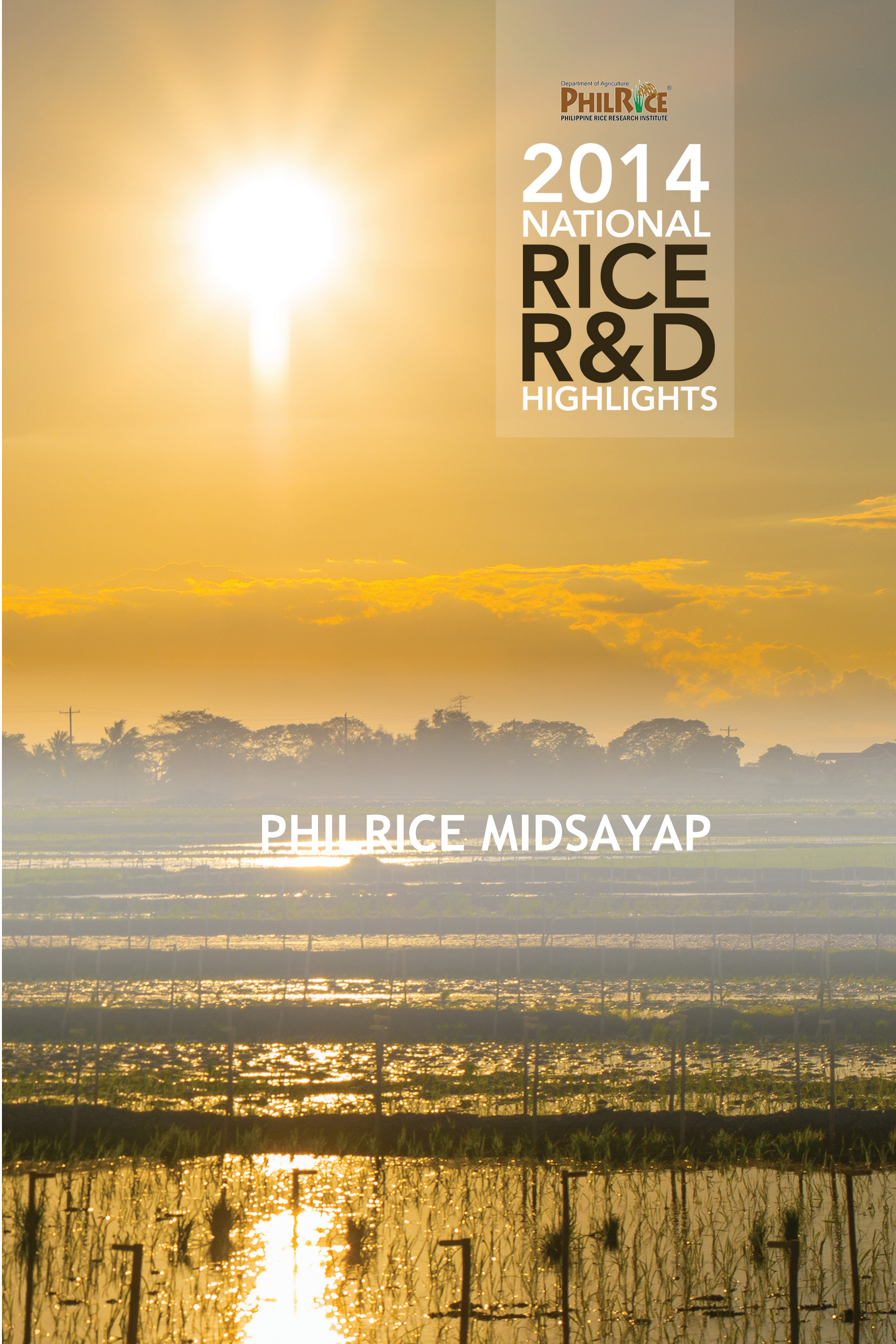

Department of Agriculture
PHILRICE
PHILIPPINE RICE RESEARCH INSTITUTE

2014 NATIONAL RICE R&D HIGHLIGHTS

PHILRICE MIDSAYAP

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I. Energy in Rice Farming: The Potential of Nipa Palm for Alcohol Production

VC Lapitan

Fossil fuel will run out, sooner or later. The fast approaching end is suggested by the increasing prices of fuel on a global scale. To prepare for this, the Philippine government is committed to the search for alternative fuels, one of which is alcohol. In the Philippines, nipa palm has been identified as an important source of biofuels because it produces a high amount of sap that can be converted to alcohol. It can yield alcohol at least 3 to 4 times that of sugar cane, the main source of ethanol in the Philippines. Ethanol production is limited by low yield. Research must be done on improving ethanol yield using biotechnology or conventional breeding. Once yield improvement of ethanol from nipa is realized, bioethanol as alternative fuel source will become more feasible.

Studies on Breeding for High Sap Yield And Tissue Culture For Mass Production Of Nipa Palm (Nypa fruticans Wurmb., Arecaceae)

VC Lapitan, KLC Nicolas

Nipa palm (Nypa fruticans Wurmb.) has been identified as an important source of biofuels in the Philippines due to its ability to produce high amount of sap that can be converted to alcohol. Alcohol productivity is at least 3 to 4 times higher than sugar cane, the main source of ethanol in the country.

Nipa propagates naturally by seed, which is believed to be highly cross pollinated. This pollinating habit, combined with the millions of years of accumulated mutations in the absence of artificial selection, explain the diversity of nipa today. In 2009, a study conducted by Rasco and his team in Camarines Norte and Surigao, identified substantial variations in sap production and sap yield related parameters between the plants and between locations they studied (Rasco et al, 2012).

Seeing the potential of this plant for ethanol production and the substantial variability in its population, developing superior plants can be a promising endeavor to increase the plant's alcohol productivity. However, propagation of nipa by seeds takes a lot of time but employing tissue culture techniques to vegetatively propagate this plant can be a promising possibility to produce large quantities of uniform planting materials with superior quality, within a short period of time. This can also be utilized to produce uniform parent materials for breeding programs.

Since there were no established tissue culture protocols for nipa, this study was conducted to develop a reliable cloning method for this plant.

This study presents the first attempt to develop in vitro clonal propagation technique for nipa using different explants like immature zygotic embryo, plumule and young leaf.

Highlights:

Clonal propagation through direct organogenesis

- Pre-treatment method (explants were soaked for 20min in water detergent solution with 500g powdered detergent) prior to decontamination under aseptic condition significantly increased decontamination percentage of explants (Figure.1D). However, sodium hydrochloride (NaOCl) concentration, an active ingredient in commercial bleach had no significant effect on decontamination rate of the embryos (Table 1). Three weeks of incubation under dark condition was observed as optimum for the growth of cultured embryos as evidenced by the emergence of plumule (Figure. 2A).

- Basal media was identified to significantly affect germination of zygotic embryos (Table 2). Higher mean germination percentage (89.07%) was observed on Modified Euwens (MY3) compared with Murashige and Skoog (MS) medium (78.12%). MY3 has higher source of amino acids as compared with MS (Table 3) which might be the reason for the observed difference on the germination percentage of the zygotic embryos. Although the results were not significant, the presence of 2,4-D in the medium decreased the rate of embryo germination while growth-promoting capability of coconut water on nipa embryos was observed specially when supplemented on MY3 medium.

- Young shoots (Figure. 2B) with 2 to 3 leaflets generated from in vitro cultured zygotic embryo explants (Figure. 2A) were identified suitable for clonal propagation (Figure. 2C) of nipa palm.

- Based from the results of first experiment on identification of suitable regeneration media, percentages of clone with shoot and root formations were not significantly affected by 6-benzylaminopurine (BAP), 1-naphthaleneaceticacid (NAA), and kinetin (Ki) combination (Table 4). However, it was observed that increasing the concentration of BAP to 1.0mg L-1 in combination with the same concentration of NAA and Ki increased the number of clones forming shoots (Figure 2A & B) but no root formation was observed. Out of the total 18 cut plantlets cultured on the said medium, 27.8% formed shoots.

- Results of second experiment (shaded portion of Table 4) revealed that the use of Indole-acetic acid (IAA) instead of NAA (2mg L-1 concentration of auxin and cytokinin) were able to increase the shoot and root regeneration ability of the clones from 22.2% to 44.4% and 44.4% to 77.7%, respectively. However, increasing the concentration of both auxin and cytokinin to 7mg L-1 did not have any effect on shoot regeneration but doubled regeneration of roots (from 33.3% to 66.7%).

- Addition of higher concentration of auxin in the media (whether NAA or IAA) was observed to have negative effect on shoot regeneration but had positive effect on root regeneration.

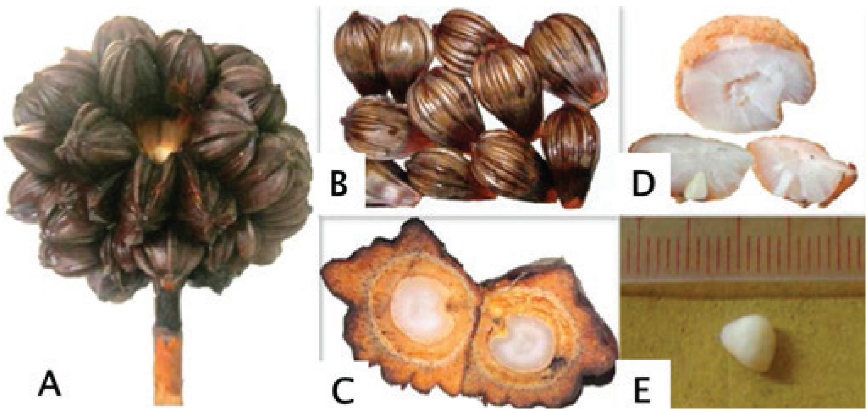

Figure 1. Planting materials utilized in the study; a) Fruiting head of nipa; b) Mature seeds detached from the fruit stem; c) Cut seeds showing the hardened endosperm; d). Cut endosperm excised from the seed; e) Zygotic embryo used as explant.

Table 1. Decontamination rate of zygotic embryos in two NaOCl concentrations soaked in varying time, with and without pre-treatment prior to sterilization under aseptic condition.

% NaOCl	Soaking time (min)		Average decontamination rate across treatments
	20	30	
Without pre-treatment			
2.62	41.67	48.33	
5.25	43.33	50.00	45.83[b]
With pre-treatment			
2.62	100	100	
5.25	100	100	100[a]

Mean separation by LSD at 5% level

Table 2. Zygotic embryo germination in Murashige and Skoog (MS) and Modified Euwens (MY3) basal media supplemented with 2,4-D and coconut water.

2,4-D concentration (mg L^{-1})	Germination (%) [a]			
	MS		MY3	
	(-) coconut water	(+) coconut water	(-) coconut water	(+) coconut water
None	81.25	81.25	87.50	93.75
7.0	71.88	78.13	84.38	90.63
Average germination rate across basal media	78.12 b		89.07 a	

[a]Average of eight replications. Mean separation by LSD at 5% level

Table 3. Nutrient composition of the two basal media utilized in the study.

Chemicals	Concentration (mg L^{-1}) Modified Y3(MY3)	MS
Macro-nutrients		
NH_4NO_3	-	1,650.00
KNO_3	2,020.00	1,900.00
KCl	1,492.00	-
NH_4Cl	535.00	-
KH_2PO_4	-	170.00
NaH_2PO_4	312.00	-
$MgSO_4$	247.00	370.00
$CaCl_2$	294.00	440.00
Micronutrients		
$MnSO_4$	11.20	6.20
KI	8.30	22.30
$ZnSO_4$	7.20	8.60
H_3BO_3	3.10	0.83
$CoCl_2.6H_20$	0.24	0.25
$Na2MoO_4.2H_2O$	0.24	0.03
$CuSO_4.5H_2O$	0.25	0.03
Iron Source		
$FeSO_4$	27.80	27.85
Na2EDTA	37.30	37.25
Vitamins		
Myo-inositol	100.00	100.00
Thiamine-HCl	1.00	0.50
Nicotinic acid	1.00	0.10
Pyridoxin-HCl	1.00	0.50
Glycine	0.00	2.00
Amino Acids		
I-Glutamine	100.00	-
I-arginine	121.00	-
I-asparagine	88.00	-
Sucrose	40g L^{-1}	40g L^{-1}
Agar	5g L^{-1}	5g L^{-1}
AC	2g L^{-1}	2g L^{-1}

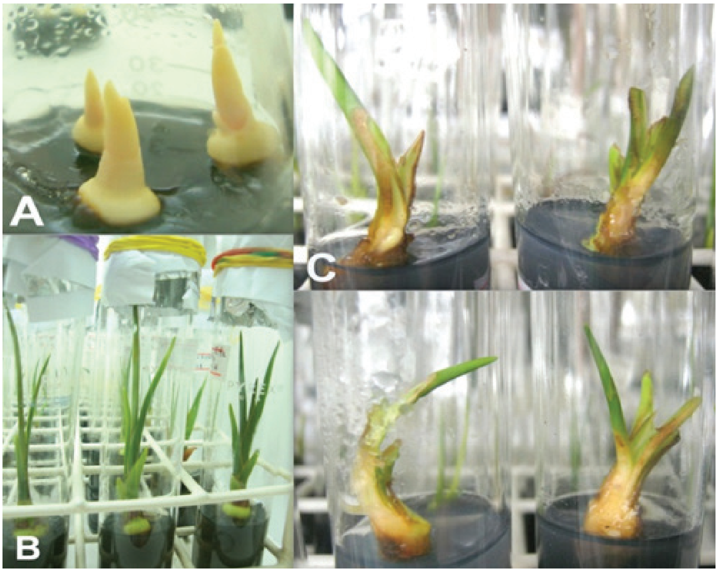

Figure 2. Clonal propagation of nipa; a) germinated zygotic embryos after almost 1 month of incubation in the dark, b) green plantlets generated from embryo cultures, c) green plantlets cut longitudinally into two sections along the shoot.

Table 4. Shoot and root formation of nipa clones as affected by different concentrations of BAP, NAA, IAA and Ki.

BAP (mg L^{-1})	NAA (mg L^{-1})	IAA (mg L^{-1})	Ki (mg L^{-1})	Clones with shoot formation (%)	Clones with root formation (%)
0.0	1.0	0.0	1.0	11.1	-
0.5	1.0	0.0	1.0	11.1	5.6
0.5	1.0	0.0	0.0	5.6	-
1.0	1.0	0.0	1.0	27.8	-
1.0	2.0	0.0	1.0	16.7	-
1.0	2.0	0.0	1.0	22.2	44.4
1.0	7.0	0.0	1.0	-	55.6
4.0	7.0	0.0	3.0	11.1	33.3
1.0	0.0	2.0	1.0	44.4	77.7
1.0	0.0	7.0	1.0	-	44.4
4.0	0.0	7.0	3.0	11.1	66.7

*Using a total of 18 clones per treatment

Clonal propagation from callus culture

- The use of 85% eTOH with 5min soaking time and combination of 1.31% NaOCl and 70% eTOH with 10min and 2min soaking time, respectively, was identified as the best sterilants for the male inflorescence explant across the experimental media tested (Table 5).

- For young leaf, it was identified that the use of 5.25% NaOCl was able to sterilized 40% of the total leaf explants used in the experiment (Table 6). However, the decontamination percentage of this explant was very low as compared with other explants since it is directly exposed to germs and other contaminants unlike the embryos and anther that were enclosed in the endosperm and spathes.

- Callus induction using plumule was observed only in media containing modified Euwens (Y3) basal salts and supplemented with either 2,4-D or picloram (Figure. 3).

- Position on plumule (type of explant: tip (P1), middle (P2) and bottom (P3) portion) were also tested in terms of their ability to produce callus. Results revealed that all types of explants were responsive in Y3 medium supplemented with picloram. However, P2 and P3 were not significantly different from each other but were significantly higher than P1 in terms of callus induction (Table 7). This would mean that the basal and middle portion of the plumule tissues have more actively growing cells that could have induced the formation of callus.

- Two types of callus were induced from all the type of explant tested. A non-embryogenic and embryogenic (Figure. 3). Non-embryogenic was observed to be soft and watery in appearance and not friable while the embryogenic calli looked compact and friable. Based on the total number of induced callus, only 0.48% of them was embryogenic.

- In male inflorescence explant, a whitish, gel-like part (with arrows) was observed from the cultured explants with cold pre-treatment after 4 to 6 weeks of incubation under dark condition (Figure. 4). High frequency was observed on modified Euwen's medium supplemented with activated charcoal. The growth was observed to be like albino plant tissues, however, under the dissecting microscope, the whitish, gelly-like parts that grow from the cultured explants seemed to be swollen anthers.

- Callus was not induced on different experimental media tested (Assy Bah, MS and Y3) even though it was supplemented with 2,4-D and picloram (2mg L-1, 4mg L-1, 6mg L-1, and 8mg L-1).

- In young leaf explant No callus induction was also observed on the different experimental media that was tested even though they were supplemented with auxin (AB,MS and Y3 basal media supplemented with 2mg L-1, 4mg L-1, 6mg L-1, and 8mg L-1 of 2,4-D and picloram)

- Callus proliferation: A callus proliferation experiment was also conducted using MS and Y3 basal salts supplemented with lower concentration of picloram (0, 0.5, 1, 3, 5mg L-1). However, no callus proliferation was observed from this experiment.

Table 5. Percentage decontamination of anther explants sterilized using different sterilants after 15 weeks of incubation.

Sterilant	Decontamination (%)			
	AB	MS	Y3	average
85% eTOH (3mins)	28.57	42.86	42.86	38.10
85% eTOH (5mins)	80.00	80.00	100.00	86.67
85% eTOH (10mins)	60.00	60.00	40.00	53.33
2.63% NaOCl (3mins)	28.57	42.86	14.29	28.57
2.63% NaOCl (5mins)	60.00	40.00	40.00	46.67
2.63% NaOCl (10mins)	40.00	100.00	60.00	66.67
1.31% NaOCl (3mins) + 70% eTOH (3mins)	57.14	42.86	28.57	42.86
1.31% NaOCl (5mins) + 70% eTOH (5mins)	60.00	20.00	40.00	40.00
1.31% NaOCl (10mins) + 70% eTOH (2mins)	60.00	80.00	100.00	80.00
average	52.70	56.51	51.75	53.65

Table 6. Percentage decontamination of young leaf explants sterilized using different sterilants after 10 weeks of incubation in the dark.

Sterilant	Decontamination (%)			
	AB	MS	Y3	average
2% NaOCl (10mins)	0.00	0.00	0.00	0.00
2% NaOCl (2mins) + 70% eTOH (3mins)	-	55.56	0.00	27.78
70% eTOH (10mins) + 2% NaOCl (5mins)	0.00	20.00	0.00	6.67
3% NaOCl (10mins)	0.00	0.00	0.00	0.00
5.25% NaOCl (10mins)	40.00	0.00	40.00	26.67
70% eTOH (5mins) + 2% NaOCl (5mins)	0.00	0.00	20.00	6.67
70% eTOH (5mins) + 3% NaOCl (5mins)	0.00	0.00	0.00	0.00
5.25% NaClO (20mins)	0.00	60.00	60.00	40.00
5.25% NaClO (25mins)	66.67	0.00	0.00	22.22
5.25% NaClO (30mins)	33.33	0.00	50.00	27.78
average	15.56	13.56	17.00	15.78

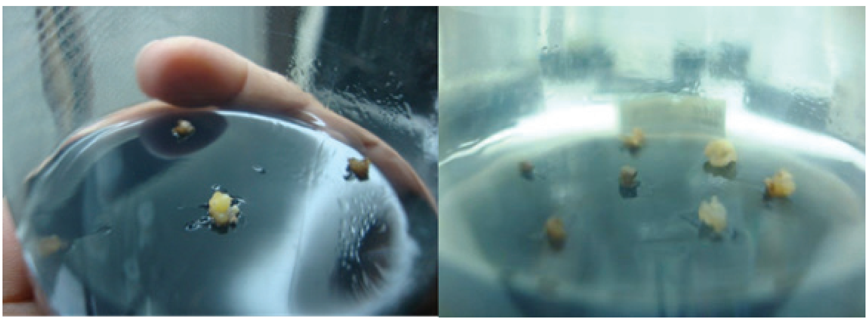

Figure 3. Types of induced calli from plumule embryogenic (left) and non-embryogenic (right).

Table 7. Effect of auxin and type of explant on callus induction of plumule.

Type of Explant	Callus Induction (%)		Callus induction across type (%)
	Y3 + picloram (30mg L^{-1})	Y3 + 2,4-D (30mg L^{-1})	
P2	45.57	7.30	26.44a
P3	42.57	8.15	25.36a
P1	31.35	0.00	15.68b
LSD (0.05)	39.83a	5.15b	

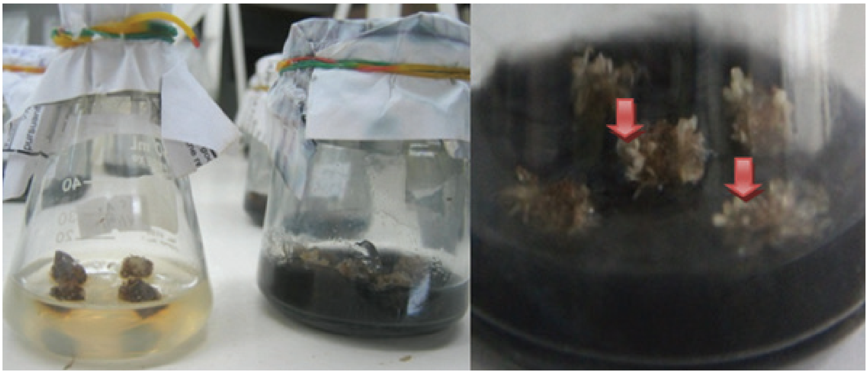

Figure 4. Explants cultured on the media without and with activated charcoal and modified Euwen's media with swollen anther (right).

II. Collection and Genetic Diversity Analysis of Nipa Palm (Nypa Fruiticans Wurmb., Aracaceae) Germplasm

VC Lapitan, KLC Nicolas

In the Philippines, there are rice fields that are near or almost connected to Nipa palm-growing areas. About 70,000ha of rice production area in Bicol and Cagayan Valley which are potentially affected by saline water intrusion are along or near the nipa palm-growing areas. In Catanduanes, the widest area of rice paddies and nipa palm mangroves are found in the contiguous wetlands of Viga, Panganiban and Bagamanoc. Nipa and rice complement each other; nipa provides fuel for farm mechanization while rice, through its biomass provides "fuel" in the production of alcohol from nipa sap (Montecalvo 2012, PhilRice Agusan). Nipa palm has been identified as an important source of biofuels because it produces a high amount of sap that can be converted to alcohol. It can yield at least 3 to 4 times than that of sugar cane, the main source of ethanol in the country. Having seen this potential, development of cultivars with high sap yield will be an important objective of improving nipa for increased alcohol productivity. Breeding for high sap yield requires selection of parents with wider genetic diversity. Molecular markers have been found to be powerful tools in the assessment of genetic variation. It can also determine the genetic identity of each accession and the relationships among genotypes in the germplasm collection. It provides information on the relatedness of different genotypes that are difficult to distinguished morphologically, thus helping in the management of plant accessions and in breeding programs. Data on the genetic diversity of nipa in the Philippines is still lacking simply because the needed research has not been done. In this study, the genetic diversity of nipa palm germplasm in Southern Luzon using simple sequence repeats (SSR) markers was examined and the ability/utility of SSR markers to detect the genetic diversity in nipa palm was assessed. SSR is among the most commonly used molecular marker due to its efficiency and cost-effectiveness.

Highlights:

- Different accessions of nipa were collected from Southern Luzon specifically from Kigtan, Calauag, Quezon; Marilag, Calauag, Quezon; Infanta, Quezon; and Vinzons, Cam. Norte and from Calumpit and Paombong, Bulacan (Figure. 5).

- Genetic diversity and the relationship among nipa palms were determined using SSR markers. One hundred sixty three accessions were screened with the use of 17 SSR markers that were identified from nipa palm, 8 SSR markers isolated from Phoenix dactylifera and 6 rice markers.

- Polymorphic SSR markers identified, out of 31 SSR markers utilized in the study 25 were polymorphic (Table 8 and Figure. 6). However, 2 markers were not clear, thus excluded in the cluster analysis which generated the dendrogram.

- One hundred seventy alleles were detected in 163 accessions with an average of 6.8 alleles per locus. An overall genetic diversity of 0.61 which indicated relative appropriate level of genetic variation among the accessions was identified.

- Seven groups with additional sub-clusters within each group were identified in the cluster analysis (Figure. 7). Generally, geographical locations of the nipa plantation were determined to define the pattern of clustering (Table 9).

- SSR markers were proven to be useful for genetic diversity analysis as they successfully distinguished polymorphisms among nipa palm collections.

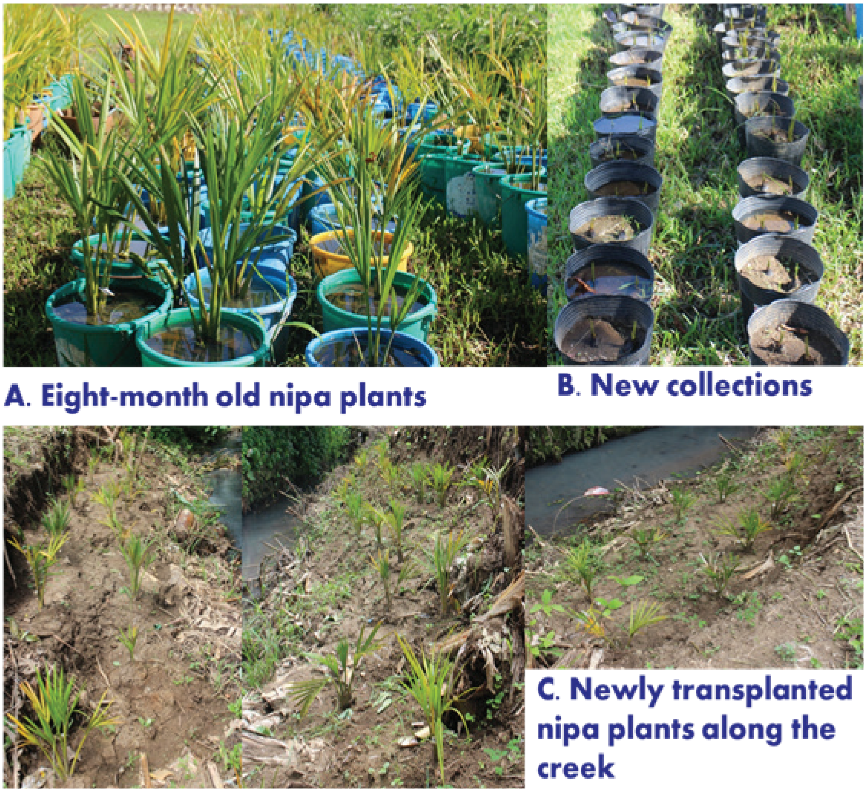

Figure 5. Nipa germplasm collection at PhilRice Los Banos A) Eight-month old nipa plant planted in plastic pails B) Newly planted collections C) Newly transplanted nipa collections along the creek in UPLB campus.

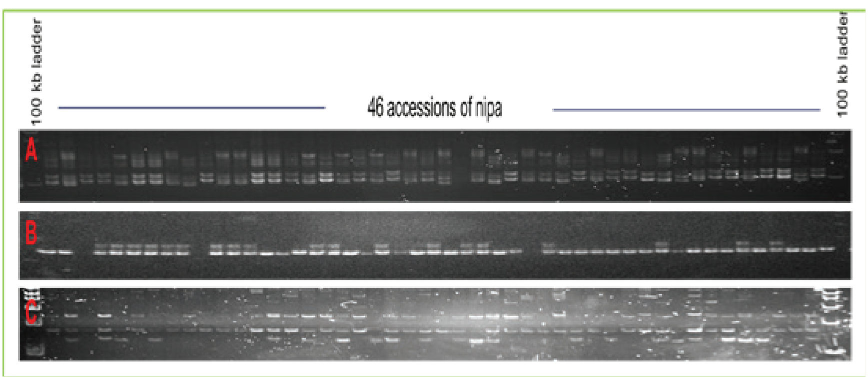

Figure 6. Polymorphism observed in at least 46 nipa accessions using molecular markers: A)EU746382, B)mPDC1R015, and C) RM14380.

Table 8. Number of alleles and genetic diversity of SSR markers across 163 nipa accessions.

SSR locus	No. of alleles	Genetic diversity	SSR locus	No. of alleles	Genetic diversity
Markers isolated from *Nypa fruticans*			**Markers isolated from *Phoenix dactylifera***		
EU746382	10	0.71	mPdC1R010	10	0.76
EU746383	7	0.23	mPdC1R015	2	0.51
EU746384	7	0.60	mPdC1R016	7	0.53
EU746385	8	0.61	mPdC1R048	8	0.65
EU746386	2	0.58	**Rice markers**		
EU746387	2	0.48	RM3	14	0.76
EU746389	3	0.52	RM271	13	0.67
EU7463891	8	0.59	RM14380	6	0.75
EU7463892	4	0.51	RM14412	12	0.60
EU7463893	6	0.84	RM 17391	7	0.79
EU7463894	4	0.54	RM 24648	15	0.75
EU7463896	2	0.40			
EU746398	5	0.53			

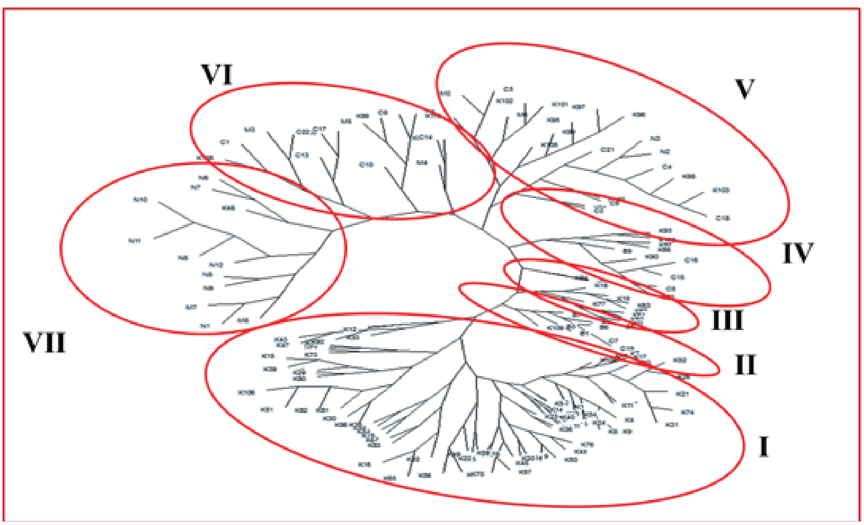

Figure 7. Dendogram of163 nipa accessions derived from cluster analysis using PowerMaker 3.0 based on 23 SSR.

Table 9. Grouping based on cluster analysis.

Cluster No.	Collection Site
I	Calauag, Quezon
II	Bulacan
III	Calauag, Quezon
IV	Infanta & Calauag, Quezon
V	Calauag & Infanta, Quezon; Vinzons, Camarines Norte
VI	Infanta, Quezon
VII	Vinzons, Camarines Norte

III. Collection and Genetic Diversity Analysis of Nipa Palm (Nypa Fruiticans Wurmb., Aracaceae) Germplasm

CJM Tado, DP Ona

The current design of PhilRice 1.3 mini combine rice harvester has been proven for its efficient performance on dry field conditions. This machine has been introduced throughout the country in previous years. However, the level of adaptation is still very low owing to various limitations. These are poor traction on soft and muddy fields, low capacity separation and cleaning system, unreliable cutterbar driver, poor performance in harvesting lodged crops, frequent clogging and damaged chain conveyors, and slow header height adjustment.

The study aims to improve the performance and reliability of the PhilRice mini combine rice harvester. Specifically, this aims to improve its traction, separation and cleaning systems, conveying systems, and header components.

Highlights:

- The prototype design had been finalized. Component speeds, sizes, and materials were established and identified. Parameters such as rotational speed and air velocity were set within the allowable range to minimize losses and crop damage.

- 3D model, working drawings, patterns and jigs were generated using computer-aided design (CAD).

- Fabrication of the prototype is 85% completed. Major components such as the header, feeder conveyor, thresher, cleaner, blower, screw conveyors, platform, chassis, and undercarriage were fabricated at Rice Engineering and Mechanization Division (REMD) machine shop. Some parts such as gears, undercarriage rollers, and hydraulics were outsourced from the members of Metalworking Industries Association of the Philippines, Inc. (MIAP).

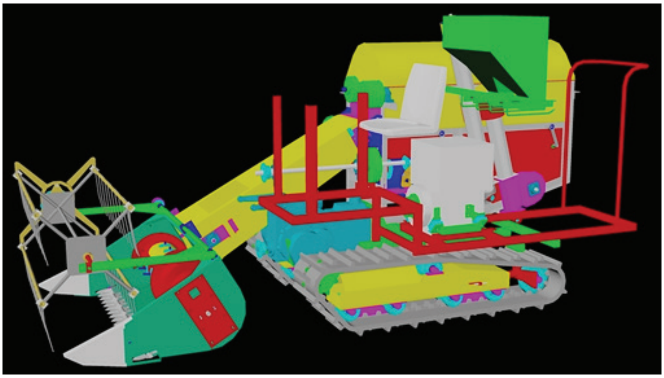

Figure 8. 3D model of the improved 1.3m rice combine harvester prototype.

Figure 9. Fabricated prototype at 85% completion.

Figure 10. Undercarriage rollers fabricated by a MIAP member.

IV. Development and Pilot Testing of a Local Riding-Type Transplanter

AS Juliano , JP Miano

With labor intensive operation requiring 20 to 25 man-days/ha and lack of manpower during the peak period of crop establishment, it is more beneficial to use mechanized transplanting system as it reduces labor costs and seed requirement (from minimum of 40 to 20kg/ha for either inbred or hybrid variety), but also allows shortening the period of raising the seedlings (from 25 to 30 days to 15 to 18 days). Thus, this project is being conducted to develop a locally made riding type rice transplanter that is suitable for transplanting inbred and hybrid rice. The local riding type transplanter was adapted based on a Japanese model utilized at PhilRice for several years. The only problem encountered with the imported units was the availability of spare parts. Therefore, reverse engineering and aesthetics were considered in the design process.

Highlights:

- The first prototype (Figure 1) was fabricated in 2014 thru the support of PCAARRD for funding and collaboration with the local fabricators (MIAP) using locally available materials. The riding type transplanter comprises 4-wheel drive transmission, 6 rows rotary type transplanting arm, 13hp air cooled reduction type single cylinder gasoline engine and a hydraulic lifting mechanism for the transplanting unit.

- Series of field tests were conducted and showed promising performance (Figure 2). Test results showed that the percentage missing hills varied from 7.68 to 9.82, plants per hill ranged from 2 to 8; planting depth from 20 to 80mm, hill spacing from 170 to 200mm while row spacing is fixed at 300mm.

- Tests proved the suitability of the local riding type transplanter in varying depth of hard pan rice field condition with a field capacity of 1.25 ha/day at 1st gear setting up to 2.16ha/day at 3rd gear setting.

- Minor parts breakdown were encountered during field tests, improvement were needed for its reliability under field conditions. Adjustments were needed to refine the no. of plants per hill and depth of planting of the machine.

- A commercial model is currently being fabricated in collaboration with local fabricators and targeted to complete this 2015. To determine its acceptability, the commercial model will undergo endurance test and pilot testing in three major islands of the country (Luzon, Visayas, and Mindanao) specifically on rice producing areas.

Figure 11. The first prototype of transplanter.

Figure 12. The transplanter during actual test.

V. Development of a locally adapted and manufacture riding-type precision seeder

EC Gagelonia, HV Valdez, JEO Abon, L Moliñawe

The rising cost of labor, the need to intensify rice production through double and triple cropping, the development of high-yielding short-duration modern varieties, and the availability of chemical weed control methods have jointly led to the switchover to direct seeding (Pandey and Velasco, 2005).

PhilRice developed a manually pulled drum seeder for direct seeding. However, it has limitations since seeds are placed on the surface, resulting to displacement of seeds when rain comes and exposure to bird and rat damage.

A mechanical riding-type seeder from Korea was demonstrated in areas where farmers commonly practiced direct seeding. The seeder has 8 rows with 25cm spacing between rows and 15cm spacing between hills. It can drop seeds to as low as 2 to 3 seeds per hill and to as high as 15 seeds per hill. The seeds are dropped and slightly covered with mud. It has built-in leveler and creates canalet every after 4 rows. Based on result of field trials, the seeder can also be used during rainy season without displacing the seeds in the rows, and even for rice seed production cultivation.

Thus, this study is being conducted to develop a local version of this Korean seeder that can drop precise number of seeds per hill and that can also be used for hybrid cultivation.

PhilRice developed and locally manufactured a mechanical riding-type precision seeder based on the mechanical riding-type seeder from Korea and a manually pulled single row seeder from China. The seeder has 8 rows with 25cm spacing between rows. It has built-in leveler and creates canalet every after 4 rows.

