), Good Quality, R-NBl, MR-LBl, Promising in Madhya Pradesh, Karnataka; IET 21415 (27P31), Good Quality, MR-LBl, Promising in Jharkhand and Andhra Pradesh; IET 21794 (KPH-371), Good Quality, MR-LBl; IET 21785 (NK6303), Good Quality
Medium (131-140)	
Varieties	IET 21009 (OR 2324-8), Good Quality, MR-ShBl, BLB, GMB1, Promising in Andhra Pradesh; IET 21510 (HKR 06-47), Good Quality, MR-GMB1, Promising in Punjab and Maharashtra; IET 22531 (TRC 2008-11), IET 22545 (R 1530-1546-1-418-1)
Hybrids	IET 21434 (27P88), Good Quality, MR-RTV; IET 21423 (VNR-203), Good Quality, R-NBl and MR-RTV
Late (>140 days)	
Varieties	IET 21477 (OR 2328-5), MR-LBl, ShR, WBPH, Promising in Tamil Nadu and Karnataka; IET 22155 (OR 2336-1), Good Quality, MR-ShBl, RTV; IET 22163 (RGL 7001); IET 22439 (MTU 1150); IET 22223 (CB 07-103)

Aromatic Rices:

Export Quality Basmati	
Varieties	IET 21669 (HUBR 10-9), Aromatic & Good Quality, Promising in Punjab and Uttar Pradesh; IET 21665 (RP 3644-1-19-5-5), Aromatic & Good Quality, Promising in Punjab and Uttar Pradesh; IET 21660 (NDR 6244), Aromatic & Good Quality, Promising in Uttarakhand and Uttar Pradesh; IET 21953 (UPR 3506-7-1-1), Aromatic & Good Quality, MR-BPH; IET 22778 (Pusa 1609-09-9-4), Aromatic & Good Quality

Aromatic Short Grain	
Varieties	IET 21053 (NDR 9542), Aromatic & Good Quality, MR-RTV, BPH, Promising in Orissa, West Bengal, Uttar Pradesh and Chhattisgarh; IET 21044 (CR 2616-3-3-3-1), Aromatic & Good Quality, Promising in Orissa, Uttar Pradesh, Chhattisgarh and Gujarat; IET 21261 (CN 1646-6-11-9) Aromatic & Good Quality; IET 21850 (CN 1268-5-7), Aromatic & Good Quality; IET 21842 (R 1536-136-1-77-1), Aromatic & Good Quaity
Aromatic Short Grain Observation Nursery (ASGON)	
Varieties	IET 22648 (CR 2713-179), Aromatic & Good Quality; IET 22650 (CR 2947-18), Aromatic & Good Quality; IET 22652 (R 1656-1146-4-512-1), Aromatic & Good Quality

Saline Alkaline Areas:

Alkaline Areas	
Varieties	IET 21729 (NDRK 50021), Good Quality; IET 21730 (TR 2005-031), Good Quality, MR-GMB1
Inland Saline	
Varieties	IET 22017 (Bulk-212), Good Quality, MR-LBl
Hybrids	IET 21734 (INDAM 300-007), Good Quality
Coastal Saline	
Varieties	IET 21944 (RP Bio 4919-13-7), Good Quality, MR-WM; IET 21729 (NDRK 50021), Good Quality
National Saline Alkaline Screening Nursery (NSASN)	
Alkalinty	IET 21610 (KAU MK 22), IET 22613 (CHR 16)
Inland Salinity	IET 22612 (MCM-101), IET 22616 (NDRK 50032)
Coastal Salinity	IET 22604 (KAU JK 70), IET 22609 (KAU JO 583)

Hills:

Irrigated Hills-Early	
Medium Elevations	**IET 21393 (VL 31449), Promising in Uttarakhand; IET 21386 (HPR 2529-4), Promising in Uttarakhand;** IET 21751 (UPRI 2008-62(IR 69726-116-1-3)), Good Quality, R-NBl; IET 21756 (VL 31441), Good Quality; IET 22272 (VL 31616), MR-LBl
Irrigated Hills-Medium	
Low Elevations	IET 21759 (HPR 2603), Good Quality; IET 21766 (VL 31348), Good Quality; IET 22286 (HPR 2720), MR-LF; IET 22283 (VL 31611), R-NBl
Medium Elevation	IET 22283 (VL 31611), R-NBl; IET 22281 (VL 31726), MR-Shbl
Upland Hills	
Low Elevations	**IET 21318 (RCPL 1-115), R-NBl, Promising in Meghalaya;** IET 21326 (VL 7954), Good Quality, R-NBl; IET 21742 (VL 8158), Good Quality; IET 22294 (HPR 2656)
Medium Elevations	**IET 21320 (VL 7852), Good Quality, Promising in Uttarakhand;**IET 21326 (VL 7954), Good Quality, R-NBl, MR-LF; IET 21738 (VL 8055), Good Quality, R-NBl, MR-LBl & BS; IET 22292 (VL 8302), R-RTV, MR-BS

