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What's inside

Rice Is Life ...

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We are happy to know that, second advance estimate for 2016-17, estimated the total food grain production in the country to a new record level of 271.98 million tonnes and rice production also to a new high of 108.86 million tonnes. This year's rice production is higher by 2.21 million tonnes than previous record production of 106.65 million tonnes during 2013-14. This has been largely due to cultivation of high yielding varieties and hybrids as well as adoption of improved crop management practices developed by the rice scientific workers of the country coupled with favourable monsoon.

The hybrid rice technology contributed towards an additional 4-5 million tonnes to the total rice production in the country and there is a vast scope for increased adoption of this technology by the farming community in future.However, despite these achievements, we still need to produce an additional 1.5-2 million tonnes of rice every year to meet the target of producing 130 million tonnes by 2025. This has to be achieved in the context of increasing incidence of pests and diseases and other abiotic stresses due to a rapidly changing climate, rapidly declining water, soil and land resources.

As per the second advance estimate, this year the record production is achieved not only in rice, but also in wheat, coarse cereals, maize, pulses (Tur and Gram) and oilseeds. Though we are disproving Malthusian theory by achieving new heights in production with limited resources, but with improved technologies. Now it is high time to think about nutritional security in addition to food security and need to concentrate more on nutritional security in rice specifically for increasing zinc, iron and vitamin A.

Targeting nutritional security of the nation, ICAR-IIRR has been coordinating Consortia Research Platform (CRP) on Biofortification, since 2014-15, encompassing rice, wheat, maize, sorghum and other millets in collaboration with National Institute of Nutrition (NIN) and National Institute of Animal Nutrition and Physiology (NIANP). Significant strides

Now, it is high time to think about nutritional security in addition to food security and need to concentrate more on nutritional security in rice specifically for increasing zinc, iron and vitamin A.

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have been made in the development of biofortified varieties in rice, wheat, maize and pearl millet, which are released and/or being evaluated under AICRP network. *In-vitro* Bioavailability studies identified, DRR Dhan 45 with 50% increased intestinal absorption of zinc and two maize genotypes with β carotene (100g) meeting 70 % of recommended dietary allowance (RDA).

The progress under research has highlighted several future targets and also constraints, which need to be addressed. ICAR-IIRR has evolved 10 point strategy to overcome and achieve the targets envisaged in Vision 2050. Though our food and nutritional security targets are high, the resources such as land, labour, water, etc. are limited. Under such a situation ICAR-IIRR along with the collaborators of AICRIP network is mainly focussing on the strategies for developing new biotic and abiotic stress resistant high yielding varieties / hybrids and to improve rice production and protection technologies to achieve higher yields with lesser inputs. Further the flagship schemes such as CRP-Biofortification, CRP-Agrobiodiversity, CRP-Molecular Breeding, CRP-Hybrid Technology and NICRA have also entered in their next phase, which will aid in achieving food and nutritional security along with climate resilient technologies. During the period, we have also revised our research projects to strengthen the collaboration with IRRI, Philippines.

Further we are proud to announce that from January – March 2017, ICAR-IIRR Newsletter (Volume 15 : Number 1), goes digital in compliance with the Department of Expenditure, Ministry of Finance, Government of India OM no. 232 dated 13-02-2017, endorsed by ICAR on 23-02-2017. I take the opportunity to congratulate the present Editorial Team for bringing out digital publication of the Newsletter and making it more informative with changed outlook.

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AICRIP NEWS / OUTCOMES

Recent Rice Variety Released by AICRIP Centre Occupies Large Area in Telangana State

The recently released rice variety, Telangana Sona (RNR 15048) has become very popular in the state and presently occupying more than 3.0 lakh acres. This variety has been preferred, because of its very fine grain quality (LB ratio: 3.03), highest milling recovery (head rice recovery up to 67%), good paddy yields (up to 7.0 t/ha), shorter crop duration (four months), resistance to blast and tolerance to other pests.

In the farmers day held by ICAR-IIRR, Rajendranagar, Hyderabad, Dr.J.S.Sandhu, DDG (crop science) visited the exhibition stall arranged by PJTSAU and distributed the Seed to farmers. Dr.V.Ravindra Babu, Director, ICAR-IIRR also interacted with the farmers about the performance of this variety in Telangana State. They appreciated the efforts of Rice Research Centre scientists in bringing about this good variety.

Dr. J.S. Sandhu, DDG (CS) along with Dr.V.Ravindra Babu, Director, ICAR-IIRR, distributing RNR 15048 seed to farmers.

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AICRIP Centre Rajendranagar Initiates Social Activities

Rice Research Centre, Rajendranagar celebrated various National functions and also local events *viz*., "Dr. B. R. Ambedkar's Jayanthi", "Mahathma Jyothirao Phule Jayanthi", "Telanganaku Haritha Haram" and ''Bathukamma festival'' during the year 2016-17. These occasions were graced by the Hon'ble Vice Chancellor, PJTSAU and Director, IIRR. All the staff and the labour participated in these programmes. While recollecting the dedication and contribution of great personalities the staff pledged to rededicate for the cause of farmers. On the occasion of "Telanganaku Haritha Haram", 44 tree seedlings were planted in the vacant lands. An innovative programme was launched at the research centre with the name "Aksharaabhyasam" to educate the illiterate women and men labour on the occasion of "Mahathma Jyothirao Phule Jayanthi". It has been decided to teach Telugu language and regular English words and numbers etc., one hour every day, so that they will read the news paper, books etc.,

Vice-Chancellor, PJTSAU participating in Bathukamma festival

Women labour learning Telugu, English and numbers

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Farmers' Training Programme under Tribal Sub Plan

A farmers' training programme was conducted under Tribal Sub Plan scheme at Regional Agricultural Research Station, Warangal, Professor Jayashankar Telangana State Agricultural University, Warangal on 27-02-2017. Dr.V.Praveen Rao, Hon'ble Vice-Chancellor, PJTSAU, Dr.P.Raghu Rami Reddy, Associate Director of Research, RARS, Warangal and Scientists of RARS, Warangal participated in the meeting. In this training, knowledge on best management practices in different crops of this region with special emphasis on rice and soil reclamation procedures were imparted to the trainee farmers of Tribal Sub Plan Scheme, 2016-17. Farmers from Sarangampalle, Chinnagunturpallethandas of Mulugumandal, Bhupalpally district were selected to implement TSP, 2016-17 as beneficiary tribal thandas. The scheme was sponsored by ICAR-IIRR, Rajendranagar, Hyderabad.

Farmers' undergoing Training Programme under Tribal Sub Plan at Warangal

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Karen Community of Andaman & Nicobar Islands Conserve Traditional Rice Varieties

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Rice is the most important and traditional cereal crop of Andaman and Nicobar Islands. The crop has wide spectrum of genetic variability owing to ethnic diversity of the settlers' population in the islands. Karen community originally came from Burma (now Myanmar) settled quite long back in North & Middle Andaman and brought unique rice cultures suiting to their taste and requirements. The word "Karen" was coined by British, whereas Burmese called them as "Kaylin" meaning "polite and good hearted". Predominantly they are agriculturists and earn their livelihood by rice farming, making mats, baskets, grain storing bins etc. The longevity of Karen people is ascribed to their love for nature, plants, herbs, fishing and hard work. Traditionally, they are practicing the concept of early to bed and early to rise and had only two meals in a day i.e. early brunch and supper.

Karen community brought ethnic rice cultures like Khushbuyya, Black Burma, White Burma, Red Burma, Mushley, Nyaw-in, etc. which suit to their likings and farm requirements. Despite efforts to introduce modern high yielding rice varieties, the Karen people are not ready to give up these landraces due to their unique characteristics including better response to low management conditions, tolerance to adverse weather conditions and better grain quality specifically liked by them for various food preparations (Table 1).

ICAR-CIARI, Port Blair took the initiative to document the traditional knowledge followed by characterization and evaluation for DUS (distinctness, uniformity and stability) parameters and genetic purification of these traditional rice varieties through social and field surveys, farmers' interaction through community leaders and research farm trials during 2011-2014.

Table 1. The special features of rice landraces grown by Karen community in Middle Andaman

Land race	Salient features as told by Karen respondents	Duration days	Grain Yield (t/ha)
Khushbaya	Also called as "*Choi-chi-manai* which in Burmese means it can grow without manure. It is nutritive, gives high yield and used for lunch.	135	4.0
White Burma	Sticky when cooked and used for *Lassa* / breakfast and gives energy for long time.	145	3.5
Black Burma	It is sticky when cooked and 'halwa' is prepared from its flour, which is better than 'maida' and used for breakfast. It has low grain yield.	145	3.5
Mushley	It is used for both lunch and dinner. It has high yield, small grains and good taste.	140	4.5
Nyaw-in	It is best in terms of taste, quality and soft like basmati rice. It is used for both lunch and dinner preparation but has low yield.	145	3.0

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IARI Develops Improved Basmati Rice Varieties with Resistance to Bacterial Blight and Blast

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Pusa Basmati 1728: It is a bacterial blight resistant Basmati rice variety developed through marker assisted backcross breeding. It carries bacterial blight resistance genes *xa13* and *Xa21* in the genetic background of Pusa Basmati 6. It is a semi-dwarf rice variety with seed to seed maturity of 140 to 145 days and average yield of 4.18 t/ ha. It possess extra-long slender grains (7.46 mm) with very occasional grain chalkiness, very good kernel length after cooking (14.62 mm), intermediate ASV (7.0), intermediate amylose content (22.84 %) and very strong aroma. In the panel tests, it has been ranked as an excellent culture and was in the top rated cultures based on two consecutive years of testing in the national Basmati trials. This variety showed resistance reaction to bacterial blight disease with the susceptibility index SI of 2 (2014) and 3.7 (2015), while the recurrent parent Pusa Basmati 6 showed susceptible reaction. This variety has been released and notified (S.O.3540(E)) for cultivation in the GI region of Basmati which includes the states of Punjab, Haryana, Delhi, Uttarakhand, parts of Jammu & Kashmir and Uttar Pradesh. Pusa Basmati 1728 being resistant to bacterial blight will help in reducing the use of antibiotic significantly, thus economizing cost of cultivation and also improving the food and environment safety by reducing pesticide residues.

Field view, grain and cooking quality traits of Pusa Basmati 1728

Pusa Basmati 1637: Basmati rice has several production constraints including biotic stresses, among which rice blast caused by the Ascomycete *Magnaporthe oryzae* is the most severe disease causing yield losses of up to 90 % and reducing the grain and cooking quality. The broad spectrum blast resistance gene *Pi9* was incorporated into the genetic background of Pusa Basmati 1 through marker assisted backcross breeding and Pusa Basmati 1637 was developed and released (S.O.3540(E)) for cultivation during 2016. Pusa Basmati 1637 showed resistance reaction against blast disease with the susceptibility index

Field view of Pusa Basmati 1637

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of 1, while the recurrent parent Pusa Basmati 1 showed susceptible reaction with the susceptibility index of 9 consecutively for two years of testing in the Basmati growing regions (AICRIP, 2014 & 2015). Pusa Basmati 1637 is characterized by semi-dwarf plant stature and non-lodging habit, yield, grain and cooking quality traits on par with Pusa Basmati 1. It possess long slender grains (7.3 mm) with very occasional grain chalkiness, very good kernel length after cooking (13.8 mm), intermediate amylose content (22.8 %) and strong aroma. In the panel test, it exhibited flaky appearance, tenderness on touching and chewing, desirable taste and optimum aroma with good elongation and overall acceptability 4.1 and 3.8, respectively which is on par with the recurrent parent Pusa Basmati 1. Currently, fungicides worth more than ~Rs. 50-60 crores annually is being used to manage blast disease in the Basmati crop. Cultivation of Pusa Basmati 1637 would significantly reduce the use of fungicides and overcome the concerns of rejections of Basmati rice consignments from the importing nations due to detection of fungicide residues.

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Recent High Yielding Varieties from APRRI, Maruteru for Intensive Cultivation in Irrigated Wetlands

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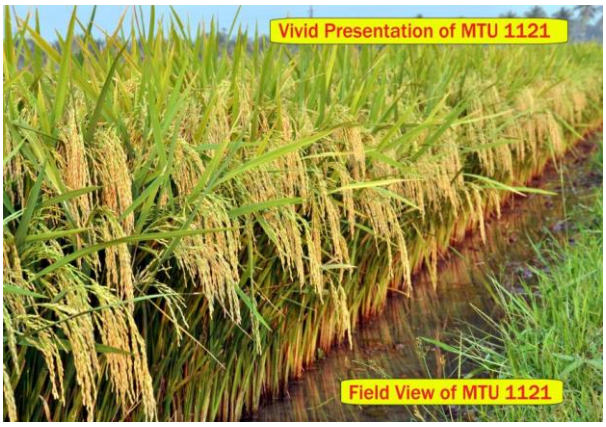
Andhra Pradesh Rice Research Institute (APRRI), Maruteru has always been in forefront in developing stable rice varieties with sustained production even under adverse climatic conditions with reduced cost of cultivation. Varieties with 115-125 days duration, non lodging, low grain shattering, resistance to blast, plant hoppers coupled with good grain quality like Tarangini (MTU 1156) and Sri Druthi (MTU 1121) were developed and released through SVRC for Andhra Pradesh and Chandra (MTU 1153) through CVRC for nine states in India. These varieties have become popular in the minikit stage itself and are being cultivated in >3.0 lakh ha. A new flood tolerant variety Bheema (MTU 1140) possessing tolerance to flash floods, stagnant flooding and anaerobic germination with non lodging trait very much suitable for coastal AP was released through SVRC in 2016. The details of all the varieties with characteristic features have been mentioned in Table 1.



MTU 1121 (Sri Dhruti)

MTU 1153 (Chandra)

MTU 1156 (Tarangini)

MTU 1140 (Bheema)

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The APRRI is recognized for the variety Swarna by Indian Society of Genetics and Plant breeding (ISGPB) for 2017. It has also been conferred with the best Regional Agricultural Research Station award for 2014-15 of Acharya N.G. Ranga Agricultural University (ANGRAU) during November 2016 at RARS, Nandyal.

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Table 1.Characteristic features of varieties released from APRRI & RARS, Maruteru during 2015 and 2016

Particulars	MTU 1153 (Chandra)	MTU 1121 (Sri Dhruthi)	MTU 1156 (Tarangini)	MTU 1140 (Bheema)
Details of release	Released through Central varietal release committee in 2016 for irrigated areas in the states Punjab (Zone II); Bihar, Madhya Pradesh and Chhattisgarh (Zone III); Maharashtra (Zone IV); Tamilnadu, Karnataka and Kerala (Zone V).	Released through State varietal Release Committee in 2015 for the state of Andhra Pradesh	Released through State varietal Release Committee in 2016 for the state of Andhra Pradesh	Released through State varietal Release Committee in 2016 for the state of Andhra Pradesh
Parentage	MTU 1010 / MTU 1081	BPT 5204/MTU BB 8- 24-1	MTU 1010 / MTU 1081	MTU 5249 / PLA 8572
Designation / pedigree	MTU II 320-41-2-1	MTU II 178-34-1-1-2	MTU II 320-51-1-1-1	MTU PLA 109-1-5-1-1
Plant height	105 -110 cm	115-120 cm	115-120 cm	125 -130 cm
Distinguishing morphological characteristics	Semi erect, Broad long flag leaf, semi erect plant shape, moderate tillering , compact panicles with long bold grains and suitable for irrigated conditions. It has 2 weeks seed dormancy	Semi erect plant type with moderate tillering, strong culm, non lodging, dark green foliage, position of panicles is at 2/3rd height of the plant. It has 3 weeks seed dormancy	Semi erect plant type with moderate tillering, dark green foliage, long slender grains with straw glume. It has 2 weeks seed dormancy.	Semi erect plant type with moderate tillering, green foliage with broad leaf, long panicles, non lodging, medium slender grains with straw glume, possessing tolerance to flash floods, stagnant flooding (30-50 cm water depth), anaerobic germination for 2 weeks, 2 weeks seed dormancy .
Maturity (Seed to seed)	115-125 days	125-130 days	115-120 days	140-145 days
Maturity group	Early maturity group	Rabi-Early	Rabi-Early	Late
Reaction to major diseases	Moderately resistant to leaf blast, neck blast, brown spot, sheath rot, RTD and leaf scald and resistant to false smut	Resistant to Leaf Blast	Resistant to Leaf Blast	Moderately tolerant to brown spot
Reaction to major pests	Moderate resistant to WBPH and GLH	Resistant to BPH	Resistant to BPH	Moderately tolerant to brown plant hopper
Agronomic features	Resistance to lodging (non lodging), low shattering and highly responsive to Nitrogen Seed rate 50 kg/ha	Non-lodging, grain shattering low (<2%), Fertilizer responsive upto 180 kg N/ha, suitable for Rabi Seed rate 50 kg/ha	Non-lodging, grain shattering low (<2%), Fertilizer responsive upto 180 kg N/ha, suitable for Rabi Seed rate 50 kg/ha	Non-lodging with strong culm, grain shattering low (<2%), Fertilizer responsive upto 90 kg N/ha, suitable for kharif in flood prone areas with elongation ability.