Highlights:

- Fabrication of the component parts for the completion of the 1st prototype of riding-type precision seeder was done These include the attachment of the hydraulic system (Figure. 13) for the seeder implements, fabrication of other components of the transmission system which is the drive mechanism (Figure. 14) for front and rear wheels, improvement of the design of the seed metering device (Figure. 15), fabrication of the floater, leveler and canalets including the frame for the seed metering assembly (Figure. 16). The fabrication of the 8 units seed metering device and hopper was contracted by the Rollmaster Machinery. The completion of the prototype was finished in November 2014 (Figure. 17)

- A series of laboratory testing (Figure. 18) of the seed-metering device was conducted for the improvement of the design of the seed plate in terms of the number of drop seeds at different settings and the distance of drop seeds per hill. It was observed during laboratory testing that further improvement or refinement on the adjustment of seed plate opening is needed to reduce number of drop seeds and to eliminate the uneven number of drop seeds per setting. Reduction of weight of the seed metering assembly is needed to reduce the overall weight as well as cost.

- Preliminary field testing (Figure. 19) of the prototype was done to test the functionality of the lifting mechanism, drive mechanism and the mobility in actual field condition. Further improvement on the lifting mechanism (orientation/location), front wheel (rubber instead of steel), steering gearbox (power steering will be installed) were identified for ease of operation.

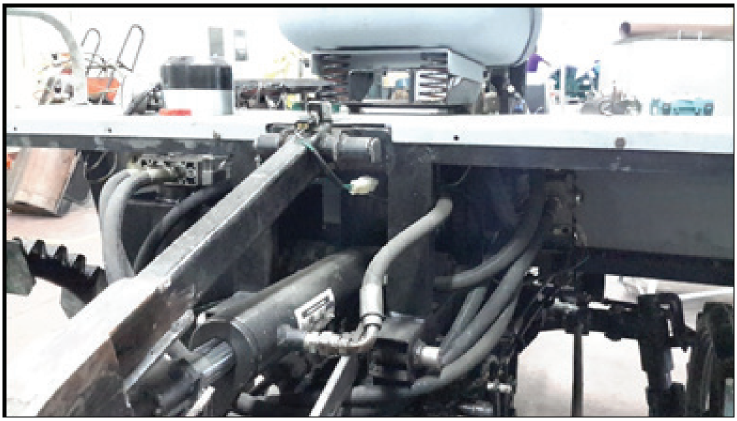

Figure 13. The hydraulic system.

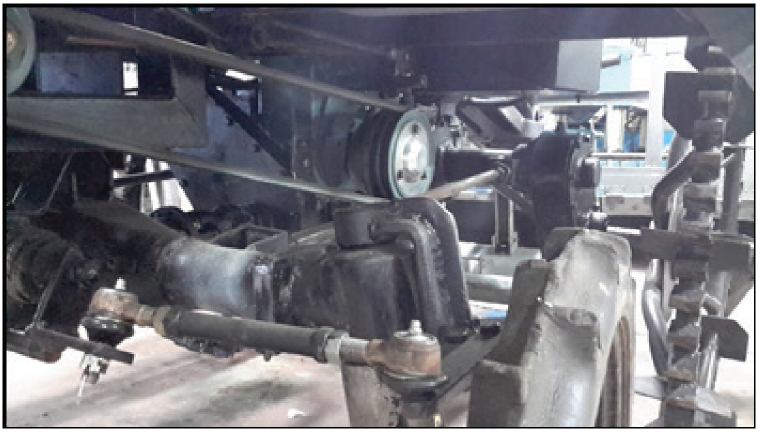

Figure 14. The drive mechanism.

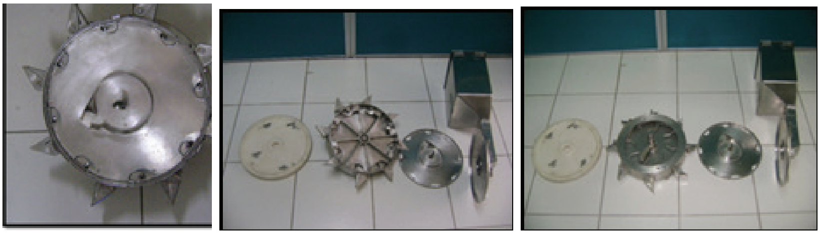

Figure 15. The seed metering device.

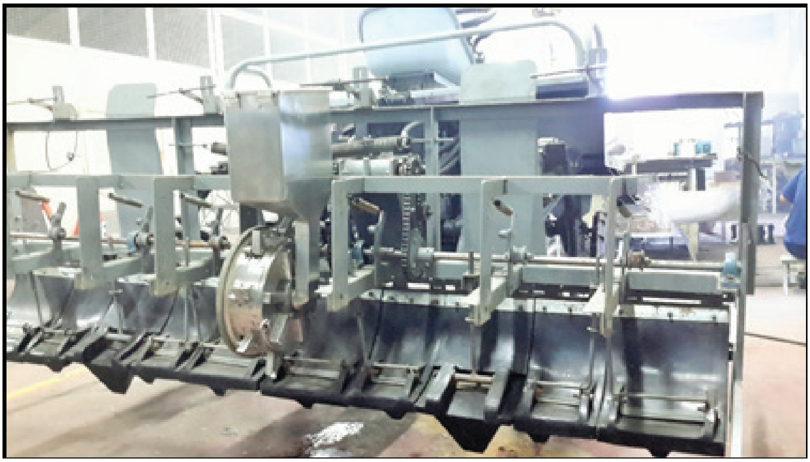

Figure 16. The frame of the seed metering assembly with floater, leveler and canalets.

Figure 17. Prototype of the riding-type precision seeder.

Figure 18. Laboratory testing of the seed metering device.

Figure 19. Preliminary field testing of the prototype.

VI. Development of Elite Heat Tolerance Rice Using the Common Germplasm and Analysis of QTLS Related to Heat Tolerance

NL Manigbas, ATP Dela Cruz

Rice is grown mainly in tropical and subtropical zones, and a high temperature at flowering can induce floret sterility and can limit grain yield (Osada et al. 1973; Satake and Yoshida, 1978; Matsushima et al. 1982). Since the 1980s, an increase in the concentration of greenhouse gases, such as carbon dioxide, in the atmosphere is thought to have been responsible for increasing the air temperature (Hansen et al. 1984). Amongst other things, global warming is expected to result in the occurrence of high temperature-induced floret sterility in rice.

Popular rice varieties in Southeast Asia, particularly in the Philippines, Vietnam, Thailand, Indonesia, and Cambodia, have high yields, good grain quality, and resistance to pests and diseases. However, they lack heat tolerance. Due to the advent of climate change caused by global warming, breeding for heat-tolerant varieties has become important. New rice varieties should possess adaptability to rising temperatures in addition to the desirable traits that a variety should have (Manigbas et al. 2014). The development of new rice genotypes for high temperature tolerance does not only include conventional breeding. Marker assisted selection and QTL analysis has been applied.

The ultimate goal of this collaborative project is to develop elite breeding lines with heat tolerance from the crosses between leading varieties of member countries and germplasm of heat tolerance and analyze QTLs related to heat tolerance.

Highlights:

- Data base of seasonal temperature and relative humidity during the high temperature season of the crop growth stage of the breeding materials and check varieties at PhilRice Central Experiment Station, Nueva Ecija (Figure 20). It showed that there was a temperature increase during the reproductive stage which is the critical period for rice to have heat-induced spikelet sterility.

- Selected 181 advanced lines had undergone Preliminary Yield Test, grain quality evaluation, and induced screening for pests and diseases. The highest yield obtained was 5.23 t/ha. These entries will be evaluated again on 2015 dry season.

- Selected 277 advance lines and 691 segregating lines that are either tolerant or intermediate tolerant in two high temperature sites in the Philippines (Table 10). Generated breeding populations in the nursery and established new crosses for advancement (Table 11 & 12).

- Marker-assisted selection was also conducted for 100 backcrossed lines. Phenotype was based from spikelet sterility and marker RM3586 was used for genotyping. Results showed that the effectivity of the marker is only 20 to 25% (Table 13 & Figure 22).

- Seven hundred fifty backcross populations had DNAs' extracted for QTL analysis. Prior from these, 396 SSR markers were surveyed for polymorphisms and 126 were identified and used for QTL analysis of 246 backcross populations. Phenotyping of plants were also done under high temperature conditions in the field and glasshouse. Sterility and fertility of plants were obtained.

- Nine QTLs were identified for high-temperature tolerance located in chromosomes 1, 3, 4, 5 and 10. These findings can be used in rice breeding using marker assisted selection (MAS) and fine mapping of novel genes for high-temperature tolerance (Figure 23 & 24).

- Generated four backcrossed populations using the Rapid Generation Advance facility for the production of RILs and further screening for heat tolerance (Table 14)
  .

- Published a scientific paper entitled; Germplasm Innovation of heat tolerance in rice for irrigated lowland condition in the Philippines. Rice Science, 2014, 21(3): 162-169.

Table 10. Summary of selected heat-tolerant rice lines during the 2014 dry season in Southern Cagayan Research Center, Cagayan and PhilRice-CES.

Location	No. of Selected Lines							
	Advanced Lines				Segregating Lines			
	Tolerant	Intermediate tolerant	Intolerant	Total	Tolerant	Intermediate tolerant	Intolerant	Total
Cagayan	**25**	**110**	**1**	**136**	**0**	**0**	**0**	**0**
PHILRICE-CES	**63**	**79**	**0**	**142**	**269**	**422**	**145**	**691**

Tolerant - <82.5% fertility; Intermediate Tolerant - 60-82% fertility; Intolerant - >40% fertility

Table 11. Summary of the total number of selected plants and/or populations established during the 2014 dry season at PhilRice-CES.

Generation	Selected Lines	No. of Cross	Selected Bulk	Plant Selections
New crosses		37		
F_3	2	2		61
F_6	121	14		363
F_7	42	5		126
F_8	66	1		198
HTVN-F8		3	21	
HTVN-F9		4	57	
BC2F4	49	7		146
BC4F4	134	5		402
BC1F5	15	5		45
BC2F5	5	2		15
BC3F5	42	8		124
BC1F6	16	7		48
RILS	3	2	3	
BILS	4	4	4	
TOTAL			**85**	**1915**

Table 12. Summary of the total number of selected plants and/or populations established and selected during the 2014 wet season at PhilRice-CES.

Generation	Planted		Selected/Harvested	
	Bulk	Plant Selections	No. of Bulk Selections	No. of Plant Selections
new crosses			23	
F1	37		37	
F2	4			27
F4		60		57
F7		210		52
BC2F5	2	138	2	51
BC4F5		600	111	
BC1F6		45	6	
BC3F6		84	18	
BILS		6	18	
PYT	188		188	
RGA	4		4	

Table 13. Selected backcross populations that were generated and advanced (Recombinant Inbred Lines) using Rapid Generation Advance (RGA) method.

Cross Combination	**Generation**
Selected populations for developing RILs	Without selections, only generation advance of all populations
1. Gayabyeo*2/N22	BC_2F_6
2. Gayabyeo*1/Dular	BC_1F_7
3. Jinmibyeo*3/N22	BC_3F_6
4. Jinmibyeo*1/Dular	BC_1F_6

Table 14. One hundred lines of backcrossed population (BC4F4) with sterility (phenotype) and marker (genotype) data during the 2014 dry season planting and phenotypically selected using Marker Assisted Selection data in the previous season.

PLOT	GEN	DESIGNATION	CROSS COMBINATION	% Sterility (Phenotype)	Marker Data (Genotype)
HT16469	BC4F4	PR44500-A3-3-2-2	NSIC Rc160*4/Dular	25.0	heterozygous
HT16219	BC4F4	PR44498-A2-1-3-1	OM 5930*4 /DULAR	29.8	tolerant
HT16220	BC4F4	PR44498-A2-1-3-2	OM 5930*4 /DULAR	23.4	tolerant
HT16221	BC4F4	PR44498-A2-1-3-3	OM 5930*4 /DULAR	26.4	tolerant
HT16236	BC4F4	PR44498-A2-7-1-3	OM 5930*4 /DULAR	15.3	tolerant
HT16237	BC4F4	PR44498-A3-1-1-1	OM 5930*4 /DULAR	19.9	tolerant
HT16238	BC4F4	PR44498-A3-1-1-2	OM 5930*4 /DULAR	24.5	tolerant
HT16239	BC4F4	PR44498-A3-1-1-3	OM 5930*4 /DULAR	20.1	tolerant
HT16249	BC4F4	PR44498-B1-5-1-1	OM 5930*4 /DULAR	19.2	tolerant
HT16250	BC4F4	PR44498-B1-5-1-2	OM 5930*4 /DULAR	14.2	tolerant
HT16251	BC4F4	PR44498-B1-5-1-3	OM 5930*4 /DULAR	28.1	tolerant
HT16253	BC4F4	PR44498-B1-6-2-2	OM 5930*4 /DULAR	16.2	tolerant
HT16255	BC4F4	PR44499-A10-3-2-1	NSIC Rc150*4/Dular	36.1	heterozygous
HT16256	BC4F4	PR44499-A10-3-2-2	NSIC Rc150*4/Dular	31.8	heterozygous
HT16259	BC4F4	PR44499-A10-5-2-2	NSIC Rc150*4/Dular	31.0	heterozygous
HT16262	BC4F4	PR44499-A1-2-1-2	NSIC Rc150*4/Dular	40.6	tolerant
HT16263	BC4F4	PR44499-A1-2-1-3	NSIC Rc150*4/Dular	14.7	tolerant
HT16264	BC4F4	PR44499-A13-1-2-1	NSIC Rc150*4/Dular	23.9	heterozygous
HT16265	BC4F4	PR44499-A13-1-2-2	NSIC Rc150*4/Dular	28.4	heterozygous
HT16267	BC4F4	PR44499-A14-1-1-1	NSIC Rc150*4/Dular	31.0	tolerant
HT16268	BC4F4	PR44499-A14-1-1-2	NSIC Rc150*4/Dular	24.5	tolerant
HT16270	BC4F4	PR44499-A14-1-3-1	NSIC Rc150*4/Dular	18.2	tolerant
HT16271	BC4F4	PR44499-A14-1-3-2	NSIC Rc150*4/Dular	22.0	tolerant
HT16273	BC4F4	PR44499-A14-3-1-1	NSIC Rc150*4/Dular	30.5	tolerant
HT16274	BC4F4	PR44499-A14-3-1-2	NSIC Rc150*4/Dular	19.8	tolerant
HT16275	BC4F4	PR44499-A14-3-1-3	NSIC Rc150*4/Dular	13.6	tolerant
HT16277	BC4F4	PR44499-A14-4-3-2	NSIC Rc150*4/Dular	19.8	tolerant
HT16281	BC4F4	PR44499-A14-5-2-3	NSIC Rc150*4/Dular	10.1	tolerant
HT16283	BC4F4	PR44499-A14-6-2-2	NSIC Rc150*4/Dular	7.8	tolerant
HT16286	BC4F4	PR44499-A14-7-2-2	NSIC Rc150*4/Dular	13.1	tolerant
HT16290	BC4F4	PR44499-A15-1-1-3	NSIC Rc150*4/Dular	14.6	heterozygous
HT16296	BC4F4	PR44499-A15-2-3-3	NSIC Rc150*4/Dular	19.3	heterozygous
HT16297	BC4F4	PR44499-A15-3-2-1	NSIC Rc150*4/Dular	17.3	heterozygous
HT16299	BC4F4	PR44499-A15-3-2-3	NSIC Rc150*4/Dular	20.0	heterozygous
HT16301	BC4F4	PR44499-A15-4-1-2	NSIC Rc150*4/Dular	13.6	heterozygous
HT16305	BC4F4	PR44499-A15-9-2-3	NSIC Rc150*4/Dular	18.2	heterozygous
HT16311	BC4F4	PR44499-A16-1-3-3	NSIC Rc150*4/Dular	19.2	tolerant
HT16314	BC4F4	PR44499-A16-3-1-3	NSIC Rc150*4/Dular	21.6	tolerant
HT16319	BC4F4	PR44499-A2-1-2-2	NSIC Rc150*4/Dular	24.3	tolerant

Table 14. One hundred lines of backcrossed population (BC4F4) with sterility (phenotype) and marker (genotype) data during the 2014 dry season planting and phenotypically selected using Marker Assisted Selection data in the previous season. (Con't...)

HT16338	BC4F4	PR44499-A4-4-2-3	NSIC Rc150*4/Dular	20.4	tolerant
HT16346	BC4F4	PR44499-A4-7-3-2	NSIC Rc150*4/Dular	16.9	tolerant
HT16360	BC4F4	PR44499-A5-6-1-1	NSIC Rc150*4/Dular	21.9	tolerant
HT16361	BC4F4	PR44499-A5-6-1-2	NSIC Rc150*4/Dular	22.8	tolerant
HT16374	BC4F4	PR44499-A7-3-1-3	NSIC Rc150*4/Dular	20.7	tolerant
HT16387	BC4F4	PR44499-A8-5-3-1	NSIC Rc150*4/Dular	18.1	heterozygous
HT16400	BC4F4	PR44499-A9-5-2-2	NSIC Rc150*4/Dular	19.7	heterozygous
HT16402	BC4F4	PR44499-A9-6-1-1	NSIC Rc150*4/Dular	20.6	heterozygous
HT16405	BC4F4	PR44499-A9-6-2-1	NSIC Rc150*4/Dular	22.6	heterozygous
HT16409	BC4F4	PR44499-A9-6-3-2	NSIC Rc150*4/Dular	27.1	heterozygous
HT16419	BC4F4	PR44499-B11-2-2-3	NSIC Rc150*4/Dular	30.4	tolerant
HT16428	BC4F4	PR44499-B12-5-1-3	NSIC Rc150*4/Dular	32.6	heterozygous
HT16447	BC4F4	PR44499-B4-4-3-1	NSIC Rc150*4/Dular	24.0	tolerant
HT16450	BC4F4	PR44499-B5-5-3-1	NSIC Rc150*4/Dular	18.6	tolerant
HT16456	BC4F4	PR44500-A21-5-2-1	NSIC Rc160*4/Dular	25.7	tolerant
HT16464	BC4F4	PR44500-A21-6-3-3	NSIC Rc160*4/Dular	42.7	tolerant
HT16484	BC4F4	PR44500-A8-2-1-2	NSIC Rc160*4/Dular	21.3	heterozygous
HT16489	BC4F4	PR44500-B13-10-2-1	NSIC Rc160*4/Dular	29.9	heterozygous
HT16490	BC4F4	PR44500-B13-10-2-2	NSIC Rc160*4/Dular	42.5	heterozygous
HT16495	BC4F4	PR44500-B15-5-1-1	NSIC Rc160*4/Dular	28.4	tolerant
HT16502	BC4F4	PR44500-B17-2-1-2	NSIC Rc160*4/Dular	15.8	tolerant
HT16504	BC4F4	PR44500-B17-3-3-1	NSIC Rc160*4/Dular	10.9	tolerant
HT16508	BC4F4	PR44500-B17-5-2-2	NSIC Rc160*4/Dular	16.1	tolerant
HT16510	BC4F4	PR44500-B4-10-2-1	NSIC Rc160*4/Dular	27.0	heterozygous
HT16511	BC4F4	PR44500-B4-10-2-2	NSIC Rc160*4/Dular	26.0	heterozygous
HT16525	BC4F4	PR44501-A15-16-1-1	IR66*4/Dular	30.2	tolerant
HT16529	BC4F4	PR44501-A15-19-2-2	IR66*4/Dular	23.7	tolerant
HT16532	BC4F4	PR44501-A4-12-1-2	IR66*4/Dular	13.5	heterozygous
HT16533	BC4F4	PR44501-A4-12-1-3	IR66*4/Dular	29.5	heterozygous
HT16536	BC4F4	PR44501-A4-13-1-3	IR66*4/Dular	15.2	heterozygous
HT16540	BC4F4	PR44501-A4-3-3-1	IR66*4/Dular	17.0	heterozygous
HT16550	BC4F4	PR44505-A12-1-3-2	Hanareumbyeo*4/N22 03911	13.0	heterozygous
HT16553	BC4F4	PR44505-A12-4-1-2	Hanareumbyeo*4/N22 03911	16.4	heterozygous
HT16555	BC4F4	PR44505-A12-8-1-1	Hanareumbyeo*4/N22 03911	13.2	heterozygous
HT16557	BC4F4	PR44505-A12-8-1-3	Hanareumbyeo*4/N22 03911	21.9	heterozygous
HT16560	BC4F4	PR44505-A14-11-1-3	Hanareumbyeo*4/N22 03911	31.4	heterozygous
HT16561	BC4F4	PR44505-A14-15-1-1	Hanareumbyeo*4/N22 03911	49.6	heterozygous
HT16562	BC4F4	PR44505-A14-15-1-2	Hanareumbyeo*4/N22 03911	50.6	heterozygous

Table 14. One hundred lines of backcrossed population (BC4F4) with sterility (phenotype) and marker (genotype) data during the 2014 dry season planting and phenotypically selected using Marker Assisted Selection data in the previous season. (Con't...)

HT16563	BC4F4	PR44505-A14-15-1-3	Hanareumbyeo*4/N22 03911	41.4	heterozygous
HT16565	BC4F4	PR44505-A14-15-2-2	Hanareumbyeo*4/N22 03911	33.2	heterozygous
HT16568	BC4F4	PR44505-A16-4-1-2	Hanareumbyeo*4/N22 03911	13.8	heterozygous
HT16570	BC4F4	PR44505-A16-4-2-1-1	Hanareumbyeo*4/N22 03911	16.6	heterozygous
HT16572	BC4F4	PR44505-A16-4-2-1-3	Hanareumbyeo*4/N22 03911	18.6	heterozygous
HT16577	BC4F4	PR44505-A16-7-2-2	Hanareumbyeo*4/N22 03911	21.5	heterozygous
HT16579	BC4F4	PR44505-A19-21-1-1	Hanareumbyeo*4/N22 03911	25.3	heterozygous
HT16581	BC4F4	PR44505-A19-21-1-3	Hanareumbyeo*4/N22 03911	21.0	heterozygous
HT16583	BC4F4	PR44505-A19-22-2-2	Hanareumbyeo*4/N22 03911	14.6	heterozygous
HT16586	BC4F4	PR44505-A19-24-1-2	Hanareumbyeo*4/N22 03911	25.9	heterozygous
HT16590	BC4F4	PR44505-A19-25-2-3	Hanareumbyeo*4/N22 03911	18.8	heterozygous
HT16598	BC4F4	PR44505-A26-5-3-2	Hanareumbyeo*4/N22 03911	16.1	heterozygous
HT16602	BC4F4	PR44505-B5-1-2-3	Hanareumbyeo*4/N22 03911	44.5	heterozygous
HT16216	BC4F4	PR44498-A1-7-1-1	OM 5930*4 /DULAR	31.2	tolerant
HT16217	BC4F4	PR44498-A1-7-1-2	OM 5930*4 /DULAR	34.1	tolerant
HT16330	BC4F4	PR44499-A3-1-2-1	NSIC Rc150*4/Dular	42.7	tolerant
HT16334	BC4F4	PR44499-A3-8-3-2	NSIC Rc150*4/Dular	50.0	tolerant
HT16335	BC4F4	PR44499-A3-8-3-3	NSIC Rc150*4/Dular	43.0	tolerant
HT16444	BC4F4	PR44499-B15-4-2-1	NSIC Rc150*4/Dular	53.1	heterozygous
HT16446	BC4F4	PR44499-B15-4-2-3	NSIC Rc150*4/Dular	48.0	heterozygous
HT16521	BC4F4	PR44500-B9-2-2-3	NSIC Rc160*4/Dular	43.4	heterozygous
HT16522	BC4F4	PR44500-B9-2-3-1	NSIC Rc160*4/Dular	50.0	heterozygous
HT16523	BC4F4	PR44500-B9-2-3-2	NSIC Rc160*4/Dular	49.5	heterozygous
N22 (03911)		Tolerant Check		16	
IR64		Check		17	
Milyang 23		Check		13	
NSIC Rc240		Susceptible Check		46	
IR52		Susceptible Check		47	

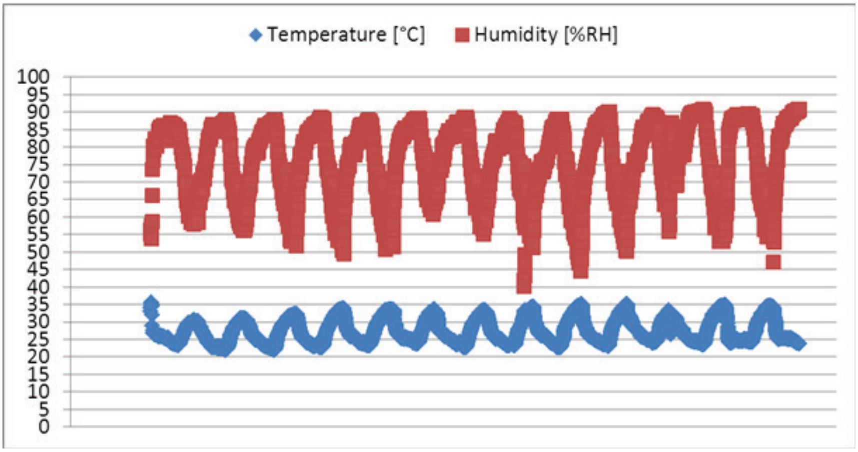

Figure 20. Temperature and relative humidity under field conditions at PhilRice, Nueva Ecija from April 14-May 28, 2014.

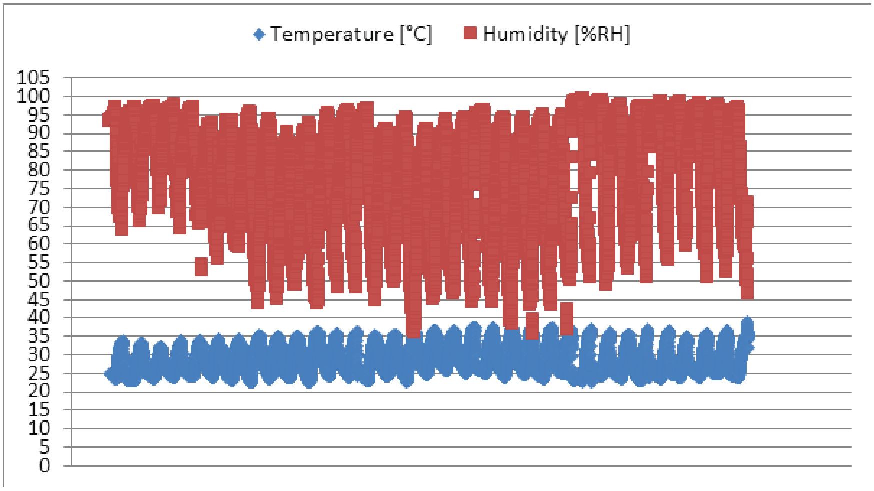

Figure 21. Temperature and relative humidity under field conditions at PhilRice, Nueva Ecija from April 14-May 28, 2014.

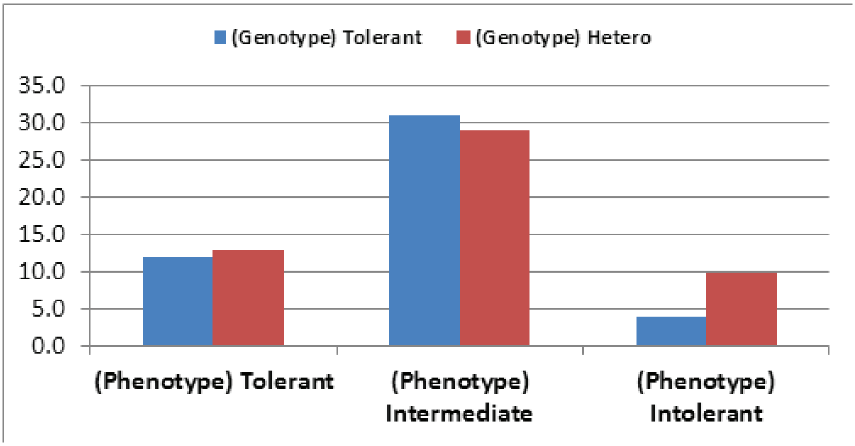

Figure 22. Number of lines selected in the field based on phenotype (percent sterility) and genotype (molecular data). Percent sterility of <17.5% is tolerant, 18-40% is intermediate tolerant, and >40% is intolerant to high temperature.

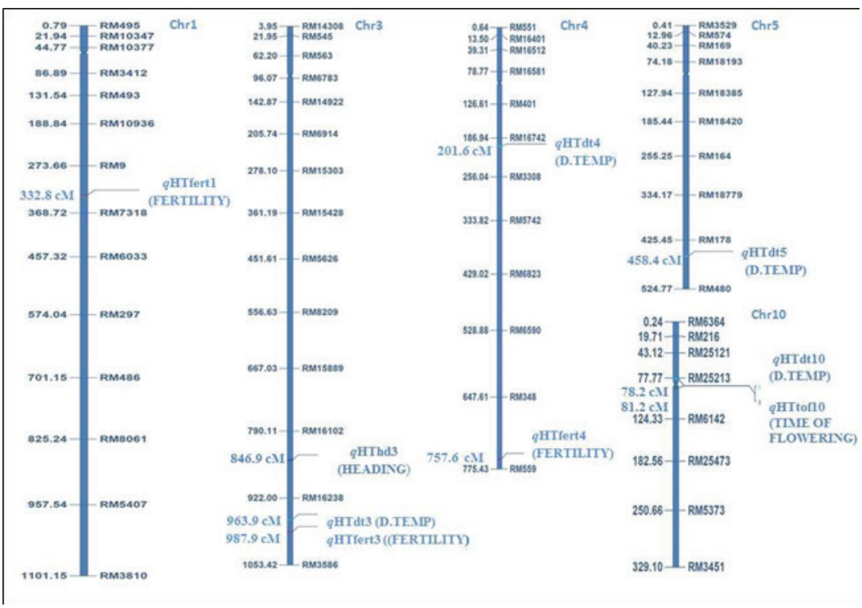

Figure 23. QTL linkage map for heat-tolerance showing the putative location of genes.

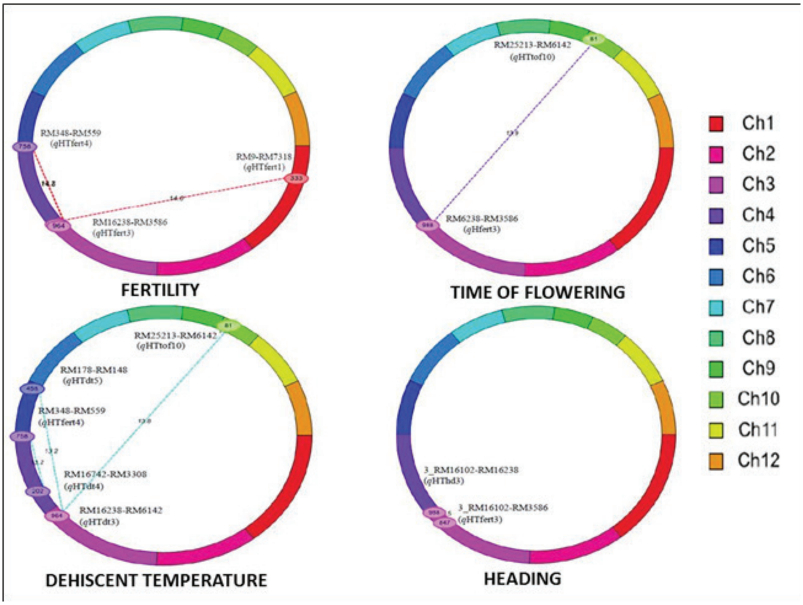

Figure 24. Cyclic graph on epistasis of QTL for heat-tolerance.

VII. Construction of Epidemiology Information Interchange System for Migratory Disease and Insect Pests in Asia Region (IPM): Assessment of Rice Planthoppers Populations and Viruses in the Philippines[1]

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Rice planthoppers (RPH) such as brown planthopper (BPH), small brown planthopper (SBPH), and white-backed planthopper (WBPH) are constraints to the rice production in Asian countries. They also transmit viruses devastating to rice plants. Recently, planthoppers are new threats to the sustainability of intensive rice production systems in Asia. BPH outbreaks and associated disease epidemics were reported in Bangladesh, Cambodia, China, India, Indonesia, Japan, Korea, Laos, Malaysia, Thailand, and Vietnam.

In the Philippines during the wet season of 2010, planthopper outbreaks have damaged about 6,700 ha in Iloilo and 40.3% of the area had significant yield losses. In view of this potential problem, it is necessary to monitor RPH and its associated viruses to avoid outbreaks. The outputs of the project will contribute to the development of efficient management strategies for impending RPH and its associated viruses in the Philippines. It is also necessary to participate in the establishment of an international cooperative network for the best management of migrating RPH and associated rice viruses in Asia as a whole.

Highlights:

- Monitoring of RPH using light trap was started in 2015 at PhilRice CES, Maligaya, Science City of Muñoz, Nueva Ecija. Results showed that RPH was initially recorded during the last week of January. The highest numbers of BPH were recorded in March (2,637) to April (2,369) and August (243) to September (4,608). WBPH followed the same patterns of populations although have lower populations as compared with BPH. The population patterns observed would indicate that RPH develops in the field and peaked towards the end or as the crop neared maturity during the dry and wet seasons. Comparing these two population peaks recorded, higher population occurred in wet season as compared with dry season.

- To determine field populations, monitoring of RPH was done using sticky trap in two sites located in PhilRice CES, Science City of Munoz and Mabini, Sto. Domingo, Nueva Ecija. During the dry season, highest number of RPH populations was observed in March in PhilRice CES, Science City of Munoz. More WBPH was recorded as compared with BPH. In Mabini, Sto. Domingo, highest populations of RPH was also recorded in March, and then decreased until the time of harvest. During the field samplings, spiders, coccinelids, mirids, and tiger beetles were commonly observed in the field. During the wet season, RPH populations were observed to be highest in August to September in both sites.

- These observed high populations of RPH monitored using sticky trap coincided with the reproductive to ripening phases of rice plants in the field. It was commonly observed that planthopper adults invaded rice at reproductive phase and seems that they infest rice earlier during wet season. For both dry and wet seasons, monitoring showed that WBPH was usually recorded earlier to colonize rice plants than BPH.

- Hopperburn due to BPH and WBPH was assessed by estimating the percent infested area and the sum of ground covered by the patches within the sampling area. Rice plant showing virus diseases transmitted by RPH and hopperburn were not observed in the selected sites during the 2014 dry season. However, patches of hopperburn were observed in nearby rice areas in April to March. Incidence of damage ranged from 10 to 50%. These rice areas were planted with inbred and hybrid rice varieties applied with insecticides 3 to 10 times. During 2014 wet season, hopperburn damage of about 5% were observed in Lagare, Cabanatuan City and Calipahan, Talavera, Nueva Ecija. Farmers applied insecticide three times, from heading to flowering stages of rice plants.

- During the time of peak RPH populations, we collected RPH samples ready for sending to Korea for genetic analysis. An addition, information on the RPH populations and damage were inputted and shared in the internet platform Asian Migratory Insects and Viruses Surveillance (AMIVS) system.

- Due to considerable populations RPH populations and the incidence of hopperburn in the fields monitored, it is necessary to take close monitoring of planthoppers and associated damage to reduce vulnerability of rice to RPH infestations thus preventing possible outbreaks causing significant rice yield losses.

VIII. Increasing productivity of direct seeded rice areas by incorporating genes for tolerance of anaerobic conditions during anaerobic germination

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In the Philippines, rice varieties are mainly bred for transplanting method due to its various advantages such as good seedling establishment for weed competition, low seed requirement, and controlled plant density. However, the system requires a lot of labor inputs which includes seedling pulling, distribution and transplanting. In the present time, such tedious endeavor is getting inadequate owing to decreasing manpower. As a result, direct seeding as an alternative method of establishing rice is gaining more acceptances to the farmers due to reduced labor, hence, reduced cost of farm inputs, labor and capital compared to transplanted rice. Farmers have been practicing direct seeding system using rice varieties for transplanted system. Owing to this, high mortality rate of germinating seeds during monsoon season affected the takings of rice farmers. Recent results in low seed requirement using mechanical seeder further added to the acceptance of the method by farmers. Yield is almost similar to the transplanted rice, however there are limited varieties suited for direct seeding. Knowing the intolerance of our modern cultivars to anaerobic germination making it not suited for direct-seeded cultivation and knowing the harsh environmental conditions of direct seeded rice, high mortality of seedlings or germinating seeds are observed in direct seeding rice varieties bred for transplanted system. However, introgression of genes that control anaerobic germination tolerance in rice, anaerobic germination 1 gene (AG1) is a way to alter our modern varieties in their reaction to impeded gas exchange in submerged or anaerobic condition. In this way, varieties bred for transplanted system could perform better to direct seeded cultivation.

The ability of rice seeds to germinate even in the presence of water is important for the plants' establishment and its eventual success. Aside from avoiding high mortality of the seeds, anaerobic germination is also seen as way to control the growth of weeds and pest infestation like birds and rodents.