Aerobic Trials	
Early / Mid Early	**IET 21686 (R1570-2649-1-1546-1), Good Quality, MR-BLB & RTV, Promising in Gujarat;** IET 21692 (CR 2696-IR 83920-B-B-CRA-103-14-1-1-1), R-LBl; IET 21918 (CR 2716-10-IR 84898-B-165), MR-LBl; IET 22704 (MGD-1104); IET 22716 (RP 5130-Bio-Trg136-5-18-8)
AVT 1 Nil Drought – IR64 Nils	
Early	IET 22836 (RP5208-3 (IR87707-445-B-B-B)) (qDTY2.1+qDTY4.1) LTD Score in Rain out shelter 1; IET 22835 (RP5208-2 (IR87707-182-B-B-B)) (qDTY2.1+qDTY4.1) LTD Score in Rain out shelter 3

Appendix 2 : Variety wise Breeder Seed Production during *kharif*, 2011

(as per DAC indent) (Quantity in Quintals)

Hybrid / variety	Produced By	Allocation as per BSP-I	Actual Production
Athira	Pattambi	2.00	3.00
ADT (R) 48	Coimbatore	1.00	1.00
ADT-36	Coimbatore	1.00	1.00
ADT-37	Coimbatore	14.00	14.00
ADT-38	Coimbatore	1.00	1.00
ADT-39	Coimbatore	10.00	10.00
ADT-43	Coimbatore	8.00	8.00
ADT-44	Coimbatore	0.50	0.50
ADT-45	Coimbatore	2.00	2.00
Akshyadhan	DRR	2.50	4.00
Amara	ANGRAU, Hyderabad	6.00	6.00
ASD-19	Coimbatore	1.00	1.00
Anupama	Jabalpur	0.50	
Bamaleshwari	Raipur	35.00	35.00
Barani Deep	Faizabad	18.00	12.00
Barh Avrodhi	Faizabad	4.00	2.20
Basmati 370	Kaul	13.00	22.00
Basmati 386	Ludhiana	6.10	3.50
Bhadra	Moncompu	7.50	7.08
Bhagirathi	Chinsurah	0.50	0.50
Bharani	ANGRAU, Hyderabad	2.00	2.00
Bhogavathi	Radhanagari	12.00	27.00
Bhrigu Dhan	Malan	0.10	0.08
Birsa Vikas Dhan 109	Ranchi	0.50	2.00
Sonamahsuri	ANGRAU, Hyderabad	13.00	13.00
Chandrahasini	Raipur	50.00	50.10
Chenab	Khudwani	2.00	2.00
Cotton Dora Sannalu	ANGRAU, Hyderabad Raipur	520.00	520.00
CO-43	Coimbatore	2.00	2.00
CR Dhan-70	Cuttack	0.50	3.90
CR 1014	Cuttack	15.00	18.00
Indra	ANGRAU, Hyderabad	5.00	5.00
Indrayani	Vadagaon Radhanagiri	18.00	25.00

Hybrid / variety	Produced By	Allocation as per BSP-I	Actual Production
Intan	Dharwad	6.50	10.00
IR 20	Hyderabad Cuttack	13.00	4.30
IR-36	Raipur Ranchi Jabalpur	150.00	230.60
IR-64	DRR Raipur Ranchi Jabalpur	176.00	227.90
IR-50	Hyderabad Cuttack	5.00	4.90
Jajati	Bhubaneswar	3.00	2.50
Jaldidhan-6	Cuttack	1.00	1.50
Jaldi dhan 13	Karnal	0.50	0.50
Jaldubhi	Raipur	5.00	6.00
Jal Lahari	Faizabad	0.50	13.00
Jarava	DRR	2.50	5.00
Jaya	DRR	40.00	60.00
Polasa Prabha	Hyderabad	6.00	7.00
Jagtial Sannalu	Hyderabad	29.00	32.00
Jhelum	Khudwani	5.00	32.00
Richa	Jabalpur	1.00	4.00
Jyothi	Pattambi	34.00	60.00
Kanak	Patna	0.50	0.50
Karjat-2	Karjat	2.00	2.20
Karjat-3	Karjat	4.50	5.00
Karjat-5	Karjat	2.50	3.00
Karjat-7	Karjat	2.00	2.50
Karma Mahsuri	Raipur	210.00	230.00
Kasturi	Malan	0.50	3.54
Kavya	Hyderabad	1.00	2.00
Ketekijoha	Cuttack, Jorhat	6.00	15.55
Khandagiri	Bhubaneshwar	63.00	28.94
Khitish	Cuttack, Chinsurah	14.00	4.00
Nellore Mahsuri	Hyderabad	16.00	16.00
Swarnamukhi	Hyderabad	5.00	6.00
Nua Kalajeera	Cuttack	1.00	1.80
Padmini	Cuttack	3.00	3.60
Palam Dhan-957	Malan	5.00	1.63