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				Seed rate 50 kg/ha Application of 25 kg urea and 25 Kg potash per hectare after recede of flood water
Grain type	Long bold	Medium slender	Long slender	Medium slender
Kernel Length / breadth ratio	2.95	2.78	3.01	2.55
1000 grain weight	23.5 g	20.5 g	22.5 g	20.3g
Quality traits	The variety MTU 1153 is having **desirable** values of ASV (4), gel consistency (65) and amylose content (22.5%). It also possesses very high head rice recovery (73%) with translucent grains .It had 14.1ppm zinc content in the milled rice.	The variety MTU 1121 is having **excellent cooking and chemical quality** as it is exhibited by intermediate and desired values of ASV, gel consistency and amylose content and high head rice recovery (68%) with translucent grains which is very much desired for marketing.	High hulling (80%), milling (73%) and head rice recovery (68%). Grain chalkiness is absent. The chemical quality indicated that cooking, eating and keeping quality of MTU 1156. ASV is 4, gel consistency is 68 cm and amylose content is 23.8%	The variety MTU 1140 is having excellent cooking and chemical quality as it is exhibited by intermediate and desired values of ASV (4), gel consistency (42mm) and amylose content (23.05%). It also possesses very high head rice recovery (65%) and the millers are giving minimum support price.
Grain yield	7.5t/ha	7.5t/ha.	7.5t/ha	6.0 t/ha

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New Long Slender Variety, KNM118 (Kunnaram Sannalu)

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Farmers have been facing problems with the old mega variety, MTU-1010 as it is prone to blast disease, and grain-shattering at the time of harvesting. This variety is being continuously cultivated over the years, and occupied more than 70-80 % of area in Telangana especially in *rabi* season, as it has huge demand by public and private agencies. Keeping in view the above problems and its high demand, the long slender culture, KNM-118 (Kunaram Sannalu) similar to MTU-1010 in grain type and duration (120-125 days) was developed from Agricultural Research Station, Kunaram through conventional breeding method (Pedigree method). The added advantage of this variety is high yield potential (28-35 quintals/acre) with tolerance to leaf blast and neck blast. The variety is recommended for cultivation in Telangana and Andhra Pradesh.

Field view, panicles, grains and milled rice of KNM 118

This culture has less shattering property at the time of harvesting and good market demand by public and private agencies. It is suitable for *kharif* , late *kharif* and *rabi* seasons. This is the first rice culture with Index No. KNM 118 from ARS, Kunaram, released in the name of “Kunaram Sannalu” through State Varietal Release Committee and notified during the year, 2016. Breeder seed production of KNM 118 is being taken up at the station level and 135 Quintals of breeder seed indents including state government and RKVY for coming season. It is estimated to cover in an area of about 20,000 ha in the forthcoming season.

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CROP IMPROVEMENT

RESEARCH HIGHLIGHTS : CROP IMPROVEMENT

Marker-Assisted Improvement of Akshayadhan, RPHR1005 and DPR17B for Resistance to Multiple Biotic Stresses

Balachiranjeevi CH, Abhilash Kumar V, Bhaskar S, Harika G, HajiraSk, Yugander A, Rambabu R, Anila, M, Mahadevaswamy M, Ravindra Kale R, Rekha G, Dilip T, Pranathi K, Swapnil Kulkarni, R, Kousik MBVN, Punniakoti E, Senguttuvel P, Kemparaju KB, Revathi P, Hariprasad AS, Madhav MS, Balachandran SM, Neeeraja CN, Mangrauthia SK, Kalyani Kulkarni, Laha GS, Prasad MS, Padmakumari AP, Jhansi Lakshmi V, Padmavathi G, Suneetha Kota, Bhadana VP, Fiyaz A, Gireesh C, Anantha MS, Jyothi Badri, Ravindra Babu V, Viraktamath BC and Sundaram RM*

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Improving host plant resistance is considered as one of the best eco-friendly and sustainable strategy to tackle attacks from insect pests and diseases in rice. As most of the elite rice varieties and hybrids are susceptible to multiple biotic stresses, we attempted to improve an elite rice variety, Akshayadhan and two, widely used hybrid rice parental lines, RPHR1005 and DRR17B for their resistance against bacterial blight, blast and gall midge through marker-assisted backcross breeding (MABB) in a project sponsored by the Department of Biotechnology, Govt. of India (Grant SO BT/PR11705/AGR/02/646/2008 dated 23.09.2009). Initially genes conferring resistance against two traits (for e.g. bacterial blight resistance + blast resistance) were combined together in the background of the above mentioned rice lines through MABB, which involved three rounds of backcrossing. At each round of backcrossing, foreground selection using the gene-specific markers (listed in Table 1) and background selection with a set of 60-65 parental polymorphic rice SSR markers was performed.

Table 1: List of target traits, target genes, donors and linked molecular markers

Trait	Genes and their donors	Molecular markers deployed	Chromosome No.
Bacterial Blight resistance	*Xa33* (FBR1-15 EM) *Xa21*(Improved Samba Mahsuri)	RM WR7.6 pTA248	7 11
Blast resistance	*Pi54* (BPT-*Pi54*) *Pi2* (BPT-*Pi2*)	*Pi54MAS* AP5659-5	11 6
Gall Midge resistance	*Gm8* (Aganni) *Gm4* (Abhaya)	PRP LRR	8 8

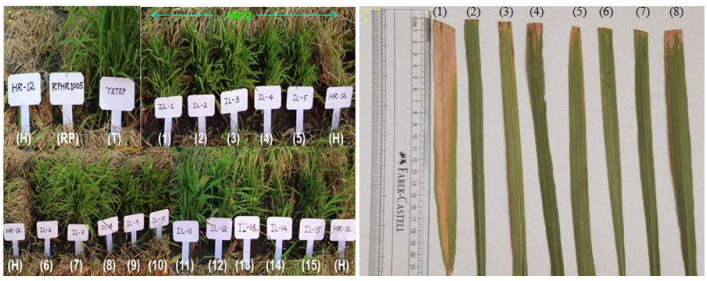

Fig. 1: Backcross derived lines of RPHR1005 showing high level of resistance against blast (A) and bacterial blight (B)

Several stable lines at BC_3F_8 generation have been developed in all the three genetic backgrounds containing gene combinations, *viz*., *Xa21+Gm4*, *Xa21+Gm8*, *Xa21+Pi54*, *Xa21+Pi2*, *Xa33*. Fig. 1 depicts the reaction of a few backcross derived lines of RPHR1005 possessing *Xa21* + *Pi54* against

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blast and bacterial blight diseases under artificial screening. Some of the backcross derived lines also out-yielded their recurrent parents, while possessing high level of resistance against bacterial blight and blast. Fig. 2A and 2B depicts bacterial blight and blast resistant backcross derived lines of Akshayadhan and DRR17B showing high yield and more grains per panicle, respectively.

Fig. 2: High yielding backcross derived lines of (A) Akshayadhan and (B) DRR17B, showing excellent plant type and high grain number per panicle

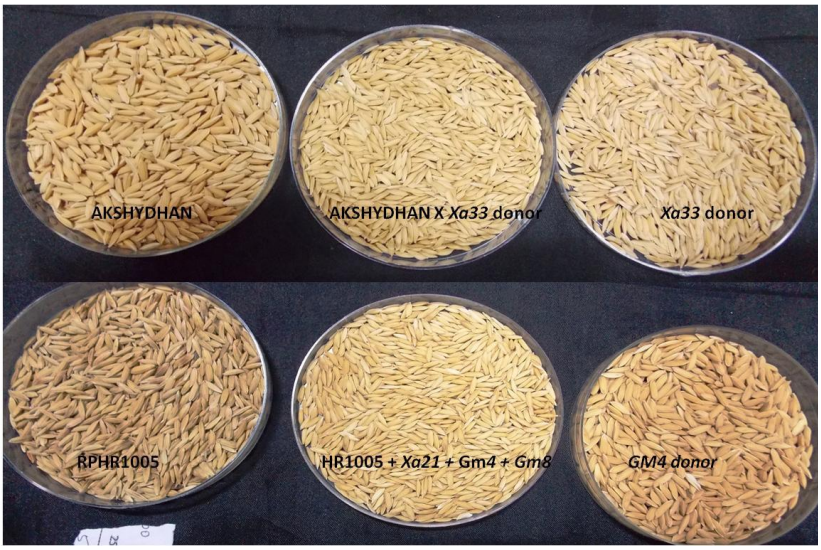

Fig. 3: Backcross derived lines of Akshayadhan (A) and RPHR1005 (B) were identical to the original parent in terms of grain quality.

Further, all the backcross derived lines were identical to their respective recurrent parents in terms of grain type (Fig. 3) and cooking quality along with high yield. Some such lines have been listed in Table 2.

Some of the promising two gene/trait containing lines (Table 2) were used for carrying out inter-crosses and double inter-crosses. Few homozygous double inter-cross plants for target genes (for two, three, four, five, six and seven genes) have been developed. They were observed to be identical to their recurrent parent. Efforts are being made to nominate some of the 2-gene, 3-gene and 4-gene containing lines in ACRIP trails and also to identify unique lines of potential academic, scientific and commercial value for registration with NBPGR, New Delhi. The developed lines can also be potentially employed as donor for the improvement of rice varieties.

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Table 2: Promising two-gene/trait containing lines in the genetic background of DRR17B, RPHR1005 and Akshayadhan

S. No.	RP Number	Gene combination	Pedigree	Background
1	RP5978	*Xa21* + *Gm4*	DRR17B/RP Bio Ent-2 (A breeding line of samba Mahsuri possessing *Xa21* + *Gm4*)	DRR17B
2	RP5979	*Xa21* + *Gm8*	DRR17B/RP Bio Ent-3 (A breeding line of samba Mahsuri possessing *Xa21* + *Gm8*)	DRR17B
3	RP5980	*Xa21* + *Pi54*	DRR17B/RP Bio Patho-2 (A breeding line of samba Mahsuri possessing *Xa21* + *Pi54*)	DRR17B
4	RP5981	*Xa21* + *Pi2*	DRR17B/RP Bio Patho-1 (A breeding line of samba Mahsuri possessing *Xa21* + *Pi2*)	DRR17B
5	RP5982	*Xa33*	DRR17B/FBR1-15 EM (A breeding line of samba Mahsuri possessing *Xa33*)	DRR17B
6	RP5983	*Bhp18*	DRR17B/ IR65482-7-216-1-2	DRR17B
7	RP5984	*Xa21* + *Gm4*	Akshyadhan /RP Bio Ent-2 (A breeding line of samba Mahsuri possessing *Xa21* + *Gm4*)	Akshyadhan
8	RP5985	*Xa21* + *Gm8*	Akshyadhan /RP Bio Ent-3 (A breeding line of samba Mahsuri possessing *Xa21* + *Gm8*)	Akshyadhan
9	RP5986	*Xa21* + *Pi54*	Akshyadhan /RP Bio Patho-2 (A breeding line of samba Mahsuri possessing *Xa21* + *Pi54*)	Akshyadhan
10	RP5987	*Xa21* + *Pi2*	Akshyadhan /RP Bio Patho-1 (A breeding line of samba Mahsuri possessing *Xa21* + *Pi2*)	Akshyadhan
11	RP5988	*Xa33*	Akshyadhan /FBR1-15 EM (A breeding line of samba Mahsuri possessing *Xa33*)	Akshyadhan
12	RP5989	*Bhp18*	Akshyadhan / IR65482-7-216-1-2	Akshyadhan
13	RP5990	*Xa21* + *Gm4*	RPHR1005/RP Bio Ent-2 (A breeding line of samba Mahsuri possessing *Xa21* + *Gm4*)	RPHR1005
14	RP5991	*Xa21* + *Gm8*	RPHR1005/RP Bio Ent-3 (A breeding line of samba Mahsuri possessing *Xa21* + *Gm8*)	RPHR1005
15	RP5992	*Xa21* + *Pi54*	RPHR1005/RP Bio Patho-2 (A breeding line of samba Mahsuri possessing *Xa21* + *Pi54*)	RPHR1005
16	RP5993	*Xa21* + *Pi2*	RPHR1005/RP Bio Patho-1 (A breeding line of samba Mahsuri possessing *Xa21* + *Pi2*)	RPHR1005
17	RP5994	*Xa33*	RPHR1005/FBR1-15 EM (A breeding line of samba Mahsuri possessing *Xa33*)	RPHR1005

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Genetic Improvement of Rice for Gall Midge and Bacterial Blight Resistance through Marker Assisted Selection (MAS)

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The Marker-Assisted Backcross Breeding (MABB) strategy coupled with phenotype-based selection was adopted for targeted transfer of *Gm4* and *Xa21* and *xa13* into the genetic background of Warangal Sannalu (WGL-32100) and Tellahamsa. Marker-assisted foreground selection involving the co-dominant/functional markers RM22554, RM547 for *Gm4*, pTA248 for *Xa21* and *xa13* promoter for *xa13,* respectively were used for selection of target traits.

When screened with *Xoo* isolate (DX002,obtained from Dr. G.S. Laha, ICAR-IIRR, Hyderabad, India) of the bacterial blight pathogen, the donor line RP1 (B 95-1 X Abhaya) displayed an average lesion length of 1.95 cm with a disease score of 3, while the recipient parents, Tellahamsa and WGL 32100 displayed an average lesion length of 15.1 cm and 14. 2 cm respectively with a disease score of 9 (SES scale developed by IRRI, 1996).

Two lines in the genetic back ground of WGL 32100 *viz*., WGL-1131 and WGL-1127 displayed a high level of resistance equivalent to or slightly higher than the donor parent with average lesion length of 2.42 cm and 2.95 cm respectively, and a disease score of 3 in each case. The line WGL-1119 showed susceptible reaction for Bacterial Blight (BB) disease but showed resistance against gall midge at 30 Days After Transplanting (DAT) and 50 DAT stage.

WGL 1131 with Gall midge and Bacterial blight resistance an improved line of WGL 32100

Five lines with the genetic back ground of Tellahamsa *viz*., WGL-1143, WGL-1146, WGL-1147, WGL-1149 and WGL-1150 displayed a high level of resistance equivalent to or slightly higher than the donor parent with average lesion lengths of 2.17 cm, 2.42 cm, 2.65 cm, 2. 32 cm and 2.95 cm respectively, and a disease score of 3 in each case. All the improved Tellahamsa lines, which were observed to be resistant to BB disease were also resistant to gall midge (Table 1).

This work demonstrates the successful application of molecular-marker technology coupled with phenotype based selection for targeted introgression of Bacterial Blight (BB) and gall midge resistance and superior grain quality into popular rice varieties.

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Table 1 : Gall midge resistance level and yield potential of genetically improved lines (*kharif, 2016)*

S. No.	Entry No.	30 DAT		50 DAT		Yield t/ha
		% Damage on hill basis	% Galls on tiller basis	% Damage on hill basis	% Galls on tiller basis	
1	WGL- 1119	0	0.00	0	0.00	6.4
2	WGL- 1127	0	0.00	0	0.00	6.0
3	WGL- 1131	0	0.00	0	0.00	5.8
4	WGL- 1143	0	0.00	0	0.00	5.8
5	WGL- 1146	0	0.00	0	0.00	5.6
6	WGL- 1147	0	0.00	0	0.00	5.4
7	WGL- 1149	0	0.00	0	0.00	5.5
8	WGL- 1150	0	0.00	0	0.00	5.5
9	WGL-32100	0	0.00	40	2.22	5.9
10	RP-1	0	0.00	0	0.00	5.2
11	Tellahamsa	50	6.99	70	15.27	5.5
12	TN-1 (C)	100	23.00	100	22.80	4.5

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Identification of Bacterial Blight Resistant Mutant Lines in the Mutagenized Samba Mashuri (BPT 5204) Population

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Bacterial blight of rice, caused by *Xanthomonas oryzae* pv. *Oryzae* (*Xoo*), is the most devastating disease of rice (*Oryza sativa* L). New sources of resistance against bacterial blight are needed as the pathogen evolves very rapidly and overcomes the existing resistance genes. To find out novel sources of resistance, a large number of Ethyl Methyl Sulphonate (EMS) mutagenized population of Samba Mahsuri (BPT 5204) was evaluated for their resistance to bacterial blight under artificial condition. In quaternary screening, 15 lines showed consistent resistance reaction for bacterial blight.

Fig 1. SES scores of selected six mutants with ADT pathotype (1-BPT, 2-TN1, 3-8 Mutants)

The Standard Evaluation System (SES) scores of these lines ranged from 1-3; while wild type (BPT 5204) exhibited a disease score of 9. Among the 15 lines, 6 lines (TI-42, 49, 61, 93, 132 and TI-133), which have medium slender grain and phenotypically almost similar to the wild type (BPT 5204) were selected and further screened with multiple *Xoo* pathotypes. These pathotypes included LUD-05-1 (IXo-090) (compatible for *xa5, xa13and Xa21*), ADT (IXo 015) (compatible for *xa5* and incompatible for *xa13* and *Xa21*), TNK-12-3 (IXo-281) (compatible for *xa5, xa13* and incompatible for *Xa21*), CHN/J (IXo-027) (compatible for *xa5, xa21* and incompatible for *Xa13)* and DRR-1 (IXo-020) pathotype (compatible for all the three genes *xa5, xa13* and *Xa21).* These lines showed resistance to all the tested pathotypes (Fig 1,2 and 3), indicating that the mode of resistance in these lines is new and novel. The allelic status of these six lines was also confirmed with gene specific (*xa5, xa13* and *Xa21*) markers and the data indicated that these lines have novel alleles of major genes responsible for bacterial blight resistance.

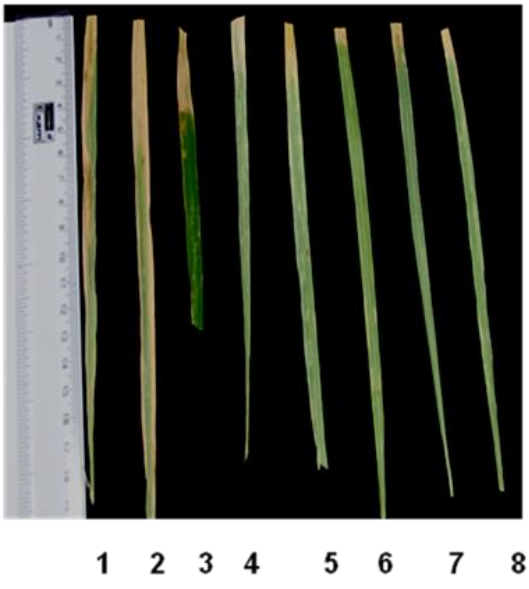

Fig 2. SES scores of selected six mutants with LUD pathotype (1-BPT, 2-TN1, 3-8 Mutants)

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Further, genotyping of these fixed mutant lines (M6) with 100 SSR markers spread uniformly across the genome, revealed that these lines share 92-95% allelic similarity with the wild type (BPT 5204). Mapping of the possible mutations, which led to the resistance in these mutant lines, is underway. It can be concluded that the novel resistance identified in some of these selected mutant lines can be well exploited in future rice improvement programmes.