Tolerance under anoxic condition of seeds can be considered as one component trait of seedling vigor in rice. It was proven that during anoxia or absence of oxygen, intolerance of certain genotypes exhibited low sugar mobilization than malfunctioning of metabolic machinery for glycolysis and ethanol production (Huang et al. 2003). Mustroph et al. (2006) demonstrated that rice shoots prevented excessive production of acetaldehyde and subsequent post-anoxic cell injuries and leaf damage. The observation can be due to the induction of aldehyde dehydrogenase (ALDH) during anaerobiosis (Tsuji et al. 2003; Nakazono et al. 2000). Consequently, the lower acetaldehyde formation is thus proposed to be another reason for the high tolerance of rice plants to anaerobic and post-anaerobic conditions (Mustroph et al. 2006).

This study attempts to introgress anaerobic germination tolerance with submergence tolerance genes, Sub1 + AG1 (Parent: Ciherang Sub1+AG1) to NSIC Rc222. It will determine the genetic and molecular mechanism of anaerobic germination tolerance to rice transplanted varieties and its relationship with agronomic performance in wet-direct seeded rice genotypes

Highlights:

- F1 seeds of Ciherang (Sub1+ Ag1) X NSIC Rc222 introgressed with anaerobic germination tolerance were planted in the glasshouse in 2014DS. Thirty-seven individual F1 plants were backcrossed to NSIC Rc222 and 1,363 BC1F1 seeds were produced (Table 15 and Figure 25).

- Leaf samples of Ciherang (Sub1+Ag1) and NSIC Rc222 were collected for DNA extraction. DNA polymorphism survey of the parents (Ciherang (Sub1+Ag1) and NSIC Rc222) was conducted using 459 simple sequence repeats (SSR) markers covering the 12 chromosomes of rice (Figure 26). Of these, 123 SSRs showed polymorphism between the parents.

- Optimization of primers using ART5, RM8300, RM105 and RM24161 were done. Both ART5 and RM8300 were found polymorphic to Ciherang (Sub1+Ag1) and NSIC Rc222 but RM105 and RM24161 were found to be monomorphic (Figure 27).

- In 2014 WS, 1,025 BC1F1 seeds were established in the glasshouse and only 422 BC1F1 plants survived. The surviving BC1F1 plants were individually collected of leaf samples for DNA extraction and were subjected to target gene assay. Published markers for submergence tolerance genes (ART5 and RM8300) and SSR markers for anaerobic germination (RM3769 and RM24141) were used for heterozygosity test (Figure 28).

- In Table 16, out of 1,025 BC1F1 plants, 46 BC1F1 plants with the Sub1 and Ag1 genes were identified. Total of 575 BC2F1 seeds were generated from 12 BC1F1 plants (no. 20-5, 20-21, 32-14, 32-16, 33-20, 41-2, 45A-14, 53a-3, 53B-1, 62-16, 62-20, 62-22). Background selection using polymorphic SSR markers were ongoing to select the best 3 BC1F1 plants to be backcrossed to NSIC Rc222.

Table 15. Total number of generated BC1F1 during 2014 DS.

Cross Combination	Generated BC1F1
F1-14/NSIC Rc222-65	115
F1-17/NSIC Rc222-91	31
F1-18/NSIC Rc222-66	51
F1-18/NSIC Rc222-80	46
F1-20/NSIC Rc222-52	60
F1-21/NSIC Rc222-58	33
F1-24/NSIC Rc222-38	24
F1-27/NSIC Rc222-52	13
F1-29/NSIC Rc222-70	59
F1-30/NSIC Rc222-82	67
F1-32/NSIC Rc222-79	49
F1-33/NSIC Rc222-77	79
F1-34/NSIC Rc222-81	79
F1-37/NSIC Rc222-65	34
F1-39/NSIC Rc222-65	78
F1-40/NSIC Rc222-81	30
F1-41/NSIC Rc222-81	20
F1-42/NSIC Rc222-99	9
F1-43/NSIC Rc222-75	18
F1-44/NSIC Rc222-162	3
F1-45/NSIC Rc222-85	81
F1-45/NSIC Rc222-6	5
F1-46/NSIC Rc222-6	37
F1-47/NSIC Rc222-92	16
F1-47/NSIC Rc222-84	9
F1-48/NSIC Rc222-90	42
F1-48/NSIC Rc222-110	24
F1-49/NSIC Rc222-82	22
F1-51/NSIC Rc222-145	36
F1-53/NSIC Rc222-74	24
F1-53/NSIC Rc222-66	8
F1-53/NSIC Rc222-80	4
F1-55/NSIC Rc222-179	30
F1-56/NSIC Rc222-153	30
F1-61/NSIC Rc222-110	71
F1-62/NSIC Rc222-99	26

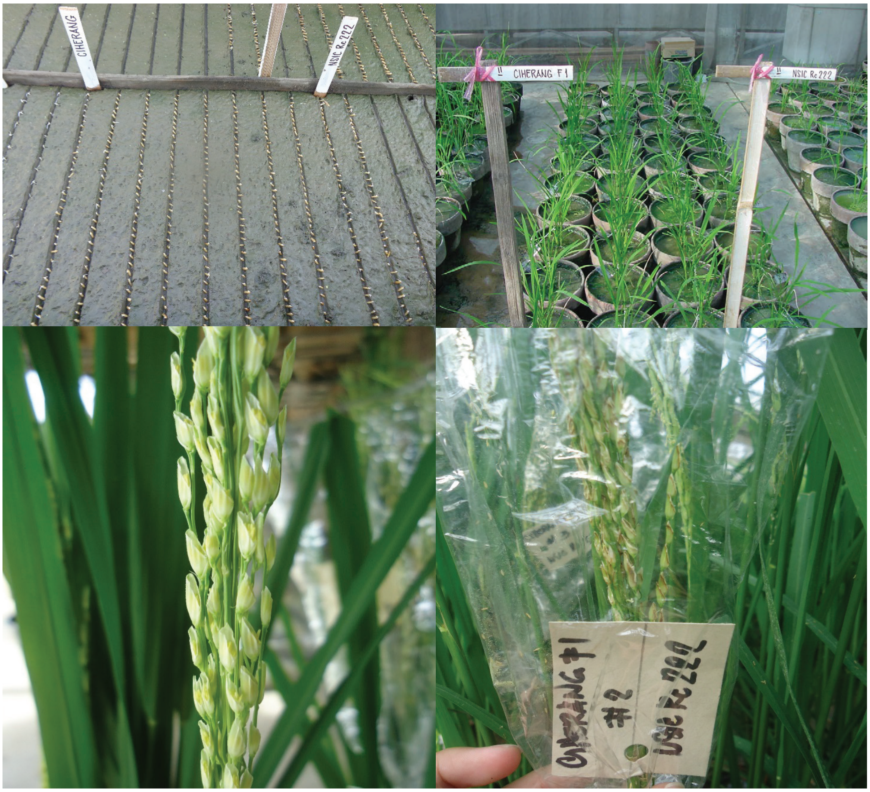

Figure 25. Establishment of anaerobic germination and crossing activities in the glasshouse during 2014 DS.

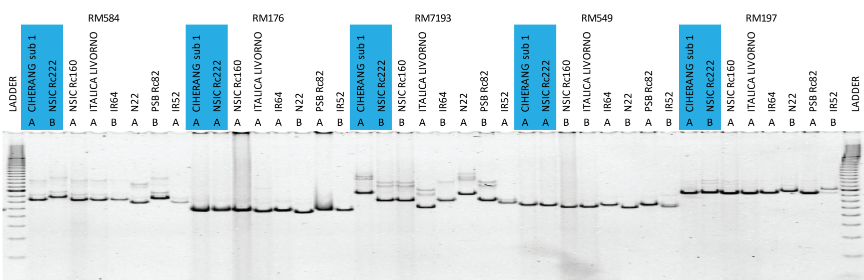

Figure 26. Polymorphism survey between Ciherang (Sub1+Ag1) and NSIC Rc222 using SSR markers.

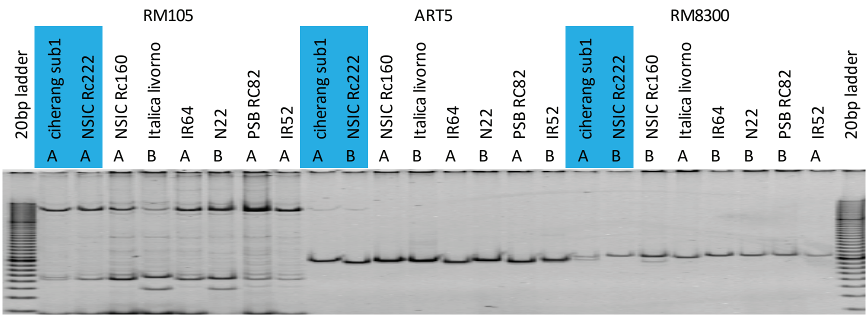

Figure 27. Optimization of primers using RM105, ART5 and RM8300.

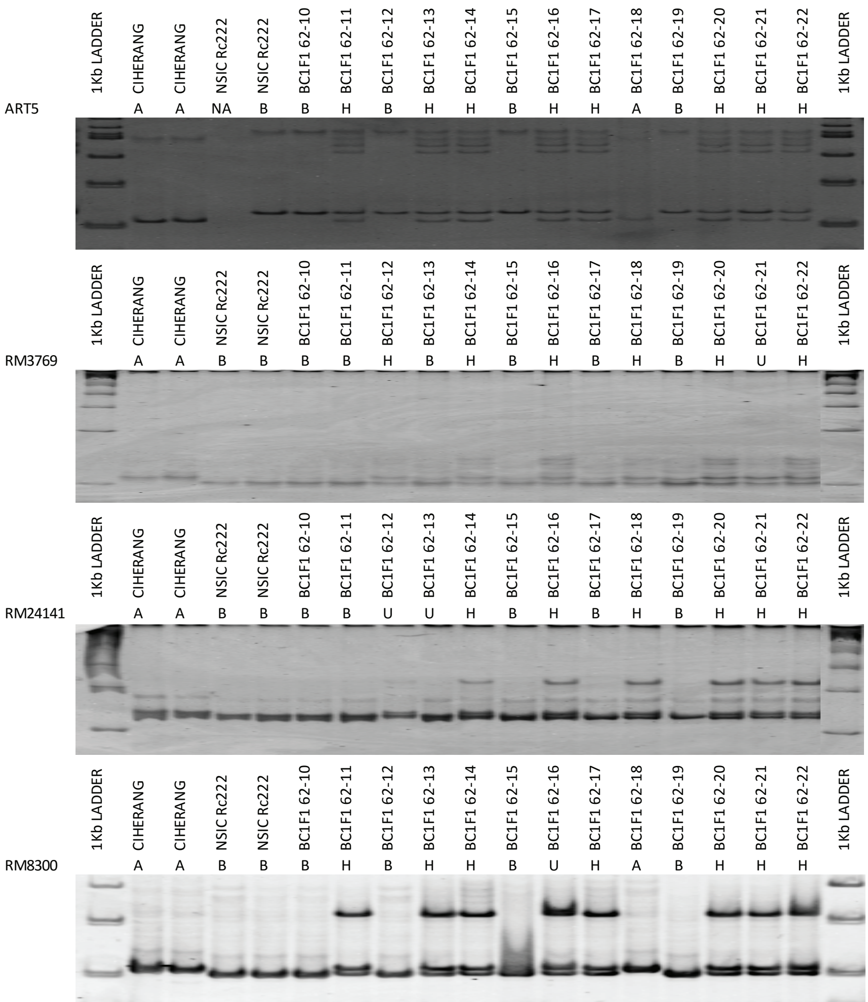

Figure 28. Heterozygosity test in F1 plants using markers for Sub1 and Ag1 genes (A=Ciherang (Sub1+Ag1) and B= NSIC Rc222) showing the introgression of both genes. Note: "A" denotes allele pattern similar to donor parent, "H" denotes heterozygous allele, "B" denotes allele pattern similar to recurrent parent, "U" denotes outlier and "NA" denotes no amplicon.

Table 16. Total number of generated BC2F1 during 2014WS.

Cross Combination	Generated BC2F1
BC1F1-20-5/NSIC Rc222-65	16
BC1F1-20-21/NSIC Rc222-65	33
BC1F1-32-14/NSIC Rc222-79	72
BC1F1-32-14/NSIC Rc222-79	22
BC1F1-33-20/NSIC Rc222-77	28
BC1F1-41-2/NSIC Rc222-81	67
BC1F1-45A-14/NSIC Rc222-85	89
BC1F1-53A-3/NSIC Rc222-74	58
BC1F1-53B-1/NSIC Rc222-66	39
BC1F1-62-16/NSIC Rc222-99	68
BC1F1-62-20/NSIC Rc222-99	14
BC1F1-62-22/NSIC Rc222-99	69

IX. Expanded GXE Experiments in Different Agro-Ecologies in Support of Bangladesh and Eastern India High-Zinc Rice Profiles: Multi-Location (Philippines) Evaluation of Recombinant Inbred Lines for Identifying Most Adapted Line for Varietal Promotion

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During the year, three replicated yield trials, two observation nurseries and one multi-location trial were conducted in the five PhilRice branch stations to evaluate the performance of the different zinc-dense breeding materials in addition to the breeding activities done at PhilRice Central Experiment Station (CES), Maligaya, Science City of Muñoz, Nueva Ecija.

Highlights:

Study 1. Replicated Yield Trial (RYT)

- Two sets of RYT were conducted at PhilRice-CES, Maligaya, RYT I and RYT II. During the dry season (DS), only RYT I was conducted with 54 entries including three check varieties (PSB Rc82, NSIC Rc216, and PSB Rc18) sub-divided into two groups; Group I composed of 38 entries with PSB Rc82 and NSIC Rc216 as check varieties while Group II composed of 13 test entries with PSB Rc18 as check variety. A plot size of 8.4sq. m (1.4m x 6m) set in RCBD with three replications was used. Distance of planting was set at 20 x 20cm apart and fertilizer rate of 120-60-60kg NPK/ha. During the wet season, RYT II was conducted in addition to RYT I. RYT I had the same test entries planted during the DS while RYT II was composed of 62 entries including one check variety (PSB Rc82). A plot size of 6.24sq. m (1.2m x 5.2m) set in RCBD with three replications was used. Planting distance was set at 20 x 20cm apart and fertilizer rate of 90-60-60kg NPK/ha.

- In both seasons, chemical control for weeds, snails and prevalent insects were applied to minimize the damages caused by these pests. Hand weeding and removal of volunteer plants were done during the implementation of the study. Uniformity, heading date, plant height, tillering ability, phenotypic acceptability, field reactions to insect pests and diseases, and yielding ability were observed.

- For the DS trial, statistical analysis showed that there were significant differences in yield among genotypes within each group with acceptable coefficient of variation of 10.2% and 7.2% for Group I and II, respectively. Table 17 shows that in Group I, three entries and NSIC Rc216 (11279kg/ha) recorded significantly higher yields than PSB Rc82 (9760kg/ha). IR84749-RIL-76-1-1-1-1 produced the highest yield of 12613 kg/ha, followed by IR84833-RIL-156-1-1-1-1 (12232kg/ha) and IR91163-AC-208 ((11279 kg/ha). Twenty-one test entries showed comparable performance to PSB Rc82 and the rest yielded significantly lower. As compared to NSIC Rc216, 14 test entries showed comparable while the rest were either significantly lower at 0.5% or at 1.0% probability level. Maturity of the test entries in this group ranged from 115 to 134 days after sowing. PSB Rc82 matured in 109 days while NSIC Rc216 matured in 118 days after sowing. Phenotypic acceptability of the test entries ranged from 4 to 7. In Group II, PSB Rc18 was used as check with yield of 10921kg/ha. Yield of the test entries ranged from 7472kg/ha to 11750kg/ha. Only IR85601-2-1-1-3-1 (11750kg/ha) numerically out-yielded PSB Rc18 with yield advantage of 7.6%. Two other entries, IR85604-19-2-3-2-2 (10372kg/ha) and IR83663-34-3-2-3 (10724 kg/ha) produced more than 10t/ha and were comparable to PSB Rc18. Phenotypic acceptability scores ranged from 5 to 7 with maturity of 105 to 107 days after sowing. Prevalent during the season were bacterial leaf blight and stemborer from severe to moderate infection/infestation. Slight bird damage was also observed.

Table 17. Yield and other agronimic characteristics of the test entries in the replicated field trial, PhilRice-CES, 4DS.

Entry No.	Designation	Mean Yield kg/ha	Mean Comparison PSB Rc82	Mean Comparison NSIC Rc216	MATURITY(DAS)	Plt Ht (cm)	Prod Tillers	PA[1]	Remarks[2]
Group 1									
1	IR 84842-7-2-3-2-3	5371	##	##	130	103	17	5	Japonica
2	IR 75862-206-2-8-3-B-B-B (MN check)	4041	##	##	131	96	17	6	Japonica
3	IR 84723-46-2-3-2-2	5190	##	##	127	95	13	6	Japonica
4	IR 75862-221-2-1-2-B-B-B (MN check)	5144	##	##	134	96	15	6	Japonica
5	IR 84723-160-1-1-3-3-2	5552	##	##	126	105	14	6	Japonica
6	IR 84723-104-1-3-2-2	6414	##	##	128	104	16	5	Japonica
7	IR 84842-131-1-2-1-1-3	4718	##	##	129	105	14	7	Japonica
8	IR 84842-87-3-1-2-2	6416	##	##	126	111	11	5	Japonica
9	IR 91158-AC 206	9997			125	98	12	5	
10	IR 69428-6-1-1-3-3 (MN check)	5547	##	##	127	95	12	6	
11	IR 84833-RIL 38-1-1-1-1	8111	#	##	113	103	22	7	blb, not uniform (nu)
12	IR 83287-RIL 11-1-1-1-1	9968			117	99	21	6	not very uniform (nvu), BLB
13	IR 84841-17-3-1-2	8818		##	120	103	20	5	nvu, just exserted, panicle number (PN) type
14	IR 84833-RIL 185-1-1-1-1	9509		#	119	104	17	5	nu
15	IR 84749-RIL 154-1-1-1-1	8107	#	#	119	104	18	6	nu, bird damage(bd)-5%
16	IR 84832-RIL 165-1-1-1-1	10563			121	92	18	5	blb, short panicle (p), PN type
17	IR 82475-110-2-2-1-2	8700		#	118	100	14	6	nvu, bd-5%
18	IR 84749-RIL 150-1-1-1-1	8757		#	116	97	14	6	BLB, nu, bd-5%
19	IR 83288-39-1-2-2-3	9854			121	97	15	5	
20	IR 83668-35-2-2-2	10370			117	107	10	5	nvu, japonica
21	IR 83286-22-1-2-1-1	8527		##	121	116	13	5	nvu
22	IR 84833-RIL 156-1-1-1-1	12232	**		120	96	17	5	
23	IR 84722-82-2-3-3-3	8661		##	119	116	16	5	sb
24	IR 83294-9-1-3-2-3	8888		##	117	102	12	5	Japonica, bd-10%
25	IR 84842-35-3-1-1-2-2	5355	##	##	121	101	9	6	Japonica
26	IR 84749-RIL 76-1-1-1-1	12613	**		119	98	11	5	slow senescence (s)
27	IR 91163-AC 208	11279	*		119	94	12	5	exposep
28	IR 84020-84-2-3-2	10277			117	95	13	5	bd-5%
29	IR 84847-1-1-2-3	9663		#	118	95	16	5	BLB
30	IR 84749-RIL 168-1-1-1-1	9260		##	121	94	12	4	bd-5%
31	IR 85826-22-2-2-1-3	9288		##	117	92	11	6	nu
32	IR 84832-RIL 1-1-1-1-1	10465			115	86	12	5	blb, bd-5%
33	IR 91152-AC 424	10308			116	87	18	5	sb, just exserted
34	IR 84833-RIL 22-1-1-1-1	7124	##	##	116	122	17	5	tall, sb, bd-5%
35	IR 83317-54-1-2-3	10110			118	95	16	5	sb
36	IR 84749-RIL 47-1-1-1-1	10867			119	95	11	5	
37	IR 84832-RIL 144-1-1-1-1	10286			117	102	16	5	bd-5%, blb
38	IR 84749-RIL 112-1-1-1-1	8819		##	117	95	11	5	bd-5%, just exserted
39	PSB Rc82 (check)	9760		#	109	92	15	6	BLB, bd-20%
40	NSIC Rc216 (check)	11245	*		118	87	14	5	good ripening color
Mean		8654							
CV%		10.2							
LSD (5%)		1441.2							
LSD (1%)		1911.3							
GROUP 2			PSB Rc18						
41	IR 85604-19-2-3-2-2	10372			115	96	12	5	bd-5%, exposep
42	IR 85850-73-2-2-3-2	9893			117	94	17	5	bd-5%
43	IR 82481-38-1-3-1	9749	#		112	92	11	5	bd-5%
44	IR 85825-189-2-3-1-3	7965	##		105	86	11	6	BLB, bd-10%
45	IR 84749-RIL 243-1-1-1-1	9979			113	85	13	5	
46	IR 83663-34-3-2-3	10724			108	86	11	6	bd-10%, blb
47	IR 84749-RIL 23-1-1-1-1	9031	##		115	103	14	5	just exserted, slow s
48	IR 84832-RIL 10-1-1-1-1	9933			113	85	11	5	sb, blb
49	IR 68144-2B-2-2-3-1-120 (MN check)	8355	##		116	63	9	6	BLB
50	IR 84847-RIL 195-1-1-1-1	8717	##		110	91	18	5	blb
51	IR 85601-2-1-1-3-1	11750			111	94	14	5	
52	IR 68144-2B-2-2-3-1-127 (MN check)	7472	##		115	71	16	7	BLB
53	IR 68144-2B-2-2-3-1-166 (MN check)	7537	##		114	69	19	7	BLB
54	PSB Rc18 (check)	10921			123	93	16	5	
Mean		9457							
CV%		7.2							
LSD (5%)		1143.0							
LSD (1%)		1545.1							

**, * = Rice selections significantly higher than the check at 0.05 and 0.01 probability level, respectively.

#, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA=phenotypic acceptability- 3 =good, 5= intermediate, 7-poor

[2] BLB(blb)-Bacterial leaf blight, SB (sb)-Stemborer, bd-bird damage,. Capital letters mean severe infection/infestation, small letters mean moderate

- For the WS trial, statistical analysis showed that in RYT I, there was a significant difference in yield among genotypes within each group with acceptable coefficient of variation of 20.1% and 14.4% for Group I and II, respectively. Similarly in RYT II, significant differences in yield among genotypes and within replication were observed with acceptable coefficient of variation of 20.1%.

- In RYT I, in Group I, only IR 83668-35-2-2-2 (4808kg/ha) numerically out-yielded PSB Rc82 (4345kg/ha) with yield advantage of 10.7%. Eight test entries and NSIC Rc216 showed comparable performance to PSB Rc82 (4345kg/ha). As compared to NSIC Rc216 (4882kg/ha), only IR 83668-35-2-2-2 (4808kg/ha) was comparable. The rest of the entries were either significantly lower than the two checks at 0.5% or at 1.0% probability level. Maturity of the test entries in this group ranged from 106 to 128 days after sowing. PSB Rc82 and NSIC Rc216 matured in 114 days after sowing. Phenotypic acceptability of the test entries ranged from 5 to 7. In Group II, PSB Rc18 had yield of 3578kg/ha. The test entries yields ranged from 2026kg/ha to 3832kg/ha. Only IR 83663-34-3-2-3 (3832kg/ha) numerically out-yielded PSB Rc18 with yield advantage of 7.1%. Nine entries showed comparable performance to PSB Rc18 while the rest were either significantly lower at 0.5% or at 1.0% probability level. Phenotypic acceptability scores ranged from 6 to 7 with maturity of 107 to 127 days after sowing (Table 18a).

- Table 18b shows that in RYT II, PSB Rc82 yielded 4411kg/ha. Yields of the test entries ranged from 1201kg/ha to 4687kg/ha. Only IR 99683-60-2-2 (4687kg/ha) numerically out-yielded PSB Rc82 with yield advantage of 6.3%. Seven entries showed comparable performance while the rest were either significantly lower at 0.5% or at 1.0% probability level. Maturity of the test entries ranged from 101 to 134 days after sowing. PSB Rc82 matured in 114 days after sowing. Phenotypic acceptability scores ranged from 5 to 7.

- Prevalent during the season were bacterial leaf blight, bacterial leaf steak, panicle blast, sheath blight, and stemborer from severe to moderate infection/infestation. Lodging incidence at heading to hard dough stage of the crops was observed in most of the test entries due to typhoon Luis and Mario.

Table 18a. Yield and other agronomic characteristics of the test entries in the Replicated Yield Trial I (RYT I), PhilRice CES, 2014WS.

Entry No.	Designation	Mean. Yield kg/ha	Mean Comparison PSB Rc82	Mean Comparison NSIC Rc216	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	LDG[2]	Reaction Pests[3]	Remarks
Group 1											
1	IR84842-7-2-3-2-3	3484		##	118	130	12	5		wh	Japonica, clean leaves, semi exposed panicle (p)
2	IR75862-206-2-8-3-B-B-B	2205	##	##	119	119	13	6		blb, SHB	Japonica, with purple tip
3	IR84723-46-2-3-2-2	2395	##	##	108	114	12	7		blb, SHB	Japonica, exposed p
4	IR75862-221-2-1-2-B-B-B	2921	##	##	119	116	11	6		blb, shb	Japonica, with purple tip
5	IR84723-160-1-1-3-3-2	2337	##	##	114	122	10	6		blb, SHB	Japonica
6	IR84723-104-1-3-2-2	2629	##	##	117	131	12	6		SHB	Japonica
7	IR84842-131-1-2-1-1-3	2550	##	##	111	121	10	5			Japonica, exposed p
8	IR84842-87-3-1-2-2	2218	##	##	113	128	11	6		wh	Japonica, exposed p
9	IR91158-AC 206	2906	##	##	127	121	13	6			not uniform (nu)
10	IR69428-6-1-1-3-3	2448	##	##	114	117	10	5		wh	
11	IR84833-RIL 38-1-1-1-1	3181	#	##	109	120	13	7		blb, shb	
12	IR83287-RIL 11-1-1-1-1	3718		#	114	126	14	6	9		nu
13	IR84841-17-3-1-2	2967	##	##	110	117	12	7		BLB, shb	
14	IR84833-RIL 185-1-1-1-1	3001	##	##	113	128	11	7	9	blb	nu
15	IR84749-RIL 154-1-1-1-1	3414		##	111	125	12	7		blb,shb	nu
16	IR84832-RIL 165-1-1-1-1	2429	##	##	128	116	15	6			short p
17	IR82475-110-2-2-1-2	2954	##	##	111	123	12	7	9		long but sparse p
18	IR84749-RIL 150-1-1-1-1	2953	##	##	110	123	15	7	9	blb	
19	IR83288-39-1-2-2-3	2347	##	##	113	125	13	6	9	bls	
20	IR83668-35-2-2-2	4808			116	142	12	7	7	blb	long but sparse p
21	IR83286-22-1-2-1-1	2031	##	##	114	133	12	7	9	blb	
22	IR84833-RIL 156-1-1-1-1	3428		##	116	120	13	6	9		
23	IR84722-82-2-3-3-3	1714	##	##	112	133	14	7	7		
24	IR83294-9-1-3-2-3	2604	##	##	110	122	12	6		wh	
25	IR84842-35-3-1-1-2-2	2235	##	##	110	124	12	6			nu, exposed p
26	IR84749-RIL 76-1-1-1-1	3091	#	##	113	129	13	6	7		semi-exposed p
27	IR91163-AC 208	3060	##	##	114	121	14	6	7		semi-exposed p
28	IR84020-84-2-3-2	2248	##	##	112	113	16	6	7	blb	
29	IR84847-1-1-2-3	3704		#	114	126	16	6		blb	
30	IR84749-RIL 168-1-1-1-1	3160	#	##	118	118	15	6			dark green leaves
31	IR85826-22-2-2-1-3	3400		##	118	130	13	6			nu
32	IR84832-RIL 1-1-1-1-1	3649		#	114	109	15	7	5	BLB	short p
33	IR91152-AC 424	2408	##	##	106	108	13	7	9	BLB	
34	IR84833-RIL 22-1-1-1-1	2946	##	##	108	154	13	7	9		
35	IR83317-54-1-2-3	2824	##	##	113	133	17	6	5		semi-exposed p
36	IR84749-RIL 47-1-1-1-1	3165	#	##	116	126	12	6	5		
37	IR84832-RIL 144-1-1-1-1	2874	##	##	109	120	14	6	9		exposed p
38	IR84749-RIL 112-1-1-1-1	2221	##	##	108	115	16	6	9		long but sparse p
39	PSB Rc82 (check)	4345			114	124	14	6	7		
40	NSIC Rc216 (check)	4882			114	115	15	5	5		
		2946									
CV%		20.1									
LSD (5%)		964.9									
LSD (1%)		1279.7									
GROUP 2			PSB Rc18								
41	IR85604-19-2-3-2-2	3405			108	123	16	6	7		exposed p, long sparse p
42	IR85850-75-2-2-3-2	3404			111	123	14	6	7	blb	sparse p
43	IR82481-38-1-3-1	2951			111	123	12	6	9	blb	with grain discoloration
44	IR85825-189-2-3-1-3	3089			107	113	16	7	7	BLB	exposed p
45	IR84749-RIL 243-1-1-1-1	3288			108	114	13	7	7	blb	
46	IR83663-34-3-2-3	3832			114	125	16	6	7		
47	IR84749-RIL 23-1-1-1-1	2026	##		107	123	17	7	9	blb	
48	IR84832-RIL 10-1-1-1-1	3014			107	112	15	7	9	blb	
49	IR68144-2B-2-2-3-1-120	2213	##		109	96	15	7	7		sparse p
50	IR84847-RIL 195-1-1-1-1	3424			111	115	14	7	9	blb,wh	
51	IR85601-2-1-1-3-1	3578			114	127	14	7	7	blb	
52	IR68144-2B-2-2-3-1-127	2586	#		109	99	14	7	9		short p
53	IR68144-2B-2-2-3-1-166	2779	#		110	91	15	7			short p
54	PSB Rc18 (check)	3578			127	120	15	5			
Mean		3107									
CV%		14.4									
LSD (5%)		751.3									
LSD (1%)		1015.7									

#, ## = Mean yield significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] Lodging incidence (LDG)= 3= 20-40%, 5= 41-60%, 7= 61-80%, 9= 81-100%

[3] BLB(blb)-Bacterial leaf blight, Whiteheads (wh), Sheath Blight (shb), Bacterial leaf streak (bls), Capital letters mean severe infection/infestation, small letters mean moderate

Table 18b. Yield and other agronomic characteristics of the test entries in the Replicated Yield Trial II (RYT II), PhilRice CES, 2014WS.

Entry No.	Designation	Mean. Yield kg/ha	Mean Comparison PSB Rc82	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	LDG[2]	Reaction Pests[3]	Remarks
1	IR95098:1-B-11-6-3-GBS	3719		104	98	13	6		blb, bls, pb	Medium grain
2	IR95133:9-B-8-16-2-GBS	2389	##	128	121	15	6	9		9 LDG
3	IR95707-26-3-1-1-B	2229	##	111	129	13	5		blb	long sparse panicle (p)
4	IR93345:26-B-14-1-B-B-B	3541	#	113	117	14	6	7	blb	medium grain
5	IR95097:15-B-22-3-9-GBS	2161	##	103	103	13	7		BLB, bls, pb	semi-exposed p
6	IR97637-150-1-3-B	2972	##	114	131	12	6			medium grain
7	IR99637-26-1-1	3137	##	116	122	14	6		blb, pb	medium grain
8	IR99645-60-1-1	2534	##	118	123	13	6			
9	IR99648-125-1-2	3106	##	111	113	13	7		BLB, bls	long sparse p
10	IR99683-60-2-2	4687		118	126	12	6		bls	
11	IR95028:4-B-20-22-14-GBS	3058	##	106	115	12	6		blb, bls	
12	IR95029:2-B-23-3-3-GBS	3345	#	111	121	13	6		BLB, BLS	
13	IR95029:6-B-10-3-17-GBS	2074	##	111	116	15	7		BLB, pb	Medium grain
14	IR95029:7-B-5-23-21-GBS	1852	##	106	123	12	7	5	BLB, BLS, pb	with purple tip
15	IR95029:8-B-6-15-6-GBS	2646	##	107	123	12	6	5	blb, pb	Medium grain
16	IR95040:2-B-7-16-20-GBS	3881		109	115	13	6		blb, pb	with purple tip
17	IR95041:8-B-5-4-22-GBS	2907	##	111	129	13	6		blb	long p
18	IR95044:8-B-5-22-19-GBS	2290	##	107	115	14	7	9	blb	medium grain
19	IR95044:15-B-7-8-4-GBS	2048	##	102	107	9	7		pb	
20	IR95044:17-B-6-18-22-GBS	1504	##	107	121	13	7	9	pb	long p
21	IR95048:1-B-11-20-10-GBS	3170	##	109	119	14	6	3	bls	
22	IR95095:10-B-19-23-6-GBS	1769	##	110	124	13	7	7	blb	
23	IR95095:11-B-13-15-16-GBS	1794	##	111	107	12	7	7	blb	Medium g
24	IR95097:1-B-19-7-13-GBS	2057	##	101	118	14	7		blb, bls, pb	Medium g
25	IR95097:3-B-16-11-4-GBS	2853	##	109	126	13	6		pb	Medium g, long sparse p
26	IR95097:4-B-20-18-8-GBS	2638	##	111	113	13	6	5	blb	
27	IR95132:7-B-12-15-7-GBS	1733	##	101	107	13	7	7		
28	IR95132:12-B-6-21-8-GBS	3190	##	134	131	14	6			
29	IR95133:1-B-16-14-10-GBS	3124	##	110	123	14	7		blb	
30	IR95133:18-B-2-22-5-GBS	1794	##	113	117	14	6	7	blb	broad leaves
31	IR95040:12-B-3-10-2-GBS	1597	##	102	126	12	7	9	BLB	
32	IR95041:9-B-7-5-17-GBS	2326	##	112	98	12	7		pb	
33	IR95048:6-B-4-21-10-GBS	1345	##	111	123	13	7	9		Medium g
34	IR95051:6-B-3-13-5-GBS	1562	##	109	152	12	7	9		
35	IR95051:10-B-6-15-13-GBS	2375	##	106	110	13	7	7	BLB	Medium g
36	IR95098:8-B-10-13-10-GBS	3418	#	114	113	13	6		BLB, bls	medium g
37	IR95098:13-B-11-4-9-GBS	3561	#	114	116	15	6		blb	
38	IR97472-65-3-2-B	2021	##	115	113	14	7	7	blb	Medium g,
39	IR95132:14-B-7-18-12-GBS	2877	##	112	121	11	6			not uniform (nu), exposed p
40	IR84847-RIL 195-1-1-1-1	3655		111	119	14	6		blb	Medium g
41	IR95133:13-B-19-10-21-GBS	2411	##	134	146	16	6			
42	IR99686-124-2-2	1607	##	117	122	13	7	7	BLB, pb	nu
43	IR99704-24-2-1	3818		112	117	15	6		BLB	exposed p
44	IR99636-96-1-1	2216	##	118	129	13	7			nu
45	IR99647-148-3-1	3193	##	119	116	13	6			Medium g, clean leaves
46	IR99637-42-2-1	2286	##	109	118	12	7		BLB, pb	
47	IR99655-35-1-3	2305	##	118	125	14	6		blb	Medium g
48	IR84841-17-3-1-2	2685	##	112	106	10	6		BLB	
49	IR94041-9-3-3-4-B	4004		116	136	14	5			Semi-exposed p
50	IR97481-99-1-2-B	2145	##	119	120	16	6		blb	semi-exposed p, sparse p
51	IR85850-75-2-2-3-2	3672		110	123	14	6		blb	long sparse p
52	IR99647-13-2-2	2695	##	114	130	13	6			sparse p
53	IR99674-9-2-2	2074	##	117	110	13	6		blb	
54	IR99674-9-4-1	1657	##	116	111	13	6	7	blb	sparse p
55	IR99674-9-4-2	2298	##	114	107	12	7		BLB	Medium g, sparse p
56	IR99674-9-5-1	2259	##	115	108	13	7		BLB,pb	Medium g, sparse p
57	IR99674-37-1-1	1807	##	115	111	11	6	7	BLB	short p
58	IR99674-51-4-2	2086	##	120	106	14	6		blb	Long g, long sparse p
59	IR99674-53-2-1	1201	##	121	105	15	6	7		short p
60	IR99680-75-2-2	2519	##	116	120	14	7		blb, pb	Medium g,long sparse p
61	IR99647-138-1-5	1493	##	115	108	14	6	7		Long g, short and exposed p
62	**PSB Rc82 (check)**	4411		114	129	13	6		blb	
Mean		2577								
CV%		20.1								
LSD (5%)		837.7								
LSD (1%)		1107.1								

, ## = Mean yield significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] Lodging incidence (LDG)= 3= 20-40%, 5= 41-60%, 7= 61-80%, 9= 81-100%

[3] BLB(blb)-Bacterial leaf blight, BLS(bls)-Bacterial leaf streak, panicle blast (pb). Capital letters mean severe infection/infestation, small letters mean moderate

Study 2. Observational Yield Trial (OYT)

- This trial was conducted at PhilRice CES both during the DS and WS. A total of 99 test entries and four check varieties (PSB Rc82, NSIC Rc216, NSIC Rc160 and PSB Rc18) were evaluated. Group 1 composed of 46 test entries with PSB Rc82 and NSIC Rc216 as check varieties while Group II composed of 56 test entries with NSIC Rc160 and PSB Rc18 as check varieties. A plot size of 8.4sq. m (1.4m x 6m) set in RCBD with three replications was used. Distance of planting was set at 20 x 20cm apart and fertilizer rate of 120-60-60kg NPK/ha during the DS and 90-60-60kg NPK/ha during the WS was applied. Chemical control for weeds, snails and prevalent insects were applied to minimize the damages caused by these pests. Hand weeding and removal of volunteer plants were done during the implementation of the study. Uniformity, heading date, plant height, tillering ability, phenotypic acceptability, field reactions to insect pests and diseases, and yielding ability were observed.