Hybrid / variety	Produced By	Allocation as per BSP-I	Actual Production
Pant Dhan 6	Pantnagar	2.00	2.00
Pant Dhan 10	Pantnagar	8.00	8.00
Pant Dhan 11	Pantnagar	3.00	13.80
Pant Dhan 12	Pantnagar	7.00	22.20
Pant Dhan 16	Pantnagar	0.50	6.90
Pant Dhan 19	Pantnagar	20.50	33.30
Pant sugandh Dhan-15	Pantnagar	1.50	5.40
Parbhani Avishkar	Tuljapur	2.00	2.00
Pardhiva	Hyderabad	2.00	2.00
Parijat	Bhubaneshwar	7.00	7.50
PAU 201	Ludhiana	38.00	38.50
Phule Radha	Radhanagari	3.00	12.00
Phule Samrudhi	Radhanagari	3.00	20.00
PKM (R) 3	Coimbatore	3.00	2.00
PKV HMT	Sindewahi	231.00	260.00
PKV Kamang	Sindewahi	1.00	17.00
PNR 381	Karnal	1.00	5.50$
PNR 519	Karnal	0.50	0.50
Pooja	Cuttack	95.00	150.00
Poornima	Raipur	10.00	10.00
Prabhat	Pusa	6.00	9.00
Pratikshya	Bhubaneshwar	36.00	35.00
PR 106	Ludhiana	1.50	7.50
PR 111	Ludhiana	16.00	16.50
PR 113	Ludhiana	66.00	78.00
PR 114	Ludhiana	37.00	45.00
PR 115	Ludhiana	8.00	12.00
PR 116	Ludhiana	14.00	20.00
PR 118	Ludhiana	71.00	80.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack,	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00

Hybrid / variety	Produced By	Allocation as per BSP-I	Actual Production
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack. Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
Savithri	Cuttack	38.00	39.00
Shalimar Rice -1	Khudwani	4.00	8.00
Shatabdi	Cuttack, Chinsurah	78.00	8.00
VL Dhan 208	Almora	3.00	3.00
VL Dhan 209	Almora	1.50	1.50
VL Dhan 221	Malan	0.50	1.23
White Ponni Improved	Coimbatore	2.00	2.00
Warangal Sannalu	Hyderabad	60.00	65.00
Warangal Sambha	Hyderabad	4.50	6.00
CR Sugandh Dhan-3	Cuttack	0.50	1.50
CR Dhan 501	Cuttack	2.00	1.20
CSR 10	Karnal	1.00	2.00
CSR 23	Karnal	0.50	7.00
CSR 27	Karnal	27.00	29.25
CSR 30	Karnal	70.00	81.25
CSR 36	Karnal	40.00	60.00

Hybrid / variety	Produced By	Allocation as per BSP-I	Actual Production
Danteshwari	Raipur	26.00	26.30
Dhanrasi	DRR	0.50	5.90
Dharithri	Cuttack	0.50	4.50
Early Samba	ANGRAU, Hyderabad	2.00	2.00
Erra Mallelu	ANGRAU, Hyderabad	8.00	10.00
Gayathri	Cuttack	7.00	7.00
Geetanjali	Cuttack	1.50	1.80
Gontra Bidhan-1	Nadia	15.50	60.00
Govind	Pantnagar	7.00	36.30
GR-4	Nawagam	2.50	2.50
GR-11	Nawagam	5.00	5.00
Gurjari	Nawagam	0.50	0.50
Tarawadi	Kaul	2.50	8.60
HKR 47	Kaul	40.50	59.60
HKR 127	Kaul	50.00	64.80
HP 2143	Malan	4.50	5.74
HPR 1068	Malan	1.00	6.17
HPR 1156	Malan	0.50	5.16
IET 1410	Chatha	0.10	0.35
IET 7191	Bangalore	4.00	30.80
IR 30864	Bangalore	3.50	20.30
IGKVR- 1	Raipur	2.00	3.60
Improved Pusa Basmati-1	Karnal	68.00	52.00
Improved Samba Mahsuri	Hyderabad	74.00	110.00
Abhilash	Mugad, Dharwad	5.00	9.00
Kranthi	Jabalpur	21.00	90.00
Krishna Hamsa	DRR	3.00	4.00
Lalat	Bhubaneshwar Ranchi	64.00	40.83
Lunishree	Cuttack	3.00	2.40
Mahamaya	Raipur	111.00	112.00
Mahsuri	Hyderabad, Jorhat	30.00	40.50
Malaviya Dhan-1	Varanasi	18.00	18.00
Malaviya Dhan-2	Varanasi	18.00	18.00
Malaviya Sugandh-4-3	Varanasi	12.00	12.00
Malaviya sugandh-105	Varanasi	12.00	12.00
Manaswini	Bhubaneshwar	6.00	1.60**
Mandya Vijaya	DRR	2.00	5.60
Maruteru Sannalu	Hyderabad	1.00	1.00
MO-21	Moncompu	1.00	4.45
MTU-7029	Raipur, Hyderabad	460.00	460.00
MTU 1031	Hyderabad	1.00	1.00
MTU 1032	Hyderabad	0.50	0.50
MTU 1075	Hyderabad	7.00	7.00
Mukthi (CTH-1)	Bengaluru	1.00	2.00
Narendra Dhan 97	Faizabad	2.00	15.30
Narendra dhan 3112-1 Prakhar	Faizabad	9.00	9.50
Narendra dhan 359	Faizabad	10.00	84.00
Narendra Usar dhan 2008	Faizabad	0.50	58.44
Narendra 8002	Faizabad	245.00	174.00
PTB-58	Pattambi	1.00	2.00
Pusa 44	Karnal	57.00	75.00
Pusa 834	Karnal	20.00	18.00
Pusa Basmati 1	Karnal, BEDF	47.00	53.50
Pusa Basmati 6	Karnal	17.00	19.00
Pusa 1121	Karnal, BEDF	145.00$	50.50
Pusa Sugandh 2	Karnal	20.00	18.75
Pusa Sugandh 3	Karnal	145.00	37.83
Pusa Sugandh 5	Karnal	126.00	62.00
Rajashree	Pusa	31.00	57.00
Rajendra Bhagavati	Pusa	51.00	68.50
Rajendra Kasturi	Pusa	16.00	5.60
Rajendra Mahsuri	Pusa	40.00	45.00
Rajendra Suwasini	Pusa	15.00	4.20
Rajendra Sweta	Patna	21.00	17.00
Ramappa	Hyderabad	5.50	6.00