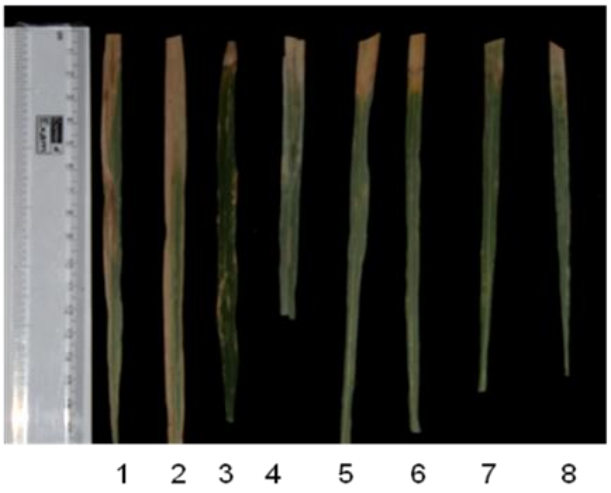

Fig 3. SES scores of selected six mutants with TNK pathotype (1-BPT, 2-TN1, 3-8 Mutants)

Fig 4. Resistant mutant plant (No.3)

Fig 5. BPT5204 (Check)

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Biotechnological Intervention for Saving *Mushkbudji* –A Rice Landrace of Kashmir

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The hilly terrains of State of Jammu and Kashmir are a home to number of rice landraces among which few like *Mushkbudji* is known for its unique aroma and exquisite quality. Unfortunately, the area under these valuable heritage rice is dwindling day by day due to numerous factors of which high susceptibility to blast happens to be the major cause. An initiative in this direction was taken by undertaking marker-assisted breeding program with the aim of targeting major blast resistance genes into *Mushkbudji* background.

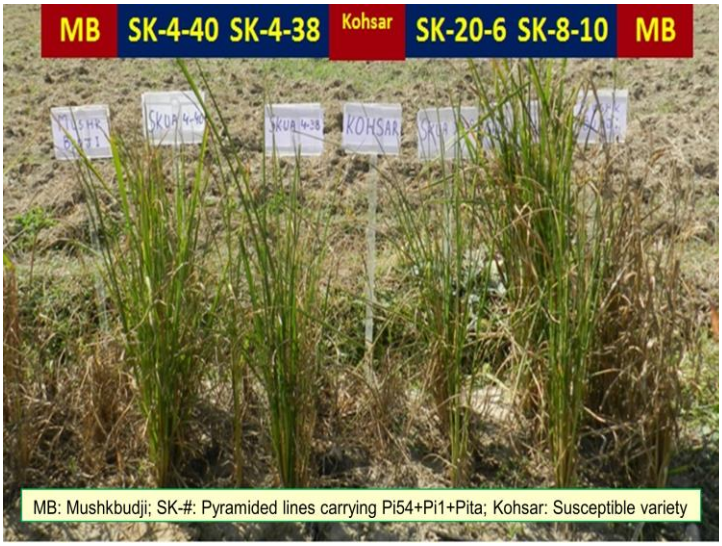

Fig. 1. Disease reaction of three-gene pyramids under Uniform blast nursery at MRCFC Khudwani

In Phase-I, our group targeted three major genes *viz*., *Pi54, Pi1* and Pita through efficient marker-assisted foreground and background selection. The three-gene donor DHMAS 70Q 164-1b carrying these genes was crossed with *Mushkbudji* and the progeny was advanced through successive backcross generations till BC_2F_4. The pyramided lines derived were recovered for recurrent parent genome and assessed/ checked for yield, cooking quality and aroma. The three-gene pyramided lines were immune to diagnostic isolates and expressed resistance under blast screening nurseries laid at several locations across Kashmir valley.

The lines or plant materials were also tested at Farmers location at Sagam, in Anantnag district, which forms the niche area of growing *Mushkbudji*. The pyramided lines performed at par or better than recurrent parent and were equally good in aroma (Fig. 1). The improved version of *Mushkbudji* is under farmers field testing stage and is expected to replace original (blast susceptible) *Mushkbudji* which shall make the cultivation not only economic but may also will help to predict good yield and quality of the produce (Table 1).

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Table 1 : Disease reaction of gene pyramids under Uniform blast nursery at MRCFC Khudwani

Plant ID	Gene combination	Isolates*		Location$^{\gamma}$		
		Mo-ei-MBI-2	Mo-nwi-kash-32	Khudwani	Sagam	Shalimar
SKUA-485-27-4-38	*Pi54+Pi1+Pita*	0	0	0	0	0
SKUA-485-27-4-40	*Pi54+Pi1+Pita*	1	1	1	1	0
SKUA-485-27-7-3	*Pi54+Pi1+Pita*	0	0	0	0	0
SKUA-485-27-77	*Pi54+Pi1+Pita*	1	0	0	0	1
SKUA-485-27-47	*Pi54+Pi1*	1	0	1	2	2
Mushkbudji	-	5	5	7	5	8
DHMAS70Q164-1b	*Pi54+Pi1+Pita*	0	0	0	0	0

Scoring as per Mackill and Bonman (1992), 0-5 scale. Score 0-2: R ; 3-5: S
$^{\gamma}$Scoring as per SES IRRI (1996), 0-9 scale. Score 0-3: R; 4-5: MS: 6-9: S

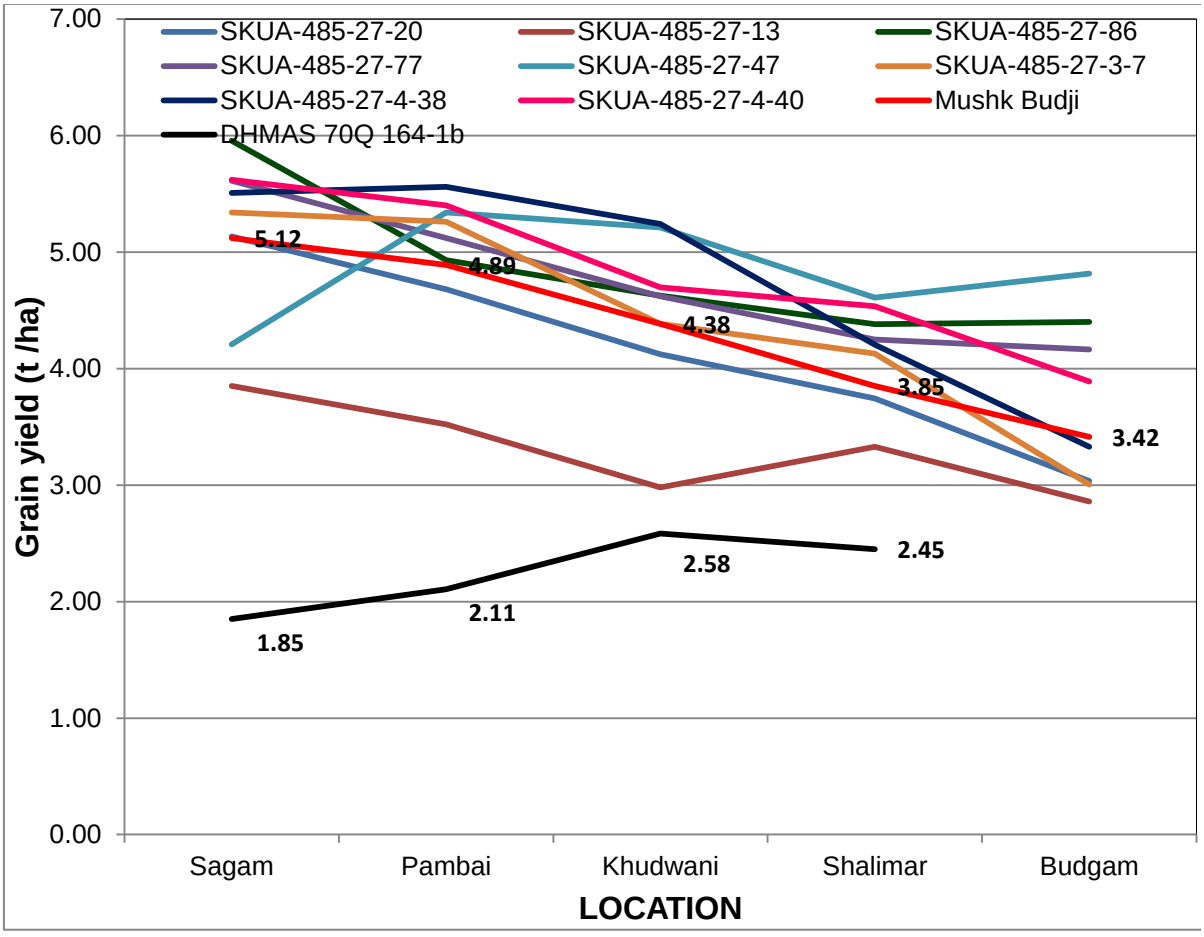

Fig. 2. Multi-location grain yield performance of pyramided lines carrying blast resistance genes *Pi54, Pita* and *Pi1*

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Marker Assisted Introgression of *Pup1,* A Major QTL Associated with Tolerance to Low Soil Phosphorus into Elite Rice Varieties

Anila M, Mahadevaswamy HK, Ravindra R Kale, Bhadana VP, Brajendra P, Hajira SK, Pranathi K, Balachiranjeevi CH, Praveen M, Abhilash Kumar V, Bhaskar S, Dhanalaxmi D, Harika G, Dilipkumar T, MBVN Kousik, Yugender A, Punniakotti E, Laxmi Prasanna B, Swapnil Kulkarni, Rekha G, Balachandran SM, Neeraja CN, Madhav MS, SurekhaK, Laha.GS, Anantha MS, Fiyaz A, Suneetha K, Gireesh C, Viraktamath BC, Ravindra Babu V and Sundaram RM*

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Phosphorus (P) is a vital element required for growth and development of rice. Indian rice growing soils have moderate to severe P-deficiency, which is due to reduced application of phosphatic fertilizers (which are becoming increasingly expensive) coupled with high P-fixing capacity of soils at many locations in the country. Due to this, a moderate to severe reduction in rice yields has been noticed in several locations with P-deficient soils. Earlier, the collaborative research teams of Japan International Research Centre for Agriculture (JIRCAS) and International Rice Research Institute (IRRI), Philippines, together identified a major quantitative trait locus (QTL) associated with tolerance to low soil P named *Pup1,* fine-mapped it on Chr. 12 and cloned the candidate gene underlying *Pup1*, named Pstol1 kinase. Suitable functional markers were developed for use in marker-assisted transfer of *Pup1* into elite rice varieties. In order to improve three elite Indian rice varieties, *viz*., Improved Samba Mahsuri, MTU1010 and IR-64, which give very low yields in P-deficient soils, we utilized marker-assisted backcross breeding strategy for targeted transfer of *Pup1* into the three varieties under a DBT sponsored project (BT/PR4665/AGII/106/854/2012 dated: 19.02.2013).

In order to improve the above mentioned rice varieties for their tolerance to soil P-deficiency, another elite, high yielding, widely adaptable rice variety, Swarna, which possesses *Pup1* was used as the donor parent. Marker-assisted backcross breeding (MABB) strategy involving two backcrosses coupled with foreground selection using the gene-specific dominant functional marker, K46-1 together with two co-dominant markers K20-1-1 and K20-2, recombinant selection using a set of parental polymorphic SSR markers located within 3 Mb on either side of *Pup1* and background selection using a set of 65 parental polymorphic SSRs (Fig. 1) distributed throughout the rice genome were deployed for targeted transfer of *Pup1*, precisely in the shortest possible time.

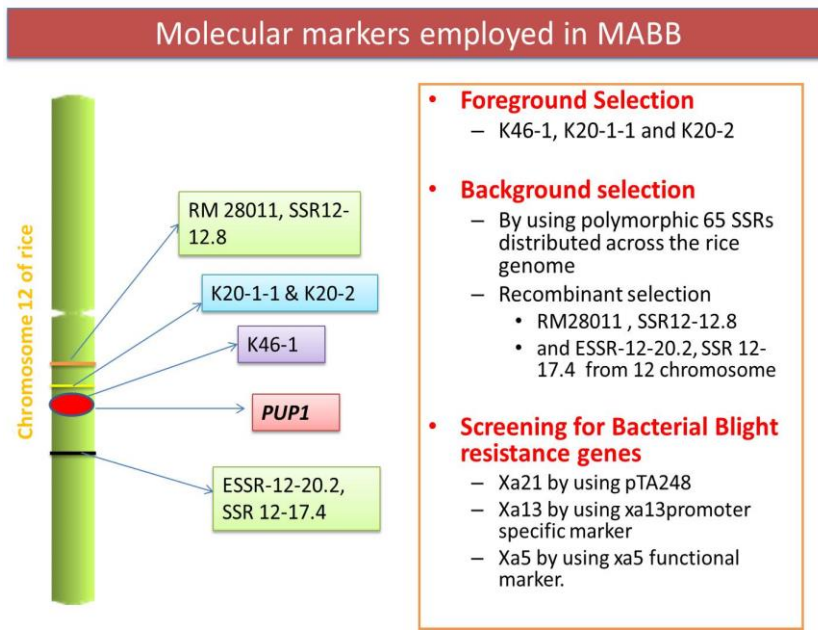

Fig. 1. Details of markers used for targeted transfer of *Pup1* into elite Indian rice varieties through MABB

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A total of 25 BC_2F_6 lines possessing *Pup1* in the background of Improved Samba Mahsuri (n = 9), MTU1010 (n = 8) and IR-64 (n = 8) in homozygous condition were developed and evaluated for their tolerance to low soil P in low P plot at ICAR-IIRR during *Kharif* 2015 and *Rabi* 2015-16. In low-P soil, *Pup1* introgressed lines performed significantly better than recurrent parents in terms of days to 50% flowering, plant height, number of productive tillers, grains per panicle, total biomass, yield and possessed better root system which improves the uptake of P from the soil (Fig. 2; Table 1). The lines were also observed to be equivalent to or better than their respective recurrent parents, when grown under soil with optimal P (Table 2).

Two lines (one line each of MTU1010 and IR-64 backgrounds), which were observed to be similar to the respective recurrent parents for all the agro-morphological traits and showed better performance under low P condition have been nominated for AICRIP trials in the category IVT-IME during *Kharif* 2016 and three better performing *Pup1* containing lines, each in the genetic background of Improved Samba Mahsuri, MTU1010 and IR-64 will be nominated for AICRIP trials under AVT1-NIL category in AICRIP trials during *Kharif* 2017. The improvement of tolerance to low soil P in the genetic background of Improved Samba Mahsuri, MTU1010 and IR-64 can result in increased acreage of these elite varieties in marginal soil (i.e. problematic soils with low P), can cut down the cost of cultivation and increase the income of the farmers. Further, breeding lines of ISM, MTU1010 and IR-64 possessing *Pup1* can also serve as good donors for targeted transfer of the major QTL to other fine-grain type rice varieties.