- For the DS trial, statistical analysis showed that there were significant differences in yield among test entries (Table 19). Percent coefficient of variation for each group was below 20%. For Group I, yield ranged from 5458kg/ha to 11768kg/ha. Majority of the test entries showed comparable yield performance to PSB Rc82 (10281kg/ha) and NSIC Rc216 (11207kg/ha). Two entries numerically out-yielded the highest yielding check, NSIC Rc216. These were IR80842-32-2-3-3 (11768kg/ha) and IR94046-11-3-2-3 (11357kg/ha) with yield advantage of 14.5% and 10.5%, respectively. Seven other entries recorded more than 10t/ha yield. Maturity of the test entries ranged from114 to 124 days from sowing. Majority of the test entries exhibited susceptible reaction to sheath blight and bacterial leaf blight. For Group II, similarly as in Group I, majority of the test entries recorded comparable yield performance to PSB Rc18. The top yield performer was IR80482-24-2-2-1 with 11335kg/ha. Eleven other test entries recorded more than 10-tonne yield and these entries showed significantly higher yield than NSIC Rc160. Majority of the test entries exhibited good to fair phenotypic acceptability, just to poor panicle exsertion, exposed panicles and slow senescence. Moderate to severe infection to sheath blight, blast, bacterial leaf blight were also observed on some entries.

- For the WS trial, statistical analysis showed that there were significant differences in yield among test entries (Group I and

II) and replication (Group II), (Table 19a) with percent CV of 28.3% and 18.6% for Group I and II, respectively. For Group I, yields of the test entries ranged from 962kg/ha to 4266kg/ha. Nineteen test entries showed comparable performance to PSB Rc82 (4415kg/ha) while the rest of the test entries were either significantly lower at 0.5% to 1.0% probability level. As compared to NSIC Rc216 (2835kg/ha), only IR 84724-87-1-2-2-2 (4266kg/ha) showed significantly higher yield with an advantage of 50.5%. Numerically, six test entries out-yielded NSIC Rc216 with yields ranged from 3079kg/ha to 4136kg/ha and advantage of 8.6% to 45.8%. Maturity of the test entries ranged from 106 to 123 days after sowing. Majority of the test entries exhibited susceptible reaction to sheath blight and bacterial leaf blight.

- For Group II, majority of the test entries recorded comparable yield performance to PSB Rc18 (2483 kg/ha). The top three significantly higher yield performers were IR 91909-53-3-1-3-3-B, IR 94046-7-2-2-5, and IR 94288-61-1-2-2 with yields of 4240kg/ha, 4107kg/ha, and 4049kg/ha, respectively. Five other test entries showed significantly higher yields than PSB Rc18. Thirty test entries numerically out-yielded PSB Rc18 with yields ranged from 2692kg/ha to 3575kg/ha and advantage of 8.0% to 44.0%. As compared to NSIC Rc160 (3102kg/ha), IR 91909-53-3-1-3-3-B showed significantly higher yield with 4240kg/ha and advantage of 36.7%. Nineteen test entries numerically out-yielded NSIC Rc160 with yield ranged from 3287kg/ha to 4107kg/ha and advantage of 6.0% to 32.0%. Maturity of the test entries ranged from 110 to 122 days after sowing with phenotypic acceptability scores ranged from 5 to 7. Moderate to severe infection to sheath blight, blast, bacterial leaf blight were also observed on some entries. Lodging incidence was observed mostly in all entries at heading to hard dough stage of the crops due to typhoon Luis and Mario

Table 19. Yield and other agronomic characteristics of the test entries in the Observational Yield Trial, PhilRice CES, 2014DS.

Entry No.	Designation	Mean. Yield kg/ha	Mean Comparison		MAT (DAS)	Plt Ht (cm)	Prod Tillers	PAcp[1]	Lodging Incidence[2]	Remarks[3]
GROUP 1 (EARLY)			PSB Rc82	NSIC Rc216						
1	IRRI 123 (PSB Rc82)	10811			114	102	20	5		
2	IR91917-6-1-1-2-3	9390			120	113	13	5		Panicle number (PN) type
3	IR91917-6-1-1-2-2	7657	#	##	120	115	15	6		not very uniform (nvu)
4	IR91965-22-2-3-1-3	8426		#	118	121	20	5		shb
5	IR68144-2B-2-2-3-1-120 (MN check)	7881	#	##	120	82	16	7		SHB, BLB
6	IR94037-61-1-1-3	9077			114	118	16	6		not uniform(nu)
7	IR94034-6-3-2-3	7904	#	##	114	126	11	6		nu
8	IR94042-23-2-1-1	10140			119	103	15	6		BLB, SHB
9	IR92937-166-1-3-5-2	9272			115	106	18	6		seg
10	IR94296-13-1-2-3	9580			120	104	12	6		seg, BLB
11	IR94042-23-2-1-2	7990		##	118	96	13	6		BLB, SHB
12	IR94042-23-2-1-3	8397		#	118	85	13	6		BLB, SHB
13	IR94042-42-1-2-3	8970			124	107	16	6		nu
14	IR94046-11-3-2-2	11357			122	106	13	5		
15	IR94046-11-3-2-3	8409		#	121	107	18	5		erect, good ripe
16	IR68144-2B-2-2-3-1-127 (MN check)	5663	##	##	118	82	12	7		SHB
17	IR94297-117-2-4-2	7419	#	##	124	111	13	5		shb
18	IR94297-117-2-4-3	6815	##	##	123	111	16	5		shb, semi-expose panicle
19	IR94299-110-2-3-2	9992			120	105	16	5		PN type, shb
20	IR94307-9-2-2-1	6955	##	##	116	108	18	5		nu
21	IR91917-6-1-1-2-1-B	7895	#	##	120	95	21	5		shb
22	IR80482-57-2-2-3	9368			118	95	20	5		shb, nvu
23	IR84726-65-3-2-3-1	5458	##	##	121	87	25	6		SHB
24	IR84726-87-2-1-3-3	7228	#	##	120	95	12	6		SHB
25	IR68144-2B-2-2-3-1-166 (MN check)	5887	##	##	116	77	17	7		SHB, BLB
26	IR82467-19-3-2	7255	#	##	116	90	14	6		BLB, SHB
27	IR82475-110-2-2-1-2	8416		#	117	95	17	6		blb, light panicle
28	IR83663-20-3-2-2	9930			116	106	14	6		blb
29	IR84726-3-3-3-2-2	6646	##	##	120	91	21	7		nvu, SHB
30	IR84726-78-2-2-2-1	6037	##	##	118	85	10	7		SHB
31	IR80482-64-3-3-3	9691			121	103	11	5		nvu, just to poor exserted, blb
32	IR80482-66-3-3-3	10870			120	104	12	5		nvu, just to poor exserted, blb
33	IR80482-32-2-3-3	11768			124	100	16	5		good ripe
34	IR82462-30-2-1-3	10058			122	95	11	5		poor to just exserted, shb
35	IR80475-B-B-19-2	8993			120	104	12	6		nu, sparse panicle
36	IR80482-73-1-3-2	9857			126	96	10	6		poor exsertion, SHB
37	IR80482-93-2-3-1	10137			116	106	21	6		just exserted
38	IR85849-33-1-2-1-2	10390			121	112	20	6		shb
39	IR82463-3-3-2-2	9082			124	103	13	5		nvu, nu grain ripening
40	IR84841-17-3-1-2	8652		#	123	96	14	6		SHB, nu grain ripening
41	IR84724-87-1-2-2-2	7463	#	##	124	143	10	6	7	tall, good ripe
42	IR85656-73-3-1-2	10109			124	101	21	5		SHB, nvu
43	IR81014-B-49-3-3-2-2	8549		#	120	114	15	6		nu, shb
44	IR84750-164-3-2-1-2	9615			126	105	16	5		PN type, shb
45	IR85825-67-3-1-3-3	9248			124	109	13	6		nu, shb
46	IR85656-2-3-1-3	11083			116	96	11	6		SHB
47	PSB Rc82 (check)	10281			114	95	11	5		blb
48	NSIC Rc216 (check)	11207			116	96	12	5		shb
Mean		8818								
CV% =		16.5								
LSD (5%)		2357.7								
LSD (1%)		3121.6								
GROUP 2 (LATE)			**PSB Rc18**	**NSIC Rc160**						
49	IR91949-78-2-3-3-1	8676	#		118	108	14	6		nu, shb, poor exertion, b
50	IR91949-87-1-3-2-1	8982			114	101	18	6		nvu, SHB
51	IR75862-206-2-8-3-B-B-B (MN check)	3111	##	##	133	103	9	6		Japonica, nvu
52	IR91964-113-1-1-2-2	9297			124	105	11	5		poor to just exserted, blb
53	IR91153-AC 578	10177		*	125	104	16	4		light panicle (p), ok plant type
54	IR91899-145-1-2-1-1	10194		*	121	112	15	4		light p, blb
55	IR91911-81-3-3-3-1	5666	##	##	124	125	16	6		nu
56	IR91967-64-1-1-2-1	8286	#		124	126	16	5		bit tall, good ripe
57	IR91899-145-1-2-1-3	9685			125	108	13	4		same plant type with OYT 58
58	IR91896-86-2-2-1-2	8993			124	106	14	4		nvu, narrow leaves, slow senescence(s), good ripe
59	IR91967-64-1-1-2-2	7528	##		122	115	14	5		slow s, long p, poor to just exserted
60	IR91967-64-1-1-2-3	8213	##		124	135	16	5		bit tall, shb,nvu
61	IR91158-AC 113	8891			126	106	13	5		Panicle weight (PW) type, good ripe, nvu, poor exsertion
62	IR91964-11-3-1-1-3	9601			126	126	17	4		PN & PW type, nvu
63	IR91896-86-2-2-1-1	9734			125	111	14	5		narrow leaves, PN type, nvu
64	IR69428-6-1-1-3-3 (MN check)	4513	##	##	130	104	11			Japonica, broad leaves
65	IR91906-4-3-1-1-1	6883	##	#	135	114	13			long grain, nvu
66	IR91909-53-3-1-3-2-B	9001			116	110	11	5		semi-expose p, PN type
67	IR91909-53-3-1-3-3-B	10465		**	114	103	11	5		semi-expose p, PN type
68	IR94033-91-1-3-2	7564	##		113	95	20	5		semi-expose p, nvu, PN type
69	IR94034-6-3-2-1	8093	##		122	120	17	5		good ripe, bit tall, sparse p
70	IR94049-14-3-2-1	8904			110	101	13	5		semi-expose p, nvu, PN type
71	IR94049-14-3-2-2	9305			111	99	13	5		expose p, nvu, PN type
72	IR94049-14-3-2-3	8874			118	108	12	4		PN type, nvu, good ripe color, semi-expose p
73	IR94288-61-1-2-1	8364	#		116	95	16	5		nvu, longer p
74	IR94288-61-1-2-2	8808			114	97	12	4		
75	IR94288-61-1-2-3	9241			117	95	11	4		PN type, short p, nvu, semi-expose p
76	IR75862-221-2-1-2-B-B-B (MN check)	3851	##	##	135	102	10			bold
77	IR94296-13-1-3-1	7019	##	#	117	95	11	5		nvu, expose p
78	IR94296-13-1-3-2	6493	##	##	117	96	10	6		nu, fast senescence
79	IR94037-27-2-2-1	8110	##		120	100	13	3		expose p, good ripe
80	IR94042-42-1-2-2	8311	#		124	121	14	7		nu, good ripe
81	IR94297-117-2-5-1	7988	##		125	105	9	3		PN type, good ripe
82	IR94297-117-2-5-3	6865	##	#	122	103	10	5		light p, blb
83	IR91901-197-3-2-2-1-B	9789			117	110	13	5		nvu, good ripe, long p, slow s
84	IR92972-170-1-1-3-3	9127			125	110	12	5		
85	IR92978-8-3-3-3-3	9687			125	104	12	4		nvu, slow s, long p, long flag, just exserted
86	IR92978-11-3-2-2-1	10694		**	125	111	10	4		nvu, slow s, long p, long flag, just exserted
87	IR92978-16-1-3-3-2	9607			126	96	12	4		nvu, slow s, long p, long flag, just exserted
88	IR92978-16-1-3-3-3	9081			126	103	13	4		nvu, slow s, long p, long flag, just exserted
89	IR92978-72-2-3-1-1	9741			124	104	9	4		nvu, slow s, long p, long flag, just exserted
90	IR92978-72-2-3-1-2	9671			124	96	11	4		nvu, slow s, long p, long flag, just exserted
91	IR92978-72-2-3-1-3	9903			125	105	15	4		nvu, slow s, long p, long flag, just exserted
92	IR92978-74-1-2-3-3	10156			121	105	12	5		blb, same pt with OYT 85
93	IR92978-77-1-2-3-1	10577		*	126	104	13	4		nvu, same pt with OYT 85
94	IR92978-77-1-2-3-3	10762		**	128	108	10	4		same pt with OYT 85
95	IR92978-90-2-2-3-1	10344		**	126	104	19	4		same pt with OYT 85
96	IR92978-90-2-2-3-2	10698		**	126	96	10	5		same pt with OYT 85
97	IR92978-166-3-1-2-2	10482		**	126	109	13	5		nvu
98	IR94040-8-2-2-2	9331			122	95	10	7		seg, blb, fast senescence
99	IR94046-7-2-2-4	9196			126	106	18	5		nu grain ripe, good ripe
100	IR94046-7-2-2-5	10059		*	124	95	12	5		nvu, same pt with OYT 99
101	IR91899-30-3-1-2-1-B	9906			126	104	19	5		shb
102	IR80482-24-2-2-1	11355		**	127	109	12	5		long p, sb
103	PSB Rc18 (check)	10048		*	122	106	11	5		good ripe
104	NSIC Rc160 (check)	8610	#		126	95	14	5		with sterility
Mean		8831								
CV% =		9.4								
LSD (5%)		1344.7								
LSD (1%)		1778.4								

**, * = Rice selections significantly higher than the check at 0.05 and 0.01 probability level, respectively.

#, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] Lodging incidence = 3= 20-40%, 5= 41-60%, 7= 61-80%

[3] BLB(blb)-Bacterial leaf blight, SHB(shb)-Sheath blight, B (b)= Blast BPH(bph)-Brown plant hopper, SB (sb)-Stemborer . Capital letters mean severe infection/infestation, small letters mean moderate.

Table 19a. Yield and other agronomic characteristics of the test entries in the Observational Yield Trial (OYT), PhilRice CES, 2014WS.

Entry No.	Designation	Mean. Yield kg/ha	Mean Comparison PSB Rc82	Mean Comparison NSIC Rc216	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	LDG[2]	Reaction Pests[3]	Remarks[3]
Group 1											
1	IRRI 123 (PSB RC 82)	2908			116	127	14	6	9		Long g (grain)
2	IR91917-6-1-1-2-3	4136			115	122	15	6		BLB, bls	
3	IR91917-6-1-1-2-2	2681			111	118	14	7		BLB	Long p (panicle)
4	IR91965-22-2-3-1-3	1282	##	#	111	123	15	6	5		Long sparse p
5	IR68144-2B-2-2-3-1-120	1438	##	#	110	91	13	7	7	blb	
6	IR94037-61-1-1-3	1880	#		113	131	13	6	7		Long g (grain)
7	IR94034-6-3-2-3	962	##	##	109	126	12	6	7		sparse p
8	IR94042-23-2-1-1	1951	#		110	116	15	7	7		nu (not uniform)
9	IR92937-166-1-3-5-2	2085	#		113	122	15	7	7		nu, long sparse p
10	IR94296-13-1-2-3	1567	##		113	117	14	7	7		long sparse p
11	IR94042-23-2-1-2	2780			112	107	15	6		blb	long sparse p
12	IR94042-23-2-1-3	2730			112	102	13	7		blb, bls	long sparse p
13	IR94042-42-1-2-3	2829			114	118	16	6		blb	long sparse p
14	IR94046-11-3-2-2	1855	##		112	119	13	5	5	blb	
15	IR94046-11-3-2-3	1929	#		111	127	17	5	5	blb	
16	IR68144-2B-2-2-3-1-127	1297	##	#	108	90	13	7	3	BLB	
17	IR94297-117-2-4-2	2268	#		116	124	16	6			semi-exposed p, sparse p
18	IR94297-117-2-4-3	2526			116	121	16	6		blb	semi-exposed p, sparse p
19	IR94299-110-2-3-2	2148	#		112	118	15	7			nu
20	IR94307-9-2-2-1	2811			110	135	12	6		blb	nu
21	IR91917-6-1-1-2-1-B	3186			110	121	15	7		BLB, pb	
22	IR80482-57-2-2-3	2366			106	109	11	7		blb	sparse p
23	IR84726-65-3-2-3-1	2133	#		117	105	15	7		BLB, pb	
24	IR84726-87-2-1-3-3	2520			117	110	17	7		BLB, pb	with awn
25	IR68144-2B-2-2-3-1-166	1847	##		109	90	18	7		BLB, SHB, pb	medium g
26	IR82467-19-3-2	3079			119	127	14	5			semi-exposed p, well exserted p, clean leaves
27	IR82475-110-2-2-1-2	2155	#		113	121	12	7	7	pb	
28	IR83663-20-3-2-2	1862	##		117	131	15	6	7		
29	IR84726-3-3-3-2-2	2358			118	109	16	7		pb	sparse p
30	IR84726-78-2-2-2-1	1831	##		115	108	15	7	7	pb	Long sparse p
31	IR80482-64-3-3-3	1606	##		111	122	14	7	9	blb	
32	IR80482-66-3-3-3	1594	##		111	126	14	7	9	blb	
33	IR80482-32-2-3-3	1871	##		112	125	14	6			
34	IR82462-30-2-1-3	2002	#		111	129	15	7			
35	IR80475-B-B-19-2	2173	#		114	127	17	6			
36	IR80482-73-1-3-2	2183	#		113	118	15	7	5	BLS	
37	IR80482-93-2-3-1	3359			117	124	18	6			
38	IR85849-33-1-2-1-2	2503			112	122	15	7		BLB	
39	IR82463-3-3-2-2	2499			119	125	15	6			Medium g
40	IR84841-17-3-1-2	2066	#		115	104	14	7		BLB, shb	nu, broad leaves
41	IR84724-87-1-2-2-2	4266		*	114	138	14	7	7		
42	IR85656-73-3-1-2	3181			116	119	15	5			
43	IR81014-B-49-3-3-2-2	2172	#		119	122	15	5			clean leaves
44	IR84750-164-3-2-1-2	2702			118	120	16	6		blb	Medium g, exposed and sparse p
45	IR85825-67-3-1-3-3	2106	#		115	129	14	6	7		
46	IR85656-2-3-1-3	3189			123	126	17	6	7		
47	**PSB RC 82 (check)**	4415			117	124	18	6			
48	**NSIC Rc 216 (check)**	2835			116	116	16	6			clean leaves
Mean		2350									
CV%		28.3									
LSD (5%)		1338.8									
LSD (1%)		1787.2									
GROUP 2			PSB Rc18	NSIC Rc160							
49	IR91949-78-2-3-3-1	1268	#	##	110	122	17	7	7		Sparse p
50	IR91949-87-1-3-2-1	2988			110	118	13	7		BLB, pb	sparse p
51	IR75862-206-2-8-3-B-B-B	1277	#	##	118	112	11	7		blb	nu
52	IR91964-113-1-1-2-2	2586			113	130	14	7	7	blb	Medium g with awn,
53	IR91153-AC 578	3226			117	123	16	5			Long g with partly awn
54	IR91899-145-1-2-1-1	3287			117	129	15	5			long sparse p
55	IR91911-81-3-3-3-1	2692			114	133	14	7		blb	semi exposed p
56	IR91967-64-1-1-2-1	1854		#	112	145	13	7	7	BLB	
57	IR91899-145-1-2-1-3	3372			117	127	15	6			
58	IR91896-86-2-2-1-2	3028			118	125	16	6			
59	IR91967-64-1-1-2-2	1712		#	116	124	14	7		BLB, shb, pb	
60	IR91967-64-1-1-2-3	3007			117	138	12	7	7	blb	semi-exposed p
61	IR91158-AC 113	2534			122	127	14	6			
62	IR91964-11-3-1-1-3	3351			116	126	13	6			semi-exposed p
63	IR91896-86-2-2-1-1	3203			119	123	15	7			nu, semi-exposed p
64	IR69428-6-1-1-3-3	1639		##	116	118	15	7			
65	IR91906-4-3-1-1-1	1856		#	119	120	13	6			
66	IR91909-53-3-1-3-2-B	3802	*		117	125	16	7		blb	
67	IR91909-53-3-1-3-3-B	4240	**	*	116	125	15	6			semi-exposed p
68	IR94033-91-1-3-2	2980			116	128	14	7	5		long sparse p
69	IR94034-6-3-2-1	1514		##	111	128	12	7	7		long sparse p
70	IR94049-14-3-2-1	3575			116	123	15	7	9	blb	
71	IR94049-14-3-2-2	2246			112	129	14	7	9		sparse p
72	IR94049-14-3-2-3	2862			111	128	14	7	9		
73	IR94288-61-1-2-1	3251			113	124	15	6			ong sparse p, semi-exposed p
74	IR94288-61-1-2-2	4049	**		118	124	14	6			semi-exposed p
75	IR94288-61-1-2-3	3373			113	127	17	6		blb	semi-exposed p, sparse p
76	IR75862-221-2-1-2-B-B-B (MN check)	1107	#	##	121	117	13	7			nu
77	IR94296-13-1-3-1	2307			118	123	13	7		pb	nu
78	IR94296-13-1-3-2	1912		#	117	128	14	7			nu
79	IR94037-27-2-2-1	2983			118	131	16	7	3		
80	IR94042-42-1-2-2	2084			117	138	13	6			
81	IR94297-117-2-5-1	2589			119	120	17	6		bls	
82	IR94297-117-2-5-3	2561			120	119	16	5		bls	
83	IR91901-197-3-2-2-1-B	3579	*		117	121	15	6			
84	IR92972-170-1-1-3-3	3886	*		119	121	15	6			semi-exposed p
85	IR92978-8-3-3-3-3	2994			120	123	17	5			
86	IR92978-11-3-2-2-1	3603	*		119	126	15	5			semi-exposed p
87	IR92978-16-1-3-3-2	3169			118	125	15	5			semi-exposed p
88	IR92978-16-1-3-3-3	3044			118	123	14	5			
89	IR92978-72-2-3-1-1	3332			118	124	15	6			long sparse p
90	IR92978-72-2-3-1-2	3065			117	126	14	6			sparse p
91	IR92978-72-2-3-1-3	3470			117	126	16	5			
92	IR92978-74-1-2-3-3	3559			119	124	14	6			long sparse p
93	IR92978-77-1-2-3-1	3483			118	126	16	6			semi-exposed p
94	IR92978-77-1-2-3-3	3336			119	124	19	6			semi-exposed p
95	IR92978-90-2-2-3-1	3243			117	122	16	5			
96	IR92978-90-2-2-3-2	3527			119	126	16	6			
97	IR92978-166-3-1-2-2	3183			117	124	16	5			
98	IR94040-8-2-2-2	3541			114	126	14	7		BLB	
99	IR94046-7-2-2-4	3844	*		118	122	15	6			semi-exposed p
100	IR94046-7-2-2-5	4107	**		118	120	17	5			
101	IR91899-30-3-1-2-1-B	3395			119	125	18	5			
102	IR80482-24-2-2-1	2789			118	125	15	6		blb	
103	PSB Rc 18 (check)	2483			126	117	15	6	5		well exserted p,
104	NSIC Rc 160 (check)	3102			116	116	14	6	5	blb, bls	
Mean		2930									
CV%		18.6									
LSD (5%)		1092.8									
LSD (1%)		1454.9									

**, * = Mean yield significantly higher than the check at 0.05 and 0.01 probability level, respectively.

, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] Lodging incidence (LDG)= 3= 20-40%, 5= 41-60%, 7= 61-80%, 9= 81-100%

[3] BLB(blb)-Bacterial leaf blight, Sheath Blight (shb), Bacterial leaf streak (bls), panicle blast (pb). Capital letters mean severe infection/infestation, small letters mean moderate

Performance Trial (Pre NCT)

- This study was conducted in four PhilRice stations during the DS namely at Central Experiment Station (CES) Nueva Ecija, Isabela, Negros and Agusan and Batac as an additional site during the WS. There were 21 test entries evaluated in comparison with PSB Rc82, the check variety. The plot size utilized was 2m x 5m with 20cm x 20cm distance of planting set in RCBD with three replications. Fertilizer rate applied varied in each location based on local recommendation. Chemical control for weeds, snails and prevalent insects were applied to minimize the damages caused by these pests. Hand weeding and removal of volunteer plants were done as needed. Uniformity, heading date, plant height, tillering ability, phenotypic acceptability, field reactions to insect pests and diseases, and yielding ability were observed.

- During the DS, overall yield performance showed that the highest mean yield was recorded in PhilRice CES (6830kg/ha) and the lowest in Negros (2985kg/ha) Consistent top four performers across locations were PR35015-GA-5-5-1, IR10M300, IR10M238, and IR08M118. These entries showed wider adaptation as compared to the other entries. (Table 4).

- In CES, three test entries significantly outyielded PSB Rc82 (6680kg/ha). These were IR10M238 (7814kg/ha), IR10M300 (8850kg/ha), and PR35015-GA-5-5-1 (8985kg/ha). These entries had fair phenotypic acceptability and were spared from insect pest and disease infestation/infection (Table 20a). Yields in Isabela ranged from 2462kg/ha to 4790kg/ha with location mean yield of 3594kg/ha. Nine entries showed comparable yield performance to PSB Rc82 (4731kg/ha). PR35015-GA-5-5-1 produced the highest yield of 4790kg/ha. Majority of the test entries showed significantly lower yields than PSB Rc82. Phenotypic acceptability rating of the test entries ranged from fair to excellent. PSB Rc82, IR10N255 and IR08M118 were rated with excellent phenotypic acceptability (Table 20b). Under the low yielding environment particularly in Negros, majority of the test entries yielded comparably to PSB Rc82 while only three entries showed significantly lower yields than PSB Rc82. Notable were the three entries which recorded more than 4t/ha yield. These were IR10N255 (4524kg/ha), IR10M210 (4098kg/ha), and IR10M255 (4003kg/ha). A mild rice tungro virus (RTV) infection was observed during early vegetative stage in few lines but not enough to cause significant damage. An insecticide was applied to suppress the population of green leafhopper to prevent the spread of disease. Severe sheath blight infection was observed on entries: PSB Rc82 (check) and IR 68144-2B-2-2-3-1-166 with 100% and 80% infection rate, respectively during ripening stage. On the other hand, a moderate neck rot infection (40%) was observed on IR09N481 during ripening stage that have possible resulted to yield loss. Maturity of the entries ranges from 108 to 126 days after sowing with IR 68144-2B-2-2-3-1-166 as the earliest line while most of the japonica lines matured late. (Table 20c). In Agusan, the first sowing was flooded; hence, 2nd sowing was done. This resulted to late establishment of the trial. Five entries had yields numerically higher than PSB Rc82. These were PR35015-GA-5-5-1 (3962kg/ha), IR10M284 (3815kg/ha), IR10N255 (3790kg/ha), IR10M118 (3723kg/ha) and IR10M210 (3684kg/ha). These entries exhibited good to fair phenotypic acceptability.

- The wet season trials overall performance showed that the highest mean yield was recorded in PhilRice-Agusan (5084kg/ha) and the lowest in PhilRice-CES (2317kg/ha). IR10N255 showed consistently one of the top yield performers in three out of five test locations. PSB Rc82, the check variety showed consistently one of the top yield performers in four out of five test locations (Table 20).

- Location performance showed that in CES (Table 21a), only IR10N255 (3808kg/ha) numerically out-yielded PSB Rc82 (3388kg/ha) with yield advantage of 12.4%. Yield of test entries ranged from 1209kg/ha to 3808kg/ha. Majority of the entries showed significantly lower at 0.5% to 1.0% probability as compared to PSB Rc82. Lower yields were observed in all test entries due to lodging incidence at heading to hard dough stage of the crops caused by typhoon Luis and Mario. Maturity of the test entries ranged from 106 to 125 days after sowing and phenotypic acceptability scores ranged from 5 to 7. Prevalent during the season were bacterial leaf blight, bacterial leaf steak, panicle blast, sheath blight, and stemborer from severe to moderate infection/infestation. In Isabela (Table 21b), yield of test entries ranged from 1005kg/ha to 4455kg/ha with location mean yield of 3602kg/ha. Five test entries showed comparable performance to PSB Rc82 while the rest of the test entries were either significantly lower at 0.5% to 1.0% probability level. Maturity of the test entries ranged from 108 to 117 days after sowing with phenotypic acceptability scores ranged from 5 to 7. Seeds of the test entries IR10M300 and IR75862-206-2-8-3-B-B-B were affected by flooding after sowing thus resulting to incomplete replication of these test entries. In Batac (Table 21c), yield of test entries ranged from 3225kg/ha to 4876kg/ha with location mean yield of 4266kg/ha. Five test entries showed comparable performance to PSB Rc82 while the rest were either significantly lower at 0.5% to 1.0% probability level. Phenotypic acceptability scores ranged from 1 to 5 with maturity ranged from 105 to 125 days after sowing. IR10M238, IR09N481, and IR10M245 showed resistant reaction to brown spot while nine entries exhibited moderate to severe reaction to brown spot. In Negros (Table 5d), yields ranged from 1282kg/ha to 4483kg/ha with location mean yield of 2984kg/ha. Two entries, IR08M118 (4483kg/ha) and PR35342-2B-1-3-1-3-1-5 (4080kg/ha) numerically out-yielded PSB Rc82 (3796kg/ha) with yield advantage of 18.1% and 7.5%, respectively. Eleven entries showed comparable performance to PSB Rc82 while the rest of the test entries were either significantly lower at 0.5% to 1.0% probability level. Maturity of the test entries ranged from 112 to 134 days after sowing with phenotypic acceptability scores ranged from 3 to 7. Three test entries were mildly infected by rice tungro virus (RTV) during vegetative stage with incidence ranging from 20-50% while IR09N481 was mildly infected by bacterial leaf blight during grain filling stage; false smut was spotted on the panicles of some entries but did not significantly infested the entries. In Agusan (Table 5e), IR10M245 (6662kg/ha) and PR35015-GA-5-5-1 (6219kg/ha), showed significantly higher yield and numerically out-yielded PSB Rc82 (5377kg/ha) with yield advantage of 23.9% and 15.7%, respectively. Another five test entries numerically out-yielded PSB Rc82 with yield ranged from 5536kg/ha to 6035kg/ha and yield advantage of 3.0% to 12.2%. Yield of the test entries ranged from 3741kg/ha to 6662kg/ha and matured in 106 to 118 days after sowing with phenotypic acceptability scores ranged from 4 to 6.

- Table 22 shows the overall performance of the test entries across locations and seasons during the year. Among the test entries, IR10N255 consistently showed better performance in both seasons across locations. Three other entries, IR10M300, IR10M238 and PR35015-GA-5-5-1 were also noted for their promising performance.

Table 20. Summary of yield performance of the test entries in the Pre NCT, 2014DS.

Entry No.	Designation	Mean. Yield CES kg/ha	Mean Comparison PSB Rc82	Mean. Yield Isabela kg/ha	Mean Comparison PSB Rc82	Mean. Yield Negros kg/ha	Mean Comparison PSB Rc82	Mean. Yield Agusan kg/ha	Mean Comparison PSB Rc82	Grand Mean Yield kg/ha	Rank
1	IR10N255	7659		4326		4524		3790		5075	2
2	IR10M238	7814	*	4361		4003		3083		4815	5
3	IR10M108	5652		2462	##	1582	#	2117		2953	21
4	IR09N481	7264		4099		2440		2982	#	4196	12
5	IR10M153	5077	##	2898	##	2698		1823	##	3124	20
6	IR10M300	8850	**	4498		2805		3370		4881	3
7	IR10M284	6583		3572	#	3282		3815		4313	9
8	IR08M118	7758		4381		3497		3723		4840	4
9	IR09M113	7273		3522	##	2150		3172		4029	15
10	IR84832-RIL 10-1-1-1-1	7095		3654	#	3399		2894	#	4260	11
11	IR10M245	7679		4007		3223		3225		4533	8
12	IR10M210	7020		4040		4098		3684		4710	6
13	IR09M106	6485		3661	#	2610		2638	##	3849	17
14	IR84833-RIL 38-1-1-1-1	6002		3297	##	3115		2782	##	3799	18
15	IR84749-RIL 243-1-1-1-1	7471		3168	##	3385		3071		4274	10
16	PR35342-2B-1-3-1-3-1-5	5470	#	4351		3656		3055		4133	13
17	PR35015-GA-5-5-1	8985	**	4790		2593		3962		5083	1
18	PR34627-B-7-4-1-1-2-1	7008		3599	#	2872		2675	# #	4038	14
19	PR34629-B-47-1-2-2-1-1	6909		3571	#	1148	##	-		3876	16
20	PSB 82	6680		4731		**3531**		3658		4650	7
21	IR68144-2B-2-2-3-2-166	4949	##	3150	##	3372		3152		3656	19
22	IR75862-206-2-8-3-B-B-B	4582	##	2614	##	1678	#	2933	#	2952	22
	Mean	6830		3594		2985		3174.0			
	CV% =	9.6		11		31.7		8.50			
	LSD(5%)	1081.5		957		1558		669			
	LSD (1%)	1445.9		1151		2083		808			

*, ** Mean yield significantly higher than the check variety at 0.05 and 0.01 probability levels, respectively.

, ## Mean yield significantly lower than the check variety at 0.05 and 0.01 probability levels, respectively.

Table 20a. Yield and other agronomic characteristics of the test entries in the Pre-NCT Trial, PhilRice-CES, 2014DS

Entry No.	Plot No	Designation	Yield (kg/ha)	Mean. Yield kg/ha	Mean Comparison PSB Rc 82	MATURITY (DAS)	Plant Ht (cm)	Prod. Tillers(no.)	PAcp[1]	Remarks[2]
1	1	IR10N255	8809	7659		115	98	13	5	expose p, nvu
	26		6832							
	66		7336							
2	2	IR10M238	8652	7814	*	119	105	11	5	
	39		6556							
	54		8235							
3	3	IR10M108	6272	5652		130	110	7		broad leaves, Japonica
	31		5278							
	60		5406							
4	4	IR09N481	9336	7264		116	98	12	5	
	25		5855							
	61		6601							
5	5	IR10M153	5178	5077	##	129	107	7		Japonica, NVU, broad leaves
	27		4747							
	51		5307							
6	6	IR10M300	9658	8850	**	120	103	11	5	
	35		8296							
	57		8597							
7	7	IR10M284	6240	6583		113	94	12	6	BLB
	38		5963							
	45		7546							
8	8	IR08M118	8446	7758		116	99	12	5	broad leaves, blb, just exerted
	36		7048							
	50		7778							
9	9	IR09M113	7644	7273		123	98	14	5	poor exertion, nvu, broad leaves
	30		6892							
	52		7282							
10	10	IR84832-RIL 10-1-1-1-1	7942	7095		117	96	17	5	BLB
	24		6115							
	59		7227							
11	11	IR10M245	8612	7679		119	119	12	5	bold, bit tall
	41		7193							
	46		7233							
12	12	IR10M210	6751	7020		105	97	15	6	BLB
	32		7029							
	53		7279							
13	13	IR09M106	7356	6485		117	108	12	5	Japonica, NVU
	28		6307							
	58		5792							
14	14	IR84833-RIL 38-1-1-1-1	5579	6002		117	105	15	6	NU, BLB, sb
	34		5800							
	47		6628							
15	15	IR84749-RIL 243-1-1-1-1	8606	7471		115	102	12	5	BLB
	43		6501							
	48		7307							
16	16	PR35342-2B-1-3-1-3-1-5	5943	5470	#	113	108	9	5	med grain, BLB
	33		5220							
	64		5246							
17	17	PR35015-GA-5-5-1	9352	8985	**	129	111	12	5	ok pt
	29		7617							
	49		9986							
18	18	PR34627-B-7-4-1-1-2-1	8627	7008		121	100	11	5	just exerted, PW type, blb
	23		5367							
	65		7030							
19	19	PR34629-B-47-1-2-2-1-1	7041	6909		122	100	10	5	just exerted, NVU, blb
	40		6825							
	55		6861							
20	20	PSB Rc 82 (check)	6692	6680		116	93	18	5	
	37		6833							
	56		6516							
21	21	IR68144-2B-2-2-3-1-166	5776	4949	##	113	73	19		
	42		4571							
	62		4499							
22	22	IR75862-206-2-8-3-B-B-B	4464	4582	##	125	97	10		Japonica, sb, nvu
	44		4669							
	63		4613							
		Mean		6830						
		CV% =		9.6						
		LSD(5%)		1081.5						
		LSD (1%)		1445.9						

**, * = Rice selections significantly higher than the check at 0.05 and 0.01 probability level, respectively.

#, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] BLB(blb)-Bacterial leaf blight, SB (sb)-Stemborer. Capital letters mean severe infection/infestation, small letters mean moderate

NVU(nvu)-Not very uniform

Table 20b. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-Isabela, 2014DS.