Hybrid / variety	Produced By	Allocation as per BSP-I	Actual Production
Ranbir Basmati	Chatha	0.50	1.15
Rani Dhan	Bhubaneshwar	20.00	12.00
Ranjeet	Jorhat	7.00	8.75
Rashmi	Jabalpur	60.00	8.00
Rasi	DRR	8.00	10.00
Sahbhaghi	Hazaribagh	1.00	99.00
Samaleshwari	Raipur	20.00	28.80
Samba Mahsuri	Hyderabad, Gorakhpur	112.00	150.00
Sampada	DRR	1.00	2.40
Sarala	Cuttack	21.00	25.50
Satya	Hyderabad	2.00	2.00
Sarjoo-52	Faizabad, Gorakhpur	22.00	125.00
DRRH-2			
1. IR 68897 A	DRR, Hyderabad	0.15	0.15
2. IR 68897 B	DRR, Hyderabad	0.30	0.30
3. DR 714-1-2R	DRR, Hyderabad	0.20	0.20
KRH-2			
1. A Line	UAS, Bangalore	8.00	8.00
2. B Line	UAS, Bangalore	4.00	8.00
3. R Line	UAS, Bangalore	16.00	20.00
Pant Sankar Dhan-3			
1. A Line	GBPUAT, Pantnagar	3.00	2.00
2. B Line	GBPUAT, Pantnagar	2.10	2.50
3. R Line	GBPUAT, Pantnagar	9.00	1.00
Sahyadri-1			
1. A Line	RARS, Karjat	3.70	3.80
2. B Line	RARS, Karjat	1.20	1.30
3. R Line	RARS, Karjat	0.60	0.70
Sahyadri-2			
1. A Line	RARS, Karjat	0.60	0.70
2. B Line	RARS, Karjat	0.20	0.30
3. R Line	RARS, Karjat	0.20	0.25
Sahyadri-3:			
1. A Line	RARS, Karjat	0.60	0.70
2. B Line	RARS, Karjat	0.15	0.20
Breeder Seed Production of Rice at Directorate of Rice Research *Kharif*, 2011 (Quintals)			
Vikas	16.50	DRR Dhan38	6.00
Improved Samba Mahsuri	50.00	Vasumathi	12.00
Jarava	6.00	Akshyadhan	21.30
Dhanrasi	8.40	Swarnadhan	4.20
Krishna Hamsa	1.59		
		Total	**125.99**

Appendix 3 : Externally funded projects as on April 2012

S. No.	Title of the Project / Scheme	Principal Investigator	Funding Agency	Period	Budget (in Lakhs)
1	Seed Production and seed technology research in Rice (NSP)	Dr. L.V. Subba Rao	ICAR	2002-12	2.00
2	DUS Tests in Rice (PPV&FRA)	Dr. L.V. Subba Rao	DUS (PPV&FRA)	2007-12	37.5
3	Generation, characterization and use of EMS induced mutants of Upland variety Nagina 22 for functional Genomics of Rice.	Dr. N. Sarla	DBT Project	2007-12	66.98
4	Transgenics in crops	Dr. S.M. Balachandran	ICAR-NPTC - Transgenic component	2008-12	89.38
5	Research into development of decision support systems for insect pests of major rice and cotton based cropping	Dr. G. Katti	NAIP- component -4	2008-12	17.50
6	Transgenics in crops	Dr. N. Sarla	ICAR-NPTC - Iron Zinc	2008-12	135.00
7	Improving the livelihoods of SC/ ST Farmers through Rice Technology Interventions	Dr. Shaik N Meera	DBT	2008-2011	17.20
8	Investigations on SRI water saving and yield optimization in irrigated ecosystem	Dr. R. Mahender Kumar	Ministry of Water resources	2009-11	54.20
9	Development of Indica Rice with Beta Carotene Rice Endosperm through Marker assisted Gene Introgression and their Evaluation	Dr. R.M. Sundaram	DBT-IRRI Project	2007-11	58.05
10	Gene and protein expression study in salt-tolerant and sensitive cultivars of Indica rice	Dr. Vandana Rai	DST	2009-12	21.00
11	Rice Knowledge Management Portal Development	Dr. Shaik Meera	NAIP	2009-12	324.55
12	Gene and protein expression study in salt-tolerant and sensitive cultivars of indica rice	Dr. Vandana Rai	DST	2009-12	21.0
13	Establishment of National Rice Resource Data base	Dr. B.C. Viraktamath / Dr. L.V. Subba Rao	DBT Project	2009-13	51.21
14	Bioprospecting of genes and allele mining for abiotic stress tolerance	Dr. N. Sarla	NAIP	2009-12	99.74