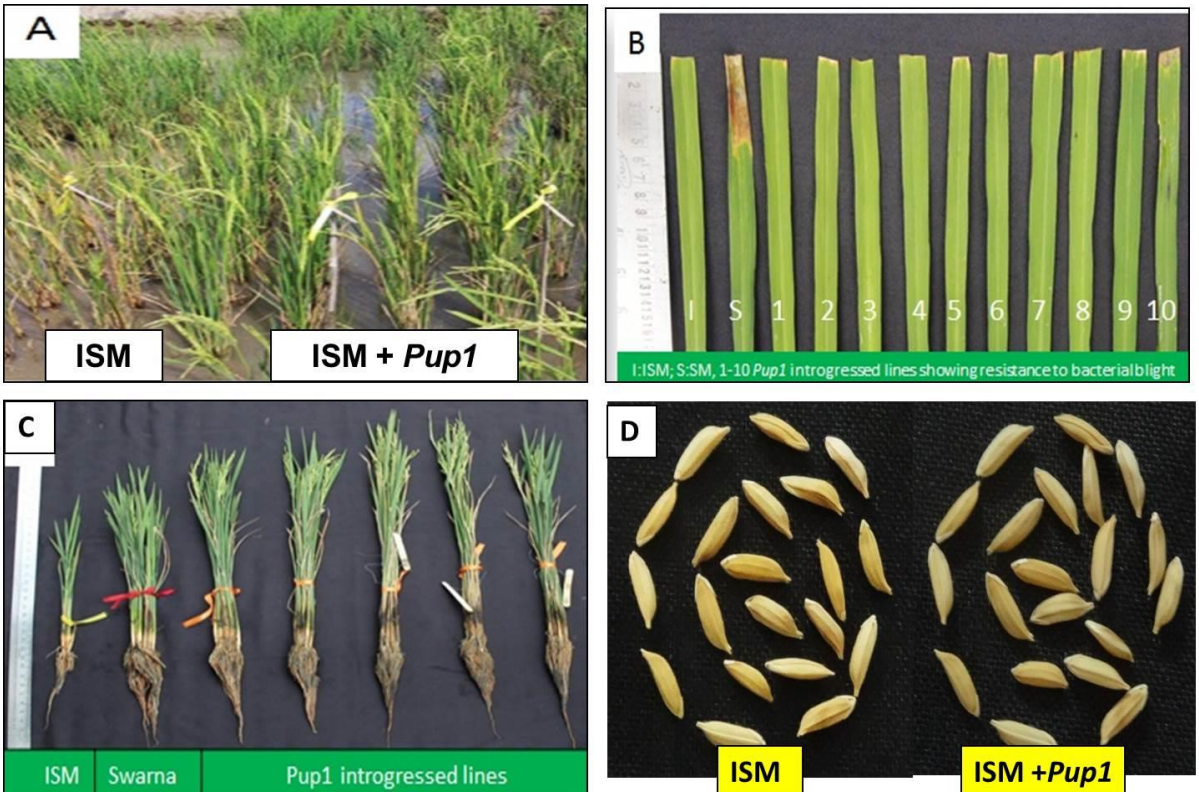

Fig 2. *Pup1* containing lines of Improved Samba Mahsuri (ISM) were observed to be better than ISM in terms of crop establishmen (A), root length and volume (C) and highly resistant to bacterial blight disease (B) and possessed grain quality features similar to ISM (D)

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Table 1: Agro morphological features of selected backcross derived lines in low soil P plot of ICAR-IIRR Hyderabad

S. No	Genotype	Days to 50% flowering	BB Score	Plant height	Number of tillers per plant	Number of productive tillers	Root length	Root volume	Panicle length	1000 seed weight	Grain yield per plant	Grain type
1	ISM# (Susceptible parent)	112	1	43.2	6	3	21.5	10	12.4	13.52	4.32	MS
2	RP5970-1-3-17-65-12	103	1	56.2	7	7	25.6	40	15.2	15.23	5.26	MS
3	RP5970-1-3-17-65-16	108	1	60.8	8	6	26.7	45	13	16.85	4.65	MS
4	RP5970-1-3-17-65-27*	101	1	58.4	6	6	29.4	35	14.6	17.56	5.64	MS
5	RP5970-1-3-17-65-49	98	1	63.2	8	7	24.3	40	15	16.78	5.31	MS
6	RP5970-1-3-17-65-61	97	1	66.7	9	9	25.7	45	13.9	15.69	4.32	MS
7	MTU1010#(Susceptible parent)	106	NA	66.2	5	4	20.3	15	16.3	23.12	4.22	LS
8	RP5972-4-1-6-129-21	97	NA	76.7	7	7	26.8	50	21	25	4.36	LS
9	RP5972-4-1-6-129-36	93	NA	79.3	8	8	27.8	45	23	24.1	5.12	LS
10	RP5972-4-1-6-129-57	99	NA	85.1	8	7	26.4	40	21	23.23	4.21	LS
11	RP5972-4-1-6-129-266*	96	NA	80.6	9	9	25.3	55	23.5	26.41	5.76	LS
12	RP5972-4-1-6-129-268	102	NA	79.2	10	9	24.2	45	22	24.63	2.65	LS
13	IR-64# (Susceptible parent)	102	NA	53.2	6	4	22.5	12.5	15.3	24.16	4.38	LS
14	RP5974-3-2-8-38-255*	93	NA	62.1	8	8	28.6	35	23.5	25.32	5.63	LS
15	RP5974-3-2-8-38-42	89	NA	58.2	9	8	29.3	40	21	26.25	4.88	LS
16	RP5974-3-2-8-38-58	91	NA	63.2	8	7	30.8	30	20.2	24.6	5.78	LS
17	RP5974-3-2-8-38-121	88	NA	65.1	9	9	26.3	45	22.1	24.38	4.27	LS
18	RP5974-3-2-8-38-135	90	NA	55.2	9	9	27.4	40	23	24.89	4.53	LS

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Table 2: Agro morphological features of selected backcross derived lines in normal soil P plot of ICAR-IIRR Hyderabad

S.No	Genotype	Days to 50% flowering	BB Score	Plant height	Number of tillers per plant	Number of productive tillers	Root length	Root volume	Panicle length	1000 seed weight	Grain yield per plant	Grain type
1	ISM# (Susceptible parent)	103	1	82.3	15	15	19.7	20	18	12.8	35.2	MS
2	RP5970-1-3-17-65-12	101	1	80.6	18	18	20.3	18	20	13.8	40.2	MS
3	RP5970-1-3-17-65-16	103	1	85.4	18	18	19.3	19	21	15.2	41.6	MS
4	RP5970-1-3-17-65-27*	98	1	79.1	19	19	22.5	22	20.5	14.6	42.3	MS
5	RP5970-1-3-17-65-49	96	1	85.5	20	20	20.8	10	22	13.5	42.1	MS
6	RP5970-1-3-17-65-61	93	1	83.8	19	19	19.4	15	19	14.2	41.7	MS
7	MTU1010#(Susceptible parent)	96	NA	92.7	13	13	18.2	15	20.4	14.2	30.1	LS
8	RP5972-4-1-6-129-21	92	NA	89.3	15	15	19.5	20	23.2	13.5	36.2	LS
9	RP5972-4-1-6-129-36	87	NA	93.2	16	16	17.3	15	22.3	15.3	37.8	LS
10	RP5972-4-1-6-129-57	89	NA	95.4	19	19	18.2	20	23	16.8	42.5	LS
11	RP5972-4-1-6-129-266*	90	NA	86.5	19	19	19.7	18	24.4	17.2	43.7	LS
12	RP5972-4-1-6-129-268	94	NA	88.4	18	18	19.8	15	24	16.6	40.6	LS
13	IR-64# (Susceptible parent)	93	NA	89.1	14	14	17.4	15	21.2	15.3	31.8	LS
14	RP5974-3-2-8-38-255*	86	NA	85.7	18	18	18.2	18	24	17.2	42.3	LS
15	RP5974-3-2-8-38-42	83	NA	83.4	17	17	17.3	15	23.5	15.9	39.2	LS
16	RP5974-3-2-8-38-58	84	NA	81.3	16	16	18.6	10	22.2	16.2	38.8	LS
17	RP5974-3-2-8-38-121	80	NA	80.4	18	18	19.2	20	21	15.5	41.1	LS
18	RP5974-3-2-8-38-135	79	NA	86.8	16	16	18.5	15	23	16.8	38.2	LS

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A Protocol for Rapid Screening for Seedling Stage Salinity Tolerance in Rice

Rekha G, Senguttuvel P, Abhilash Kumar V, pranathi K, Kousik MBVN, LaxmiPrasanna B, Swapnil K, Backiya Laxmi N, Pragyasinha, Mahadevaswamy HK, Ravindra R Kale, Hajira SK, Bhaskar B, Balachiranjeevi CH, punniakotti E, Harika G, Dilipkumar T, Anila M, Chaitra K, Balachandran SM, Brajendra P, Kalyani Kulkarni, Surekha K, Fiyaz A, Padmavathi G, Ravindra Babu V and Sundaram RM*

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One of the foremost requirements for studying genetics and molecular mapping for salinity tolerance is the availability of rapid, but reliable techniques for screening. Presently, breeding lines and mapping populations are screened phenotypically in a hydroponic media by growing the seedlings in a stryrofoam base as the standard method. However, it is very laborious and time-consuming method and often leads to inconsistent results, if adequate care is not taken to regularly change the solution. We have developed a modified protocol using silica sand (with a particle size of 1-2 mm) as the base for the culture media, replacing the styrofoam base, thus raising the seedlings on a solid base along with Yoshida solution added with pre-determined concentration of salt. The method was validated in a set of 12 breeding lines of Improved Samba Samba Mahsuri (ISM) possessing the major QTL associated with seedling stage salinity tolerance, *viz*., *Saltol*along with the susceptible check, ISM and a tolerant check, FL478.

The pre-germinated seeds were grown in a tray filled with silica sand and supplied with Yoshida's solution using perforated tubes (pipelines with 4-5 mm width) on each corner of the tray, ensuring adequate supply of culture media (i.e. standard Yoshida medium without any extra salt) (Fig. 1A). About 25 days after germination, the seedlings were treated with culture media containing different salt concentrations ranging from 60 mM, 80 mM, 100 mM and 120 mM. The symptoms of salt stress was observed seven days after treatment and the parameters like shoot length (cm), root length (cm) and germination rate (%) were analyzed in 2-3 day intervals. The Sodium (Na^+) and Potassium (K^+) concentrations in the root and shoot along with Na/K ratio were also recorded. All the 12 *Saltol* containing lines of ISM were observed to show high levels of tolerance to salinity along with the tolerant check, FL478, while the susceptible check, IR29 and ISM showed symptoms of susceptibility (Fig. 1B and 1D).

This experimental setup saves time, labour and reduces the quantity of the solution required for the hydroponic growth of the experimental material. Further, the present set up also ensures easy handling of the experimental material and quick uprooting of the roots without any rotting as silica sand is inert and brittle (Fig. 1D). Moreover, the solid growth base (i.e. silica sand) also facilitates the entrapment of the Yoshida's solution for a longer period which in turn results in healthier plant growth without any algal growth with clear distinction between tolerant and susceptible lines. We also attempted the same methodology in pots and found it to be equally efficient in performance as in trays (Fig. 1C).

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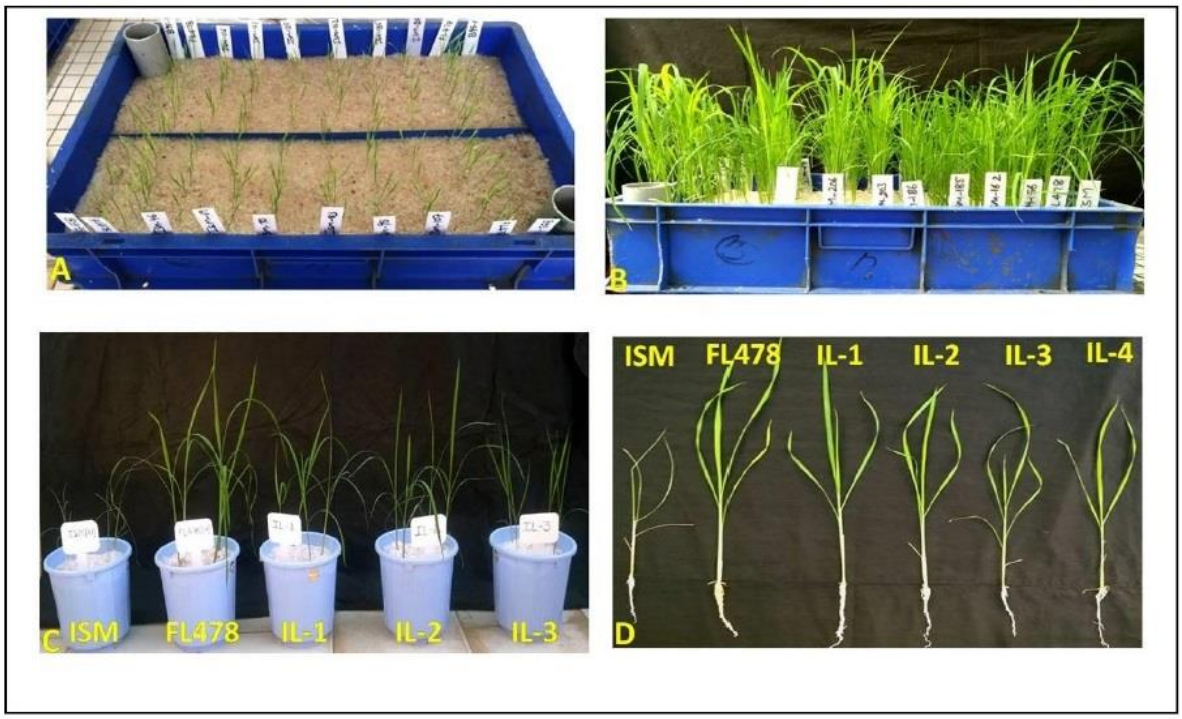

Fig. 1 : Screening for seedling stage salinity tolerance

A) 7 days old rice seedlings on silica sand based tray
B) 21 days old seedlings of *Saltol* containing lines of ISM showing tolerance
C) Screening of lines for seedling stage salinity tolerance in plastic pots
D) Uprooted seedlings of checks (ISM and FL478) and improved lines of ISM possessing *Saltol*(IL1 to IL4)

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CROP PRODUCTION

RESEARCH HIGHLIGHTS : CROP PRODUCTION

Direct Seeded Rice : A Boon for Bihar

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The traditionally puddled rice (TPR) cultivation in Bihar is presently facing serious problems of groundwater depletion, negative impact of puddling on soil and delayed transplanting of rice due to shortage of labour. Direct seeded rice (DSR) requires less water and is more tolerant to water stress as compared to TPR, it also got better adaptive capacity to climate change. Growing DSR could have substantial impact in reduction of methane emission as DSR fields are not continuously submerged with water. DSR is getting increasingly popular among farmers due to labour and water savings, though it has a lower yield potential than TPR. Earlier, the farmers were not convinced, but through the extension activities such as: OFTs (on farm trial), FLDs (front line demonstrations), trainings, travelling seminars, method demonstrations, printing material and media, DSR technology is being disseminated among the farmers, due to which they gradually started believing in this technology.

Recommended varieties for Direct Seeded Rice (DSR) cultivation in Bihar:

Among the existing varieties and hybrids which were bred for puddled rice, some varieties and hybrids as listed below have been found suitable for DSR.

Group	Varieties/Hybrids
Public Sector	RajendraBhagwati, RajendraNeelam, Prabhat, RajendraSuwashini, RajendraKasturi
Private sector	27 P-31, ArizeTej, DRH-834, DRH-775, Arize-6129, JKRH-401, JKRH-3333

Keeping in view the above facts, a case study on DSR was conducted by the University at various locations with the objectives *viz.,* to create and extend the awareness of DSR technology, popularize package of practices for DSR technology, conserve the resources through DSR and to save environment from methane pollution. To achieve these objectives, five KVK's were selected in five different districts *viz*. Saran, Muzaffarpur, East Champaran, Begusarai and Siwan of North Bihar and trials were conducted for two consecutive seasons (*kharif* 2014 and 2015). From each KVK two progressive farmers were identified. For each location one acre of land was selected for demonstration. Half an acre was used for normal TPR and another half an acre was used for DSR with appropriate package of practices at all 10 locations and one acre at University farm, Pusa. In DSR trials, selective pre-emergence herbicide, pendimethalin was used within 48 hours of sowing @ 1 litre/200 litre of water, while selective post emergence herbicide bispyribac sodium was used within 15-20 days of sowing @ 100ml/200 litres of water for one acre. Irrigation was applied next day and gap filling was also done with subsequent top dressing of urea for better crop establishment and uniform plant density.

During *kharif*-2014 data recorded from farmer's field for both DSR and TPR trials indicated that yield performance for DSR ranged from 3.8 to 5.6 t/ha while in TPR it ranged from 3.5 to 4.8 t/ha.

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During *kharif*-2015, data recorded from farmer's field ranged from 3.0 to 5.5 t/ha in DSR, whereas 4.0 to 4.8 t/ha in TPR. In DSR trial, highest yield of 5.5 t/ha was recorded at Choraili village of Siwan district while lowest yield of 3.0 t/ha was recorded in Hariharpur village of Muzaffarpur district. In TPR the highest yield of 4.8 t/ha was recorded in Keshawe village of Begusarai district, while lowest yield of 4.0 t/ha was recorded in the field of Bheldi village of Saran and Choraili village of Siwan district (Table 1). Based on the study, it can be presumed that DSR technology has great potential in Bihar and it is gaining popularity day-by-day. If proper awareness and dissemination is provided to the farmers then it will be able to cover at least 40-50% of total cultivated rice area within a span of five years.

Table 1 : Yield performance of rice variety Rajendra Bhagwati at farmer's field during *Kharif-2014* and *Kharif-2015*.

Sl. No.	Name of KVK	Location	Yield q/ha		Location	Yield q/ha 11	
			DSR	TPR		DSR	TPR
1.	KVK, Begusarai	Vill.- Keshawe, Dist.- Begusarai	56.0	48.0	Vill.- Keshawe, Dist.- Begusarai	45.0	48.0
		Vill.- Gangraha, Dist.- Begusarai	41.0	45.0	Vill.- Makardahi, Dist.- Begusarai	42.0	45.0
2.	KVK, Saran	Vill.- Bheldi, Dist.- Chhapra	45.0	Trial Failed	Vill.- Bheldi, Dist.- Chhapra	40.0	42.0
		Vill.- Afaur, Dist.- Chhapra, Saran	48.0	42.0	Vill.- Bheldi, Dist.- Chhapra, Saran	38.0	40.0
3.	KVK, Muzaffarpur	Vill.- Bhatoina, Dist.- Muzaffarpur	42.0	35.0	Vill.- Gangaulia, Dist.- Muzaffarpur	40.0	45.0
		Vill.- Hariharpur , Dist.- Muzaffarpur	38.0	42.0	Vill.- Hariharpur Dist.- Muzaffarpur	30.0	42.0
4	KVK, East Champaran	Vill.- Mahuwawa Dist.- East Champaran	43.0	45.0	Vill.- Mahuwawa Dist.- East Champaran	35.0	45.0
		Vill.- Jasauli, Dist.- East Champaran	47.0	Trial Failed	Vill.- Paharpur Dist.- East Champaran	40.0	-
5	KVK, Siwan	Vill.- GoreyaKothi, Dist.- Siwan	44.0	46.0	Vill.- Chorauli, Dist.- Siwan	44.0	46.0
		Vill.- Choraili, Dist.- Siwan	48.0	45.0	Vill.- Choraili, Dist.- Siwan	55.0	40.0

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CROP PRODUCTION

Two Tier System of Cultivating Field Crops as Relay Cropping in Rice Field – A New Concept to Improve the Livelihood of Resource Poor Farmers

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Tribal farmers of Pashim Barachowki (Alipurduar-II, Alipurduar district) were not aware of modern agricultural practices. They used to cultivate only rice during *kharif* season and few scattered farmers used to grow local variety of mustard and some vegetables mainly for their own consumption during *rabi* season. Most of the land of tribal farmers would remain fallow during *rabi* season. Another constraint is the unavailability of irrigation facility. Mustard (*Brassica juncea*) and Masur or lentil (*Lens culinaris*) are important crops in northern part of West Bengal. To avoid the dry condition of the crop field during germination and seedling establishment, two tier system of relay cropping of mustard and lentil practiced in Pashim Barachowki (Alipurduar-II, Alipurduar district) under Tribal Sub Plan of IISS (Main Scheme), Mau (Fig. 1). This system helped to enhance conservation of agricultural resources and income of the farm family to improve the livelihood of the tribal farmers. A total of 30 demonstrations were under taken for each category of relay cropping.