Entry No.	Plot No.	Designation	Yield (kg/ha)	Mean Yield (kg/ha)	Mean Comparison PSB Rc82	Plant Height (cm)	Productive Tiller per hill (no.)	PAcp[1]	Reaction to Stemborer[2]	Remarks
1	1	IR10N255	4535	4326		87	16	1	1	long dense panicle/high
	26		4246							fertility and clean medium
	66		4196							slender grains
2	2	IR10M238	4543	4361		91	15	3	1	long dense panicle/some
	39		4538							sterile/long slender grains
	54		4003							
3	3	IR10M108	2624	2462	##	108	10	5	1	bold grains/stay green/late
	31		2532							maturing/long dense panicle/
	60		2228							high fertility/2-5 plants mix
4	4	IR09N481	3811	4099		88	16	3	3	medium grains/some sterile
	25		4038							
	61		4446							
5	5	IR10M153	3240	2898	##	101	9	5	0	late maturing/bold grains/long
	27		2671							dense panicle/10 mix plants
	51		2783							
6	6	IR10M300	4500	4498		100	14	5	5	some sterile/stay green/long
	35		4675							dense panicle/medium grains
	57		4319							
7	7	IR10M284	3727	3572	#	83	17	3	1	some sterile/medium to long
	38		3348							panicle/slender grains
	45		3640							
8	8	IR08M118	4902	4381		93	14	1	1	medium grains/medium panicle
	36		4176							high fertility
	50		4065							
9	9	IR09M113	3541	3522	##	96	13	5	5	bold grains/some sterile/
	30		3474							medium to long dense panicle/
	52		3549							stem borer affected/mix plants
10	10	IR84832-RIL 10-1-1-1-1	3673	3654	#	83	15	5	5	small/small grains/medium
	24		3440							dense panicle/some sterile
	59		3847							
11	11	IR10M245	4202	4007		116	13	3	1	tall/long heavy panicle/bold grains
	41		4020							prone to lodging/mix plants
	46		3799							
12	12	IR10M210	3706	4040		85	14	3	3	medium to long dense panicle/
	32		4460							some sterile/medium grains
	53		3953							
13	13	IR09M106	2624	3661	#	109	13	5	7	good phenotype but bold grains/
	28		4011							medium to long dense panicle/mix
	58		4349							plants
14	14	IR84833-RIL 38-1-1-1-1	3613	3297	##	99	14		1	medium slender grains/5% shattering
	34		3434							medium dense panicle
	47		2846							
15	15	IR84749-RIL 243-1-1-1-1	3293	3168	##	85	14	3	3	small/some sterile/medium to
	43		3285							long dense panicle/slender grains
	48		2926							
16	16	PR35342-2B-1-3-1-3-1-5	4052	4351		101	11	5	1	medium bold grains/medium to
	33		4442							long dense panicle/high fertility
	64		4558							mix plants
17	17	PR35015-GA-5-5-1	5013	4790		107	16	5	0	stay green/late maturing/small
	29		5054							slender grains/long dense panicle
	49		4305							
18	18	PR34627-B-7-4-1-1-2-1	3039	3599	#	90	10	5	1	heavy long dense panicle/medium
	23		3292							slender grains/stay green/some
	65		4465							sterile/stem borer affected
19	19	PR34629-B-47-1-2-2-1-1	3062	3571	#	91	12	3	1	medium dense but long panicle/
	40		3997							stay green/slender grains/some
	55		3652							sterile
20	20	PSB Rc82	4599	4731		91	14	1	1	medium dense panicle/medium
	37		4975							slender grains/high fertilty
	56		4617							
21	21	IR68144-2B-2-2-3-2-166	2989	3150	##	64	17	5	1	small/just exerted panicle/dwarf/
	42		3065							high fertilty/small grains
	62		3396							
22	22	IR75862-206-2-8-3-B-B-B	2307	2614	##	93	11	5	3	bold grains/good phenotype/long
	44		3374							dense panicle/stay green/late
	63		2162							maturing/mix plants
		Mean		3761.3						
		CV%		10.672						
		LSD (5%)		1003.6						
		LSD (1%)		1207.1						

#, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PAcp= Phenotypic Acceptability- 1= Excellent 3= Good, 5= Intermediate, 7-Poor

[2] Reaction to stemborer 0= no damage, 1= 1-10%, 3= 11-20%, 5= 21-30%, 7= 31-60%

Table 20c. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-Negros, 2014DS.

Index No.	Plot No.	Designation	Yield (kg/ha)	Mean Yield (kg/ha)	Mean Comparison PSB Rc82	Maturity (DAS)	Plant Height (cm)	Prod Tillers/hill (no)	PAcp[1]	Reaction to Pest/Diseases[2]
1	1	IR10N255	7866	4524		120	88	16	3	
	26		3500							
	66		2205							
2	2	IR10M238	4486	4003		124	96	16	3	
	39		4214							
	54		3310							
3	3	IR10M108	1771	1582	#	126	95	10	5	
	31		1551							
	60		1425							
4	4	IR09N481	2020	2440		116	84	16	7	nr
	25		2683							
	61		2616							
5	5	IR10M153	1484	2698		125	92	9	5	
	27		5141							
	51		1469							
6	6	IR10M300	3026	2805		114	88	14	5	
	35		2668							
	57		2721							
7	7	IR10M284	3574	3282		114	89	15	5	
	38		3527							
	45		2744							
8	8	IR08M118	3822	3497		116	100	15	5	
	36		3386							
	50		3281							
9	9	IR09M113	2571	2150		125	88	11	7	
	30		1777							
	52		2103							
10	10	IR84832-RIL 10-1-1-1-1	3304	3399		113	83	15	5	
	24		3412							
	59		3480							
11	11	IR10M245	2954	3223		116	116	14	5	
	41		3280							
	46		3436							
12	12	IR10M210	3818	4098		114	90	15	3	
	42		5194							
	53		3281							
13	13	IR09M106	2300	2610		117	98	12	5	
	28		2472							
	58		3058							
14	14	IR84833-RIL 38-1-1-1-1	3635	3115		125	98	15	7	
	34		3056							
	47		2656							
15	15	IR84749-RIL 243-1-1-1-1	2789	3385		116	87	15	5	
	43		3701							
	48		3663							
16	16	PR35342-2B-1-3-1-3-1-5	3459	3656		118	102	12	5	
	33		3991							
	64		3516							
17	17	PR35015-GA-5-5-1	2928	2593		126	98	14	7	
	29		2078							
	49		2774							
18	18	PR34627-B-7-4-1-1-2-1	3535	2872		126	102	10	7	
	23		2714							
	65		2367							
19	19	PR34629-B-47-1-2-2-1-1	1387	1148	##	125	96	10	7	
	40		916							
	55		1142							
20	20	PSB Rc82	4082	3531		118	101	17	5	ShB
	37		3464							
	56		3046							
21	21	IR68144-2B-2-2-3-1-166	1656	3372		108	69	19	7	ShB
	42		4933							
	62		3528							
22	22	IR75862-206--2-8-3-B-B-B	1439	1678	#	118	79	12	5	
	44		1424							
	63		2171							
		Mean		2985						
		CV (%)		31.7						
		LSD (5%)		1558						
		LSD (1%)		2083						

, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level based on Dunnett's t-test for yield, respectively.

[1] PAcp= Phenotypic Acceptability- 3= Good, 5= Intermediate, 7-Poor

[2] NR(nr)= Neck Rot, ShB(shb)= Sheath blight. Capital letters mean severe infection/infestation, small letters mean moderate

Table 21. Summary of yield performance of the test entries in the Pre NCT, 2014WS.

Entry No.	Designation	Mean. Yield CES kg/ha	Mean Comparison PSB Rc82	Mean. Yield Isabela kg/ha	Mean Comparison PSB Rc82	Mean. Yield BATAC kg/ha	Mean Comparison PSB Rc82	Mean. Yield Negros kg/ha	Mean Comparison PSB Rc82	Mean. Yield Agusan kg/ha	Mean Comparison PSB Rc82	**Mean Yield (5 Test Locations)**	**Rank**
1	IR10N255	3808		4365		4095	##	3592		6035		4379	2
2	IR10M238	2708		3929	#	4766		3636		5995		4207	3
3	IR10M108	1209	##	3861	#	4371	#	2008	##	3975	##	3085	20
4	IR09N481	2329	#	4168		3817	##	2662	#	5008		3597	11
5	IR10M153	1690	##	1934	##	3765	##	1896	##	3714	##	2600	21
6	IR10M300	2727		2046	##	4446	#	3295		5536		3610	10
7	IR10M284	2101	##	1978	##	4201	##	2825	#	5578		3337	18
8	IR08M118	2404	#	3527	##	4542		4483		4954		3982	6
9	IR09M113	2089	##	3137	##	4417	#	2224	##	5302		3434	16
10	IR84832-RIL 10-1-1-1-1	2341	#	3709	##	3893	##	3445		4076	##	3493	14
11	IR10M245	2442	#	3665	##	4772		3247		6662	**	4158	4
12	IR10M210	3270		4114		4336	#	3675		5230		4125	5
13	IR09M106	1486	##	4455		4417	#	2507	##	4870		3547	12
14	IR84833-RIL 38-1-1-1-1	1815	##	3527	##	3624	##	2683	#	5261		3382	17
15	IR84749-RIL 243-1-1-1-1	1443	##	4297		4165	##	3667		4638		3642	9
16	PR35342-2B-1-3-1-3-1-5	1762	##	3524	##	4718		4080		4649		3747	8
17	PR35015-GA-5-5-1	2433	#	2944	##	4876		3165		6219	*	3927	7
18	PR34627-B-7-4-1-1-2-1	2014	##	3387	##	4409	#	2714	#	4760		3457	15
19	PR34629-B-47-1-2-2-1-1	3136		3498	##	4140	##	1282	##	5622		3535	13
20	PSB 82	3388		4895		5108		3796		5377		4513	1
21	IR68144-2B-2-2-3-2-166	2503	#	3597	##	3225	##	2868		4359	#	3310	19
22	IR75862-206-2-8-3-B-B-B	1860	##	1005		3750	##	1907	##	4036	##	2512	22
	Mean	2317		3602		4266		2984		5084			
	CV% =	21.5		14.3		9.1		19.2		9.1			
	LSD(5%)	820.6		850.0		640.5		945.4		761.8			
	LSD (1%)	1097.2		1138.0		856.4		1263.9		1018.6			

*, ** Mean yield significantly higher than the check variety at 0.05 and 0.01 probability levels, respectively.

#, ## Mean yield significantly lower than the check variety at 0.05 and 0.01 probability levels, respectively.

Excluded in the analysis due to missing data (two replications)

Table 21a. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-CES Maligaya, 2014WS.

Entry No.	Plot No.	Designation	Yield kg/ha	Mean. Yield kg/ha	Mean Comparison PSB Rc 82	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	Lodging Incidence[2]	Reaction Pests[3]	Remarks
1	1	IR10N255	4516	3808		111	120	15	6			Long grain (g), exposed panicle (p)
	26		3496									
	66		3414									
2	2	IR10M238	2924	2708		116	117	15	5	3		not uniform (NU)
	39		2439									
	54		2762									
3	3	IR10M108	860	1209	##	119	124	12	7			not very uniform (NVU) exposed p
	31		1653									
	60		1114									
4	4	IR09N481	2526	2329	#	113	116	14	7	5		NVU
	25		1479									
	61		2982									
5	5	IR10M153	1681	1690	##	116	115	11	7		blb, shb	NVU, exposed p
	27		1757									
	51		1633									
6	6	IR10M300	2786	2727		113	121	16	6	5		Long g with awn
	35		2822									
	57		2574									
7	7	IR10M284	1848	2101	##	106	113	14	6	9		short p, long p, exposed p
	38		2290									
	45		2164									
8	8	IR08M118	2620	2404	#	113	122	13	7	7	BLB	medium g, broad leaves
	36		2162									
	50		2429									
9	9	IR09M113	2157	2089	##	114	112	12	6		blb	long and dense p
	30		1849									
	52		2261									
10	10	IR84832-RIL 10-1-1-1-1	2325	2341	#	107	112	14	7	9	blb, wh	medium g
	24		1935									
	59		2762									
11	11	IR10M245	2738	2442	#	118	144	13	6	7	BLB	exposed pan, semi-bold g
	41		2117									
	46		2471									
12	12	IR10M210	3916	3270		113	116	14	6	7	blb, pb	sparse p
	32		2743									
	53		3152									
13	13	IR09M106	1393	1486	##	116	128	20	6	3	blb	NU
	28		1587									
	58		1477									
14	14	IR84833-RIL 38-1-1-1-1	1098	1815	##	107	122	15	6		BLB, shb	NU
	34		2174									
	47		2174									
15	15	IR84749-RIL 243-1-1-1-1	1049	1443	##	108	119	12	7	7	BLB	exposed p
	43		1830									
	48		1452									
16	16	PR35342-2B-1-3-1-3-1-5	1228	1762	##	113	129	14	7	7		NVU
	33		2036									
	64		2020									
17	17	PR35015-GA-5-5-1	2103	2433	#	125	124	15	5	7		broad leaves, with kneeing ability, clean leaves
	29		2677									
	49		2519									
18	18	PR34627-B-7-4-1-1-2-1	1828	2014	##	124	109	13	5			Long g
	23		2494									
	65		1719									
19	19	PR34629-B-47-1-2-2-1-1	2916	3136		124	124	14	5			Medium g, clean leaves
	40		2289									
	55		4203									
20	20	PSB Rc 82 (check)	3888	3388		118	127	17	6	7		long g
	37		2329									
	56		3947									
21	21	IR68144-2B-2-2-3-1-166	2288	2503	#	109	90	15	7		BLB	
	42		1853									
	62		3370									
22	22	IR75862-206-2-8-3-B-B-B	2115	1860	##	117	116	12	7			NVU
	44		2101									
	63		1363									
Mean				2317								
CV%				21.5								
LSD (5%)				820.6								
LSD (1%)				1097.2								

, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level , respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] Lodging incidence (LDG)= 3= 20-40% , 5= 41-60% , 7= 61-80% , 9= 81-100%

[3] BLB(blb)-Bacterial leaf blight, Whiteheads WH(wh), Sheath Blight SHB(shb), panicle blast -PB(pb). Capital letters mean severe infection/infestation, small letters mean moderate

Table 21b. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-Isabela, 2014WS.

Entry No.	Plot No.	Designation	Yield (kg/ha)	Mean. Yield kg/ha	Mean Comparison PSB Rc 82	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	Reaction Pests[2]	Remarks
1	1	IR10N255	4486	4365		109	104	16	5		not very uniform (nvu),long grains,stay green
	26		3350								
	66		5260								
2	2	IR10M238	4136	3929	#	111	110	18	5		late mat, long grains,nvu
	39		4545								
	54		3106								
3	3	IR10M108	3475	3861	#	111	124	10	5		bold grains,brd leaves,stay green
	31		3518								
	60		4590								
4	4	IR09N481	3990	4168		109	109	14	5		medium grains,just exerted panicle
	25		4883								
	61		3630								
5	5	IR10M153	1742	1934	##	110	91	14	7		late mat, bold grains,broad leaves
	27		2209								
	51		1850								
6	6	IR10M300	3782	2046	##	110	116	9	5		nvu,medium grains,prone to lodging
	35		2357								
	57		no data								
7	7	IR10M284	1980	1978	##	108	92	16	7		prone to lodging,early mat
	38		2105								
	45		1850								
8	8	IR08M118	3148	3527	##	109	110	22	5	BLS	medium grains,BLS
	36		2814								
	50		4619								
9	9	IR09M113	3442	3137	##	110	111	14	5		nvu, late maturing
	30		3108								
	52		2860								
10	10	IR84832-RIL 10-1-1-1-1	3926	3709	##	108	90	20	5		nvu,medium grains
	24		3230								
	59		3969								
11	11	IR10M245	3689	3665	##	111	128	17	5		bold grains,prone to lodging
	41		3428								
	46		3879								
12	12	IR10M210	4519	4114		109	103	18	7		medium grains,prone to lodging,just exerted
	32		3989								
	53		3833								
13	13	IR09M106	4633	4455		109	112	11	5		bold grains,just exerted
	28		3799								
	58		4933								
14	14	IR84833-RIL 38-1-1-1-1	3607	3527	##	109	112	16	7		medium grains,late maturing
	34		2898								
	47		4077								
15	15	IR84749-RIL 243-1-1-1-1	4650	4297		108	97	16	7		prone to lodging,long grains
	43		3764								
	48		4477								
16	16	PR35342-2B-1-3-1-3-1-5	3567	3524	##	110	117	15	5		medium grains, just exerted
	33		2970								
	64		4035								
17	17	PR35015-GA-5-5-1	3504	2944	##	111	110	16	5		medium grains,just exerted panicle
	29		2325								
	49		3002								
18	18	PR34627-B-7-4-1-1-2-1	3237	3387	##	111	109	15	5		just exerted panicles,nvu,long grains
	23		3508								
	65		3416								
19	19	PR34629-B-47-1-2-2-1-1	3701	3498	##	110	113	14	5		nvu,long grains,just exerted
	40		3217								
	55		3575								
20	20	PSB Rc 82 (check)	4800	4895		110	108	19	5		late mat,long paincles
	37		5193								
	56		4691								
21	21	IR 68144-2B-2-2-3-1-166	3833	3597	##	108	73	19	5		small plants,just exerted panicles,med grains
	42		3596								
	62		3363								
22	22	IR75862-206-2-8-3-B-B-B	3016	1005		118	96	12	5		bold grains,nvu(almost half),just exerted,stay green
	44		no data								
	63		no data								
Mean				3602							Pre-NCT 22 was exluded in the analysis due to missing data of two replications
CV% =				14.3							
LSD (5%) =				850.0							
LSD (1%) =				1138.0							

Entry No. 6 and 22 were not included in the analysis due to missing data

\# , ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] BLS(blb)-Bacterial leaf streak, Capital letters mean severe infection/infestation, small letters mean moderate

Table 21c. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-Batac, 2014WS.

Entry No.	Plot No.	Designation	Yield (kg/ha)	Mean. Yield kg/ha	Mean Comparison PSB Rc 82	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	Reaction Pests[2]	Remarks
1	1	IR10N255	3924	4095	##	107	83	19	3		uniform, resistant to diseases
	26		4193								
	66		4169								
2	2	IR10M238	4443	4766		118	86	19	3		uniform
	39		4753								
	54		5103								
3	3	IR10M108	4465	4371	#	123	107	11	1		uniform, bold grains, late maturing
	31		4014								
	60		4634								
4	4	IR09N481	3165	3817	##	117	76	19	3		uniform, good crop stand, resistant to BS
	25		4111								
	61		4174								
5	5	IR10M153	3875	3765	##	123	97	9	1		uniform, bold grains, late maturing, good phenotype
	27		3287								
	51		4134								
6	6	IR10M300	4613	4446	#	109	94	26	3		uniform, mod. Resistant to BS
	35		3772								
	57		4952								
7	7	IR10M284	4038	4201	##	105	82	19	3		uniform, well-exserted panicles, good phenotype
	38		4275								
	45		4289								
8	8	IR08M118	4670	4542		106	87	16	3	bls	uniform, late senescence
	36		4621								
	50		4335								
9	9	IR09M113	4065	4417	#	117	81	15	3		uniform, short plants, early senescence
	30		4332								
	52		4854								
10	10	IR84832-RIL-10-1-1-1-1	3997	3893	##	106	71	22	3		uniform, short plants, early senescence
	24		3721								
	59		3960								
11	11	IR10M245	4845	4772		119	110	14	3		Tall and uniform, late senescence
	41		5214								
	46		4258								
12	12	IR10M210	4191	4336	#	108	84	18	3	bls	Med. Tall. Still segregating,
	32		3904								
	53		4913								
13	13	IR09M106	4436	4417	#	117	89	14	3	bls	not uniform and still segregating
	28		4439								
	58		4375								
14	14	IR84833-RIL-38-1-1-1-1	3739	3624	##	125	89	16	3	bls	Good phenotype, panicles just exerted.
	34		3734								
	47		3399								
15	15	IR84749-RIL-243-1-1-1-1	4406	4165	##	106	82	16	3	BLB, BLS	Early and fast senesecence
	43		3957								
	48		4132								
16	16	PR35342-2B-1-3-1-3-1-5	5023	4718		119	97	13	3	bls	Long panicles, heavy seeds, good phenotype, med tall.
	33		3866								
	64		5266								
17	17	PR35015-GA-5-5-1	4178	4876		123	100	17	3	bls	good phenotype, mod well-exserted panicles, tall plants
	29		5206								
	49		5243								
18	18	PR34627-B-7-4-1-1-2-1	4922	4409	#	123	93	13	1	BLS	late maturing, well-exserted panicles, susc to BS
	23		3825								
	65		4481								
19	19	PR34629-B-47-1-2-2-1-1	3669	4140	##	123	94	13	1		Late maturing, long grains, tall plants, low tillering
	40		4337								
	55		4415								
20	20	PSB Rc 82 (check)	5039	5108		105	89	17	3		Intermediate senescence, high % filled grains
	37		4596								
	56		5688								
21	21	IR68144(check)	2940	3225	##	107	68	23	5		low tillering and short, short panicles, early maturing and fast senescence
	37		3162								
	56		3572								
22	22	IR75862-206-2-8-3-13-13-13	3527	3750	##	119	91	13	3	BLS	well-exserted, good phenotype
	44		3409								
	63		4315								
Mean			4266								
CV% =			9.1								
LSD (5%) =			640.5								
LSD (1%) =			856.4								

, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] BLB(blb)-Bacterial leaf blight, Bacterial leaf streak (bls), panicle blast (pb). Capital letters mean severe infection/infestation, small letters mean moderate

Table 21d. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-Negros, 2014WS.

Entry No.	Plot No.	Designation	Yield Kg/ha	Mean. Yield kg/ha	Mean Comparison PSB Rc 82	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	Reaction Pests[2]	Remarks
1	1	IR10N255	3605	3592		127	102	15	3	blb	
	26		4119							blb	
	66		3051							blb	
2	2	IR10M238	3882	3636		121	101	13	5		
	39		2901								
	54		4124								
3	3	IR10M108	2005	2008	##	131	113	9	5		
	31		2387								
	60		1631								
4	4	IR09N481	2393	2662	#	123	85	14	4	RTV	
	25		2814							RTV	
	61		2779							RTV	
5	5	IR10M153	2627	1896	##	128	104	9	4		
	27		1273								
	51		1787								
6	6	IR10M300	3604	3295		121	101	20	4		
	35		4083								
	57		2197								
7	7	IR10M284	3392	2825	#	114	88	15	4		
	38		2158								
	45		2926								
8	8	IR08M118	4491	4483		121	103	13	3		
	36		4883								
	50		4074								
9	9	IR09M113	2552	2224	##	124	98	11	5	Blb	
	30		2792							Blb	
	52		1329							Blb	
10	10	IR84832-RIL 10-1-1-1-1	4071	3445		116	91	14	4		
	24		3591								
	59		2673								
11	11	IR10M245	3893	3247		128	119	10	5		
	41		2597								
	46		3252								
12	12	IR10M210	4656	3675		116	102	12	4	BLB	
	42		4011							BLB	
	53		2359							BLB	
13	13	IR09M106	2148	2507	##	121	103	12	5		
	28		2676								
	58		2697								
14	14	IR84833-RIL 38-1-1-1-1	2687	2683	#	123	107	13	6		
	34		2731								
	47		2631								
15	15	IR84749-RIL 243-1-1-1-1	3681	3667		114	99	13	5		
	43		3437								
	48		3883								
16	16	PR35342-2B-1-3-1-3-1-5	4468	4080		118	109	12	5		
	33		3862								
	64		3911								
17	17	PR35015-GA-5-5-1	3494	3165		132	104	13	5		
	29		1928								
	49		4074								
18	18	PR34627-B-7-4-1-1-2-1	2801	2714	#	131	101	11	4	BLB	
	23		2290							BLB	
	65		3051							BLB	
19	19	PR34629-B-47-1-2-2-1-1	1871	1282	##	134	104	9	7		
	40		1278								
	55		696								
20	20	PSB Rc82	4335	3796		121	106	12	4		
	37		3781								
	56		3271								
21	21	IR68144-2B-2-2-3-1-166	3292	2868		112	76	14	5		
	42		2792								
	62		2519								
22	22	IR75862-206--2-8-3-B-B-E	2243	1907	##	128	100	12	5		
	44		1394								
	63		2082								
Mean			2984								
CV% =			19.2								
LSD (5%) =			945.4								
LSD (1%) =			1263.9								

#, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] BLB(blb)-Bacterial leaf blight, RTV(rtv)= rice tungro virus Capital letters mean severe infection/infestation, small letters mean moderate

Table 21e. Yield and other agronomic characteristics of the test entries in the Pre-NCT trial, PhilRice-Agusan, 2014WS

Entry No.	Plot No.	Designation	Yield kg/ha	Mean. Yield kg/ha	Mean Comparison PSB Rc 82	MAT (DAS)	Plt Ht (cm)	Prod Tillers/hill	PA[1]	Reaction Pests[2]	Remarks
1	1	IR10N255	6778	6035		109	98	15	5	BLS	light panicle, not very uniform (NVU)
	26		5881								
	66		5446								
2	2	IR10M238	6306	5995		112	100	13	5	blb, shb	Grain discoloration (GDC)
	39		5735								
	54		5946								
3	3	IR10M108	4547	3975	##	118	108	12	5		Bold, NVU, pigmented
	31		4015								
	60		3365								
4	4	IR09N481	5442	5008		109	95	16	5	BLS, shb	NVU, light panicle,
	25		4901								
	61		4680								
5	5	IR10M153	3292	3714	##	117	105	11	5		NU, GDC
	27		3885								
	51		3965								
6	6	IR10M300	5546	5536		108	155	20	5	BLS, shb	light panicle
	35		5374								
	57		5687								
7	7	IR10M284	4984	5578		108	96	15	6	blb, BLS, shb	light panicle
	38		5272								
	45		6479								
8	8	IR08M118	4409	4954		109	102	14	6	blb, BLS, shb	NU
	36		4764								
	50		5688								
9	9	IR09M113	5466	5302		112	96	12	6	blb, shb	NU
	30		5087								
	52		5352								
10	10	IR84832-RIL 10-1-1-1-1	4066	4076	##	106	91	15	6	BLS, blb, shb	
	24		3622								
	59		4539								
11	11	IR10M245	6206	6662	**	117	120	14	5	BLS	NVU
	41		6831								
	46		6948								
12	12	IR10M210	4972	5230		108	97	15	6	BLS, shb	
	32		5108								
	53		5610								
13	13	IR09M106	4998	4870		110	103	13	5	shb	NU, GDC
	28		4687								
	58		4926								
14	14	IR84833-RIL 38-1-1-1-1	5130	5261		113	104	14	5	shb	NVU, NBLS
	34		5154								
	47		5500								
15	15	IR84749-RIL 243-1-1-1-1	3899	4638		106	100	14	6	blb, BLS, shb	
	43		4735								
	48		5279								
16	16	PR35342-2B-1-3-1-3-1-5	4450	4649		111	101	13	6	blb, shb, BLS	NU
	33		4835								
	64		4663								
17	17	PR35015-GA-5-5-1	6211	6219	*	116	106	15	4	BLS	Uniform, GDC
	29		6042								
	49		6405								
18	18	PR34627-B-7-4-1-1-2-1	4411	4760		118	105	12	5	shb	GDC
	23		5010								
	65		4860								
19	19	PR34629-B-47-1-2-2-1-1	5189	5622		117	103	11	5	shb	GDC, uniform
	40		6127								
	55		5548								
20	20	PSB Rc 82 (check)	4813	5377		110	103	15	5	blb, shb	
	37		5271								
	56		6047								
21	21	IR68144-2B-2-2-3-1-166	3918	4359	#	106	78	15	6	blb, shb	short
	42		4818								
	62		4341								
22	22	IR75862-206-2-8-3-B-B-B	3596	4036	##	114	102	13	5	shb	NVU, GDC
	44		4931								
	63		3579								
Mean			5084								
CV%			9.1								
LSD (5%)			761.8								
LSD (1%)			1018.6								

*, ** = Rice selections significantly lower than the check at 0.05 and 0.01 probability level , respectively.

#, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level , respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] BLB(blb)-Bacterial leaf blight, Bacterial leaf streak-BLS(bls), Sheath Blight SHB(shb). Capital letters mean severe infection/infestation, small letters mean moderate

Table 22. Summary of yield performance of the test entries in the Pre NCT, 2014 DS and WS.

Entry No.	Designation	Mean Yield (Four Test Locations)	Rank	Mean Yield (Five Test Locations)	Rank	Grand Mean	Rank
		2014DS		2014WS			
1	IR10N255	5075	2	4379	2	4727	1
2	IR10M238	4815	5	4207	3	4511	4
3	IR10M108	2953	21	3085	20	3019	20
4	IR09N481	4196	12	3597	11	3896	11
5	IR10M153	3124	20	2600	21	2862	21
6	IR10M300	4881	3	3610	10	4245	3
7	IR10M284	4313	9	3337	18	3825	13
8	IR08M118	4840	4	3982	6	4411	7
9	IR09M113	4029	15	3434	16	3731	15
10	IR84832-RIL 10-1-1-1-1	4260	11	3493	14	3876	12
11	IR10M245	4533	8	4158	4	4346	8
12	IR10M210	4710	6	4125	5	4418	6
13	IR09M106	3849	17	3547	12	3698	17
14	IR84833-RIL 38-1-1-1-1	3799	18	3382	17	3591	18
15	IR84749-RIL 243-1-1-1-1	4274	10	3642	9	3958	9
16	PR35342-2B-1-3-1-3-1-5	4133	13	3747	8	3940	10
17	PR35015-GA-5-5-1	5083	1	3927	7	4505	5
18	PR34627-B-7-4-1-1-2-1	4038	14	3457	15	3748	14
19	PR34629-B-47-1-2-2-1-1	3876	16	3535	13	3706	16
20	PSB 82	4650	7	4513	1	4581	2
21	IR68144-2B-2-2-3-2-166	3656	19	3310	19	3483	19
22	IR75862-206-2-8-3-B-B-B	2952	22	2512	22	2732	22

Study 4. Preliminary Yield Trial (PYT)

- This study was conducted at PhilRice-CES during the wet season only. A total of 17 test entries and one check variety (PSB Rc82). A plot size of 8.32sq. m (1.6m x 5.2m) set in RCBD with three replications was used. Planting distance was set at 20 x 20cm apart and fertilizer rate of 90-60-60 kg NPK/ha. The same chemical control for weeds, snails and prevalent insects to minimize the damages caused by these pests and other cultural management was applied. Uniformity, heading date, plant height, tillering ability, phenotypic acceptability, field reactions to pests and diseases, and yielding ability were observed.

- Statistical analysis showed that there were significant differences in yield among entries and replications (Table 23). Percent coefficient of variation was 22.6%. Six entries showed comparable performance to PSB Rc82 (5008kg/ha) with yields ranging from 3694kg/ha to 4796kg/ha. Majority of the test entries showed significantly lower yield at 0.5% to 1.0% probability level compared to PSB Rc82. Maturity of the test entries ranged from 113 to 131 days after sowing with phenotypic acceptability scores ranged from 5 to 7. Lodging incidence was observed in some entries due to typhoon Luis and Mario at heading to hard dough stage of the crops.

Table 23. Yield and other agronomic characteristics of the test entries in the Preliminary Yield Trial (PYT), PhilRice-CES, 2014WS.

Entry No.	Designation	Mean. Yield kg/ha	Mean Comparison PSB Rc82	MAT	Plt Ht (cm)	Prod Tillers	PA[1]	Reaction Pests[2]	Remarks
1	IR96248-16-2-3-3-B	4658		114	117	11	6	blb	Long g with awn
2	IR96248-16-3-3-2-B	3283	#	120	115	15	6	blb,bls, pb	Long g with awn, erect culm
3	IR97632-63-3-4-B	3391	#	121	116	11	6	blb	poor exsertion
4	IR97472-65-3-6-B	2723	##	123	110	15	5	blb	Long g
5	IR94306-25-3-1-3-B	2396	##	123	141	12	7		
6	IR94041-9-3-3-6-B	4796		125	132	15	5		semi-exposed p, just exserted p
7	IR97632-59-3-3-B	4108		122	110	14	6		Long g, exposed p
8	IR97454-60-3-1-B	3373	#	131	126	15	5		Long g, clean leaves
9	IR94296-13-1-2-3	3340	#	114	114	16	7	BLB, pb, wh	sparse p
10	IR82475-110-2-2-1-2	3749		113	116	15	6	BLB ,pb	
11	IR97637-150-3-2-B	3694		129	136	13	5		Clean leaves, sparse p, well exserted p
12	IR97472-65-3-11-B	2718	##	125	111	12	5	pb	Long g, clean leaves
13	IR97647-17-2-1-B	2614	##	123	106	14	6		exposed p
14	IR97641-35-2-2-B	4718		125	126	16	5		Long g, long p, clean leaves
15	IR97481-99-1-3-B	2926	##	128	119	15	5		Long g with awn,
16	IR97483-65-1-2-B	3571	#	121	123	14	6		
17	PSB Rc82	5008		121	122	15	6	blb	
18	IR75862-206-2-8-3-B-B-B	2279	##	123	110	10	6	shb	NU
Mean		3519							
CV%		22.6							
LSD (5%)		1320.6							
LSD (1%)		1773.0							

, ## = Rice selections significantly lower than the check at 0.05 and 0.01 probability level, respectively.

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] BLB(blb)-Bacterial leaf blight, Whiteheads (wh), Sheath Blight (shb), Bacterial leaf streak (bls), panicle blast (pb). Capital letters mean severe infection/infestation, small letters mean moderate

Study 5. Observation Nursery of MAGIC and AUS

- This was conducted at PhilRice-CES during the wet season only. There were 142 MAGIC and 370 AUS test entries. A plot size of 2.56sq. m (0.8m x3.2m) with a planting distance of 20 x 20cm apart and fertilizer rate of 90-60-60kg NPK/ ha. Chemical control for weeds, snails and prevalent insects were applied to minimize the damages caused by these pests. Hand weeding and removal of volunteer plants were done during the implementation of the study. Uniformity, heading date, plant height, tillering ability, phenotypic acceptability, field reactions to pests and diseases, and yielding ability were observed.

- Yields of the MAGIC test entries ranged from 82kg/ha to 6243kg/ha (Table 24). Eleven entries showed higher yield ranged from 5029kg/ha to 6243kg/ha. The maturity of the test entries ranged from 100 to 139 days after sowing with phenotypic acceptability scores ranged from 4 to 7. Prevalent during the season were bacterial leaf blight, bacterial leaf steak, panicle blast, sheath blight, and stemborer from severe to moderate infection/infestation. Lodging incidence was observed in some entries due to typhoon Luis and Mario at heading to hard dough stage of the crops. The AUS entries yields ranged from 20kg/ha to 2156kg/ha. Only DJ 123 produced the 2-tonne yield. Low yield was observed in majority of the test entries from booting to maturity due to severe lodging incidence caused by typhoon Luis and Mario. Majority of the test entries were tall which were vulnerable to lodging. The maturity of the test entries ranged from 92 to 149 days after sowing with phenotypic acceptability scores ranged from 6 to 9. Some entries had low germination and weak seedlings and did not recover after transplanting. Moderate reaction to bacterial leaf blight, leaf spot and panicle blast were observed on some of the entries.