S. No.	Title of the Project / Scheme	Principal Investigator	Funding Agency	Period	Budget (in Lakhs)
15	Functional Validation of Identified candidate gall midge resistance genes FGR Ph II 4A	Dr. J.S. Bentur	DBT Project	2009-14	88.67
16	Identification and functional validation of BPH resistance genes FGR Ph II 5A	Dr. J.S. Bentur	DBT Project	2009-14	39.80
17	Functional analysis of gene regulatory networks during flower and seed development in rice FGR Ph II 7	Dr. S.M. Balachandran	DBT Project	2009-14	89.05
18	High resolution fine mapping, identification and functional analysis of rice tungro virus resistance genes FGR PH II 6	Dr. C.N. Neeraja	DBT Project	2009-14	59.18
19	Identification and functional analysis of novel blast resistance genes in rice FGR Ph II 3B	Dr. M.S. Prasad	DBT Project	2009-14	58.11
20	Fine mapping of yield enhancing QTLs from wild rice FGR Ph II 1A	Dr. N. Sarla	DBT Project	2009-14	92.84
21	Development of Biotic stress resistant rice through marker assisted breeding sub project- I A&B (DBSRR - GCP)	Dr. B.C. Viraktamath	DBT Project	2009-14	146.88
22	Functional Characterization of novel bacterial blight resistance genes from wild relative of Oryza spp FGR Ph II 2A	Dr. B.C. Viraktamath / Dr. R.M. Sundaram	DBT Project	2009-14	74.38
23	Multi locational evaluation of rice germplasm	Dr. L. V. Subba Rao	ICAR/ NBPGR	2010-12	6.25
24	BMGF " Stress tolerant rice for poor farmers in Africa and South Asia " STRASA	Dr. T. Ram	IRRI	2011-14	6.00
25	Molecular basis of insect plant interactions in rice	Dr. J.S. Bentur	NF-NAIP	2010-12	78.12
26	Marker assisted breeding of abiotic stress tolerant rice varieties with major QTLs for drought, submergence and slat tolerance	Dr. T. Ram	DBT Project	2010-14	104.29
27	Seed Production in Agriculture (MEGA SEED)	Dr. LV. Subba Rao	ICAR	2010-14	65.60
28	Gender Issues in Rice Based Production System & Refinement of Selected	Dr. S.P. Singh	ICAR	2019-12	9.00

S. No.	Title of the Project / Scheme	Principal Investigator	Funding Agency	Period	Budget (in Lakhs)
29	National Centre For Integrated Pest Management (NICRA) 2011-12	Dr. J.S. Bentur	ICAR-NCIPM	2010-15	5.00
30	National Initiative on Climate resilient agriculture	Dr. S.R. Voleti	ICAR	2010-15	600.00
31	Identification of candidate genes for enhanced water use efficiency in rice through activation tagging	Dr. S.M. Balachandran	DBT Project	2010-15	68.53
32	"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 Project	2012-17	123.00
33	Conversion of Elite partial restorers of rice cultivars in to restorer by Marker-assisted introgression of major fertility restorer genes, Rf4 & Rf3	Dr. P. Revathi	DBT Project	2012-17	25.44
34	Marker assisted Recurrent Selection (MARS) for improvement biotic stress resistance in parental lines of hybrid rice	Dr. P. Revathi	DST- women scientist	2012-14	25.002
35	Investigations on System of Rice Intensification (SRI) for water saving and yield optimization in irrigated ecosystem	Dr. R. Mahender Kumar	Ministry of Water resources	2012-2015	49.76
36	Exploitation of RNAi technology for management of yellow stem borer in rice	Dr. M. Seshu Madhav	DBT	2012-2015	65.00
37	Identification of molecular Mapping of a novel neck blast resistance gene(s) from local landraces and introgression lines of *Oryza*	Dr. M. Seshu Madhav	DBT	2012-2015	40.00
38	Metabolic and molecular profiling of aromatic rice germplasm of India for gaining insights about aroma	Dr. N. Shobha Rani	DBT	2012-2015	56.00
39	Molecular and functional characterisation of yield enhancing QTL from wild rice	Dr. N. Sarla	DBT	2012-2015	12.03
40	Identification and Molecular Mapping of a novel neck blast resistance gene (s) from local land races and introgression lines of Oryza	Dr. Seshu Madhav	BCIL (Biotech Consortium India Limited)	2012-15	26.75
			Total		3009.99

Appendix 4 : Funded AICRIP centres with staff positions during 2011-12.

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

Appendix 5 : Approved on-going projects 2011-12.

P1: GEY: Genetic enhancement of yield potential and stress resistance in rice for irrigated ecology.