Fig. 1. Lentil and mustard as two tier relay crop at PashimBarachowki (Alipurduar-II, Alipurduar district)

Lentil seed (local cultivar) was soaked overnight and sown in the ripen standing crop of rice field. The seed rate of lentil was 24.5 kg/ha. In the same field *Jhati sarson*, a local cultivar of mustard was sown on the same day at a rate of 0.75 kg/ha. Sowing was done 10 days before the harvest of the rice crop. Here the seed rate of mustard was reduced to about 1/4th of the normal seed rate, because, the lentil was considered as the main crop. Here the objective is to get mustard as additional crop. Mustard and lentil used the residual moisture of the paddy field for germination and establishment of seedling. Mustard crop is much taller than lentil and it form the upper tier of this cropping pattern and lentil formed the lower tier. The population of the mustard was very thin, thus there was no shedding created by the mustard for the lentil crop. The nitrogen fixed by the pulse crop (lentil) was used by both crops. There was no rain during the crop period and no irrigation was also provided by the farmers. The yield of *Jhati Sarson* was 0.21 t/ha and lentil was 0.65 t/ha. Thus, without significant reduction the yield of lentil, the farmers got additional yield of mustard. This programme was implemented in a tribal village of Alipurduar district. Before our intervention in this village, the farmers would keep the land as fallow during *rabi* season, except vegetables for their own consumption. Non-tribal farmers of the same village and farmers of nearby areas also adopted this technology. This mustard and lentil based two tier relay cropping system in rice field was supervised in collaboration with Tarai Research Society, Kayakhata, Salsalabari, Alipurduar district.

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Cultural Management Technologies to Enhance Productivity of Rice

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Cultural management practices include all the activities carried out on farm before, during and after planting of crops like pre-planting, planting and post-planting operations. These practices are adopted to improve crop growth, prevent and reduce weed problems and increase the grain yield in different systems of rice establishment by manipulating the micro climate. With the idea of utilizing economic and effective cultural practices in enhancing grain yields of rainfed, aerobic, direct sown rice under puddled condition and System of Rice Intensification (SRI) cultivation are compared. A total of seven AICRIP trials were analysed for technology assessment with respect to yield advantage over traditional practices which were conducted during 2015 at various locations of India. It revealed that agronomic cultural management plays a major role in enhancing the productivity of rice. The yield varied from 3.26 in semi dry rice to 5.96 t/ha recorded in best farmer field across the trials and locations. The yield increase was from 4.0% to 18.1% with respect to various technologies (Table 1). The average yield increase was 8.7 % due to cultural management technologies compared to traditional farmers practice. It indicates that cultural management technologies need to be integrated with other technologies such as new varieties and crop protection technologies which will be more sustainable in the coming year to achieve the potential yield of rice under various changing climate scenario.

Table 1: Comparative performance of agronomic cultural management technologies and traditional farmers practice

S. No.	Traditional practice	Yield (t/ha)	Cultural management technology	Yield (t/ha)	Yield gain (%)
1	Transplanting	4.76	Wet direct seeded rice using drum seeder	4.98	4.6
2	Optional method of sowing location specific	3.07	Semi dry rice	3.26	6.2
3	Transplanting	4.72	Mechanical transplanting followed by (fb) SRI principles	4.91	4.0
4	Transplanting	4.24	SRI	4.70	10.8
5	Farmers practice	4.65	Site Specific Nutrient Management NE@	5.49	18.1
6	Recommended INM	5.54	Best farmers's practice of the region	5.96	7.6
7	Farmers practice	5.01	Mechanised transplanting (fb) SRI principles	5.49	9.6

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CROP PROTECTION

RESEARCH HIGHLIGHTS : CROP PROTECTION

Swarming Caterpillar : A Menace to Rice Farmers in Assam

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Swarming caterpillar, one of the minor insect pest in the rice ecosystem had attained a status of major pest in *kharif* 2016, which became a menace to the rice farmers in Assam. Early dry spell followed by heavy rainfall with aberrant high temperature causing hot and humid weather and changes in cultivation practices might be attributed to the swarming caterpillar epidemics. Around 30,000 hectares of rice fields, i.e. more than 1.6% of total *kharif* rice area was severely damaged in twenty two districts of Assam (Fig. 1). Literature shows that the epidemics of swarming caterpillar was reported during 1967 in Assam. The condition was worst in Golaghat district, where 6,671 hectares of rice had been nearly destroyed followed by Dibrugarh district with 5,000 hectares.

The larvae of *Spodoptera mauritia* was responsible for the epidemic condition in the state. Caterpillars marched in large numbers in the evening hours and fed on the leaves of paddy seedlings till the morning and hided during daytime. After finishing the crop of one field the swarm marches to another field in a regular army formation manner, hence this insect pest is also called as “Army worm”. Under severe infestation crop gave the grazed up appearance. Attacked plants were reduced to stumps. Nurseries situated in ill-drained marshy areas were attacked earlier than dry fields. Damage was severe during July to September, 2016. The female lays about 200-300 eggs on the rice leaves, larvae hatches within 5-7 days. More interestingly, the adult females are able to mate just 24 hours of emergence from pupa, which increases the pest population at an alarming rate. The neonates were not visible due to the same color with leaves. Later instars become visible as they turn into dark blackish brown colour and they feed voraciously on the leaves leaving only stumps. They are nocturnal and hide in the lower portion of the rice plant or weeds of rice bunds and nearby areas during day time.

The climate change may be one of the prime reason for the last out-break of swarming caterpillar. A comparison of the last 20 years weather parameters revealed that in *kharif* 2016 season rainfall was scanty during premonsoon causing drought like situation, followed by heavy rainfall causing devastating flood and then again dry spells prevailed**.** This condition would have accelerated the growth rate of swarming caterpillar. Another factor which induced the pest is the changing pattern of cultivation practices. The farmers rarely leave the field fallow which makes the plant available throughout for the insect pests to develop. The weeds on rice bunds and nearby areas normally serve as the alternate host of swarming caterpillar. The farmers do not usually remove the weeds and stubbles of the previous season’s crop properly, which provide shelter for many insect pest and disease inoculums. A team of scientists from the Department of Entomology, Assam Agricultural University, Jorhat campus along with the personnel of Regional Agricultural Research Stations and KVKs and Agricultural Department of the state visited the affected fields and suggested the strategies to the farmers in managing the pest.

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Fig. 1. Swarming caterpillars reducing rice plants to stumps

Farmers were advised to shake the rice plants with coconut fronds dipped in a solution of water and kerosene oil or chemical insecticide over the rice plant, so that the larvae will fall down. Application of Kerosene oil @250 ml/bigha in the water after shaking the larvae was advised. Flooding of the nursery and main field were advised to bring out the hiding larvae, which can be picked up by birds. The application of powdery form of any of chemical insecticides i.e. Quinalphos 1.5%, Chloropyriphos 1% @ 3-4 kg /bigha on the rice bunds were advisable to check the spread to the unaffected fields. Spraying of Chloropyriphos 20EC@2ml/ litre or Quinalphos 25 EC @2.5ml/litre in the affected fields were suggested to the farmers for immediate control. Seedling root dip treatment in a solution of 1 liter of water mixed with 1 ml of Chloropyriphos 20 EC and 10 gm of urea for three hours before transplanting was advised. Some small trees like, *Jamlaphuti, phutkola*, *helos,* etc. that grow easily near crop land should be planted to attract bird. Placing of bamboo posts @ 3 per bigha and erecting T-perch can attract birds and owl to feed on worms. The fields can be sprayed with neem oil or other neem product to repel the insects. Farmers should regularly monitor the field for the presence of swarming caterpillar and initiate management measures immediately after finding the pest.

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Injection Method : A Novel Inoculation Technique for Evaluation of Neck Blast Resistance in Rice Genotypes

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Rice blast caused by *Pyricularia oryzae* is a major disease that causes huge yield losses. Out of the three phases of blast disease *viz.,* leaf blast, node blast and neck blast, neck blast is more serious and directly reduces the economic yield. Even though several methods are available to manage the disease, host plant resistance is not only economical but also environmental friendly. The rice genotypes are generally evaluated against leaf blast in Uniform Blast Nursery (UBN) method. But the evaluation of large number of test entries for neck blast resistance under artificial conditions has become a major constraint due to lack of suitable screening method.

Standardisation of artificial inoculation

Three procedures of inoculations *i.e.* Injection, smearing and tying of inoculum bits were attempted. All these three methods were employed on susceptible cultivar BPT 5204 at milky stage of the panicles during evening hours (5-6 PM). Each method was replicated ten times (One replication equal to one panicle). In injection method, spore suspension (1×10^5 spores/ml) of *P. oryzae* was injected at two cm below the panicle base with one ml capacity Hamilton syringe (Fig. 1 and 2). In smearing method, spore suspension (1×10^5 spores/ml) smeared with sterile cotton around the panicle base and tying method involves tying the grass bits (*Brachiaria mutica* grass bits on which *P. oryzae* was multiplied) around the panicle base. In check, all panicles were treated with sterile distilled water. Out of these three methods, injection method gave

Fig.1.Spore suspension of *P. oryzae*

Fig.2. Point of Injection

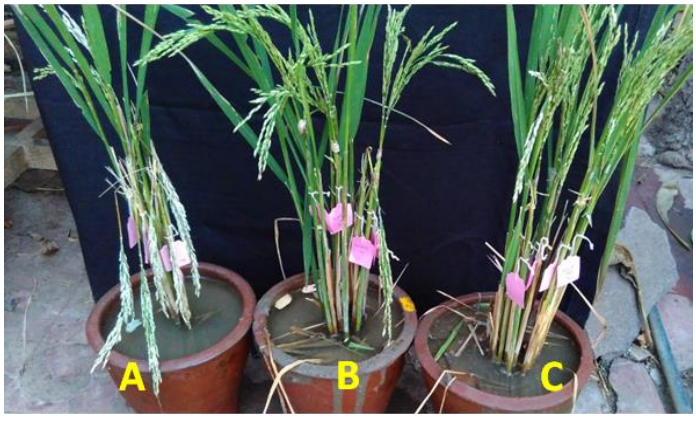

Fig. 3. Comparison of different inoculation methods
A. Injection; B. Smearing; C. Tying

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100% infection at 6 DAI (Days After Inoculation), whereas smearing method gave 20% infection at 8 DAI and tying method gave 10% infection at 10 DAI (Fig. 3). The quantity of spore suspension required for infection under injection method was also standardised. 50 µl, 100 µl, 150 µl, 200 µl and 250 µl of spore suspensions were tested. However 100% infection with typical blast lesions (Fig. 4) was observed in all the cases. Therefore, it is presumed that minimum dose of spore suspension (1×10^5 spores/ml) was 50 µl for infection in injection method.

In another experiment injection method was validated using twenty different rice genotypes. In each genotype five panicles were injected with 50µl of spore suspension (1×10^5 spores/ml). Validation of this method in different genotypes (Table 1) revealed that 100% severe neck blast incidence was observed in susceptible cultivars like BPT 5204, TN-1, Swarna and HR-12. However, there was no neck blast incidence in Tetep (resistant to blast) and all the test entries reacted differently.

Fig. 4. Typical Blast lesions. A. Young lesion at the point of inoculation; B. Spindle shaped lesion; C. Sporulated greyish lesions; D. Breakage of neck at lesion

Conclusion: Out of the three methods tested, injection method with 50 µl of spore suspension (1×10^5 spores/ml) was quick and superior compared to other two methods. Therefore injection method of inoculation is one of the solution to evaluate neck blast resistance in rice genotypes.

Table 1 : Validation of Injection method against neck blast in different rice genotypes

Line No	Variety / IET no	Reaction	% neck blast incidence in injection method	Line No	Variety / IET no	Reaction	% neck blast incidence in injection method
139	BPT 5204(S)	S	100	85	IET 24947	R	0
147	NLR 34449	S	100	78	IET 24790	R	0
145	IR 36	S	80	16	IET 24814	R	0
144	NLR 145	R	0	80	IET 24808	R	0
135	IET 24925	S	40	116	IET 25192	R	0
134	IET 24850	R	0	134	IET 24850	R	0
116	IET 25192	R	0		TN-1(S)	S	100
91	RP 2015DN 142	R	0		Swarna (S)	S	100
137	RP 2015DN 130	R	0		HR-12 (S)	S	100
93	RP 2015DN 173	R	0		Tetep (R)	R	0

*S = Susceptible check; R= Resistant check

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Kernel Smut of Rice : An Emerging Disease in Gangetic Alluvial Zone of West Bengal

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Kernel smut of rice is also known as Black smut of rice or bunt of rice, caused by *Neovossia horrida* (*Tilletia barclayana*). Earlier, it was considered as a minor disease and now gaining importance among rice diseases. In India, the disease known to occur in Haryana, Punjab, Uttar Pradesh, Gujarat, Madya Pradesh Andhra Pradesh, Tamil Nadu, West Bengal, Assam and Orissa. An experiment was conducted at Regional Research Sub Station (RRSS), Chakdah, BCKV, Nadia, West Bengal, India to evaluate aromatic and traditional germplasm against various diseases during *Kharif*-2016. Thirty six (36) varieties comprising of aromatic and traditional germplasms *viz.,* BM-1, BM-4, BM-34, Basmati, Gobindabhog, Radhunipagol, Tulaipanji, Shatibhog, Kalabhog, Sitabhog, Badshabhog, Indrabhog, Kaminibhog, Kalozira, Champakushi, Chamermani, Tulsibhog, Kataribhog, Dudheswar, Khaskani-small-1, Khaskani-small-2, Tulsimanjari, Kalikasha, Krishna Hamza, Seetasal, Narasimhajata, Nonakati, Kapurtul, Narayan kamini, Kabirajsal, Dudhemaular, Swarnadhan, Shibsita HR-12, Satabdi, and MTU-7029 were transplanted and grown in 100 m^2 plot individually.

During the study, Kernel Smut was first observed on the variety Krishna Hamsa on 25/10/2016 (*i.e.,* 98 Days after sowing), where the average maximum and minimum temperature was about 33.9^0 and 22.7^0 C, respectively. Whereas, average maximum and minimum Relative Humidity (RH) was about 95% and 65%, respectively. Development of kernel smut was observed in all 36 aromatic and traditional lines. The fungus damaged the grains by replacing endosperm by fungal spores and in severely affected varieties a beak like outgrowth of mycelium from ruptured glumes was observed. Disease severity and percentage of infection was calculated based on equation given by Slaton *et al.,* (2004).

Fig. Smutted grains during grain filling and dough stage

Disease incidence through natural infection varied from 9.5% (Seetasal) to 76.4% (Krishna Hamsa). Severity of damage was categorized into low to severe (4.1 - 43.3%) based on the presence of black spore powder in the ruptured glumes of rice kernel. However, high disease severity was observed in Nonakti (35.5%), Shanthibhog (31.2%) and Krishna Hamsa (43.3%); and low disease severity was observed in Gobindabhog (8.5%), Indrabhog (11.4%) and Seetsal (4.1%). Kernel smut symptom was not observed in the varieties *viz.,* Kaminibhog, Kalozira, Kataribhog, Kalikasha, Tulsimanjari and Dudhemullar.

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Interception of Rice Blackbug, *Scotinophara lurida* Burmeister – An Emerging Pest of Rice at TRRI, Aduthurai Farm

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Japanese rice blackbug, *Scotinophara lurida* Burmeister (Podopidae: Hemiptera) is an emerging serious pest in rice and gains economic importance now a days. Its occurrence in Tamil Nadu was observed in all rice growing areas and endemic in districts of Thanjavur, Thiruvarur, Nagapattinam, Cuddalore, Trichy, Thiruvallur, Coimbatore, Dharmapuri, Vellore, Villupuram and in Pondicherry UT. The incidence of this blackbug in rice got familiarised among farmers after the Tsunami in 2004 in Nagapattinam and Thiruvarur districts and vernacularly called as “Tsunami Vandu” in Tamil meaning “Tsunami Beetle”. During day time they congregate at the base of rice plants, just above the water level and move up during night and suck the sap from stem, leaf sheath and leaves of tillers from seedling to flowering stage.

Adults are black in colour and can live up to 7 months. The female bug lays its eggs on the lower part of the leaves or on the basal part of the rice plant near the water surface. It lays about 200 eggs during her lifetime in groups of 40-60 eggs. The eggs are 1 mm long and greenish when laid which turns pink at maturity. The incubation period is 4 to 7 days. On hatching the nymphs undergo moulting for 5 times (in 30-37 days) and reach the adult stage. The adult bugs live up to 7 months (Fig. 1).

Fig.1.Rice black bug along with eggs and light trap catches

The movement of adult insects in the rice ecosystem at Tamil Nadu Rice Research Institute, Aduthurai was monitored by the use of light trap with 125 W mercury vapour lamp as lighting source and 12 hours of lighting period from 2011 to 2016. Daily catches of *Scotinophara* were sorted out and identified. The light trap catches of standard weeks were correlated with major meteorological data.

Maximum light trap catches was observed in the month of July and August, immediately after the receipt of rainfall, which favoured the brood emergence. There were two peaks of blackbug observed on 11.08.2014 (23190 no./trap) and 12.08.2014 (5296 no./trap) during 2014 (Table 1). The unusual rainfall on 09.08.14 (13 mm) and on 11.08.14 (12 mm) would have favoured the emergence of adults from resting stage. During 2015, there were two peaks observed on 02.07.2015 (20128 no./trap) and 22.07.2015 (5213no./trap) and the rainfall on 01.07.15 (52.8 mm) and on 21.07.15 (18.0 mm) would have favoured the brood emergence. There was one peak observed on 31.08.2016 (5115 no/trap) during 2016 and the unusual rainfall on 27.08.2016 (55.4 mm) and on 30.08.2016 (16.0 mm) would have favoured the emergence of adults.