Table 24. Yield and other agronomic characteristics of the MAGIC test entries, PhilRice-CES, 2014WS

Entry Code	Designation	Plot No.	MAT (DAS)	Plant ht (cm)	Prod tillers/hill	Grain Yield (kg/ha)	PA[1]	Lodging Incidence[2]	Reaction to Pests[3]	Remarks
MAGIC 1	IR95028:1-B-4-5-12-GBS	1	113	127	17	4070	5	3		long panicle (p), medium grain (G)
MAGIC 2	IR95028:2-B-8-18-9-GBS	2	109	119	17	2112	7	7		long p, medium G
MAGIC 3	IR95028:3-B-3-7-20-GBS	3	117	124	16	3420	4			medium G with awn
MAGIC 4	IR95028:4-B-20-22-14-GBS	4	106	119	13	3326	4			long p, medium/long G with awn
MAGIC 5	IR95028:5-B-16-17-10-GBS	5	113	121	16	2758	5		blb	medium G with awn
MAGIC 6	IR95028:7-B-7-4-16-GBS	6	125	105	17	3650	6			medium/long G with awn
MAGIC 7	IR95028:8-B-11-20-18-GBS	7	117	115	14	2501	6		blb	Long G with awn
MAGIC 8	IR95028:9-B-22-5-7-GBS	8	117	132	18	4950	5			medium G, exposed p
MAGIC 9	IR95028:10-B-15-19-9-GBS	9	125	133	16	3489	6			
MAGIC 10	IR95029:1-B-22-8-15-GBS	10	113	154	14	1878	5	5		medium G, long p
MAGIC 11	IR95029:2-B-23-3-3-GBS	11	115	115	19	3204	7		blb	medium G, sparse p
MAGIC 12	IR95029:3-B-8-20-2-GBS	12	125	130	13	1574	7			semi-bold G
MAGIC 13	IR95029:4-B-11-9-10-GBS	13	115	127	20	2663	5			short medium G with awn
MAGIC 14	IR95029:5-B-22-11-22-GBS	14	115	117	23	2553	5			medium G
MAGIC 15	IR95029:6-B-10-3-17-GBS	15	125	109	18	3331	6			
MAGIC 16	IR95029:7-B-5-23-21-GBS	16	106	114	16	3156	5		ls	long G with puple tip
MAGIC 17	IR95029:8-B-6-15-6-GBS	17	109	114	17	3291	5		ls	medium G
MAGIC 18	IR95040:1-B-20-20-9-GBS	18	110	110	14	4526	5			medium G
MAGIC 19	IR95040:2-B-7-16-20-GBS	19	111	106	13	5037	5			medium G
MAGIC 20	IR95040:4-B-23-6-10-GBS	20	121	126	17	4121	4			Long G with brown furrows, long p
MAGIC 21	IR95040:5-B-17-12-6-GBS	21	111	118	17	3806	5			long p, medium/long G
MAGIC 22	IR95040:6-B-18-10-16-GBS	22	139	133	14	3382	6		blb	
MAGIC 23	IR95041:1-B-11-21-18-GBS	23	109	125	15	2142	7			not uniform (NU)
MAGIC 24	IR95041:2-B-12-5-7-GBS	24	111	120	12	2546	7			NU
MAGIC 25	IR95041:4-B-11-7-15-GBS	25	109	116	16	2155	7	7		medium G
MAGIC 26	IR95041:5-B-5-22-3-GBS	26	109	124	16	3184	5			NU , semi-exposed p
MAGIC 27	IR95041:6-B-12-17-2-GBS	27	109	118	12	4457	5			medium G with short awn
MAGIC 28	IR95041:8-B-5-4-22-GBS	28	115	120	12	1600	7			NVU
MAGIC 29	IR95044:1-B-7-6-10-GBS	29	117	127	12	2600	7		blb	small medium G, sparse p
MAGIC 30	IR95044:2-B-10-12-22-GBS	30	113	103	13	2375	5			medium G with brown furrows
MAGIC 31	IR95044:3-B-17-10-17-GBS	31	115	108	17	502	5			medium G with brown furrows
MAGIC 32	IR95044:4-B-7-21-21-GBS	32	125	125	15	4196	4			
MAGIC 33	IR95044:5-B-12-5-6-GBS	33	125	113	16	3923	4			
MAGIC 34	IR95044:7-B-9-7-11-GBS	34	106	99	18	5959	5		ls	medium G
MAGIC 35	IR95044:8-B-5-22-19-GBS	35	113	110	15	3257	5			medium G with brown furrows
MAGIC 36	IR95044:10-B-5-14-23-GBS	36	113	118	14	1300	7			NU
MAGIC 37	IR95044:11-B-3-2-7-GBS	37	108	114	14	1741	7	3		medium G with purple tip
MAGIC 38	IR95044:15-B-7-8-4-GBS	38	113	114	13	2230	5			long p, medium G
MAGIC 39	IR95044:17-B-6-18-22-GBS	39	115	121	13	1481	5			long p, medium G
MAGIC 40	IR95048:1-B-11-20-10-GBS	40	115	123	18	1217	5			long sparse p, small medium G
MAGIC 41	IR95048:2-B-9-5-6-GBS	41	106	136	13	1344	7	5		medium G
MAGIC 42	IR95051:1-B-7-21-7-GBS	42	104	106	18	2344	5			medium G
MAGIC 43	IR95051:2-B-4-5-2-GBS	43	117	109	11	2135	7			NVU
MAGIC 44	IR95051:3-B-8-18-13-GBS	44	109	108	12	1442	7		wh	long p
MAGIC 45	IR95051:4-B-10-7-17-GBS	45	116	121	14	2553	5			medium G
MAGIC 46	IR95058:1-B-5-16-22-GBS	46	113	127	13	2823	5	5		medium G
MAGIC 47	IR95058:2-B-5-4-12-GBS	47	115	120	14	3450	5			small medium G, semi-exposed p
MAGIC 48	IR95058:3-B-11-6-15-GBS	48	115	111	16	2870	7			small medium G, sparse p
MAGIC 49	IR95058:4-B-6-12-20-GBS	49	139	111	16	4334	5			
MAGIC 50	IR95058:5-B-6-10-14-GBS	50	115	124	17	5029	5			medium/long G, semi-exposed p
MAGIC 51	IR95058:6-B-6-21-10-GBS	51	115	128	11	3966	5			medium/long G, semi-exposed p
MAGIC 52	IR95058:8-B-5-18-16-GBS	52	113	119	15	5132	5			medium G, long p
MAGIC 53	IR95058:11-B-12-17-9-GBS	53	113	115	16	3765	7			medium G, sparse p
MAGIC 54	IR95058:12-B-2-14-15-GBS	54	105	92	15	2140	5			medium G, long pan, short plant
MAGIC 55	IR95095:2-B-11-5-17-GBS	55	100	112	15	1079	7			long G
MAGIC 56	IR95095:3-B-11-19-8-GBS	56	102	112	11	2513	7			medium G
MAGIC 57	IR95095:5-B-5-3-12-GBS	57	113	115	14	3993	4			long G
MAGIC 58	IR95095:8-B-7-11-14-GBS	58	115	113	13	3784	5			long G
MAGIC 59	IR95095:9-B-12-3-10-GBS	59	115	119	13	3081	4			long dense p, medium/long G
MAGIC 60	IR95095:10-B-19-23-6-GBS	60	107	115	10	2679	5			long G
MAGIC 61	IR95095:11-B-13-15-16-GBS	61	117	115	15	2064	7			NU
MAGIC 62	IR95097:1-B-19-7-13-GBS	62	104	112	17	2991	7			sparse pan, medium G
MAGIC 63	IR95097:3-B-16-11-4-GBS	63	113	117	13	4828	7			NVU
MAGIC 64	IR95097:4-B-20-18-8-GBS	64	116	105	13	3031	5		blb	medium G
MAGIC 65	IR95097:5-B-8-7-22-GBS	65	113	107	14	5329	5		blb	medium G
MAGIC 66	IR95097:6-B-3-9-12-GBS	66	121	105	16	4060	5			medium G
MAGIC 67	IR95097:9-B-2-10-14-GBS	67	104	101	13	3921	5			medium G, exposed pan
MAGIC 68	IR95097:10-B-23-5-10-GBS	68	104	90	13	3405	5			medium G, exposed pan
MAGIC 69	IR95097:11-B-20-2-6-GBS	69	107	106	18	3604	7		blb	long sparse p, medium G
MAGIC 70	IR95097:12-B-8-15-16-GBS	70	115	103	12	4755	5		blb	medium G
MAGIC 71	IR95097:13-B-15-19-18-GBS	71	129	123	13	5965	6		blb	medium G
MAGIC 72	IR95097:14-B-4-8-7-GBS	72	137	106	16	2704	6	7		
MAGIC 73	IR95097:15-B-22-3-9-GBS	73	100	98	14	4076	7		blb	long G
MAGIC 74	IR95097:17-B-15-16-21-GBS	74	107	112	17	4701	5			long G
MAGIC 75	IR95098:1-B-11-6-3-GBS	75	104	96	11	2922	5			medium G
MAGIC 76	IR95098:2-B-8-12-11-GBS	76	109	114	13	4760	6			medium G
MAGIC 77	IR95128:1-B-8-3-2-GBS	77	113	125	15	4477	5			long G
MAGIC 78	IR95128:3-B-10-9-22-GBS	78	113	106	11	3272	5			medium G
MAGIC 79	IR95128:4-B-4-11-17-GBS	79	130	118	19	4115	5			medium G, Erect culm
MAGIC 80	IR95132:2-B-8-23-3-GBS	80	137	131	15	85	7	9		
MAGIC 81	IR95132:3-B-18-13-11-GBS	81	115	117	14	6200	6			medium G
MAGIC 82	IR95132:4-B-3-10-19-GBS	82	117	113	13	4099	6			medium G
MAGIC 83	IR95132:5-B-16-5-5-GBS	83	115	119	14	4710	6		blb	Long G
MAGIC 84	IR95132:7-B-12-15-7-GBS	84	104	113	14	3120	7			NVU
MAGIC 85	IR95132:8-B-16-4-2-GBS	85	125	120	13	4611	5			long p, long G
MAGIC 86	IR95132:9-B-4-6-13-GBS	86	125	116	14	5068	6			long G
MAGIC 87	IR95132:10-B-12-12-17-GBS	87	127	120	11	2303	5			clean leaves
MAGIC 88	IR95132:11-B-18-10-4-GBS	88	129	117	15	2930	6		blb	medium G
MAGIC 89	IR95132:12-B-6-21-8-GBS	89	113	114	12	3726	7		blb	medium G
MAGIC 90	IR95132:14-B-7-18-12-GBS	90	115	111	15	3746	5			long G
MAGIC 91	IR95132:17-B-3-17-14-GBS	91	115	114	14	4308	6			long G
MAGIC 92	IR95133:1-B-16-14-10-GBS	92	108	120	12	4808	5			exposed p, long G
MAGIC 93	IR95133:3-B-10-20-16-GBS	93	123	121	13	3489	6		blb, LS	medium G
MAGIC 94	IR95133:4-B-4-5-18-GBS	94	117	104	13	3790	6			NU
MAGIC 95	IR95133:5-B-19-19-7-GBS	95	108	115	12	4848	5		blb	long p, medium G
MAGIC 96	IR95133:6-B-8-8-9-GBS	96	117	119	14	4681	5			long p
MAGIC 97	IR95133:7-B-13-3-15-GBS	97	117	106	15	3722	6			long slender G
MAGIC 98	IR95133:8-B-4-20-3-GBS	98	118	132	14	4535	6			long G
MAGIC 99	IR95133:9-B-8-16-2-GBS	99	123	113	14	3006	6			NVU, long G
MAGIC 100	IR95133:10-B-3-4-10-GBS	100	129	129	10	3442	5			long pan, long G
MAGIC 101	IR95133:11-B-8-6-22-GBS	101	119	114	13	3520	6			medium G
MAGIC 102	IR95133:12-B-6-12-17-GBS	102	121	115	14	3530	5			long G
MAGIC 103	IR95133:13-B-19-10-21-GBS	103	139	138	19	3138	6			
MAGIC 104	IR95133:14-B-3-21-6-GBS	104	121	120	18	6076	5			medium G
MAGIC 105	IR95133:15-B-11-5-3-GBS	105	117	104	15	5571	6			medium G
MAGIC 106	IR95133:17-B-21-7-19-GBS	106	125	102	15	6243	5			small medium G, clean leaves
MAGIC 107	IR95133:18-B-2-22-5-GBS	107	115	113	13	2909	7		BLB	medium G
MAGIC 108	IR95040:8-B-6-16-19-GBS	108	113	111	14	3584	6		blb	medium G with awn
MAGIC 109	IR95040:9-B-22-4-5-GBS	109	115	126	14	2890	7		blb	medium G
MAGIC 110	IR95040:10-B-5-6-23-GBS	110	113	106	12	3346	7		blb	medium G
MAGIC 111	IR95040:11-B-5-12-7-GBS	111	113	103	13	3222	7		blb	medium G
MAGIC 112	IR95040:12-B-3-10-2-GBS	112	100	111	12	1760	7		BLB	medium G
MAGIC 113	IR95041:9-B-7-5-17-GBS	113	113	92	13	2997	7		blb	medium G
MAGIC 114	IR95041:10-B-6-18-4-GBS	114	111	119	13	3732	6			long G
MAGIC 115	IR95041:11-B-4-7-8-GBS	115	113	120	15	2846	6		blb	medium G
MAGIC 116	IR95041:12-B-4-22-22-GBS	116	113	141	10	2474	7			long G with awn
MAGIC 117	IR95041:13-B-5-17-12-GBS	117	113	122	13	2910	7		blb	medium G
MAGIC 118	IR95048:4-B-6-12-20-GBS	118	118	125	14	4326	7			NU
MAGIC 119	IR95048:5-B-3-10-14-GBS	119	113	105	12	3742	7			NVU
MAGIC 120	IR95048:6-B-4-21-10-GBS	120	121	125	15	1393	7		blb	short p
MAGIC 121	IR95048:7-B-6-5-6-GBS	121	105	136	14	696	7	9		medium G
MAGIC 122	IR95048:8-B-3-3-16-GBS	122	123	106	14	3530	6		blb	medium G
MAGIC 123	IR95048:10-B-7-22-7-GBS	123	104	89	13	2405	7		BLB	short p, medium G
MAGIC 124	IR95048:11-B-9-17-9-GBS	124	123	106	17	4999	6			medium G, semi-exposed p
MAGIC 125	IR95048:13-B-11-2-3-GBS	125	117	104	13	2273	7		blb	medium G, short p
MAGIC 126	IR95051:6-B-3-13-5-GBS	126	110	141	13	182	7	9		long G
MAGIC 127	IR95051:7-B-3-10-23-GBS	127	109	125	12	1811	7	7		long G
MAGIC 128	IR95051:8-B-6-5-7-GBS	128	116	126	16	2526	7	7		long G with awn
MAGIC 129	IR95051:9-B-4-2-2-GBS	129	129	119	13	3643	6			
MAGIC 130	IR95051:10-B-6-15-13-GBS	130	110	115	14	342	7		BLB, pb	short p
MAGIC 131	IR95051:11-B-9-4-17-GBS	131	115	118	17	1740	7		BLB	medium G
MAGIC 132	IR95051:12-B-7-6-4-GBS	132	138	128	19	3850	6			
MAGIC 133	IR95051:13-B-5-12-8-GBS	133	108	134	10	2025	7	9	BLB	long G
MAGIC 134	IR95098:5-B-10-7-9-GBS	134	113	127	13	3101	7		blb	medium G
MAGIC 135	IR95098:7-B-8-23-14-GBS	135	111	113	14	3109	6		blb	medium G
MAGIC 136	IR95098:8-B-10-13-10-GBS	136	115	126	17	3953	7		blb	
MAGIC 137	IR95098:10-B-4-5-16-GBS	137	111	119	13	3217	6		blb	semi bold G
MAGIC 138	IR95098:13-B-11-4-9-GBS	138	113	110	12	3685	6		blb	medium G,
MAGIC 139	IR95128:5-B-9-20-19-GBS	139	125	104	17	1989	7			semi bold G
MAGIC 140	IR95128:9-B-20-3-2-GBS	140	125	122	14	3205	7		blb, pb	medium G
MAGIC 141	IR95128:12-B-17-11-4-GBS	141	115	96	15	1893	7		BLB	medium G
MAGIC 142	IR95128:13-B-15-3-8-GBS	142	111	145	13	1458	7			bd: 30%, tall

[1] PA= phenotypic acceptability- 3= good, 5= intermediate, 7-poor

[2] Lodging incidence (LDG)= 3= 20-40%, 5= 41-60%, 7= 61-80%, 9= 81-100%

[3] BLB(blb)-Bacterial leaf blight, Whiteheads WH(wh), Leaf spot LS(ls), panicle blast -PB(pb). Capital letters mean severe infection/infestation, small letters mean moderate

Study 6. Breeding for High Iron/Zinc Rice Varieties

Hybridization and breeding line development

- There were 100 new crosses generated involving parents with known high grain iron/zinc, high yielding ability, better resistance and good grain qualities. From the 15 F1s planted, 16crosses were selected for generation advance and 35 for single plant selection. The rest were discarded due to poor plant type and susceptibility to ShB, BLB and blast.

- A total of 567 pedigree lines with the desired agronomic traits including good to excellent kernel qualities were selected for further line selection and 70 uniform lines were elevated to Advanced Observational Nursery (AON).

Performance Trials

- Fifteen test entries better than the check were advanced to Preliminary Yield trial (PYT) during the year. Yields of the selected entries ranged from 8.5t/ha to 9.8t/ha (DS) and 4.0t/ha to 5.4t/ha (WS).
- From the PYT, 8 entries with 7.0t/ha to 8.2t/ha yields were seed increased awaiting slots in the multi-environment trial (MET).
- Three entries in MET 1 were highlighted with PR38963 (Fe)-B-5-4-2-1-1 as the highest yielding entry (9.0t/ha) higher than the best yielding check, NSIC Rc238 (7.6t/ha)).
- Two entries were also nominated to the newly composed micronutrient-dense group in the NCT-Special Purpose this 2014WS crop. PR38963(Fe)-B-7-1 ranked 2nd with yield of 5.2t/ha. MS13, the check variety had 3.5t/ha yield.

X. Ecological Engineering Approach for Pest Management

GS Arida

Agricultural systems are often designed to maximize specific provisioning services at the expense of other services and are characterized by low biodiversity. In addition, ecosystem services such as invasion resistance and pest regulation are further depressed by pesticides. In rice production, insecticide sprays especially in the early crop stages caused disruptions that can lead to outbreaks of pests such as rice planthopper.

Ecological engineering (EE) is the development of strategies to maximize ecosystem services through improving biodiversity to provide refuge, food and breeding places for predators, parasitoids and pollinators. Its main philosophy is the use of cultural techniques to affect habitat manipulation, like planting of flowering plants as source of nectar and pollen of parasitoids and in effect, enhance biological control. There is a wide acceptance of the importance of field margins as reservoirs of the natural enemies and more effective biological controls where crops are bordered by wild vegetation from which natural enemies colonize. Ecological engineering approach for pest management is new in rice and limited information is available. In fact, research on ecological engineering in rice is in its infant stage.

Studies were conducted to determine arthropod diversity and population of the different arthropod functional groups in poor and rich structured fields. Rich structured fields refer to rice fields adjacent to other vegetation like vegetables grass land, trees and other plants while poor structured fields refer to an area at the center of a large rice monoculture and at least 300 meters away from other vegetation. The second study was conducted to determine the effect of habitat manipulation through planting of flowering plants near rice field on population of important arthropod functional groups.

Highlights:

Arthropod Diversity in Good and Poor Structured Rice Fields

- Good structured field has higher species diversity with lower population of herbivores while the population of predators and parasitoids were higher compared to poor structured fields.

Effect of Habitat Manipulation through Planting of Flowering Plants near Rice Field

- Population of predators, parasitoids and species richness were higher in fields close to flowering plants compared to field without flowering plants. This could be attributed to the presence of flowering plants that serve as refuge and source of food like honey, nectar and pollen for these beneficial organisms.

- Conservation of the rich communities of these beneficial organisms in the rice ecosystem is an important component for a sustainable Integrated Pest Management (IPM) in rice. Since rice is a monoculture crop with low habitat biodiversity for beneficial organisms like parasitoids and some species of predators, they are the most affected group since they need food which is not found in the rice field. In most cases they have to fly long distances in order to feed for honey and nectar from flowering plants. Therefore it is vital for their survival and effectiveness as a biological control agent to plant these flowering plants in order to benefit from their function in the rice ecosystem. Planting of flowering plants improve habitat diversity resulting to higher arthropod species richness, higher population of predators and parasitoids in rice fields and in effect with low vulnerability for pest outbreaks.

XI. Hybrid Rice Development Consortium Multi-Location Replicated Yield Trial

LV Gramaje, KA Garcia, JE Carampatana, JM Domingo, DA Tabanao

Evaluating experimental hybrids generate substantial information on their performance in terms of grain yield, as well as their strengths and weaknesses against pests and diseases, over check varieties under local conditions. Assessment done on multiple sites ensures real time evidence of observations on these parameters across different environmental conditions. This is especially useful in identifying location-specific and season-specific hybrids. The multi-location replicated hybrid rice yield trial aims to assist members of the hybrid rice development consortium in assessing the performance of their own hybrids across a set of test locations namely India, Bangladesh, Indonesia, Vietnam and the Philippines. Test sites in the Philippines are located in Los Baños, Laguna; Science City of Muñoz, Nueva Ecija; and General Santos City.

Highlights:

- For MRYT 2014, 43 test entries were established including the check varieties PSB Rc82 and IR75217H. An entry developed by PhilRice, PR35711H, was also included in the trial and was given the code HRDC1435. It out-yielded both checks during the dry season with 10.420 t/ha. PSB Rc82 consistently ranked higher than IR75217H. It came in at 29th and yielded 9.087 t/ha during the dry season and 3rd with 7.892 t/ha during the wet season, while IR75217H followed closely at 8.896 t/ha and ranked 32nd during the dry season and 9th with 7.0 t/ha during the wet season (Table 25).

- HRDC1415 consistently topped in terms of yield for both seasons, whereas HRDC1404 and HRDC1423 were consistently in the top ten (Table 25 and 26).

Table 25. Yield and trait performance of hybrids in 2014DS at Science City of Muñoz, Nueva Ecija, Philippines.

Entry	Yield (g)	Height (cm)	Maturity (DAS)	Productive Panicles	Total Spikelet	Filled Spikelet	Unfilled Spikelet	Seedset (%)
HRDC1415	14507	108	124	15	167	144	23	85.1
HRDC1422	13172	113	126	12	228	153	75	66.3
HRDC1427	12969	116	126	12	186	115	71	62.2
HRDC1423	12627	110	127	14	197	141	56	73.0
HRDC1404	12174	108	120	12	254	159	95	63.2
HRDC1426	12103	110	127	12	211	137	74	64.5
HRDC1429	11749	107	124	12	162	143	19	88.1
HRDC1419	11318	111	127	13	168	117	51	69.5
HRDC1428	10918	117	127	15	170	117	52	68.9
HRDC1414	10902	106	122	13	191	131	60	68.9
HRDC1435	10420	110	120	15	174	114	60	65.5
HRDC1436	10370	127	127	14	205	124	81	60.6
HRDC1442	10306	90	112	13	182	132	50	73.3
HRDC1421	10076	115	122	13	180	105	75	58.2
HRDC1431	10033	113	127	14	189	113	76	60.9
HRDC1433	10011	104	127	15	172	119	53	70.5
HRDC1408	9984	110	126	14	218	141	77	64.7
HRDC1439	9911	110	122	13	194	143	52	73.0
HRDC1425	9839	121	126	12	231	138	92	59.7
HRDC1405	9766	116	120	14	183	142	42	77.7
HRDC1418	9632	131	126	15	184	103	82	56.2
HRDC1441	9618	99	112	13	163	131	32	80.6
HRDC1434	9452	105	117	13	229	138	91	60.6
HRDC1440	9375	107	115	12	149	122	27	81.9
HRDC1407	9358	115	120	13	212	150	62	72.2
HRDC1409	9244	115	122	13	181	124	57	67.9
HRDC1401	9194	108	126	14	223	116	108	52.1
HRDC1438	9089	107	115	12	155	128	26	82.6
HRDC1446	9087	95	112	16	147	124	23	84.5
HRDC1410	9055	108	120	13	168	110	58	65.4
HRDC1403	8931	102	112	14	144	124	20	85.8
HRDC1445	8896	104	117	14	164	96	68	58.3
HRDC1406	8854	110	117	12	213	163	50	77.6
HRDC1424	8799	120	127	13	216	116	100	52.1
HRDC1444	8686	105	119	13	170	113	57	66.6
HRDC1417	8657	117	117	13	224	158	66	70.5
HRDC1443	8632	101	112	14	157	111	46	70.0
HRDC1437	8189	135	122	14	180	124	55	69.8

Table 26. Yield and trait performance of hybrids in 2014WS at Science City of Muñoz, Nueva Ecija, Philippines

Entry	Yield (g)	DTH	Maturity (DAS)	Height (cm)	Productive Panicles	Total Spikelet	Filled Spikelet	Unfilled Spikelet	Seed (%
HRDC1415	8921	84	117	120	10	220	142	78	64.
HRDC1444	7933	83	114	116	11	198	111	87	56.
HRDC1446	7892	87	119	124	13	115	84	32	72.
HRDC1414	7834	88	119	118	11	173	135	38	77.
HRDC1410	7771	87	118	115	15	150	97	52	66.
HRDC1404	7454	83	118	125	11	175	89	87	51.
HRDC1408	7261	81	112	113	11	243	125	118	51.
HRDC1423	7100	85	116	121	12	165	116	50	69.
HRDC1445	7000	80	112	116	11	182	111	70	61.
HRDC1406	6984	87	118	130	15	158	103	55	65.
HRDC1426	6755	91	123	118	15	146	63	83	42.
HRDC1409	6622	81	112	132	13	173	126	48	72.
HRDC1429	6560	86	119	132	11	136	87	49	63.
HRDC1420	6546	82	114	151	11	165	100	64	60.
HRDC1437	6538	84	116	151	13	146	103	43	69.
HRDC1424	6479	88	120	126	10	206	114	92	54.
HRDC1425	6461	86	118	136	11	202	104	97	51.
HRDC1407	6434	86	118	131	12	222	140	82	63.
HRDC1432	6345	85	117	139	10	160	95	65	58.
HRDC1436	6331	81	112	127	12	149	83	67	54.
HRDC1419	6306	84	114	121	12	178	122	55	69.
HRDC1418	6266	85	116	133	12	116	67	49	56.
HRDC1417	6080	83	116	128	13	136	72	64	52.
HRDC1438	6005	86	117	119	13	146	90	56	62.
HRDC1428	5990	86	117	123	14	145	76	69	52.
HRDC1435	5940	80	112	117	12	141	83	58	59.
HRDC1433	5871	82	111	113	11	155	88	67	56.
HRDC1434	5829	82	112	112	11	130	75	55	58.
HRDC1401	5704	81	112	105	11	188	91	97	48.
HRDC1403	5559	80	112	120	10	163	92	71	57.
HRDC1402	5206	86	118	139	13	161	75	87	48.
HRDC1441	5204	81	112	108	9	135	55	80	42.
HRDC1421	4917	80	112	117	10	221	113	108	51.
HRDC1443	4518	86	112	132	14	164	97	66	59.
HRDC1442	4446	81	111	107	12	147	67	80	45.

XII. Increasing Farmers' Access to High-Quality Rice Seeds through Efficient Seed Production Systems

EB Gergon, J Paraguison, R Undan, AB Mataia

The project funded by DOST-PCAARRD officially started on July 01, 2012 for a four-year implementation in three pilot provinces in the country--Ilocos Norte, Leyte, and Sultan Kudarat. It aims to enhance the capabilities of SUC-SeedNet members and rice farmers to produce and use high-quality rice seeds for a viable seed supply system, increase farmers' yield by at least 10%, and contribute in increasing national rice production and reducing rice importation. The project has four components: (1) Enhancing seed production system for SUC-SeedNet members with scientific interventions; (2) Enhancing seed production system for farmers through training and project-guided seed production system and monitoring; (3) Production of information, education, and communication (IEC) materials on quality seed production, and (4) Monitoring and impact evaluation.

The project provided initial 2kg of new and pure seeds of Green Super Rice (GSR) and registered seeds of newly released NSIC rice varieties to farmers and partner SCUs---Mariano Marcos State University (MMSU) and Sultan Kudarat State University (SKSU). It also conducted varietal demonstrations cum seed increase, multi-location test of GSR in farmers' fields, rice technology adoption trials, farmers' field days, and retooling of seed growers. The project is more than just giving seeds. It trained selected farmers on how to produce and maintain quality inbred rice seeds prior to seed dissemination and distribution, apply natural farming systems and efficient yield-increasing seed production technologies, and field follow through. It also conducted monitoring and assessment of interventions to determine if the project achieved its objectives. An impact assessment to assess the overall performance of the project will be done after the completion of the implementation of the project.

Highlights:

- Dissemination and distribution of GSR and certified seeds for 2014 WS cropping with 2,590kg seeds to 708 farmers in Leyte and 640kg to 320 farmers in Sultan Kudarat.

- Establishment of varietal demonstration trial cum seed increase of new Green Super Rice (GSR) lines and Korean varieties in Sultan Kudarat in collaboration with Sultan Kudarat State University.

- Technology demonstration on the application of computer based-Crop Manager in collaboration with Sultan Kudarat State University

- Printing, reproduction, and dissemination of a book on "Farmers' Primer on Production of Quality Inbred Rice Seeds" and compact video in Tagalog on "Usapang Magsasaka: Pagpaparami ng purong binhi ng palay". These educational and campaign materials can serve as bible for the farmers every time they grow rice for seeds.

- A baseline survey to farmer beneficiaries prior to the project implementation was conducted to establish key impact indicators which will be used as basis for measuring the outcome of the project interventions.

- Seasonal monitoring survey after 2013 DS and 2014 WS harvest was carried out to evaluate the results of the project interventions particularly the impact of the 2kg seeds in facilitating adoption of HQS and the provision of training to farmers on improving and maintaining rice seed quality.

XIII. Green Super Rice (GSR) for Resource-poor Farmers of the Philippines

TF Padolina, RC Braceros, LR Pautin, JF Parinas, MT Garcia, JM Dancel (PBBD); AM Corales, VL DeGuzman (TMS), EB Gergon, RV Undan (PhilRice LB)

The Green Super Rice project Phase II was launched in the Philippines in 2011 to assess the relative merits offered by the GSR materials/lines. These products were developed by conventional methods, large-scale molecular breeding process and highly efficient genotyping platform. Access to the GSR materials was made possible through the NCT (Spell out NCT) system as well as the multi-tiered multi-environment trials (MET) initiated by IRRI for early generation materials. There are 3 successive stages in the MET before it gets nominated to the NCT. In these stages, their stability and adaptability across contrasting environments are assessed. Following the guidelines and policies of the NCT, any GSR promising lines can be a potential commercial variety. Another pathway was the informal seed system which disseminated the climate smart GSR lines in rainfed rice areas in Tarlac, Nueva Ecija, Ilocos Norte, Leyte and Sultan Kudarat. Farmers were introduced to high production technologies by conducting on-farm adaptability trials, farm walks, field visitation and Lakbay Aral activities.

Highlights:

- Varieties identified through the formal Multi-Environment Trials (Stages 0, 1, 2 and NCT).

Under the MET system, the GSR materials were evaluated along with the breeding materials bred by IRRI and PhilRice and compared to standard check varieties. Five key sites representing contrasting environments were utilized using row-column experimental design with two replications. Poor performing lines were eliminated and the best ones were advanced to the next stage, Stage 1 and later on to Stage 2 before it went to NCT. They were tested in both dry and wet seasons before advancing to the next stage by assessing yield performance and adaptation across environments, pest resistance, and good grain quality. In 2014, there were 766 test entries including 72 GSRs and 8 maturity and yield checks in the MET (Table 27).

In the NCT, there were 31 GSR entries with active evaluation in 2014, 26 were in the various ecosystem trials, 2 were advanced to the Multi-adaptation Trials, and 3 promising lines were recommended by the RTWG, passed Technical Secretariat and were approved by the NSIC as presented in Table 28, namely: irrigated lowland including special purpose types (11), saline-prone (5), upland (5), rainfed dry-seeded (4), and cool elevated areas (6). By the end of the year in November 28, 2014, three GSR lines were approved for commercialization: IR83140-B-28-B and IR84675-58-4-1-B-B, named as NSIC 2014 Rc390 (Salinas 19) and NSIC Rc2014 Rc392 (Salinas 20), for saline-prone areas, respectively. Also, IR83140-B-36-B was accredited as NSIC 2014 Rc29 (Katihan 4) for the uplands.

- Locally-adapted GSR lines under the informal seed dissemination system in rainfed drought-prone areas

Province of Tarlac & Nueva Ecija

The informal seed dissemination of five lines (GSR IRI-1, GSR IRI-5, GSR IRI-8, and GSR IRI-12 and NSIC Rc138) was done in 2013 WS. Seeds were multiplied and again disseminated through seed exchange in 2014 DS. There were 30 participating farmers and the total area was planted to more than 10 hectares (102,417sq.m). Under the farmer's management practices, yields of the GSR lines ranged from 3.3 to 4.3t/ha as compared to the local check used with 3.2 t/ha (Table 29).

In 2014 DS with additional lines such IR83142-13-21-13, GSR IRI 2-Y3-D1-SU-LI, GSR IRI 5-D7-Y3-S1, and GSR IRI

15-513-Y1, on farm adaptation trial was implemented with technical assistance from PhilRice and DA-LGU staff. As a result, during the Farm Walk Activity and Evaluation on Feb. 4, 2014, GSR IRI 1 emerged as the most preferred with farmer's comments on its drought resistance, higher yield and adaptation than the local check in the area. GSR IRI 1 produced a computed yield of 7.8 t/ha for GSR 1 as compared to NSIC Rc138 with only 5.0 t/ha (Table 30). In the same season, more farmers in the adjacent municipalities in Gerona, Camiling, Moncada, and Pura, Tarlac, and Nampicuan, Nueva Ecija were able to access the seeds for planting in the next WS. As a result (Table 32), GSR lines exhibited better yields (6.82 to 8.38t/ha) with GSR IRI 1 as the highest. To further assist the famers, in cooperation with the Department of Agriculture-Mayantoc and a non-government entity, Tulay sa Kaunlaran (TSPI), a Farmers' Field School was conducted every Wednesday in the original demo site in Rotrottooc, Mayantoc, Tarlac and was attended by 32 farmers.

Sultan Kudarat

Seeds of 4 GSR lines (GSR 1, 12, 8 and 5) were further distributed to 140 farmers in Sultan Kudarat, Leyte and Ilocos Norte initially in 2013 including a demo cum seed production Sultan Kudarat State University (SKSU). Most number of farmer recipients were in Sultan Kudarat followed by Ilocos Norte and Leyte (Table 33). Tracking of the seeds is in progress in Sultan Kudarat. In the same area, the Rice Crop Manager (RCM) application software was introduced to farmers in Lutayan, Sultan Kudarat as a decision tool for improving farm productivity. A comparison trial was established to show them the benefits of maximizing inputs for better efficiency. The use of RCM, RCM+ and farmer's practice were compared using 6 inbreds including 2 GSR lines. Under the irrigated conditions, yield of GSR 8 and 12 is not significantly different (Table 34). GSR 8 differed significantly with NSIC Rc286. Under rainfed conditions, GSR 8 has the highest yield among the varieties, particularly under RCM+ (Table 35).

Table 27. Profile of the MET entries including GSR lines, 2014.

Stage/ No. of sites	Number of test entries (TE), GSR, and check varieties	
	2014 (DS & WS)	
	Test entries + check	GSR lines
MET 0/ 5	472, 8 checks	45
MET 1/ 7	220, 8 checks	25
MET 2/ 7	74, 8 checks	2
TOTAL (TE)	**766**	**72**

TE– entries nominated by breeding teams of IRRI & PhilRice

Table 28. Summary of nominated GSR lines in the NCT, 2011 WS to 2014 WS.

ECOSYSTEM/ LINE DESIGNATION	YEAR/SEASON IN THE NCT	STATUS/REMARKS
1. NCT 1		
Group I		
HHZ3-SAL13-Y1-SAL1 (tpr)	2013DS-2014WS	Retain (R) 2014WS
GSR IR1-5-D7-Y3-S1 (dsr)	2013WS-2014WS	R 2014WS
GSR IR1-1-D1-D1-Y1-D3 (dsr)	2014DS-2014WS	R 2014WS
Group II		
HHZ-2-Y13-DT1-DT1 (tpr/dsr)	2012DS-2013WS	**Elevated to MAT, 2014WS**
HHZ8-SAL6-SAL3-DT1 (dsr)	2012DS,12WS, 13WS	**Elevated to MAT, 2014WS**
HHZ14-SAL13-L12-DT1 (tpr)	2013DS-2014WS	R 2014WS
GSR IR1-21-Y4-Y2-Y1 (tpr)	2013WS-2014WS	R 2014WS
GSR IR1-22-T3-D1-Y1 (tpr)	2013WS-2014WS	R 2014WS
GSR IR1-23-D16-D1-D1 (dsr)	2013WS-2014WS	R 2014WS
2. SPECIAL PURPOSE		
GSR IR1-S5-Y2-Y1 (A)	2013WS-2014WS	R 2014WS
GSR IR1-14-Y7-Y1-D2 (A)	2014WS	New (N) 2014WS
3. SALINE		
IR83140-B-28-B	**2011WS-2013DS**	**Approved as NSIC Rc390**
IR84675-58-4-1-B-B	**2011WS-2013DS**	**Approved as NSIC Rc392**
GSR IR1-12-S2-Y3-Y2	2013WS-2014WS	R 2014WS
HHZ8-SAL6-SAL3-Y2	2013WS-2014WS	R 2014WS
GSR IR1-12-D10-S1-D1	2014WS	N 2014WS
4. UPLAND (WS only)		
IR83140-B-36-B	**2011WS-2013WS**	**Approved as NSIC Rc229**
GSR IR1-2-Y3-D1-SU1-L1	2013WS-2014WS	R 2014WS
HHZ-15-SAL13-Y1	2013WS-2014WS	R 2014WS
HHZ19-SAL14-Y1	2013WS-2014WS	R 2014WS
GSR IR2-1-L1-L1-L2	2014WS	N 2014WS
5. RAINFED DRY SEEDED (WS only)		
IR83142-B-19-B	2011WS-2014WS	R 2014WS
GSR IR1-6-Y2-Y1-DT1	2013WS-2014WS	R 2014WS
GSR IR1-3-S6-Y1-Y1	2013WS-2014WS	R 2014WS
HHZ8-SAL6-SAL3-Y2	2013WS-2014WS	R 2014WS
6. COOL ELEVATED (WS)		
IR83140-B-11-B	2011WS-2014WS	R 2014WS
IR83140-B-28-B	2011WS-2014WS	R 2014WS
TME 80518	2013WS-2014WS	R 2014WS
WTR1	2013WS-2014WS	R 2014WS
GSR IR1-6-S9-L2-Y1-Y1	2014WS	N 2014WS
GSR IR1-18-D4-Y1-L1-L1	2014WS	N 2014WS

R- retain in the trial; N-new

Table 29. Computed yields of GSR lines under farmer's management practices of 38 participating farmers in Rotrottooc, Mayantoc ,Tarlac, 2014 DS.