Program leader: B.C. Viraktamath

Project Title/Code	Project Leader & Associates
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. **(GEY/CI/BR/12)**	**T. Ram,** S.P. Singh, G.S. Laha, A.P. Padamakumari, D. Krishnaveni, R.M. Sundaram, B. Sreedevi, S.K. Mangrauthia, D. Ladhalakshmi, V. Jhansi Lakshmi
Breeding varieties for Boro areas. **(GEY/CI/BR/9)**	**L.V. Subba Rao,** T. Ram, V. Ravindra Babu, Ch. Padmavathi, M.S. Prasad, R. Mahendra Kumar
Breeding rice varieties for resistance to planthoppers **(GEY/CI/BR/16)**	**G. Padmavathi,** V. Jhansi Lakshmi, G.S.V. Prasad
Breeding rice for enhanced phosphorous use efficiency **(GEY/CI/BR/14)**	**V.P. Bhadana,** T. Ram, G.S.V. Prasad, P. Krishnamurthy, D. Subrahmanyam, R.M. Sundaram, Brajendra
Development of high yielding rice varieties for conservation agriculture **(GEY/CI/BR/17)**	**Suneetha K,** N. Shobha Rani, V.P. Bhadana, P. Senguttuvel, S.P. Singh, M.B.B. Prasad Babu, B. Gangaiah, G. Katti
Development and evaluation of three line hybrids with better grain quality and resistance to major pests and diseases **(GEY/CI/HY/1)**	**B.C. Viraktamath,** A.S. Hari Prasad, P. Senguttuvel, P. Revathi, N. Shobha Rani, C.N. Neeraja, D. Ladhalakshmi, K.B. Kemparaju
Exploitation of inter sub-specific heterosis in rice (*Oryza sativa* L.) **(GEY/CI/HY/7)**	**A.S. Hari Prasad,** P. Revathi, R.M. Sundaram, B.C. Viraktamath, K.B. Kemparaju, S. Arun Kumar, P. Senguttuvel
Breeding of parental lines and hybrids suited to aerobic and salinity conditions **(GEY/CI/HY/8)**	**PSenguttuvel,** A.S. Hariprasad, P. Revathi, B.C. Viraktamath, R. Mahender Kumar, J.S. Prasad, Brajendra, Vandana Rai, R.K. Gautam (CSSRI) K. Suneetha, K.B. Kemparaju
Genetic improvement of maintainers and development of CMS lines **(GEY/CI/HY/6)**	**K.B. Kemparaju,** B.C. Viraktamath, A.S. Hari Prasad, P. Senguttuvel, P. Revathi, G.S. Laha
Increasing the yield potential in irrigated rice: manipulating sources and sinks **(GEY/CP/PP/8)**	**P. Raghuveer Rao,** R. Mahender Kumar, S. Ravichandran, A.S. Ramprasad

P2 GEQ: Genetic enhancement of grain and nutritional quality for domestic and export purposes.

Programme leader: N. Shobha Rani

Project Title/Code	Project Leader & Associates
Genetic enhancement of quality rice varieties through conventional and molecular breeding approaches **(GEQ/CI/BR/11)**	**N. Shobha Rani,** G.S.V. Prasad, L.V. Subba Rao, V. Ravindra Babu, R.M. Sundaram, M.S. Madhav, G.S. Laha, M. Srinivas Prasad, V. Jhansi Lakshmi
Enhancing nutritional quality of rice through bio-fortification **(GEQ/CI/ BR/8)**	**V. Ravindra Babu,** N. Shobha Rani, L.V. Subba Rao, B. Sreedevi, K. Surekha, C.N. Neeraja, G. Padmavathi
Genetic enhancement of aromatic short and medium grain rices **(GEQ/CI/BR/13)**	**G.S. Varaprasad,** B.C. Viraktamath, N. Shobha Rani, G. Padmavathi, M. Sheshu Madhav, J.S. Bentur, V. Jhansi Lakshmi, G.S. Laha

P3 ABR: Development and application of biotechnology tools for rice improvement. **Programme leader: N. Sarla**

Project Title	Project Leader & Associates
Introgression of yield contributing genes/alleles from wild species to rice using molecular markers **(ABR/CI/ BT/5)**	**N. Sarla**, Vandana Rai and P. Krishnamurthy
Genetic improvement of rice against biotic and abiotic stresses through transgenic approach **(ABR/CI/ BT/9)**	**S.M. Balachandran,** A.P. Padmakumari, Ch. Padmavathi, S.R. Voleti, S.K. Mangrauthia
Identification of genes for grain filling in rice (*Oryza sativa* L.) **(ABR/CI/ BT/6)**	**C.N. Neeraja,** S.R. Voleti, L.V. Subba Rao, S.M. Balachandran, M. Sheshu Madhav, G.S.V. Prasad
Application of biotechnological tools for understanding molecular basis of yield heterosis and WA-CMS trait in rice **(ABR/CI/ BT/7)**	**R.M. Sundaram,** S.M. Balachandran, S.R. Voleti
Development of molecular markers for important quality traits in rice **(ABR/CI/ BT/8)**	**M. Seshu Madhav,** N. Shobha Rani, G.S.V. Prasad
Gene discovery and "allele-mining" for water limiting conditions and salt tolerance in rice **(ABR/CI/BT/10)**	**Vandana Rai**, N. Sarla, T. Ram, D. Subrahmaniam, N.K. Singh (NRCPB) and R.K. Gautam (CSSRI)
Molecular breeding for fertility restoration, wide compatibility and disease resistance in rice **(ABR/CI/HY/9)**	**P. Revathi,** A.S. Hariprasad, P. Senguttuvel, B.C. Viraktamath, K.B. Kemparaju, M. Sheshu Madhav
Suppression of Rice tungro virus through RNA interference **(ABR/CPT/PATH/16)**	**S.K. Mangrauthia,** S.M. Balachandran, D. Krishnaveni