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Table 1 : Rice Blackbug *Scotinophara lurida* Burmeister catches in light trap during 2011-2016 at Aduthurai, Tamil Nadu.

Months	Light trap catches (Cumulative total/month)											
	2011		2012		2013		2014		2015		2016	
	No. trapped	% of total	No. trapped	% of total	No. trapped	% of total	No. trapped	% of total	No. trapped	% of total	No. trapped	% of total
January	83	0.55	0	0	130	0.93	660	0.71	0	0	270	2.37
February	0	0.00	0	0	0	0.00	1339	1.44	0	0	535	4.70
March	0	0.00	490	7.45	153	1.09	2258	2.42	1228	3.58	962	8.45
April	0	0.00	114	1.73	148	1.06	1125	1.21	784	2.28	880	7.73
May	0	0.00	0	0.00	21	0.15	405	0.43	30	0.09	126	1.11
June	0	0.00	0	0.00	30	0.21	27	0.03	0	0.00	42	0.37
July	379	2.51	0	0.00	77	0.55	3554	3.82	25600	74.57	1132	9.95
August	11197	74.17	4660	70.87	11649	83.16	82240	88.29	3836	11.17	6166	54.19
September	2939	19.47	134	2.04	488	3.48	470	0.50	84	0.24	292	2.57
October	475	3.15	246	3.74	463	3.31	969	1.04	1145	3.34	495	4.35
November	23	0.15	181	2.75	803	5.73	98	0.11	1578	4.60	155	1.36
December	0	0.00	750	11.41	46	0.33	0	0.00	47	0.14	323	2.84
TOTAL	**15096**	**100**	**6575**	**100**	**14008**	**100**	**93145**	**100**	**34332**	**100**	**11378**	**100**

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Development of Electrospun Nanofiber Sex Pheromone for Yellow Stem Borer, *Scirpophaga incertulas* in Rice

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There is a need for development of alternate safe technology to manage the rice yellow stem borer (YSB), *Scirpophaga incertulas* Walker a serious threat to rice cultivation. Use of insect pheromone is one of the best alternate and eco-friendly technology. YSB pheromones (blend consist of Z -9: hexadecenal and Z-11: hexadecenal) are very sensitive to heat, oxygen and sustainability of pheromone is a major challenge because of its volatile nature, therefore, the stabilization of pheromone compound is very important for its prolonged functionality. Encapsulation of pheromone through electrospinning with polymers facilitates controlled release of active substances by concentration-dependent passive diffusion pattern for trapping more moths.

A preliminary study was carried out to develop a polymer based electrospunfiber matrix fortified with yellow stem borer pheromone (5 times dilution) for controlled release. Nanofibers were fabricated by electrospinning and pheromone was loaded in a diameter 144.6 nm in the electrospunfiber. The pheromone compound was actively loaded in electrospun matrix and characterized using scanning electron microscope, gas chromatography and mass spectrometry analysis (Fig. 1). Field testing of electrospun nanofibers were done with funnel and delta trap to assess the trapping efficiency of male moth in rice (Fig. 2).

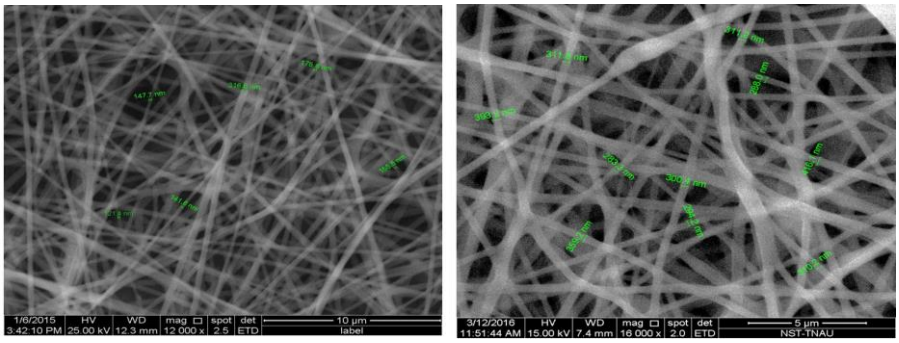

Fig. 1. SEM Nanofiber of polymer alone and loaded with pheromone

Fig 2. Fitting of Electrospun nanofiber in funnel trap cover and delta trap

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Fig. 3. Yellow stem borer moth catches in delta trap with electrospun nanofiber

Among the traps, the delta trap attracted more moths as total trap catches (76.6 nos.) than funnel trap (34.6 nos.). Among the treatments, more moths were recorded in pheromone fortified with electrospun polymer fiber (8.3 in funnel trap and 22.7 in delta trap) (Fig. 3), than pheromone alone in rubber septa (2.3 in funnel trap, 5.3 in delta trap). Controlled release of pheromone and moth catches were recorded around 21 days in electrospun polymer fiber and 14 days in pheromone alone in rubber septa.

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TRANSFER OF TECHNOLOGY

RESEARCH HIGHLIGHTS : TRANSFER OF TECHNOLOGY

Spread of Medium Slender Variety GAR-13 in Gujarat

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In Gujarat, rice is one of the major cereal crop grown in *kharif* as well as in summer in around 7.5 to 8.0 lakh hectares. The variety GR-11 released in 1977, was much popular for long time, but, because of much longer time in cultivation chain, now a days this genotype became susceptible to major pests and diseases and hence its productivity was decreased. To mitigate such problem Main Rice Research Station, Nawagam has developed and released the medium slender variety GAR-13 from GR-11 x IET-14726 through pedigree method of selection in the year 2009 for Gujarat state (Fig. 1).

Fig. 1. Field view of medium slender variety GAR-13

GAR-13 had shown 18.2% higher yield than the popular variety GR-11. Because of midlate maturity, fine grain, moderate tolerance to diseases and insect-pests and good cooking quality this variety became much popular among farmers and traders of Gujarat within a short period of time.

The breeder seed production data of this station indicated that the variety GAR-13 is becoming much popular amongst the farmers of the State (Table 1). The breeder seed demand was also received from neighboring States like Madhya Pradesh, Maharashtra and Rajasthan. Since the year of release, this variety fetches higher price than other varieties in the market. In the year 2014, Main Rice Research Station, Nawagam had received the prestigious award 'Sadvichar Pariwar Award (2013) from the Gujarat Association for Agricultural Sciences, Ahmedabad, for the popularity of the variety GAR-13.

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Table 1: Comparison of Breeder Seed Indent (Kg.) of GR-11 and GAR-13 from 2009 to 2017.

Sr. No.	Year	GR-11	GAR-13
1	2009-10	5000	--
2	2010-11	5000	1000
3	2011-12	1950	1000
4	2012-13	1000	1200
5	2013-14	2508	2500
6	2014-15	1500	2000
7	2015-16	1108	2500
8	2016-17	1000	2500

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TRANSFER OF TECHNOLOGY

Adoption of New 'PR' Varieties Pay Rich Dividends to Punjab and India

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Punjab has made remarkable progress in rice productivity and production during the past 50 years. But genetic gain for productivity shows a de-accelerated trend causing concern about matching the projected food grain requirements in the near future. Application of high doses of nitrogenous fertilizers, sowing at higher plant densities and availability of assured irrigation, resulted in emergence of new biotic stresses like bacterial blight (BB), brown plant hopper (BPH) and white backed plant hopper (WBPH).

The breeding strategies in the past decade have been reoriented towards the development of short duration varieties with higher per day productivity, resistance to various biotic stresses and acceptable grain quality. As a result of concerted research efforts, PAU has released five new non-Basmati varieties *viz*., PR 121, PR 122, PR 123, PR 124 and PR 126 during the last five years. These varieties are being widely adopted by the farmers as these help in saving water, fertilizers, pesticides, etc. and are eco-friendly. The adoption of the new varieties has resulted in increased production, productivity, profitability and sustainability of agricultural enterprises in Punjab as discussed below:

i) Increase in area under new 'PR' varieties: The new varieties mature one to four weeks earlier than the traditional / popular varieties and have higher yield per unit area, time and inputs. Also these varieties possess marker assisted pyramided bacterial blight (BB) resistant genes (*Xa*4 /*xa5* / *xa*13 /*Xa*2) and are resistant to all the 10 presently known pathotypes of BB pathogen in the Punjab state.

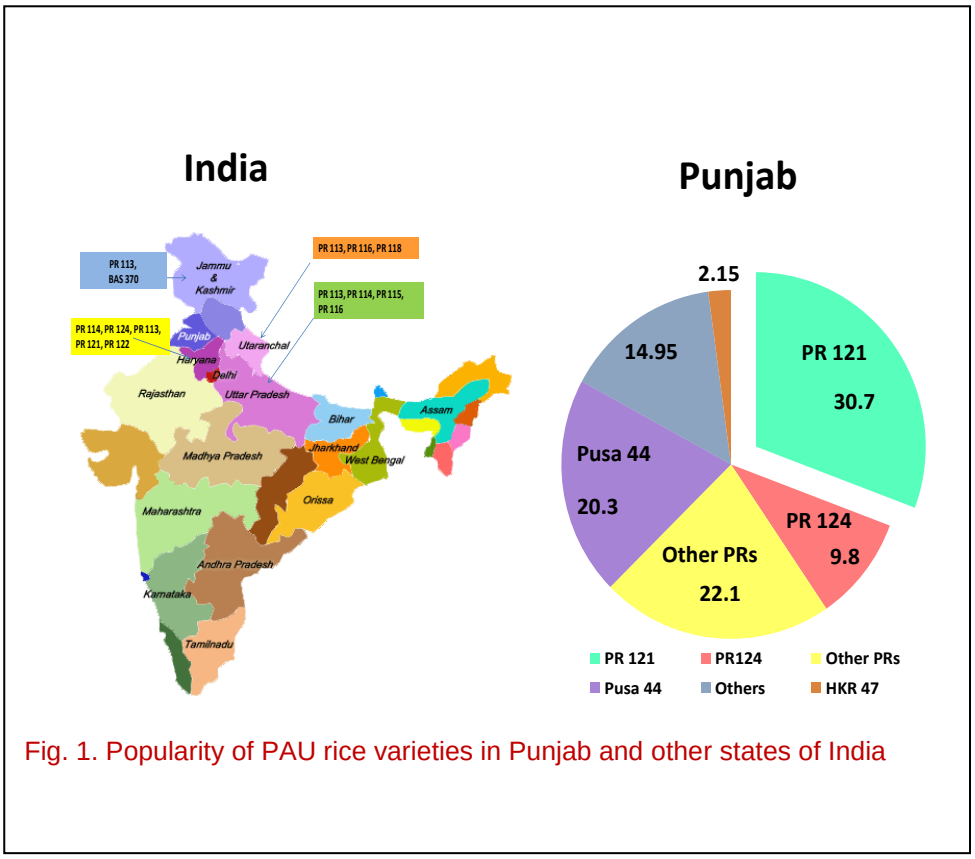

Fig. 1. Popularity of PAU rice varieties in Punjab and other states of India

Among the newly released varieties, PR 121 emerged as a popular variety among the farmers of the state (Fig. 1). Released in the year 2013, the variety gained popularity among the farmers of the state because of its stable performance over varied agro-ecological zones in the state. It also possesses excellent milling quality characteristics.

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The variety PR 121 was grown on more than 7.0 lakh ha (30 percent) area and PR 124 occupied around 10 percent area during *Kharif* 2016. The PR varieties are popular in other states also.

ii) Record production, productivity and contribution: As a result of adoption of short duration high yielding varieties, during *Kharif* 2016, there is record production of 186.76 lakh tonnes of paddy (124.51 lakh tonnes of rice) in the state. Punjab has also set a new record productivity of 6154 kg/ha of paddy (4103 kg/ha of milled rice) breaking the earlier record set during 2008. Punjab has made record contribution of 110.44 lakh tonnes of rice to the central pool during 2016-17.

iii) Benefit to farmers, traders and environment. The new varieties which mature in 125-140 days vacate the fields by first week of October. The farmers have a window period of at least 15-20 days for residue management and reduce further decline in underground water table and also allow timely sowing of succeeding wheat crop.The newly released varieties are yielding almost at par with the earlier released/popular long duration varieties (Fig. 2). The farmers/state agencies/millers on an average accrued additional income of Rs. 2000 crores during the last two paddy seasons.

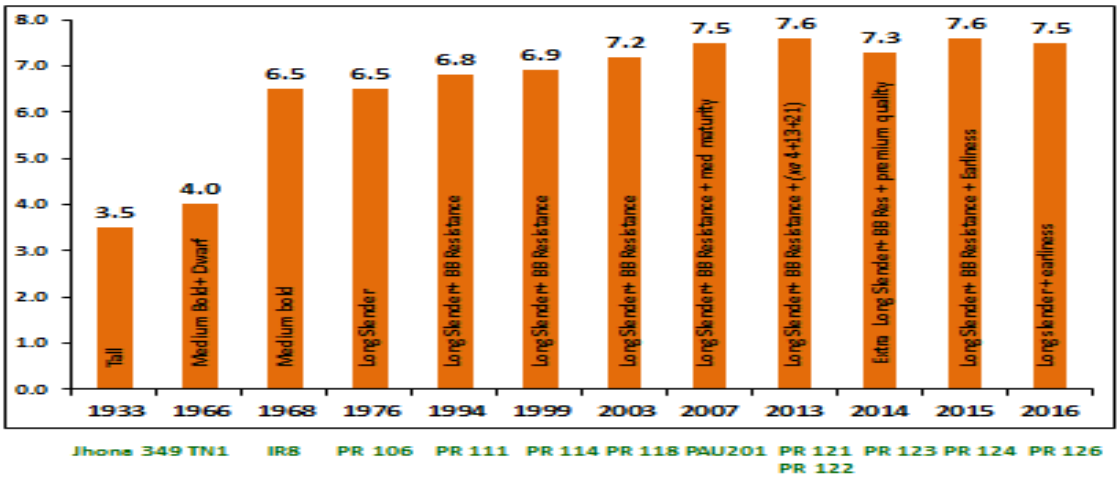

Fig. 2: Average productivity of successive rice varieties released by PAU, Ludhiana

iv) Nurturing the Basmati Niche:

During the year 2013, Punjab Basmati 3, a BB resistant and dwarf version of traditional Basmati variety Basmati 386 was released. During 2017, two new Basmati varieties Punjab Basmati 4 and Punjab Basmati 5 have been released. These varieties are photoperiod sensitive, lodging tolerant, BB resistant and possess excellent grain quality characteristics.

On account of its achievements, the PAU-AICRIP Centre was adjudged as the overall best AICRIP centre during 2011-12 and was also awarded the Golden Jubilee Best AICRIP Centre Award for outstanding contributions to the All India Coordinated Rice Improvement Project and development of improved varieties and technologies of rice during the last 50 years at the 50th Annual Rice Research Group Meeting held at the Indian Institute of Rice Research, Hyderabad on April 11-15, 2015.

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In-situ Conservation of *Mushkbudji* – A Scented Rice of Kashmir: Way Towards Socio-Economic Development of Farmers

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More than 100 landraces of rice suited to different agro-ecological niches have been documented from Kashmir valley. Most of these landraces had lost their identity due to admixtures, susceptibility to blast disease and low yield and thus were on the verge of extinction. These landraces mostly belong to short and bold grained japonica types and are early maturing and cold tolerant. They are known for their unique quality features particularly aroma with desirable taste and texture of the cooked rice. Some aromatic rice varieties like *Mushkbudgi* and *Kamad* enjoy good demand in local markets due to high consumer preference, particularly during matrimonial occasions and festivals. Most of these traditional varieties/landraces have been conserved and characterised for different traits at Khudwani Centre of SKUAST-Kashmir.

The following objectives were framed by Khudwani Centre of SKUAST-Kashmir for revival programme of traditional rice cultivar *Mushkbudji*;

- ✓ Genetic purification
- ✓ Standardization of IDM and INM modules
- ✓ Popularization and adoption through farmers' participatory mode
- ✓ Market intervention
- ✓ Biotechnological approach for blast resistance

The broad set of activities followed to achieve the goal of revival of *Mushkbudji* a heritage rice are;

Mushkbudji like other landraces was under threat of extinction and was confined to few households on a very small area in a highly admixtured form. Khudwani centre of SKUAST-K conducted exploratory visits during 2007 in the hot spots of rice for variability and more than 300 *Mushkbudji* samples were collected from across the valley. The samples were evaluated for aroma and promising ones were purified by ear to row method during 2008 and 2009. Purified and the high aromatic line was put under nucleus seed production during 2010 and 2011. Farmer's participatory trials were conducted during 2011 and 2012 for adoption and popularization of improved version. Integrated disease and nutrient management modules were also standardized for yield maximization and paddy blast management. Organized marketing through public-private partnership was put in place to safeguard the interests of *Mushkbudji* growers since 2013. Biotechnological intervention for incorporation of blast resistance genes in pure *Mushkbudji* version has been successfully done.