DS 2014	GSR IRI 1	GSR IRI 5	GSR IRI 8	GSR IRI 12	GSR only	Mestizo 29	Overall performance
No. of farmers	3	10	5	11	29	9	38
Area planted, m^2	4,885	22,058	9,864	32,975	69,782	32,635	102,417
Actual yield, kg	1,617	9,310	3,748	14,156	28,831	10,326	39,157
Computed yield, t/ha	3.3	4.2	3.8	4.3	4.1	3.2	3.82

Table 30. Computed yields of GSR lines in the demonstration farm in Rotrottooc, Mayantoc Tarlac , DS 2014.

DS 2014	GSR IRI 1	GSR IRI 5	GSR IRI 8	GSR IRI 12	GSR only	NSIC Rc138	Overall performance
Area planted, m^2	450m^2	450m^2	450m^2	450m^2	1,800m^2	450m^2	2,250m^2
Actual yield, cav	7	6	5	4.5	22.5	4.5	27
Computed yield, t/ha	7.78	6.67	5.56	5.00	6.25	5.00	5.63

Table 31. Results of the farmer demo farm, Nueva Ecija and Tarlac. 2014 WS.

Location	Name of farmer	GSR 1		GSR 5		GSR 8		GSR 12		Overall performance t/ha
		Area planted	Yield, t/ha	Area planted	Yield, t/ha	Area planted	Yield, t/ha	Area planted	Yield, t/ha	
Nampicuan, N. E.	Jimmy Pascua	.0397	11.34			.0866	6.35	.0512	9.77	9.15
Gerona, Tarlac	Winnie Lactaotao	.0249	9.76	.0386	6.85	.0369	7.67	.0372	7.04	7.83
Pura, Tarlac	Vicente Cariaso	.0236	6.35	.0292	6.80	.0379	6.59	.0423	7.09	6.71
Mayantoc, Tarlac	Victorio Abalos	.0150	6.07			.0150	9.33	.0150	7.20	7.53
Total Area Planted, ha		0.1032		0.0678		0.1764		0.1457		0.4931 ha
Average yield, t/ha			8.38		6.82		7.48		7.78	7.62 t/ha

Table 32. List of farmer-recipients for the GSR lines in the techno-demo cum seed production trials, 2013.

PROVINCE		G S R LINES (kg)			
Municipality	# farmers	IRI 1	IRI 5	IRI 8	IRI 12
SULTAN KUDARAT					
Lutayan	16	8	0	10	13
Columbio	10	14	0	2	6
Bagumbayan	6	6	0	6	6
Pres. Quirino	10	5	0	7	9
Isulan	8	12	0	12	9
SNA	13	7	0	7	13
SKSU		74	2	64	56
Total	63	126	2	108	112
LEYTE					
Capoocan	8	6	0	4	6
Dagami	11	7	0	7	5
Tanauan	9	7	0	5	7
Total	28	20	0	16	18
ILOCOS NORTE					
Adams	10	8	0	4	8
Bangui	12	5	0	7	9
Dumalneg	8	6	0	8	2
Pagudpud	17	12	0	11	13
OPAG Laoag City	2	1	0	1	
MMSU		3	2	3	3
Total	49	35	2	34	35
GRAND TOTAL	140	181	4	158	165

Table 33. Rice Crop Manager application under irrigated ecosystem, SKSU, Lutayan, S. Kudarat, 2014 WS.

Fertilizer Mgt	Yield. Kg/ha	#Grains/ panicle	Plant height, cm	Days to maturity
RCM+	4912.8	205.8a	110.5a	
RCM	4554.6	189.8b	117.8ab	
Farmers' practice	4702.2	186.5b	103.5b	
Variety				
NSIC Rc158	4643.7ab	187bc	117.1a	106.7
NSIC Rc238	4530.9ab	203a	108.9ab	104.7
NSIC Rc282	4837.2ab	185c	121.8a	108.7
NSIC Rc286	4114.9b	186bc	111.1ab	107.7
GSR 8	5278.6a	204a	99.2b	103.7
GSR 12	4934.0ab	200ab	105.8ab	104.7

Table 34. Rice Crop Manager application under rainfed ecosystem, SKSU, Lutayan, S. Kudarat, 2014 WS.

Fertilizer Mgt	Yield. Kg/ha	#Grains/ panicle	Plant height, cm	#Productive tillers
RCM+	4210a	193	101.0	27.8
RCM	3642b	196	103.5	27.2
Farmers' practice	3798b	196	103.8	27.5
Variety				
NSIC Rc158	3979b	207ab	99.1b	26.2b
NSIC Rc238	3875bc	196bc	100.0b	28.3a
NSIC Rc282	3582bc	194c	111.3a	29.4a
NSIC Rc286	3408c	172d	108.6a	26.3b
GSR 8	4479a	208a	97.5b	26.3b
GSR 12	3979b	193c	99.1b	28.3a

XIV. Detection of Rice Viruses in Infected Plants and Viruliferous Insect by Loop Mediated Isothermal Amplification (LAMP) and its Application for Virus Disease Management in the Philippines Rice Cropping System

ER Tiongco

Highlights:

- LAMP detected the rice tungro bacilliform virus (RTBV) in asymptomatic plants that later developed recognizable tungro symptoms. It detected RTBV a day after inoculation; besting by two days the earliest time RTBV is detectable by enzyme-linked immunosorbent assay (ELISA).

- LAMP detected the rice ragged stunt virus (RRSV) not only in infected rice plant but also in the Brown Planthopper (BPH) vector. This is the first report of RRSV detection in BPH using the LAMP technique. Detecting the virus in the insect vector would forestall the impending threat of spread of persistent-circulative insect-borne virus in the field.

- LAMP assay detected RTBV and RTSV in field collected rice plants from Isabela, Negros, and Midsayap PhilRice branch stations during the 2014 wet season (WS) and 2015 dry season (DS) cropping. Generally, the LAMP results conformed to the visual assessment of symptoms of the plants.

- Unsuccessful detection by LAMP of RTBV in plants collected in Midsayap branch station during the 2014 WS and 2015 DS cropping was obtained. It is suspected that a different RTBV strain prevails in the area that is considered a tungro “hotspot”.

- The optimization studies revealed that LAMP assay should be done in a cautious and fastidious manner under aseptic conditions to avoid false-positive results. It is considered that LAMP would play an important role as a confirmatory test device and may also be suitable for routine high capacity virus detection exercise under appropriate molecular laboratory conditions.

XV. Smart Farming-Based Nutrient and Water Management for Rice and Corn Production

EB Sibayan

Assessing water-use efficiency of rice in different water-saving technologies using stable isotope techniques

KS Pascual, FS Grospe, AP Sabasaje, RMS Martin

Nuclear and isotopic techniques are very valuable tools in assessing the soil nutrient and water productivity in rice production. This study aims to increase the water-use efficiency of the different irrigation techniques in rice using smart-farming technologies through nuclear analytical techniques. Stable isotopes as tracers were used to measure the rate of uptake, storage, and cycling of water in the soil and plants. There were four water management techniques laid out in RCBD with four replications and were established during the 2014 dry and wet seasons. The treatments consisted of continuously flooding or CF (maintained water level at 2 to 5cm depth); Alternate-wetting and drying or AWD (irrigating the field when water depth reached 15cm below soil surface); Mid-season drainage or MSD (withdrawn flood water 7 to 10 days before panicle initiation); and Saturated condition or SSC (irrigated the field at 2 to 3cm water depth when there is no visible surface water).

Highlights:

- In 2014 DS, 35% water savings was generated using AWD when compared with CF with irrigation water use of 342mm in AWD and 523 in CF; During wet season, more than 80% of the total irrigation used came from rainfall (Table 35 and 36).

- A significant lower irrigation frequency (number of irrigation events) was obtained in AWD when compared with CF and SSC in which the reduction was almost double from the traditional practice (CF);

- Grain yield was not significantly affected by water management, with grain yield ranged from 6.2 to 6.7 and 5.4 to 5.6t/ha in dry and wet seasons, respectively.

- A significant high water productivity with respect to irrigation input was obtained in AWD (1.8g grain per kg water) compared with CF and SSC (1.2g grain/ kg water). The water productivity was attributed by high grain yield but lower irrigation input. The same trend was also observed in the water productivity with respect to irrigation plus rainfall (Table 37).

- Results of the isotopic analysis are still in progress (PNRI did not yet provide the results).

Table 35. Frequency of irrigation, % savings and yield, 2014

Water Management Techniques	Dry Season			Wet Season		
	Irrigation frequency (days)	% Savings	Yield (Tons/ha)	Frequency of Irrigation	% Savings	Yield (Tons/ha)
CF	15[b]	control	6.5[a]	3[a]	control	5.4[a]
AWD	8[d]	35%	6.2[a]	1[b]	76%	5.4[a]
SSC	17[a]	-1%	6.3[a]	3[a]	22%	5.6[a]
MSD	14[c]	5%	6.7[a]	3[a]	11%	5.5[a]

*means in column with the same letters are not significantly different at 5% level using LSD. CF- continuously flooding; AWD- alternate-wetting and drying; SSC-saturated soil culture; and MSD-mid-season drainage

Table 36. Total volume of water applied from the start of implementation of water management up to maturity, 2014.

Water Management Techniques	Dry Season			Wet Season		
	Irrigation (I)	Rainfall (R)	Total	Irrigation (I)	Rainfall (R)	Total
CF	523[a]	0	523[a]	105[a]	531	636[a]
AWD	342[b]	0	342[b]	25[c]	531	556[c]
SSC	527[a]	0	527[a]	82[b]	531	613[b]
MSD	496[a]	0	496[a]	94[ab]	531	625[ab]

* means in column with the same letters are not significantly different at 5% level using LSD. CF- continuously flooding; AWD- alternate-wetting and drying; SSC-saturated soil culture; and MSD-mid-season drainage

Table 37. Water productivity (g grain/kg of water) of different water regimes, 2014.

Water Management Techniques	Dry Season		Wet Season	
	(I)	(I+R)	(I)	(I+R)
CF	1.2[b]	1.2[b]	5.3	0.9[a]
AWD	1.8[a]	1.8[a]	14.6	1.0[a]
SSC	1.2[b]	1.2[b]	7.1	0.9[a]
MSD	1.4[b]	1.4[b]	6.4	0.9[a]

* means in column with the same letters are not significantly different at 5% level using LSD.. CF- continuously flooding; AWD- alternate-wetting and drying; SSC- saturated soil culture; and MSD-mid-season drainage

XVI. Genetic Improvement for Upland Rice Through Marker-Assisted Selection (MAS) for Tolerance to Phosphorus Deficiency

VC Lapitan, MJT Mercado

Phosphorus (P) deficiency is a major abiotic stress that limits plant growth and yield in upland rice production in many parts of the world (Sahrawat et al., 2001). It has lower productivity as compared with both irrigated and rainfed lowland rice, which contributes only about 0.3 percent of the Philippines total rice production (BAS, 2009). Omission of P (- P) nutrient in the soil under the pot experiment caused yield loss of rice between 33 to 50% (Mukhopadhyay et al. 2008). Several approaches such as application of P fertilizer and irrigation enhancements can be employed to lessen the effect of low P availability and mitigate drought stress. However, the lack of locally available P sources and the high cost of importing and transporting fertilizers prevent many resource-poor rice farmers from applying P. On the other hand, excessive application and use of P fertilizers particularly rock phosphate (RP) is potentially and environmentally undesirable. The development of phosphorus uptake (Pup1) rice cultivars may be an attractive and cost effective approach to increasing rice yields where P deficiency is the major constraint (Chin et al. 2010, Ismail et al. 2007). Pup1 is a major quantitative trait locus (QTL) located on rice chromosome 12 which confers tolerance of P deficiency in soil (Wissuwa et al., 1998, 2002).

More rapid progress in breeding may be achieved through the application of modern molecular approaches such as marker-assisted selection (MAS) and double haploid technique. Marker-assisted selection would be advantageous in selecting for complex traits, pyramiding of multiple genes and in backcrossing (Mackill and Ni, 2001; Ribaut and

Hoisington 1998). Double haploid systems allow rapid generation of homozygous lines, which improves breeding efficiency by reducing the amount of time required to develop fixed lines. Furthermore, DH-based breeding systems should allow breeders to select elite genotypes that may have been missed during conventional breeding. Apparently, the combination of the MAS and doubled haploid techniques can be a powerful tool in the breeding program for upland rice and can be a faster way for success with much more certainty.

Highlights:

- Figure 29 shows the schematic diagram of the integrated application of MAS and dihaploidy technique in rice breeding for tolerance to P-deficient condition being employed in the study.

- The germplasm survey with molecular markers associated with Pup1 was conducted. Pup1 is a major quantitative trait locus (QTL) which confers tolerance of P deficiency in soil. From a total of 93 rice germplasm surveyed with Pup1 markers (65 elite rainfed lines, 19 rainfed and 1 upland varieties; 7 doubled haploid lines; and 1 traditional variety), 30 genotypes were identified as tolerant to phosphorus deficiency while the remaining 63 were intolerant to such stress. Figure 30 shows some of the genotypes surveyed with Pup1 gene-based markers.

- Among the genotypes, 12 were selected for evaluation at seedling stage under phosphorus (P) deficient condition in the screenhouse. Variation in terms of their response to P deficiency was observed among them. All the genotypes produced more lateral roots under minus P (–P) condition (Figure 31). Salumpikit, NSIC Rc14, PR39495 VAC 3485, Palawanin, Azucena, and PR40858-NSIC Rc9-M4R-338 were found more responsive to P insufficiency by producing longer roots and higher root dry weights under –P condition.

- To further evaluate the germplasm, adaptability trial of the 12 genotypes was conducted in P deficient soil condition in Brgy. Layug, Cavinti, Laguna in 2014 wet season. The following were the 12 varieties evaluated:

  - PSB Rc11
  - PSB Rc14
  - PSB Rc 60
  - PSB Rc 62
  - NSIC Rc138

- NSIC Rc146
- NSIC Rc152
- NSIC Rc238
- NSIC Rc240
- PR39495VAC3485
- PR39495VAC3706
- Vandana

- The experiment was laid out using the Randomized Complete Block Design with three replications. To determine the level of P deficiency as well as other nutrients in the soil, analysis of the samples collected from Cavinti, Laguna was performed. The following were the results of the analysis: pH – 4.7; OM – 3.32%; P – 1.0 ppm; K – 0.11 me/100g soil.

- Based on survey using Pup1 markers and agro-morphological characterization, four modern rice varieties (NSIC Rc238, NSIC Rc240, PSB Rc82, and NSIC Rc222) were selected as recipients of Pup1 gene from the Vandana genotype. Four cross combinations were produced: NSIC Rc238 x Vandana, NSIC Rc240 x Vandana, PSB Rc82 x Vandana, and NSIC Rc222 x Vandana. .

- A total of 298 F1s were produced from the four cross combinations from which 76 were genotyped using Pup1 marker. Foreground selection using K29-1 on the 21 day-old F1 seedlings revealed that Pup1 gene was present on 44 out of 76 F1 seeds (Table 39). Figure 32 shows sample bands of the F1 materials surveyed using K29-1 marker.

- The F1 materials carrying Pup1 gene were utilized accordingly in the generation of different elite lines such as near isogenic lines (NILs), recombinant inbred lines (RILs) and doubled haploid lines (DHLs). For NILs, out of 142 BC1F1 genotyped 105 were selected with Pup1. The MAS selected BC1F1 were further backcrossed with the respective recurrent parents to generate BC2F1. Foreground selection was performed using the following markers; K46-1, K20-2, and K29-1 from which 47 backcross progenies were selected and further advanced to BC2F2 in 2015 DS.

- For RILs, 91 F2 plants were selected through MAS out of 170 being genotyped in 2014 DS. The materials were further advanced to F3 generation in 2014 WS and those progenies selected based on morphological traits are now being evaluated under upland condition.

- Figure 33 shows sample bands of the F2 and BC1F1 materials using markers while Table 3 shows the results of selection in F2 and BC1F1 populations among the four cross combinations in 2014 DS. Among the four crosses, NSIC Rc222 x Vandana had the highest percentage of plant selection with Pup1 gene using the three markers followed by PSB Rc82 x Vandana for both F2 and BC1F1 populations. Very few plants were selected for NSIC Rc240 x Vandana for both F2 and BC1F1, 5% and 10% respectively, while for NSIC Rc238 x Vandana, at least 53% F2 plants were selected and none for BC1F1.

- In relation with the doubled haploid production (Figure 34), selected F2 materials with Pup1 gene were utilized for anther culture to generate doubled haploid lines. Anthers were plated in the callus induction medium with N6 basal salts supplemented with 2.0mg/l 2,4-D + 1.0mg/l NAA + 0.5mg/l Ki + 50g/l maltose. Cultures were incubated under dark condition. Callus induction was observed on some of the genotypes plated.

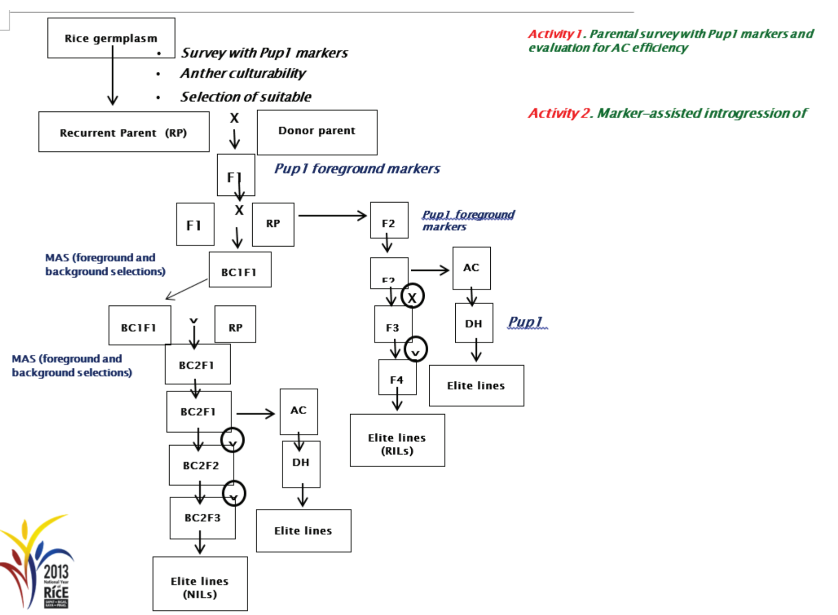

Figure 29. Integrated application of MAS and dihaploidy technique in rice breeding for tolerance to P-deficient conditions

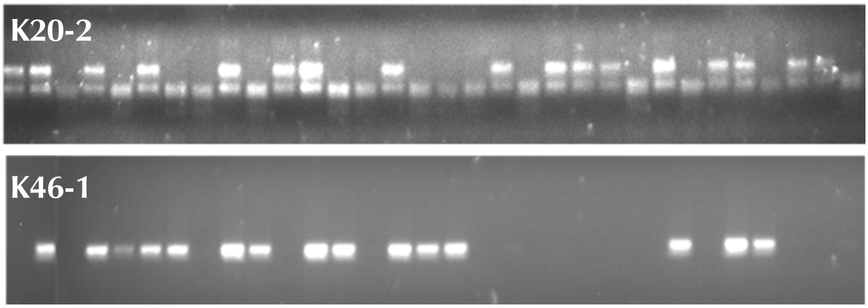

Figure 30. Sample of germplasm survey with Pup1 gene-based markers; K20-2 (co-dominant marker) and K46-1 (dominant marker) on some of the 93 genotypes.

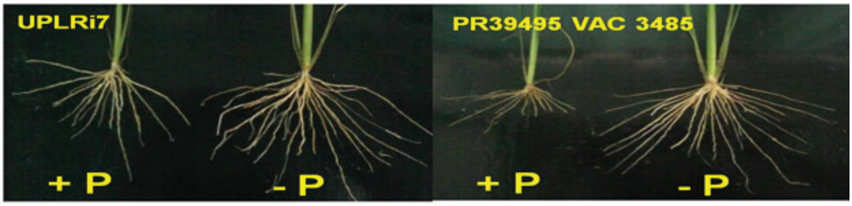

Figure 31. Root formation of UPL Ri7 and PR39495 VAC3485 (DH line) under +P and –P conditions

Table 38. Number of F1 seeds generated from the different cross combinations and identified with Pup1 gene using gene-based markers.

Cross	Total F1 generated	No. of F1 genotyped	No. of true F1 with Pup1 gene
NSIC Rc238 x Vandana	32	20	9
NSIC Rc240 x Vandana	50	20	1
PSB Rc82 x Vandana	107	16	14
NSIC Rc222 x Vandana	109	20	20

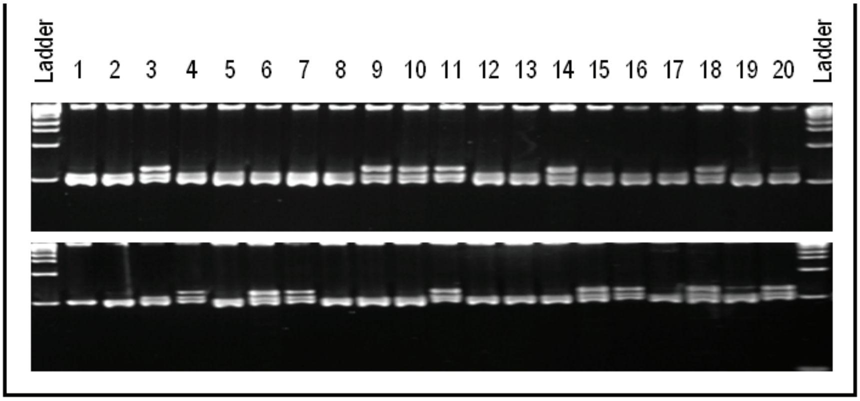

Figure 32. Sample genotypes of the F1 seedlings produced from NSIC Rc222 x Vandana (upper gel) and NSIC Rc238 x Vandana (lower gel). Double bands = F1 materials; Single bands = either one of the parents.

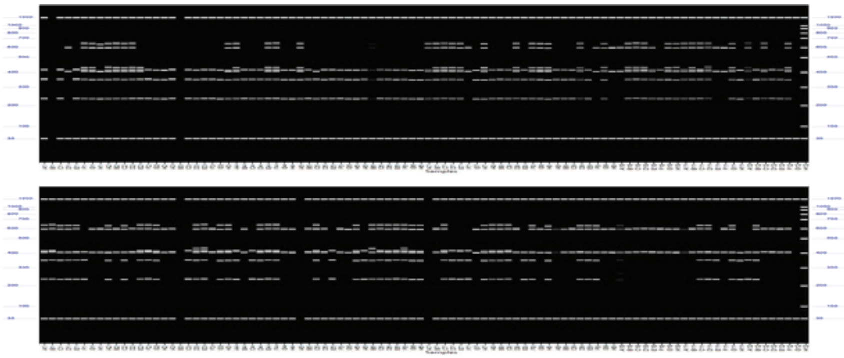

Figure 33. Sample genotypes of some BC1F1 plants (upper gel) and F2 plants (lower gel) using K46-1

Table 39. Number of F2 and BC1F1 plants selected with Pup1 markers during 2014 DS.

Cross	F2 population		BC1F1 population	
	Selected	% Success	Selected	% Success
NSIC Rc238 x Vandana	16	53	0	0
NSIC Rc240 x Vandana	2	5	2	10
PSB Rc82 x Vandana	32	64	57	89
NSIC Rc222 x Vandana	41	68	46	96

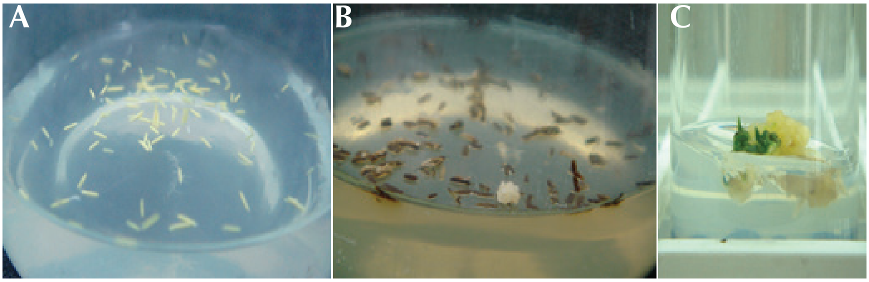

Figure 34. Production of doubled haploid lines through anther culture; A) Plated anthers in the culture medium, B) Callus induction, C) Plant regeneration.

XVII. Philippine Rices as Substrates in the Production and Utilization of Biopigments from Monascus Purpureus Went

HF Mamucod, MV Romero, and EI Dizon

The fungus Monascus purpureus has been the subject of extensive research because of its potential as natural colorant and dietary supplement. The fungus is traditionally cultivated on starch-containing substrate such as rice, resulting in a fermented product known as red mold rice (RMR) or angkak. This product is used commonly in Asia as a natural food colorant in fish, soy cheese, red wine, rice koji, meat, and meat products such as sausages. Mevinolin or monacolin K, the active component of RMR, is considered a cardiovascular agent capable of reducing total cholesterol, low-density lipoprotein, and triglyceride levels. In the Philippines, RMR is used for coloring burong isda (fermented fish and rice) and bagoong (fermented fish paste). Imported either from Taiwan or China, the availability of RMR is seasonal and very limited. It is found only in few areas, particularly in Central Luzon, where fermented fish products are processed. Because of its enormous economic and health potential, production of RMR locally would be a lucrative venture. Thus, this research aimed to generate vital information that can propel the possible production of RMR in the country and to maximize its utilization. Specifically, it sought to identify mold isolate and suitable Philippine rice variety for maximum pigment production, to develop efficient processing technologies for RMR production and pigment extraction, to generate data on the antioxidant activity, total phenolic content, antimicrobial properties, and mevinolin content of Monascus pigments, to evaluate shelf-life and identify suitable packaging for RMR or Monascus pigments, and to enhance the utilization of Monascus pigments through development of value-added products.

Highlights:

- Ten Monascus isolates were screened for pigment production. Among the isolates, B2 produced the pigments with highest optical density (2701.42 AU/g dry wt.) using potato dextrose (PD) broth during submerged culture fermentation. This was followed by B1 (818.25 AU/g dry wt.). The optical densities of the pigments produced by the other isolates ranged from 46.52 to 343.55 AU/g dry wt (Figure 35). No significant differences were observed among the biomass of the isolates. In solid-state fermentation, B2 also gave the pigment with the highest optical density (729.18 AU/g dry wt.), followed by B1 (556.72 AU/d dry wt.) (Figure 36).

- On the optimization of process parameter, pigment production was highly affected by the substrate's pH. On PD broth, B2 produced the pigments with highest optical density at pH 6.5 (2646.47 AU/g dry wt.) (Figure 37). The same trend was observed in solid-state fermentation (Figure 38). Rice at pH 6.5 provided the optimum condition for pigment production of B2 isolate (755.69 AU/g dry wt.). However, comparable results were also obtained at pH 5.5 (653.39 AU/g dry wt.) and 7.5 (497.9 AU/g dry wt.). For moisture content optimization, significantly higher amount of pigments were produced in rice with 30 to 40% moisture (538.61 to 705.43 AU/g dry wt.) (Figure 39). Higher moisture content resulted in reduced production of pigments and agglomeration of grains. In terms of temperature requirement, B2 produced the pigment with the highest optical density at 30 (574.98 AU/g dry wt.) to 37°C (593.57 AU/g dry wt.) (Figure 40). The isolate barely survived at 16 and 50°C.

- To identify the suitable rice variety for RMR production, four common rice samples with varying amylose content and sizes were screened. Result showed that higher amount of pigments was obtained from long-grain and non-glutinous rice varieties NSIC Rc160, NSIC Rc222, and NSIC Rc282 with optical densities of 702.62, 539.10, and 445.81 Au/g dry wt., respectively. Monascus purpureus, cultivated on glutinous rice, NSIC Rc13, produced sticky and clumped RMR (Figure 41).

- The effect of RMR supplementation on the quality of cookies (Figure 42) was evaluated. Result of the laboratory sensory analysis showed that color of the samples was highly distinguished by the panelists. Among the samples, cookie supplemented with 3% RMR was rated as darkest or reddest. RMR supplementation had no significant effect on the aroma, taste, mouthfeel, and tenderness of the cookies. RMR did not impart any significant off-odor to the cookies. Unfortunately, cookie treated with 3% RMR had pronounced off-flavor mainly attributed to bitterness of the sample. This perception resulted in its significantly lower over-all acceptability rating. At 0.5 to 2.0% RMR supplementation, bitterness was no longer perceived. Cookies with 0.5 up to 1.0% RMR had over-all acceptability scores comparable with the control sample (Table 40).

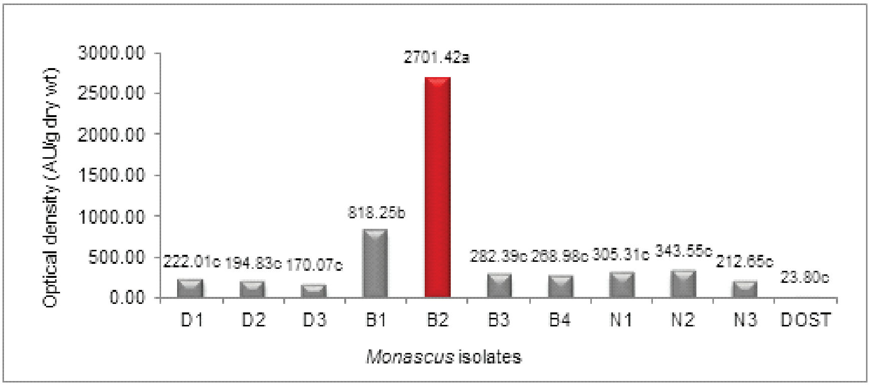

Figure 35. Optical density (AU/g dry wt.) of pigments produced by the 10 Monascus isolates cultivated on PD broth.

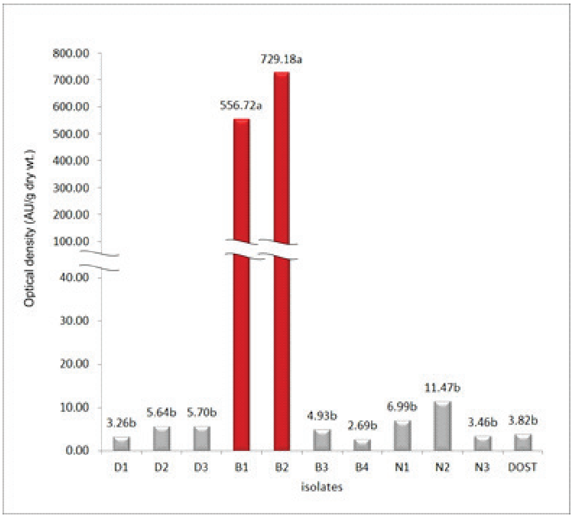

Figure 36. Optical density (AU/g dry wt.) of pigments produced by the 10 Monascus isolates cultivated on NSIC Rc160 rice.

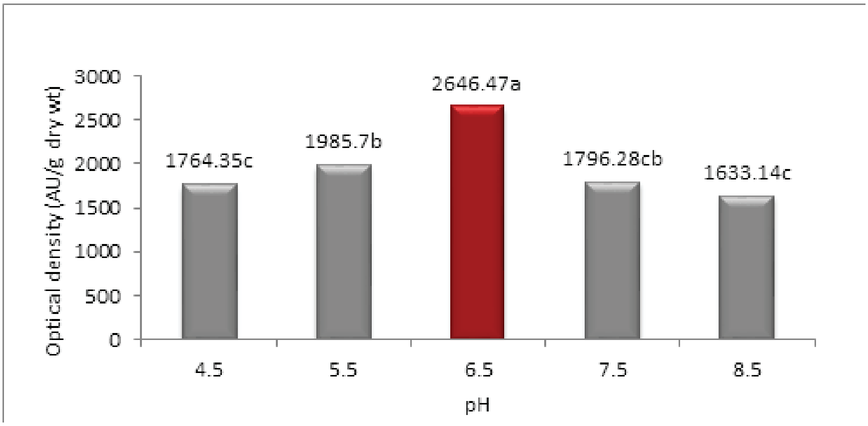

Figure 37. Optical density (AU/g dry wt) of pigments produced by B2 isolate cultivated on PD broth with different pH levels.

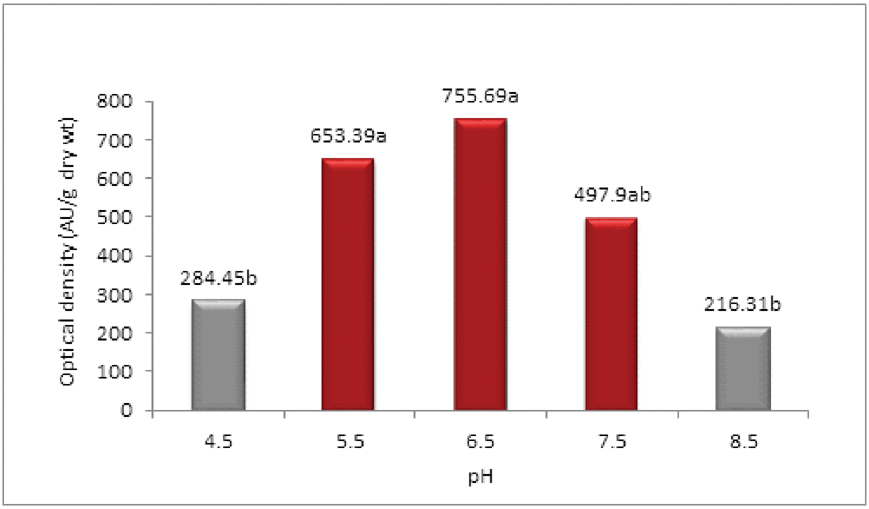

Figure 38. Optical density (AU/g dry wt) of pigments produced by B2 isolate cultivated on rice with different pH levels.

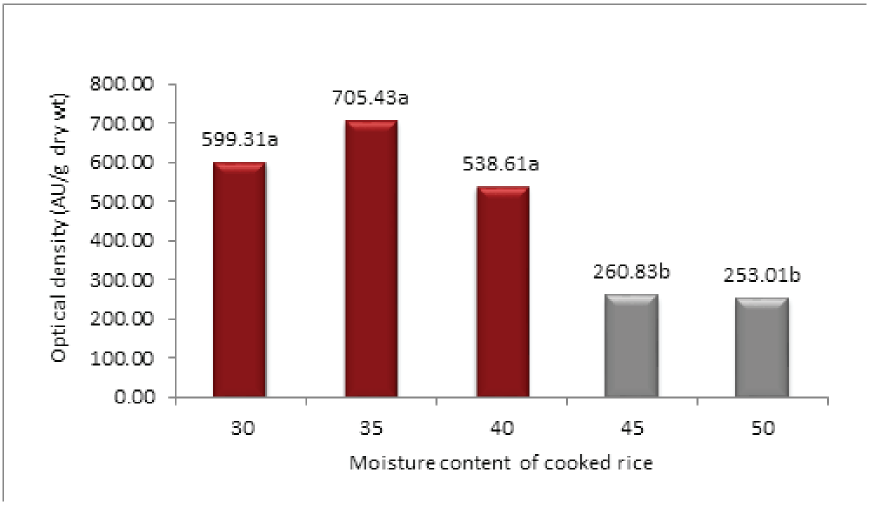

Figure 39. Optical density (AU/g dry wt.) of pigments produced by B2 isolate cultivated on rice with different moisture content.