P4 RUE: Enhancing resource and input use efficiency. **Program leader: S.P. Singh**

Project Title	Project Leader & Associates
Resource conservation technologies to improve input use efficiency and to sustain rice system productivity **(RUE/CP/AG/12)**	**S.P. Singh,** B. Sreedevi, K.V. Rao, R.M. Kumar, G.R. Katti, B. Nirmala, N. Somasekhar, D. Subrahmaniam, Brajendra
Evaluation of the system of rice intensification (SRI) for its potential to save water and sustaining rice productivity **(RUE/CP/AG/10)**	**R. Mahender Kumar,** V. Ravindra Babu, L.V. SubbaRao, K. Surekha, P.C. Latha, Ch. Padmavathi, N. Somasekhar, M.S. Prasad, P. Raghuveer Rao, P. Muthuraman, S. Ravichandran, B. Nirmala, Shaik N Meera, B. Sailaja, S.P. Singh, T. Vidhan Singh
Studies on enhancing Phosphorus-use efficiency and rice crop productivity under a-biotic stress conditions **(RUE/CP/AG/9)**	**P. Krishnamurthy,** B. Sreedevi, P.C. Latha, P. Raghuveer Rao, P. Venkata Reddy (ANGRAU), G. Padmavathi, N.Sarla
Development of suitable agronomic management practices for aerobic rice **(RUE/CP/AG/13)**	**B. Sreedevi,** S.P. Singh, Brajendra.

P5 SSP: Sustaining rice system productivity **Program leader : K.V. Rao**

Project Title	Project Leader & Associates
Enhancing productivity of water in irrigated rice through integrated resource and crop management **(SSP/CP/SS/6)**	**K.V. Rao,** K. Surekha, S.P. Singh, P. Hemashankari
Assessment and improving nitrogen use efficiency in irrigated **rice (SSP/CP/SS/11)**	**K. Surekha**, K.V. Rao, V.P. Bhadana**,** C.N. Neeraja, M.B.B. Prasad Babu
Assessment of soil quality for improved rice productivity **(SSP/CP/SS/9)**	**Brajendra,** K.V. Rao, K. Surekha, P.C. Latha, Vijayapal Bhadana, B. Sailaja
Rhizosphere microbial community composition and root exudation patterns as influenced by rice genotypes and soil types **(SSP/CP/SS/8)**	**P.C. Latha,** S.R. Voleti, R.M. Sundaram, K. Surekha and P. Krishnamurthy

P6 CCR: Assessing and managing crop response to climate change **Program leader: S.R. Voleti**

Project Title	Project Leader & Associates
Impact of changing temperatures on nitrogen dynamics and use efficiency in rice **(CCR/CP/SS/10)**	**M.B.B. Prasad Babu,** P.C. Latha, K.V. Rao, B. Gangaiah
Physiological studies on Heat tolerance due to ambient and Elevated carbon dioxide in rice **(CCR/CP/PP/9)**	**S.R. Voleti,** P.R. Rao, B. Sailaja, N. Somasekhar, P.C. Latha, KV Rao/K Surekha, Chitra Shanker, D. Krishnaveni, Shaik N. Meera and M. Vanaja (CRIDA), M.B.B. Prasad Babu, Vijayapal Bhadana, Vandana Rai, B. Sailaja
Influence of post anthesis water stress on stem carbohydrate reserve mobilization in rice **(CCR/CP/PP/10)**	**D. Subrahmanyam,** P. Raghuveer Rao

P7 HRI: Host-plant resistance against insect pests and management **Program leader: JS Bentur**

Project Title	Project Leader & Associates
Host-plant resistance to gall midge in rice **(HRI/CPT/ ENT/17)**	**J.S. Bentur,** C.N. Neeraja, K. Suneetha, M. Sampath Kumar
Assessment of host plant resistance to rice planthoppers and their management **(HRI/CPT/ENT/11)**	**V. Jhansilakshmi,** J.S. Bentur, G. Padmavathi, K. Surekha, M. Sampath Kumar
Insect-plant interactions with special reference to yellow stem borer **(HRI/CPT/ENT/18)**	**A.P. Padmakumari,** S.R. Voleti, T. Ram and Y. Kondala Rao
Dynamics of leaf folder- host plant -insecticide interactions **(HRI/CPT/ENT/12)**	**Ch. Padmavathi,** G. Katti, P. Raghuveer Rao, L.V. Subba Rao, M. Mohan

P8 HRP: Host-plant resistance against pathogens and its management **Program leader : M.S. Prasad**