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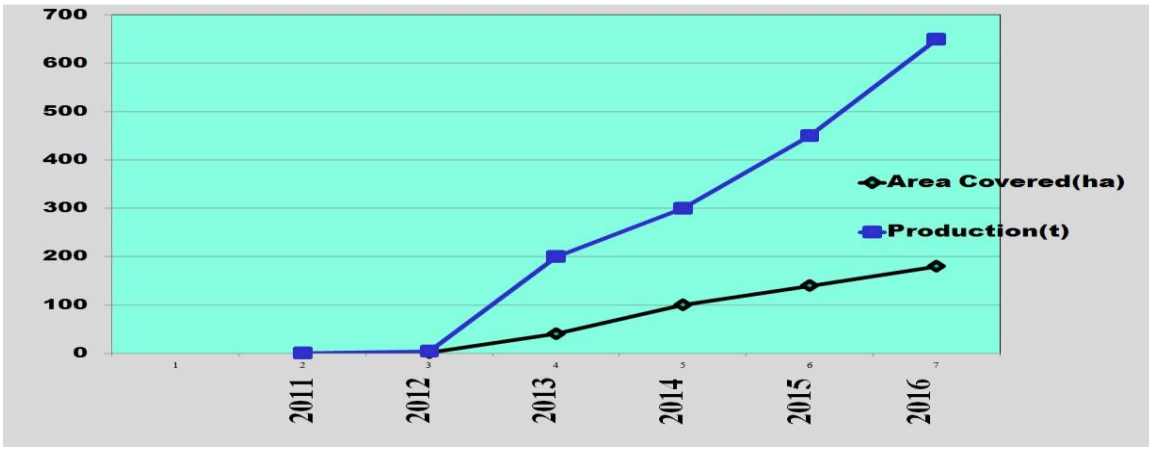

Fig 1. Increasing are and production under pure Mushkbudji rice varieity

Increasing trends in Mushkbudji production since 2012: Economic Impact :

The farmers started cultivation of Mushkbudji since 2012. During 2013, an area of ~40 ha was brought under pure *Mushkbudji* seed in Tehsil Sagam of District Anantnag and around 2000 q of pure seed was produced as against 40 q produced from 1.0 ha area in previous year. Such achievement was declared as the success story of the SKUAST-K by the Hon'ble Governor of J&K State in the 3rd Agriculture Science Congress and the first harvest of pure *Mushkbudji* was released on the occasion. To boost *Mushkbudji* production and to bring other identified niches, SKUAST-K in collaboration with State Department of Agriculture brought an area of 100 ha and 140 ha under its cultivation during 2014 and 2015, respectively. During 2014 and 2015, farmers were able to produce ~3000 and 4500 q of pure *Mushkibudji* rice and realized an increase in production to the tune of 50% in 2015 over the previous year. During 2016, 175 q seed of *Mushkbudji* was provided to growers by SKUAST-K through State Department of Agriculture for an area of 220 ha in the Agriculture Zone, Sagam. At the end of the season around 6500-7000 q of *Mushkbudji* rice is estimated to be produced by the farmers (Fig. 1). Pure *Mushkbudji* rice produced during 2016 is of the worth around Rs. 50 million, which is about 200% more income as compared to income realized by *Mushkbudji* farmers during previous year. Agriculture zone Sagam has produced *Mushkbudji* to the tune of Rs.100 million since 2012.

Recently the rates fixed by the State Government of Jammu and Kashmir for *Mushkbudji* paddy is at Rs. 8500/q which is 5-6 times more than normal rice varieties. Despite the fact that

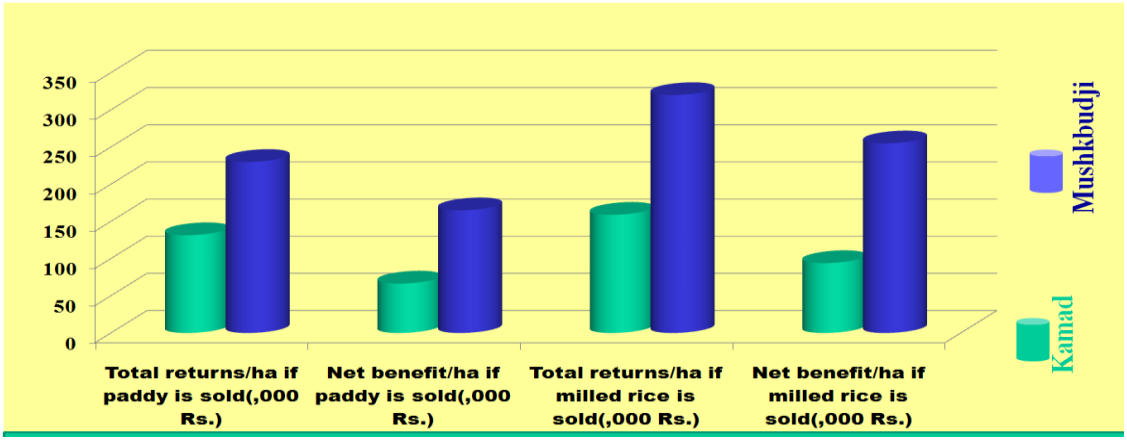

Fig 2. Economics of cultivating pure Mushkbudji in the niche area against normal rice

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Mushkbudji being low yielder giving just 75% of the yield of other high yielding varieties, it is still 4-5 times more remunerative. Therefore, *Mushkbudji* is recommended for cultivation in the identified niches. Economics of cultivating different varieties in the niche area showed that improved *Mushkbudji* is the best commercial choice for the farmers providing a net benefit of Rs. 2.50 lakhs / ha which is around 150% more income than the other popular varieties like K 39 (Fig. 2).

On 21st December, 2016 the custodian of *Mushkbudji* and *Kamad* two important farmer's varieties were given National recognition by PPV & FR Authority and were felicitated with the prestigious "**The Genome Saviour Community Award"** of Rs.10 lac along with Momento and Citation by Hon'ble Union Agriculture Minister.

Conclusion

- The cultivation of improved *Mushkbudji* has improved the livelihood security of the farmers.
- Promotion through market links encouraged the farmers to conserve and maintain the local and scented rice biodiversity for present and future generations.
- Marketing of pure *Mushkbudji* can be taken up in a Public-private partnership mode.
- The cultivation of other important landraces like *Kamad* and *Zag* types (red rices) rich in Fe and Zn has to be revived.

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Mobile Agri Clinic as an Extension Method

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Mobile Agri-clinic program was officially inaugurated on 18 November 2016 by honourable Union Minister of Labour Sh. Bandaru Dattatreya. The Mobile Agri Clinic program aims at directly benefiting the farmers of Telangana. This is a modest beginning to serve the farming community directly and to take the practically applicable technologies / knowledge to farmers' doorsteps.

From Soil testing to Marketing, from credit to storage - our rice farmers are in dire need of several time critical services. The mobile agri clinic apart from providing the essential services such as soil testing (through Instant Soil Health Analysis Kit), tries to document as many service needs of farmers as possible, and pass them on to the appropriate organizations and government departments.

As a part of this program, a Mobile van with state of art facilities (soil testing kit, seed samples, information standees, brochures, health care products etc.,) is built. Each month a multi disciplinary team of 3-4 scientists visit different villages to interact with the farmers and to visit the fields (Fig 1). The program is planned in collaboration with PJT State Agricultural University, State department of Agriculture, ATAARI, KVKs and several NGOs.

The Mobile Van is not a simple vehicle where few scientists will visit villages and give their advices. It is going to be a comprehensive Extension Advisory Ecosystem. As a part of this program, first few visits are planned to document "technological needs of farmers from villages".

The ICAR-IIRR is planning strategic extension programs in those villages such as demonstrations (that we are already doing currently, but we are going to re-focus them based on the actual needs), On farm Trials, Video Extension modules, participatory seed production etc., based on the analysis of such documentation and farmers' feedback. One of the prime activities under Mobile Agri Clinic program would be developing the capacity of farmers with onsite training programs (on SRI, INM, IPM, Hybrid seed production etc.).

Team approach for ICAR-IIRR outreach activities can be strengthened using this approach. Till now, individual scientists are taking few FLDs and are executing them in isolation. Regular visits will develop rapport with field conditions / farmers to understand what rice farming are about. This will also give a confidence that rice technologies will work in field conditions as well.

The Mobile Agri Clinic program will give an opportunity to collect huge amount of field data , farmers profiles, their mobile numbers, field problems, soil health status, live samples of insects, diseases and weeds etc., Even we can think of collecting the varietal choice of a particular area and reasons for choosing a particular variety.

Mobile van epitomizes the concept of "Learning by Doing". We, as scientists, can learn many things when we do the things in the field. Regular interaction and implementing our ideas in the farmers' fields gives us an excellent opportunity to learn.

The Mobile Agri-clinic program will thus become a comprehensive Extension Advisory Ecosystem. If proven to be successful, the same can be scaled to all AICRIP centres in due course.

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Fig. 1. ICAR-IIRR Scientists in mobile agri clinic interacting with farmers

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TRANSFER OF TECHNOLOGY

Impact of Front Line Demonstrations of Rice in Farmers' Fields in Kangra District of Himachal Pradesh

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In Himachal Pradesh rice is cultivated in an area of 0.77 lakh ha with a productivity of 1.750 t/ha, and the annual rice production is 1.32 lakh tonnes. Rice and Wheat Research Centre (CSKHPKV), Malan conducted 5 FLDs on different rice varieties including Palam Basmati 1 (HPR 2612) in Kangra district in the year 2014. In the irrigated and hill ecology all these varieties performed well with visible yield advantage. In Kangra district Palam Basmati 1 gave a yield advantage of 49% over check Raja (Hybrid) and RP 2421. If suitable strategies are in place, Palam Basmati 1 can be popularized effectively in place of Kasturi basmati areas in Himachal Pradesh. In case of hail storms, HPR 2143 can thrive well and farmers expressed their satisfaction about trait. These varieties are non-lodging type. They are early and medium duration and hence are most suitable to this region.

In the year 2015, 5 FLDs on different rice varieties like HPR 2612 (basmati), HPR 2720 (red rice) and HPR 2143 (parmal) in Kangra district were conducted with complete package of practices in 40 farmers' fields in the Ghiyanakhurd village of Kangra district. The new technologies proved advantageous to the farmers as the technologies were high yielding, disease resistant and hail resistant.

Moreover, the FLD helped them in following the complete package of practices for rice cultivation, which was not followed in their own traditional system of cultivation. As a result, these varieties performed well with visible yield advantages. In Kangra district, the demonstrated varieties recorded a yield advantage of 46.64% over the local check.

Ten FLDs were conducted on different rice varieties like HPR 2612(basmati), HPR 2720 (red rice) & HPR 1068 (parmal) in Kangra district in the year 2016 with complete package of practices in 37 farmers' fields at Menjha & Dadh villages of Kangra district with Complete package of practices including improved variety & bio-fertilizers. Instead of chemical fertilizers like IFFCO (12:32:16) & urea, bio-fertilizers like Bokashi Agriculture fermented organic / bio-fertilizers & liquid micronutrient bio-fertilizers (EM 1) were used. It was found that the yield of above HYVs did not reduce due to use of bio-fertilizers and yield was at par as chemical fertilizers along with better quality.

It is evident from Menjha village FLD on rice in 2016, that the farmers are quite satisfied following this improved technology of rice cultivation adopting high yielding, particularly Red Rice Variety (HPR 2720), which fetched premium price in the market due to its nutritional superiority & purchased (~50 quintals) by Department of Agriculture, for using as seed at higher price (Rs 4500/q). Field day / Paddy day / Kisan Gosthi was organized on dated 14.10.2016. The neighboring farmers have also shown interest to follow this improved practices in future particularly red rice variety HPR 2720 & application of bio-fertilizers (liquid and solid) (Table 1).

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Table 1: Details of FLD conducted from 2014 to 2016 in Kangra District

Year	Technology Demonstrated	Area (ha)	Local checks	Locations	FLD Yield (t/ha)	Check Yield (t/ha)	Increase over check (%)
2014	HPR 2143, Palam Basmati 1 (HPR 2612)	5	Raja, RP 2421	Kohala, Bhawarna, Malan Distt. Kangra	5.36	4.49	49.64
2015	HPR 2143, Palam Basmati 1 (HPR 2612), HPR 2720 (Palam Lal Dhan 1)	5	Chinnu, RP 2421	Village: GhiyanaKhurd Taluka: Dharamshala District: Kangra	3.37	2.23	46.64
2016	HPR 1068, Palam Basmati 1 (HPR 2612), HPR 2720 (Palam Lal Dhan 1)	10	Chinnu, RP 2421	Village: Menjha, Dadh Taluka: Dharamshala District: Kangra	3.67	2.43	36.85

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ICAR-IIRR IN NEWS

Institutional Activities

New Year-2017 Celebrations :

ICAR-IIRR welcomed the New Year with a bang on 02/01/2017 at the Institute auditorium. Director presided over the function. All the scientific, technical, administrative, and supporting staff of ICAR-IIRR attended the function and were greeted by the Director on this occasion. All the staff also participated in the recreational activities.

Republic day celebrations at ICAR-IIRR :

68th Republic Day was celebrated with great enthusiasm at ICAR-IIRR and ICRISAT campus. Dr. V. Ravindra Babu, Director hoisted the national flag and highlighted the significance of Republic Day. The Director in his message narrated the salient achievements made by

ICAR-IIRR and thanked all the staff for the good work done during the last year. On this occasion, prizes were distributed to the winners under various categories. Director, ICAR-IIRR inaugurated Irrigation and Power House at ICAR-IIRR Farm on the same day.

Health Camp :

A health camp was organized at ICAR-IIRR on 20-02-2017 by Sai Sanjeevani Hospitals, Hyderabad. The doctors conducted the health check-ups such as BP, Blood Sugar, ECG, etc. and suggested further course of treatment. The ICAR-IIRR staff participated in the health camp and were benefitted by the advice of the Doctors.

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ICAR-IIRR Staff Thrift Society Donates for Welfare Activities :

DRR Employees Mutually Aided Co-operative Thrift & Credit Society Ltd., ICAR-Indian Institute of Rice Research, Hyderabad donated money to the socially/economically deprived people. The members of the Society, generously contributed a portion of their profit money of Rs. 83,000/- (Rupees eighty three thousand only) for social cause. The amount was donated to the beneficiaries during the year 2016-17 by Dr. V. RavindraBabu, Director, ICAR-IIRR and the President of the Society, Dr. S.M. Balachandran along with the other office bearers of the Society. The beneficiaries are: 1) Aashri Society, Lingampally, Hyderabad (Rs. 25,000/-), 2) Mr. R.K. Venkateshwarlu, Village Kalluru, Kurnool (Rs. 25,000), 3) Mr. A. Veera Babu, Rajendranagar (Rs. 13,000), 4) Mr. R. Anil, Hyderguda, Hyderabad (Rs. 10,000) and 5) Armed Forces Flag Day Fund (Rs. 10,000).

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Training Programmes, Workshops and Meetings

ICAR Short course on "Prebreeding using wild species for sustainable yield in crops" :

The 10 days ICAR sponsored Short course on **"Prebreeding using wild species for sustainable yield in crops"** was organised during 16-25, January, 2017 at Indian Institute of Rice Research, Rajendranagar, Hyderabad. The short course was designed to encourage the trainees to use wild species in breeding programs and enable them to plan and apply for prebreeding projects, forge collaborations and also to strategically accelerate breeding of crops for sustainable yield using wild species. The short course was attended by 19 participants.

Short course was inaugurated by Prof.E.A. Siddiq on 16.01.17. Dr V. Ravindra Babu, Director, ICAR-IIRR welcomed the chief guest and stressed the importance of pre breeding to enable breeders to use the wide variability in germplasm and accelerate release of improved varieties, especially in the context of climate change. In his inaugural lecture Prof.Siddiq highlighted the need for pre breeding using wild species for sustainable yield in all major food crops to guard against vulnerability and ensure food security. Dr N.Sarla, ICAR-National Professor and Course Director gave a brief account of the course highlighting the significance of wild species.

More than 34 sessions including theoretical lectures by expert researchers coupled with practical classes, demonstrations and visits to R&D facilities of public sector organizations were arranged during the training programme. Trainees were also taken on visits to ICRISAT, CIMMYT, IRRI South Asia Hub facilities at ICRISAT Campus, ICAR-IIMR and ICAR NBPGR, Hyderabad. The training programme concluded on 25-01-2017.

Training course on "Bioinformatics for Biotechnology Beginners" :

The training course on Bioinformatics for Biotechnology Beginners (Feb 08-10, 2017) was organized by ICAR-IIRR. The programme was aimed at sensitisation of young work force including students, projects staff and young scientists. Thirty participants from different institutes had registered for the training program. The objective of the program was to make biotechnology researchers to appreciate bioinformatics tools and methods and enable them to utilize bioinformatics in their biotechnology research and thereby hasten the biotechnology aided crop improvement programs.

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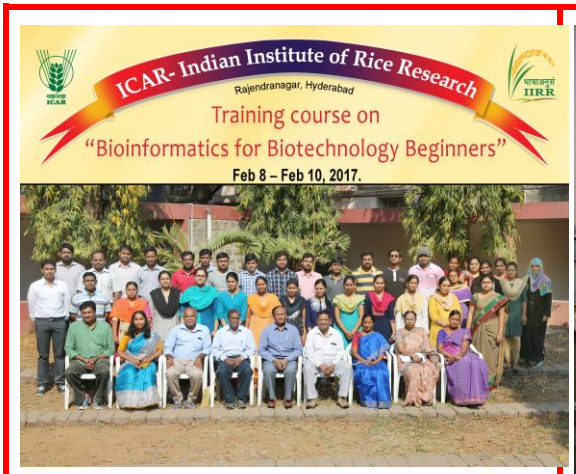

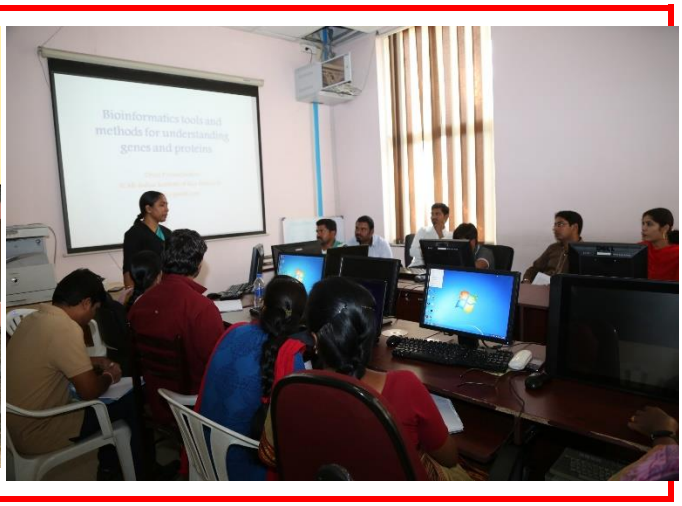

The three days course included 18 lectures/hands on sessions of which 3 were by external experts from ICRISAT and NAARM covering diverse topics from molecular breeding to genetic engineering and RNAi technology. The training also provided hands on experience in Linux operating system and R programming which are essential basics for bioinformatics research. Dr. V. Ravindra Babu, Director, ICAR-IIRR, interacted with the participants on the occasion of valedictory session and got feedback of trainees on sensitization about the utility of bioinformatics tools in their biotechnology research.