Project Title	Project Leader & Associates
Assessment of host plant resistance and strainal variation in rice tungro disease **(HRI/CPT/PATH/14)**	**D. Krishnaveni,** Chitra Shankar, C.N. Neeraja, S.K. Mangrauthia, D. Ladhalakshmi
Assessment of host plant resistance to rice blast disease and management through botanicals **(HRI/CPT/ PATH/15)**	**M.S. Prasad,** S.M. Balachandran and M. Seshu Madhav
Assessment of resistant sources and monitoring of pathogen virulence in bacterial leaf blight of rice **(HRI/CPT/ PATH/13)**	**G.S. Laha,** D. Krishnaveni, R.M. Sundaram, T. Ram, S.K. Mangrauthia

P9 IPM: Integrated Pest Management **Program Leader : J.S. Prasad**

Project Title	Project Leader & Associates
Invertebrate biodiversity of irrigated ecosystem, its functional significance and potential for natural control of pests **(IPM/ CPT/ENT/13)**	**Chitra Shanker,** Gururaj Katti, P. Krishnamurthy, M. Mohan
Microbes and their toxins for sustainable pest management in rice **(IPM/CPT/ENT/16)**	**M. Mohan,** J.S. Prasad, S.M. Balachandran, Chitra Shanker, P.C. Latha, Ch Padmavathi, A.P. Padmakumari, M. Sampath Kumar
Investigations on plant parasitic nematodes in rice **(IPM/ CPT/ENT/14)**	**J.S. Prasad,** N. Somasekhar, M. Mohan, K.S. Varaprasad (NBPGR) and Y. Kondala Rao
Evaluation of Entomopathogenic Nematodes for the Management of Insect Pests in Rice Ecosystem **(IPM/CPT/ ENT/15)**	**N. Somasekhar,** J.S. Prasad, A.P. Padmakumari and G. Katti
Chemical control of rice insect pests as a component of rice IPM **(IPM/CPT/ENT/3)**	**Gururaj Katti,** V. Jhansi Lakshmi, A.P. Padmakumari, Chitra Shanker
Biology of false smut disease of rice **(IPM/CPT/ PATH/17)**	**D. Ladhalakshmi,** G.S. Laha, S.K. Mangrauthia

P 10 TTI: Transfer of technology and training **Program leader: Mangal Sain**

Project Title	Project Leader & Associates
A study on awareness, perception and constraints in adoption of Integrated Pest Management in rice farming **(TTT/EXT/7)**	**Mangal Sain,** P. Muthuraman, Shaik N. Meera, S. Arun Kumar
Sustainable rice production practices: Problems and prospects **(TTT/EXT/8)**	**P. Muthuraman,** Shaik N. Meera, Mangal Sain, S. Arun Kumar, S. Ravichandran
Applications of E-Learning in Agriculture: Designing an ODL Content Management System for Rice Technologies **(TTI/TTT/EXT/6)**	**Shaik N. Meera,** Mangal Sain, P. Muthuraman and B. Nirmala
An Exploratory study on public-private-partnerships: Impact and implications **(TTI/TTT/EXT/9)**	**S. Arun Kumar**, Shaik N. Meera, P. Muthuraman, Mangal Sain
Development of crop growth models for simulating climate change response in irrigated ecosystems **(TTT/STAT/3)**	**S. Ravichandran**, D. Subrahmanyam, P. Raghuveer Rao
AICRIP database management system for DRR **(TTI/CP/CA/2)**	**B. Sailaja**, All PIs of AICRIP, S. Ravichandran, Shaik N. Meera, B. Nirmala
Yield gaps and constraints in rice production - an econometric analysis **(TTI/TTT/ECON/1)**	**B. Nirmala**, Mangal Sain, P. Muthuraman

List of approved new projects

Project Title	Project Leader & Associates
Selective mechanisation in rice cultivation **(CP/ENG/6)**	**T. Vidhan Singh**, R.M. Kumar, B. Gangaiah, Aum Sharma (ANGRAU)
Plastic film mulching cultivation of rice for resource conservation **(CP/AG/14)**	**B. Gangaiah**, M.B.B. Prasad Babu, P. Raghuveer Rao, T. Vidhan Singh, P.C. Latha
Integrated crop and nutrient management to realise potential yields **(CP/SS/12)**	**K.V. Rao**, K. Surekha, B. Sailaja, Brajendra, R.M. Kumar, D. Subrahmanyam
Utilization of plant growth promoting micro organisms for improving nitrogen and water use efficiency in rice **(CP/SS/13)**	**P.C. Latha**, S.R. Voleti, B. Sreedevi, K. Surekha
Host plant resistance for leaf folder in rice **(CPT/ENT/19)**	**Ch. Padmavathi**, M. Mohan, L.V. Subba Rao, N. Sarla
Semiochemical approaches to manage rice pests with special emphasis on sex pheromones **(CPT/ENT/20)**	**M. Sampath Kumar**, J.S. Bentur, Ch. Padmavathi, G.R. Katti, M. Mohan
Gender Dimensions in Different Rice -Eco systems-An Exploratory Study in Andhra Pradesh **(TTT/EXT/10)**	**Amtul Waris**, N. Shobha Rani, Mangal Sain, R. Mahender Kumar, P. Muthuraman, S. N. Meera, S. Arun Kumar

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