Annual hill rice research group meeting on 13th February, 2017 :

The 4th annual hill rice research group meeting was organized at ICAR- National Bureau of Plant Genetic Resources, New Delhi on 13th February, 2017. The inaugural session was chaired by Dr. J.S. Sandhu, DDG (CS) ICAR. Dr.Himanshu Pathak, Director, ICAR-NRRI, Cuttack; Dr. S.C. Dubey, Director I/C, ICAR-NBPGR, New Delhi; Dr. R.P. Kaushik, Emeritus Scientist, RWRC, Malan and Dr. V. Ravindra Babu, Director, ICAR-IIRR were the dignitaries for the inaugural session of the group meeting. A total of 20 Scientists from different cooperating centres of hill ecology participated in the meeting. Dr. V. Ravindra Babu extended a very warm welcome to all the participants and gave a brief account of salient findings of AICRIP activities of hill ecology and highlighted the results of the trials conducted by 7 funded and 23 voluntary centres of hill region. Five varieties were released in the last year from this region for hill ecology.

MIS & FMS -Hands on Training Programme organised at ICAR-IIRR :

MIS&FMS -Hands on Training Programme organised at ICAR-IIRR from 20th-24th February 2017. The programme was organised for both administrative and scientific staff. Scientists were sensitised in the modules *viz*., employee self service, indenting and project management on 21st and 22nd February 2017. Similarly administrative staff were also trained in employee self service, indenting, bill processing, payroll and material management modules on 20th, 23rd and 24th of February 2017.

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Hands-on training program for farmers from Datia, Madhya Pradesh was organized at ICAR-ICAR-IIRR on February 17, 2017 :

A hands-on training program for farmers from Datia, Madhya Pradesh on use of soil analysis kit and SRI cultivation was organized at ICAR-IIRR on February 17, 2017. A group of 45 farmers attended the programme under the Mukhya Mantri Khet Teerth Yojana. The programme was organised by Dr.Amtul Waris. Skills for using the soil testing kit developed by ICAR-IIRR for field level analysis of soil samples was practically demonstrated by Dr.Brajendra, Principal Scientist.

The important components of SRI and the hands on session on use of field line marker, transplanting of young seedlings, use of paani pipes and direct seeded rice using drum seeder were demonstrated by Dr. R. Mahender Kumar, Principal Scientist. The training opportunities and extension activities under outreach programs of the institute were elaborated upon by Dr. P. Mutthuraman, Principal Scientist.

Training on Soil Test Kit to Progressive farmers of Sirsa district of Haryana :

The progressive farmers from Sirsa District of Haryana were trained on using soil test kit as well as economising urea in rice by use of LCC (Leaf Colour Chart) was given on 06-03-2017 by Dr.Brajendra, Principal Scientist.

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Training on Eco-entrepreneurship development of tribal farm women of Bodukonda Tanda,Ranga Reddy District,Telangana :

Under the ICAR-IIRR Tribal Sub Plan activities, a one day training program on setting up of vermicompost units for eco-entrepreneurship development of tribal farm women of Bodukonda Tanda, Ranga Reddy District, Telangana was organized on February 8, 2017 by Dr.Amtul Waris, Principal Scientist. The important steps and precautions in vermicompost preparation were explained and demonstrated to the tribal farm women. High quality and easy to set up HDPE Vermi-beds were distributed to selected tribal farm women. The Self Help Group members of the Badukonda tanda were motivated to adopt it as an eco-entrepreneurship activity through sale of vermicompost in thier own and nearby villages.

Review Meeting on Biofortification :

A Review meeting of ICAR-Consortium Research Platform (CRP) on Biofortification was held at Krishi Bhawan on 13th January 2017 under chairmanship of Hon'ble DG Dr. T. Mohapatra and Drs. J. S. Sandhu (DDG-CS), B.B.Singh (ADG-Oil Seeds), I. S. Solanki (ADG-FFC), V. Ravindra Babu (Director, ICAR-IIRR), Om Vir Singh (PC-Pearl Millet) and other PIs of the projects participated in the meeting.

Green Super Rice Meeting :

GSR management team from the Chinese Academy of Agricultural Sciences (CAAS) and the Shanghai Agro-biological Gene Center (SAGC), BMGF along with Dr.Jauhar Ali had a meeting with the GSR team of ICAR-IIRR on 20th February 2017. The meeting was convened under the chairmanship of Dr.V. Ravindra Babu, Director, ICAR-IIRR. In the meeting, progress made in India and ICAR-IRRI work plan and targets for next 4 years were discussed. The new work plan for the year 2017-18 was finalized.

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Outreach Programmes

ICAR-IIRR-CCMB Farmers Day at Nadupatti village, Tamil Nadu, 30th Jan. 2017 :

The Indian Institute of Rice Research (ICAR-IIRR) and Centre for Cellular and Molecular Biology (CCMB) in association with the Joint Director of Agriculture, Karur district, Tamil Nadu organized a Farmers Day on 30th Jan 2017 at Shri Ganapathy Goundar Farm, Nadupaati village, under the jurisdiction of Assistant Director of Agriculture, Kulithalai. Approximately 450 farmers consisting of mainly the target farmers for cultivation of Improved Sambha Mahsuri a bacterial blight disease resistant variety developed by ICAR-IIRR, participated in the one day event. Dr. R.V. Sonti, Principal scientist, Dr.Hitten, Scientist from CCMB and Drs.R. Mahender Kumar (Agronomist), R. M. Sundaram (Biotechnologist), and P. Muthuraman (Extension Specialist) from ICAR-IIRR participated in this event. The other dignitaries in this event included Dr. S. J. .Diravium (Program coordinator KVK, Karur, and his team of subject matter specialists) Shri. K. Rajendran, Deputy Director of Agriculture (FTC) Karur, Smt.K. Kavitha, Assistant Director of Agriculture (Kulithalia), Shri. P. Ravichandran, Assistant Director of Agriculture (Quality Control), Karur and Shri. K.S. Selvendran, Block Technology Manager (Kulithalai). The farmers from Ariyalur, Karur, Nagapatinam, Perambalur, Pudukottai, Thanjavur, Trichy and villuppuram districts also participated in the programme. A question answer session was organized to clear the doubts raised by the rice farmers about over all rice production practices in general and Improved Samba Mahsuri in particular. The video films on the BLB resistant variety and information folder about the package of practices were distributed to the farmers. The whole program was organized with the financial support under CSIR-800 scheme. The farmers expressed their appreciation that this BLB resistant variety helped them to overcome the dreaded disease which has no chemical control.

Participation in Krishi Melas :

ICAR –IIRR has set up Exhibitions stalls at the Farmers' Day organized by the ICAR-IIMR on 09/02/2017, 'National Castor Kisan Mela' organized by ICAR-IIOR on 24/02/2017 and National Agripreneurs Convention 2017, organized during 07-09 March 2017 by MANAGE, Hyderabad. Many rice farmers and agripreneurs visited the ICAR-IIRR stall and got enlightened about the various technologies developed by ICAR-IIRR.

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ICAR-IIRR also participated in the Krishi Unnati Mela-National Agriculture Fair' organized at ICAR-IARI, Pusa, New Delhi during 15-17 March, 2017. The mega event was organized by the Ministry of Agriculture and Farmer' welfare, Government of India. The National Fair was inaugurated by Hon'ble Union Minister of Agriculture, Shri. Radha Mohan Singh. ICAR-IIRR technologies, varieties and hybrids as well as posters were displayed. The ICAR-IIRR stall was visited by the farmers from across the country.

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Distinguished Visitors

Visit of Dr. SS Virmani and Dr. Ish Kumar to ICAR-IIRR :

Dr. Sant Singh Virmani, a renowned plant breeder, rice scientist and a former Principal Scientist at the International Rice Research Institute (IRRI) along with Dr. Ish Kumar, President Research- Field Crops, Rasi seeds Private limited visited ICAR-IIRR on 10th January, 2017. Dr. V.Ravindra Babu, Director, ICAR-IIRR in his welcome address briefed the ongoing activities at ICAR-IIRR. Both the stalwarts of the hybrid rice program with their vast global field experience addressed the scientists and project staff of ICAR-IIRR. Dr. Ish Kumar in his address to the gathering emphasised the need to explore the available and unutilized germplasm. Taking an analogy from China where 15 t/ha with 400 grains /panicle was obtained in 7 ha of land, he suggested the gathering to fix a target and aim to obtain more yield from less land. Dr. SS Virmani, a pioneer rice breeder addressing the scientists suggested that a PPP mode would be better as in China. He advocated the concept of 'Farmers first' and any research that would benefit the farmer. He suggested that the team work should be the focus to maximize the outcome of the effort.

Visit of Iranian delegates :

A team of Iranian delegation visited to ICAR-IIRR and interacted with the Heads of section on 23rd February, 2017.

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Visit of AS & FA, DARE/ICAR :

The Additional Secretary and Financial Advisor, DARE/ICAR, Shri. Sunil Kumar Singh visited ICAR-IIRR on 21st February 2017. He visited the various facilities available at ICAR-IIRR and also interacted with scientific, technical and administrative staff of ICAR-IIRR.

Felicitation of Former Directors :

Dr.S.V.S.Sastry and Dr.E.A.Siddiq, Former Directors, ICAR-IIRR, were felicitated by Dr.V.Ravindra Babu, Director, ICAR-IIRR on 25th February, 2017 and handed over the mementoes awarded to them on 11th February, 2017 by Indian Society of Genetics and Plant Breeding, New Delhi. Both the dignitaries addressed the scientists.

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Staff Achievements / Activities

Awards :

Dr. Satendra Kumar Mangrauthia has been selected as Associate of the National Academy of Agricultural Sciences (NAAS) w.e.f. January 1, 2017.

Dr. Brajendra was awarded "Certificate of Recognition for Remarkable Research Work" by Endling Organization, Phillipines at the International Conference on Food & Agriculture" held during February 20-22,2017 in New Delhi, India.

Dr.Chitra Shanker won the best oral presentation Award for paper 'Chitra Shanker, Sampathkumar, M., Jhansirani, B. and Gururaj Katt. 2017. Ecological Engineering for enhancing biocontrol of hoppers in rice. In Fifth National Conference on Biological Control held at Bengaluru, 9-10, February, 2017.

Dr. Brajendra was awarded "SEE Fellow award" by the Society for Extension Education, Agra, UP during their 8th National Extension Education Congress-2017,at NAARM Hyderabad

Dr.L.V.Subba Rao, was awarded "Certificate of Recognition" for contribution in implementation of various provisions of PPV&FRA Act 2001, by Protection of Plant Varieties and Farmers' Rights Authority on 27th February, 2017.

Deputations :

Dr. Suneetha Kota has joined as Post Doctoral Fellow, Plant Breeding at International Rice Research Institute (IRRI), Philippines from February 2017 to August 2019.

Dr. Brajendra attended the 6th Intergovernmental Technical Panel on Soils (ITPS) workshop, First Global Symposium on Soil Organic Carbon-17, International Network of Black Soils Meeting and World Water Day Celebrations at the United Nations Food and Agriculture Organization Rome, Italy from 20th to 24th March, 2017

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RICE NEWS AROUND

RICE NEWS AROUND

Record Rice Production

As per 2nd Advance Estimates, the estimated production of food grains during 2016-17 is 271.98 million tonnes (record). Total production of **Rice** is estimated as 108.86 million tones, which is also a new record. This year's Rice production is higher by 2.21 million tonnes than previous record production of 106.65 million tonnes achieved during 2013-14. It is also higher by 3.44 million tonnes than the five years' average rice production of 105.42 million tonnes. Production of rice has increased significantly by 4.45 million tonnes than the production of 104.41 million tonnes during 2015-16.
http://pib.nic.in/newsite/PrintRelease.aspx?relid=158478

Cheruvayal Raman – A Legendary Conserver of Wayanad Rice Germplasm

Mr. Raman K, popularly known as "Cheruvayal Raman" hailing from Cheruvayal house of Wayanad, Kerala is a tribal farmer and conserver of traditional rice cultivars of Wayanad district of Kerala. He is conserving 35 traditional rice varieties unique to Wayanad district. Owing to a high awareness about biodiversity conservation, he is conserving cultivars as a gift for next generation. Some of these rice varieties are presently available only in "Raman's collection" and hence Raman is often described as "Savior of traditional Wayanadan rice varieties". As a conserver, Cheruvayal Raman has received many awards and appreciation certificates including the prestigious Plant Genome Saviour Farmer Recognition Award from PPV&FR Authority. An award winning documentary film has been prepared about his conservation and cultivation activities.
https://www.youtube.com/watch?v=4UNEmoes1JE

Rice premix fortified with iron

In order to address the problem of anaemia Department of Biotechnology (DBT) has developed appropriate technology on iron fortified rice premix from broken rice kernels. This iron fortified rice premix matches with the normal rice kernel in shape and size, and when mixed with normal rice in the ratio of 1:100 it provides 50 per cent of recommended daily allowance (RDA) of iron to the children. Clinical studies have substantiated that regular feeding for one year increases iron store and decreases anaemia, in school going children. The rice is fortified through a process called extrusion in which dough made of rice flour, vitamin and mineral mix, and water, is passed through an extruder and cut into grain-like structures that resemble rice grains.
http://www.dbtindia.nic.in/fortified-food-products/

CRISPR-Cas: The new breeding technology

Researchers used CRISPR/Cas9 gene editing technology to generate transgene free high-amylose rice by targeted mutagenesis in starch branching enzymes (*SBEI* and *SBEIIb*). It was also demonstrated that *SBEIIb* plays a more important role than SBEI in determining the fine structure of amylopectin and nutritional properties of starch in rice grain.
http://journal.frontiersin.org/article/10.3389/fpls.2017.00298/full

Low methane emitting rice

Atmospheric methane is the second most important greenhouse gas after carbon dioxide, and is responsible for about 20% of the global warming effect since pre-industrial times. Rice paddies are the largest anthropogenic methane source and produce 7–17% of atmospheric methane. A Chinese team of Scientists showed that the addition of a single transcription factor gene, barley *SUSIBA2*,

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conferred a shift of carbon flux to *SUSIBA2* rice, favouring the allocation of photosynthates to above ground biomass over allocation to roots. The altered allocation resulted in an increased biomass and starch content in the seeds and stems, and suppressed methanogenesis, possibly through a reduction in root exudates.
http://www.nature.com/nature/journal/v523/n7562/full/nature14673.html

Over expression of AmRosea1 Gene Confers Drought and Salt Tolerance in Rice

Ectopic expression of the MYB transcription factor of ***AmROSEA1*** from *Antirrhinum majus* has been reported to change anthocyanin and other metabolites in several species. Overexpression of AmRosea1 significantly improved the tolerance of transgenic rice to drought and salinity stresses. Transcriptome analysis revealed that a considerable number of stress-related genes were affected by exogenous AmRosea1 during both drought and salinity stress treatments. These affected genes are involved in stress signal transduction, the hormone signal pathway, ion homeostasis and the enzymes that remove peroxides. This work suggests that the AmRosea1 gene is a potential candidate for genetic engineering of crops.
Mingzhu Dou, Sanhong Fan , Suxin Yang, Rongfeng Huang, Huiyun Yu and Xianzhong Feng. 2017. Int. J. Mol. Sci.18, (2); doi: 10.3390/ijms18010002.

How to get rid of Arsenic in rice

Excessive pesticides or contaminated water can seep into the agricultural produce, making them toxic for consumption, and long time intake can even lead to cancer. Rice is causing what is known as Arsenic poisoning. According to the researchers of the Queens University Belfast study, before eating rice, soaking them overnight in water reduce the chances of arsenic poisoning by 80 % and thus keep a check on the risks of heart disease, diabetes and cancer. However, cooking with five parts of water to one part of rice and the excess water washed off, almost halved the arsenic levels.
http://food.ndtv.com/fooddrinks/havewebeencookingricetherightwayorpoisoningourselvesinstead1657229

Spiders – Largest group of predators:

Dr Martin Nyffeler and his group in the University of Basel based on 40 years of gathering experience, concluded that the entire population of the world's spiders - weighing 25 million tonnes - hunts and eats between 400 million and 800 million tonnes of insect prey annually which is equivalent to the weight of meat and fish eaten every year by humans.
http://www.bbc.com/news/science-environment-39273661

Satellite based monitoring of Rice

On 9 February 2017, Government of Andhra Pradesh and International Rice Research Institute (IRRI) signed a Memorandum of Agreement in presence of its Director General Mathew Morell for operationalization of satellite based rice monitoring system. IRRI will provide technical support. The system will help to collect detailed and accurate data on rice production of the state, crop evaluation during and after natural disaster for crop insurance. Use of this technology will ensure better results in estimating crop losses in case of natural calamities. The system will be institutionalized and maintained by the AP State Department of Agriculture (DA) and Acharya N. G. Ranga Agricultural University (ANGRAU).
http://news.irri.org/2017/02/satellite-based-monitoring-system-to.html

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