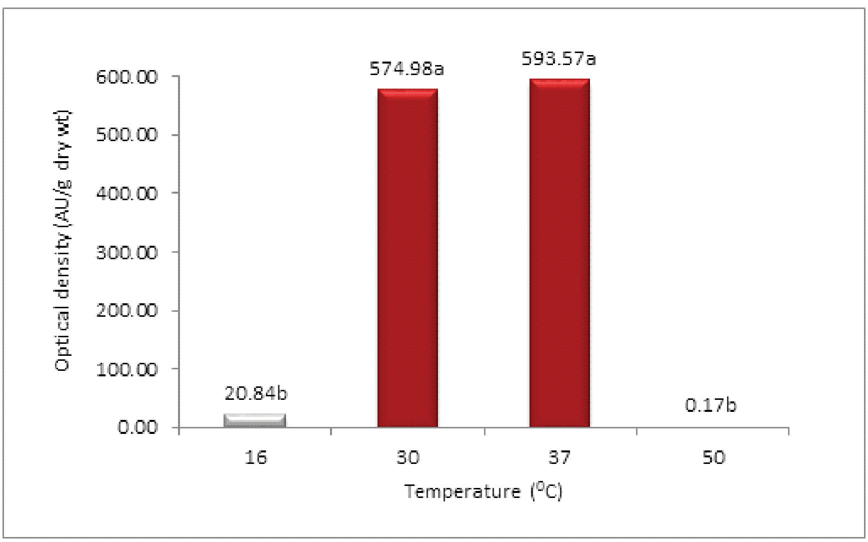

Figure 40. Optical density (AU/g dry wt.) of pigments produced by B2 isolate cultivated on rice and incubated at different temperatures.

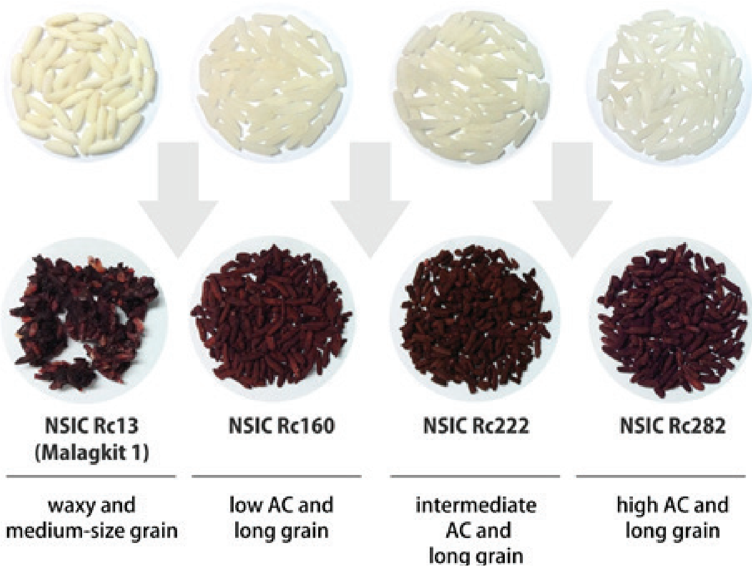

Figure 41. RMR produced from four common rice varieties.

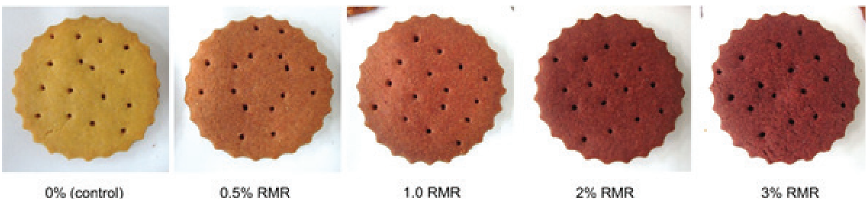

Figure 42. Cookies supplemented with RMR

Table 40. Laboratory sensory scores of cookies supplemented with RMR (n=11).

Sensory attributes	Percent (%) RMR powder				
	0	0.5	1	2	3
Appearance					
Color[1]	0.00[e]	5.17[d]	7.83[c]	11.96[b]	15.00[a]
Surface texture[2]	2.51[b]	3.27[ab]	3.75[ab]	3.95[ab]	4.78[a]
Aroma (plesant)[3]	8.53[a]	7.47[a]	7.66[a]	7.70[a]	6.58[a]
Off-odor (moldy)[3]	0.00	0.00	0.00	0.00	0.00
Taste (pleasant)[3]	8.07[a]	7.75[a]	7.11[a]	6.53[a]	5.12[a]
Aftertaste[4]	0.00[b]	0.00[b]	0.91[b]	2.59[b]	6.60[a]
Mouthfeel[5]	5.05[a]	6.16[a]	6.10[a]	6.28[a]	6.50[a]
Moistness[6]	2.90[a]	1.75[ab]	1.36[b]	1.40[b]	1.47[b]
Tenderness[7]	4.31[a]	3.83[a]	4.56[a]	3.22[a]	3.67[a]
Overall acceptabilty[8]	10.88[a]	10.55[a]	9.75[a]	6.77[b]	5.49[b]
Rank score[9]	1.64[d]	2.09[cd]	3.09[bc]	3.91[ab]	4.27[a]

[1]0=old yellow; 15= dark/reddish brown
[2]0=smooth; 15=very rough
[3]0=none; 15= very intense
[4]0=none; 15=very perceptible
[5]0=smooth; 15=very grainy
[6]0=dry; 15=very moist
[7]0=hard; 15=very tender
[8]0=dislike; 15=like very much
[9]1=highest; 5=lowest

XVIII. Elucidation of Growth Promotion Mechanisms of Radiation-Modified Carrageenan and Chitosan on Rice

LM Juliano, FS Grospe, JAA Maningas, JM Niones, HD Villanueva, NB Lucob, RR Suralta, MR Ordonia Jr., CA Asis Jr.

Rice is the staple crop of the population in the Philippines and it is grown on about 4.34 million hectares. On the average, the per-capita rice consumption is 119kg/year. National average of rice yield increased from 3.07t/ha in 2000 to 3.62t/ha in 2010. However, this is still far below the yielding potential of the varieties released for cultivation in the country. Moreover, while rice production has increased steadily from 12.39 million metric tons in 2000 to 15.77 million metric tons in 2010, the country has to import still large quantities of rice yearly to satisfy the domestic demand. The reason is that Filipinos have been consuming more milled rice than what is being produced domestically. In 2008 alone, 2.27 million metric tons were imported to cope with the demand for rice supply of our increasing population which is growing at an annual rate of 2.3% (GMA Rice Program 2008). These scenarios indicate a large and exploitable yield gap in rice production.

One of the plant growth-promotion and yield-enhancing technologies in rice production is site-specific nutrient management where essential nutrients are supplied to the plants at appropriate time, amount, and method of application (Buresh, 2004). Sebastian et al. (2006) reported that when micronutrient deficiency was corrected yield is increased from by one ton/ha. Moreover, when macronutrient limitation was alleviated, yield was further increased by another one ton/ha.

Recently, the Philippine Nuclear Research Institute (PNRI) reported that application of radiation-modified carrageenan and chitosan at low concentrations enhanced the growth of crops including rice (Dela Rosa et al. 2002). This information is very important in the Agriculture sector. As application requires only a small dose, the product could be used as an effective foliar organic fertilizer. Unlike granular fertilizer, the use of effective foliar fertilizer will save space and avoid losses owing to storage. However, the growth promotion mechanism of radiation-modified carrageenan and chitosan has not been fully understood. Thus, to take advantage of radiation-modified carrageenan and chitosan in rice production, it is important to understand the mechanisms of their growth promotion effect.

This study aimed at elucidating the possible explanation of the growth promotion effect of radiation-modified carrageenan and chitosan in rice production. Further, we would like to demonstrate these effects not only under controlled conditions but also under farmers' field conditions. The findings in this study will serve as the foundation for further use of radiation-modified carrageenan in rice production.

The hypothesis is that application of radiation-modified carrageenan and chitosan may have provided mineral nutrition and physiological effects to the plants that eventually increase rice yield. Our country is considered as world's top producer of Eucheuma seaweed which produces carrageenan. We are also exporting raw materials for chitosan production. Thus, this research on carrageenan and chitosan will generate technology that will positively affect the marine farming in the Philippines and increase the yield of rice, the important crop in the Philippines.

The overall objective of the project is to elucidate the mechanism of growth promotion effects of radiation-modified carrageenan and chitosan on rice under greenhouse, and field conditions. Specifically, study the influence of radiation-modified carrageenan and chitosan application on the: a) Growth, nutrient uptake, yield, and yield components of rice;b) Physiological responses of rice in terms of stomatal conductance, transpiration, and photosynthesis, as well as root and growth under greenhouse conditions; 2) Demonstrate the effect of radiation-modified carrageenan and chitosan on rice under field conditions; and 3) Conduct economic analysis on the use of radiation-modified carrageenan and chitosan as plant growth promoter on rice

Highlights:

Study 1. Effect of radiation-modified carrageenan application on the growth, nutrient, and yield of rice.

A pot experiment was conducted under greenhouse condition at PhilRice-CES (Central Experiment Station), Maligaya, Science City of Muñoz, Nueva Ecija during the dry season 2014 to determine the influence of radiation- modified carrageenan application on the growth, nutrient uptake, yield and yield components of rice and to establish optimum rate of application of carrageenan and chitosan for increased nutrient uptake. Twelve (12) treatments were included: two rates of inorganic fertilizer, 90-40-40kg NPK/ha which is the recommended rate (RR) and half RR (45-20-20kg NPK/ha); varying rates of radiation-modified carrageenan (with and without stickers) were laid out in randomized completely block design with three replication. Inorganic RR fertilizer was applied in two splits. Half of full recommended rate (90kg N/ha) and half recommended rate (45kg N/ha) of N fertilizer and all of P and K fertilizer was applied at planting date (0DAT). The remaining half of N recommended rate was further split and applied equally at 14 DAT at panicle initiation stage (42DAT). Foliar application of varying rates of carrageenan was applied at tillering (15DAT), panicle initiation (40 DAT), and at milking stage (75DAT).

Activity 1. Effect of radiation modified carrageenan on the growth and yield of rice (Experiment 2)

Table 41. Tiller number per hill of NSIC Rc216 as affected by different treatments grown under greenhouse condition (DS2014).

Treatment		Tiller number at harvest
0kg NPK	0ppm	8.00 c
0kg NPK	50ppm	7.67 c
0kg NPK	100ppm	8.33 c
0kg NPK	100ppm (with sticker)	7.67 c
45-20-20kg NPK/ha	0ppm	11.33 bc
45-20-20 kg NPK/ha	50ppm	12.67 ab
45-20-20 kg NPK/ha	100ppm	11.33 bc
45-20-20 kg NPK/ha	100ppm (with sticker)	11.67 abc
90-40-40 kg NPK/ha	0ppm	14.67 ab
90-40-40 kg NPK/ha	50ppm	15.00 ab
90-40-40 kg NPK/ha	100ppm	15.67 a
90-40-40 kg NPK/ha	100ppm (with sticker)	15.00 ab

- Highest tiller count was obtained in treatment with full recommended rate of fertilizer and 100ppm carrageenan without sticker. However, other treatments with full NPK including those with only full NPK were not significantly different.

- No significant differences can be obtained with treatments without fertilizers.

- Treatment with 50ppm and half NPK produced more tillers compared to the other treatments with half NPK rate.

Table 42. Chlorophyll measurement using SPAD-502 of NSIC Rc216 as affected by different treatments (DS2014).

Treatment		53 DAT	61 DAT	85 DAT
0kg NPK	0ppm	33.60 bc	30.20 a	29.23 a
0kg NPK	50ppm	32.20 c	30.60 a	24.17 a
0kg NPK	100ppm	34.53 abc	31.17 a	26.97 a
0kg NPK	100ppm (with sticker)	31.63 c	30.17 a	26.20 a
45-20-20kg NPK/ha	0ppm	40.00 a	35.43 a	29.67 a
45-20-20 kg NPK/ha	50ppm	37.33 abc	30.77 a	28.43 a
45-20-20 kg NPK/ha	100ppm	36.97 abc	31.00 a	27.03 a
45-20-20 kg NPK/ha	100ppm (with sticker)	36.77 abc	35.77 a	27.17 a
90-40-40 kg NPK/ha	0ppm	37.70 abc	31.87 a	27.60 a
90-40-40 kg NPK/ha	50ppm	39.70 ab	33.77 a	30.57 a
90-40-40 kg NPK/ha	100ppm	37.27 abc	32.83 a	28.70 a
90-40-40 kg NPK/ha	100ppm (with sticker)	40.07 a	30.77 a	26.87 a

- Chlorophyll meter (SPAD-502) reading was most affected by NPK application and varying rates of carrageenan application at 53DAT (booting stage).
- At tillering stage, SPAD readings were not significantly affected by NPK application (data not shown).
- At reproductive stage, no significant differences can be obtained from SPAD readings.

Table 43. Grain yield (14% MC) of NSIC Rc216 as influenced by application of two N rates and varying rates of carrageenan (DS2014).

Treatment		Yield (14%MC)
0kg NPK	0ppm	2.21 d
0kg NPK	50ppm	2.05 d
0kg NPK	100ppm	2.27 d
0kg NPK	100ppm (with sticker)	2.21 d
45-20-20kg NPK/ha	0ppm	4.57 c
45-20-20 kg NPK/ha	50ppm	5.93 abc
45-20-20 kg NPK/ha	100ppm	5.05 bc
45-20-20 kg NPK/ha	100ppm (with sticker)	5.62 abc
90-40-40 kg NPK/ha	0ppm	5.82 abc
90-40-40 kg NPK/ha	50ppm	5.81 abc
90-40-40 kg NPK/ha	100ppm	7.51 a
90-40-40 kg NPK/ha	100ppm (with sticker)	7.11 ab

- Plants with full NPK fertilizer produced higher yield compared to those applied with half the recommended of NPK fertilizer. Additionally, application of carrageenan further boost the yield produced.

- Plants applied with 90-40-40 kg NPK/ha with 100ppm carrageenan without sticker produced grain yield (7.51 t/ha) which is slightly higher than with sticker (7.11 t/ha).

- Plants applied with 45-20-20kg NPK/ha with 100ppm carrageenan with sticker produced higher yield than those without sticker at the same fertilizer rate. However, note that 50ppm with half NPK also increased yield.

- There was no significant effect of treatments with stickers on the yield of rice.

During the wet weason 2014, pot experiments using rice variety NSIC Rc216 were laid out in randomized complete block design with three replications, under greenhouse condition at PhilRice Nueva Ecija. The experiment consisted of 24 treatments for testing: unfertilized treatment, two rates of inorganic fertilizer; 90-40-40kg NPK/ha which is the recommended full rate (Full RR) and 45-20-20kg NPK/ha which is the half recommended fertilizer rate (1/2 RR); and foliar spraying of varying concentrations of radiation-modified carrageenan and commercially available carrageenan formulation, Algafer. Foliar applications were done at tillering (15 DAT) and panicle initiation (45 DAT) for experiment 1 and an additional application at milking stage (75 DAT) for experiment 2. Data for yield at 14% moisture content was obtained and corresponding data analysis was carried out to determine the significance of the treatments.

Highlights:

- Grain yield in experiment 1 was increased by 34% with 7.05g/pot upon application of 200ppm carrageenan over the untreated control which only yielded 5.23g/pot. However, no significant difference was observed with the application of 25ppm which yielded 7.04g/pot, a 34.6% increase over the untreated control. Application of inorganic fertilizer intensified the effect of carrageenan compared to unfertilized treatments. Application of 200ppm carrageenan with ½ RR increased the yield by 25.6% (17.07g/pot) compared to the treatment with fertilizer alone (13.57g/pot). The application of 200ppm carrageenan under full RR yielded 15% (24.19g/pot) more than fertilizer alone (21.03g/pot). Yields obtained using Algafer did not differ significantly over treatments at unfertilized condition, comparable to ½ RR alone but yielded lower than the other treatments in full RR.

- Results for experiment 1 showed that using 200ppm concentration of Carrageenan yielded higher results compared to the unfertilized treatments, ½ RR, and full RR showing its efficiency compared to the other treatments and with the commercially available foliar spray, Algafer.

- Experiment 2 presented no significant differences in grain yield under unfertilized treatments after additional spraying at milking stage (75 DAT). Conversely, application of 100ppm carrageenan boosted the yield by 31.2% (6.86g/pot) over untreated control (5.23g/pot). Addition of inorganic fertilizer at ½ RR increased the yield compared to the untreated control. An increase in yield was observed in plants treated with varying concentrations of carrageenan in combination of the half rate fertilizer. Twenty-five ppm yielded a 28.8% (17.48g/pot) increase; 75ppm, gained a 26% (17.11g/pot) increase, and lastly, 100ppm had a 27.5% (17.3g/pot) increase compared to ½ RR alone (13.57g/pot). Full rate fertilizer with the addition of 75ppm, 100ppm and 150ppm application generated no significant difference but yielded an increase of 17.8% and 16.4% upon application of 75ppm (25.58g/pot) and 100ppm (25.14 g/pot), respectively. Algafer application did not differ significantly to other treatments at unfertilized treatment, comparable to ½ RR, and yielded lower than other treatments at full RR.

- The second experiment showed varying result from that of experiment 1, showing that lower concentrations of carrageenan, specifically 75ppm and 100ppm, yielded more grains compared to the pots treated with 200ppm.

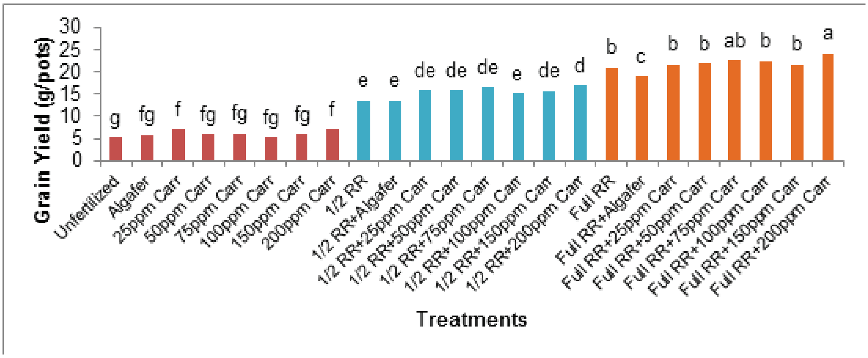

Figure 44. Grain yield of NSIC Rc216 at 14% moisture content (MC) affected by different treatments applied at mid tillering and panicle initiation for 2014 Wet Season (WS).

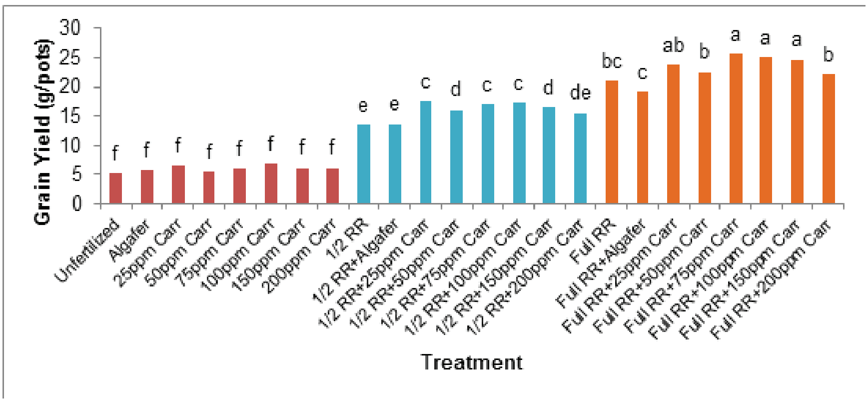

Figure 45. NSIC Rc216 grain yield at 14%MC as affected by the different treatments applied at mid tillering, panicle initiation and at milking stage for 2014 Wet Season (WS).

Study 2. Effect of radiation-modified carrageenan and chitosan application on physiological processes of rice plant

For DS 2014, PSB Rc18 was used with different water treatments; continuous waterlogged (CWL) and well-watered (WW) at 22% soil moisture content (SMC). Fertilizer rates were ½ the recommended rate of NPK (45-30-30kg/ha) and full rate of NPK (90-60-60kg/ha).

Table 44. Summary data for shoot dry weight (SDW) and root dry weight (RDW) using carrageenan and chitosan treatments in well-watered condition (DS2014).

Water treatment	Fertilizer Treatment	Growth Promoter	Time of Application	Shoot Dry Wt(g)	Root Dry Wt (g)
Well-watered (WW)	0N (Control)	0ppm	-	0.41 ± 0.06	0.13 ± 0.03
		100ppm Chitosan	24DAS	0.35 ± 0.06	0.14 ± 0.02
			8DAS, 16DAS, 24DAS	0.43 ± 0.18	0.14 ± 0.05
			8DAS,16DAS,24DAs,32DAS,40DAS	0.36 ± 0.06	0.14 ± 0.03
		100ppm Carrageenan	24DAS	0.33 ± 0.02	0.11 ± 0.01
			8DAS, 16DAS, 24DAS	0.34 ± 0.11	0.109 ± 0.05
			8DAS,16DAS,24DAs,32DAS,40DAS	0.33 ± 0.11	0.11 ± 0.04
	45-30-30 NPK/ha or 1/2 RR	0ppm	-	1.40 ± 0.44	0.31 ± 0.08
		100ppm Chitosan	24DAS	1.48 ± 0.18	0.26 ± 0.04
			8DAS, 16DAS, 24DAS	0.70 ± 0.39	0.20 ± 0.01
			8DAS,16DAS,24DAs,32DAS,40DAS	1.11 ± 0.35	0.242 ± 0.07
		100ppm Carrageenan	24DAS	1.49 ± 0.09	0.29 ± 0.06
			8DAS, 16DAS, 24DAS	1.23 ± 0.39	0.25 ± 0.07
			8DAS,16DAS,24DAs,32DAS,40DAS	1.44 ± 0.28	0.29 ± 0.06
	90-60-60 NPK/ha or FRR	0ppm	-	1.63 ± 0.90	0.316 ± 0.14
		100ppm Chitosan	24DAS	1.88 ± 0.50	0.37 ± 0.09
			8DAS, 16DAS, 24DAS	1.43 ± 0.15	0.28 ± 0.02
			8DAS,16DAS,24DAs,32DAS,40DAS	1.67 ± 0.19	0.31 ± 0.05
		100ppm Carrageenan	24DAS	1.81 ± 0.68	0.31 ± 0.11
			8DAS, 16DAS, 24DAS	1.62 ± 0.02	0.31 ± 0.02
			8DAS,16DAS,24DAs,32DAS,40DAS	1.31 ± 0.61	0.22 ± 0.07

- In well-watered condition and no fertilizer, chitosan applied 3 times increased shoot dry weight (SDW) by 4.9%.
- Full NPK rate with one application of both chitosan and carrageenan increased SDW by 13.25% and 10%, respectively.
- On the other hand, root dry weight (RDW) in well-watered condition was affected by the application of chitosan in all treatments.
- These figures imply that a single application of chitosan and carrageenan can increase SDW and RDW. The application of fertilizers can further boost shoot and root growth of rice.

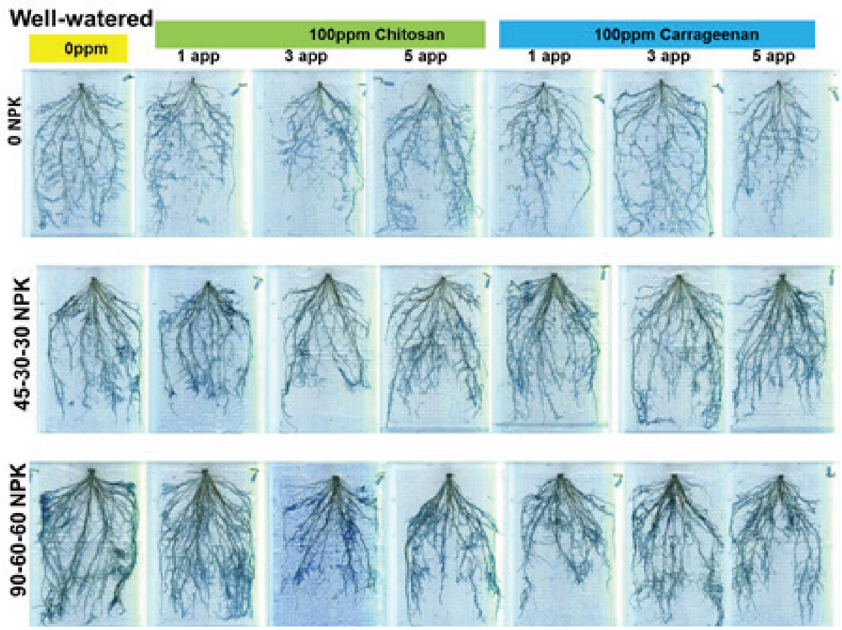

Figure 46. Root profile of NSIC Rc18 in well-watered condition (DS2014).

- In well-watered and no NPK, the total root length (TRL) only increased with one (1) application of carrageenan at 100ppm which was 2413.0cm over 2393.09cm of control (0.83% increase). The increase in TRL value in well-watered condition is associated with the favorable elongation of total lateral root length (TLRL) and total nodal root length (TNRL).

- Application of NPK also attributed to the increase of total nodal root length (TNRL) compared to no NPK with an increase of 53.81% at half rate and 49.48% at full rate.

Table 45. Summary data for shoot dry weight (SDW) and root dry weight (RDW) using carrageenan and chitosan treatments in continuous waterlogged condition (DS2014).

Water treatment	Fertilizer Treatment	Growth Promoter	Time of Application	Shoot Dry Wt(g)	Root Dry Wt (g)
Continues Waterlog (CWL)	0N (Control)	0ppm	-	0.71 ± 0.15	0.23 ± 0.08
		100ppm Chitosan	24DAS	0.75 ± 0.12	0.175 ± 0.03
			8DAS, 16DAS, 24DAS	0.67 ± 0.02	0.158 ± 0.06
			8DAS,16DAS,24DAs,32DAS,40DAS	0.67 ± 0.14	0.22 ± 0.03
		100ppm Carrageenan	24DAS	0.77 ± 0.08	0.18 ± 0.02
			8DAS, 16DAS, 24DAS	0.65 ± 0.23	0.17 ± 0.04
			8DAS,16DAS,24DAs,32DAS,40DAS	0.75 ± 0.77	0.17 ± 0.06
	45-30-30 NPK/ha or 1/2 RR	0ppm	-	1.39 ± 0.57	0.27 ± 0.09
		100ppm Chitosan	24DAS	1.72 ± 0.52	0.27 ± 0.02
			8DAS, 16DAS, 24DAS	1.93 ± 0.72	0.32 ± 0.13
			8DAS,16DAS,24DAs,32DAS,40DAS	1.49 ± 0.44	0.23 ± 0.05
		100ppm Carrageenan	24DAS	1.73 ± 0.18	0.33 ± 0.06
			8DAS, 16DAS, 24DAS	2.13 ± 0.49	0.34 ± 0.05
			8DAS,16DAS,24DAs,32DAS,40DAS	1.48 ± 0.18	0.28 ± 0.05
	90-60-60 NPK/ha or FRR	0ppm	-	1.86 ± 0.05	0.28 ± 0.03
		100ppm Chitosan	24DAS	2.10 ± 0.18	0.29 ± 0.05
			8DAS, 16DAS, 24DAS	2.03 ± 0.05	0.32 ± 0.03
			8DAS,16DAS,24DAs,32DAS,40DAS	2.00 ± 0.18	0.30 ± 0.05
		100ppm Carrageenan	24DAS	2.05 ± 0.66	0.30 ± 0.10
			8DAS, 16DAS, 24DAS	1.80 ± 0.67	0.26 ± 0.12
			8DAS,16DAS,24DAs,32DAS,40DAS	1.87 ± 0.38	0.28 ± 0.06

- Significant increase in root dry weight (RDW) at 0.332g with one (1) application (24DAS) of 100ppm carrageenan and ½ RR of NPK, and 3 applications (8DAS, 16DAS and 24DAS) at 0.345g compared to the control at 0.274g in continuous waterlogged condition or CWL.

- Further, the table also indicated that chitosan regardless of fertilizer rate can increase RDW.

- Application of carrageenan at 100ppm can increase SDW in continuous waterlogged condition. Further, the application of half rate of NPK and carrageenan at 1, 3, 5 application times showed an increased in SDW compared to the control with the respective values of 1.73 g, 2.13g and 1.48g over 1.39g of control.

- Further, increasing application of chitosan or carrageenan can increase SDW and RDW but at five applications, the values decreased. Hence, maximum of 3 applications is enough to boost SDW and RDW.

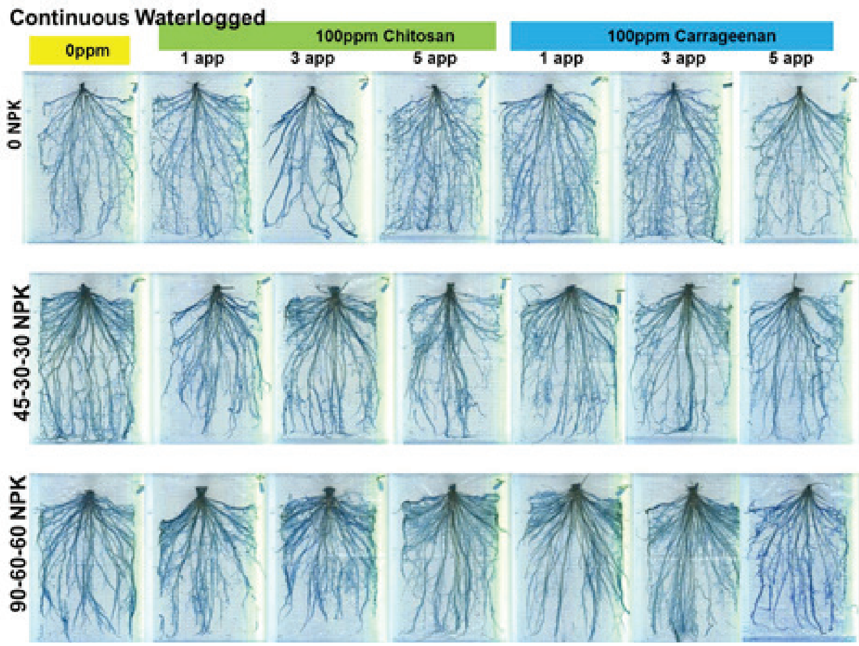

Figure 47. Root profile of NSIC Rc18 in continuous waterlogged condition (DS2014).

- Total root length (TRL) as measured by WinRhizo root analyser shows a significant difference between three times application of 50ppm carrageenan and 100ppm carrageenan. The result showed that TRL in WW condition and sprayed with 50ppm carrageenan without fertilizer increased about 57% and plants treated with 45-30-30kg NPK/ha and sprayed with 100ppm carrageenan increased 44% total root length. However, in CWL condition with 0N, 45-30-30kgNPK, and 90-60-60kgNPK significantly increased the total root length at 25%, 54%, and 62% respectively when 50ppm carrageenan were applied.

- The interaction between water and carrageenan treatments showed a significant difference in TRL, number of nodal roots, and total nodal root length per plant. Increased in TRL may attributed to higher total lateral root length and total nodal root length with 53% to 95% when 100ppm carrageenan applied plus fertilizer rate of 45-30-30kg NPK/ha, and 56%-96% increased after 100ppm carrageenan and 90-60-60kg NPK/ha applied relative to control (0N fertilizer) with 19% in both water treatment conditions.

- In relation to TRL, the RDW also increased when 50ppm carrageenan were applied three times at vegetative stage of rice.

- In WW condition without 0N the RDW had 32.3 mg higher than control with 22.0 mg, and 100ppm carrageenan treatment with 45-30-30kg NPK/ha contributed a 53% increased. Moreover, in CWL application of 50ppm carrageenan with different fertilizer levels 0N, 45-30-30kg NPK/ha, and 90-60-60 kg NPK/ha the RDW significantly increased with 41.6mg, 42.4mg, and 48.6mg respectively relative to control with range value of 19.5mg to 22.13mg.

- Shoot dry weight as upper yield increased with a total of 34% in WW condition and 59% increased in CWL water treatment when 500ppm carrageenan were applied together with three fertilizer level.

- Generally, the increased in TRL and gained weight of RDW resulted to the increased of shoot dry weight as upper yield component of 45 days rice plant.

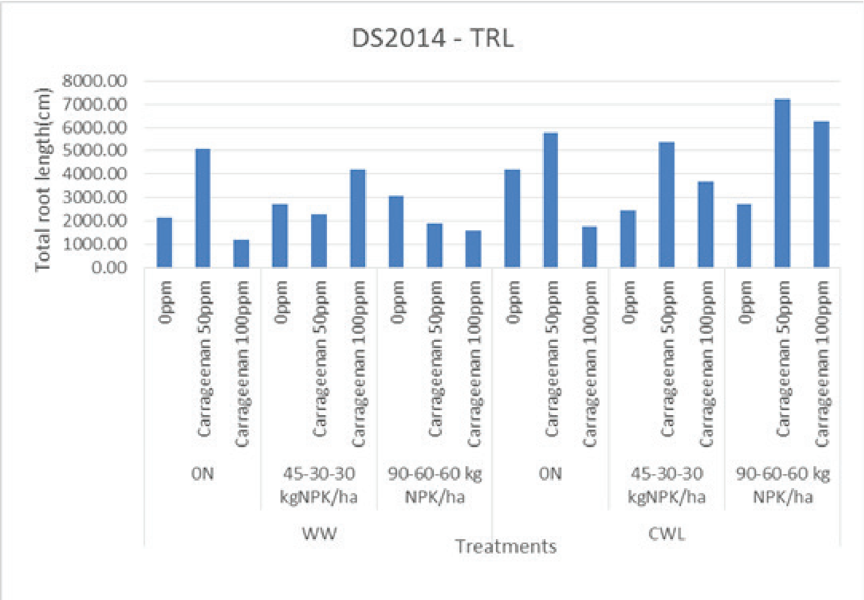

Figure 48. Total root length (cm) of PSB Rc18 in 45DAS as affected by different treatments during DS2014.

Table 46. Root dry weight (mg) and shoot dry weight (mg) of PSB Rc18/hill at 45DAS as affected by different treatments during DS 2014.

Water Trt	Fertilizer Level	Growth Promoter	RDW(mg)	SDW(mg)
WW	0N	0ppm	22.1	112.5
		Carrageenan 50ppm	32.3	154.2
		Carrageenan 100ppm	23.8	109.2
	45-30-30 kgNPK/ha	0ppm	16.6	61.3
		Carrageenan 50ppm	13.7	66.0
		Carrageenan 100ppm	29.2	126.6
	90-60-60 kg NPK/ha	0ppm	16.2	138.0
		Carrageenan 50ppm	10.6	53.3
		Carrageenan 100ppm	7.4	71.6
CWL	0N	0ppm	22.1	130.5
		Carrageenan 50ppm	41.6	191.1
		Carrageenan 100ppm	13.2	97.5
	45-30-30 kgNPK/ha	0ppm	19.5	165.8
		Carrageenan 50ppm	42.4	196.2
		Carrageenan 100ppm	43.7	231.2
	90-60-60 kg NPK/ha	0ppm	21.7	219.4
		Carrageenan 50ppm	48.7	253.2
		Carrageenan 100ppm	53.2	255.6

XIX. Screenhouse and Field Evaluation of Wide Cross-Derived Rice Breeding Lines for Drought Tolerance

AA Alfonso, RT Miranda, RF Diocton IV, CFS Te

The rainfed lowlands in the Philippines, which is estimated to be 0.96 M ha or 37.1% of rice cultivated areas during wet season (BAS, 2009), hold high potential for increasing rice production in the country and for attaining and sustaining rice self-sufficiency. Currently, grain yield level in these areas is low, averaging only 2.99t/ha (BAS, 2009). Not surprisingly, these areas are also where farmers are usually resource-poor. While building new irrigation facilities can alleviate the problem of water scarcity, development of modern varieties can also be a practical and cost-effective complementary strategy to address water constraints in rice production.

The wild relatives of rice are rich sources of resistance/tolerance to biotic and abiotic stresses such as drought. Several wild rice accessions have been found to possess drought tolerance. These can be used as donor parents to develop drought tolerant rice varieties through wide hybridization.

Drought screening to select donor genotypes and tolerant progenies cannot be conducted on a year-round basis due to less predictable weather conditions. In addition, some accessions cannot be evaluated directly in the field because of their potential to become weeds. These limitations can be addressed through rapid drought evaluation under screenhouse condition to identify donor parents and develop breeding lines prior to field evaluation.

Furthermore, superior progenies in stable generation should undergo replicated yield trials to evaluate their relative performance in the field under drought condition. Identification of superior genotypes in the field is very important so they can be advanced in a breeding program. This study was conducted to evaluate elite breeding lines, including those derived from wide crosses with several accessions of Oryza glaberrima, for drought tolerance under field condition.

Highlights:

- Four hundred forty-five (445) breeding lines composed of 58 Pedigree Nursery (PN), 119 Observational Nursery (ON) and 268 Advance Observational Nursery (AON) were screened for drought tolerance on 2014 dry season. Among these, 9 lines under PN and 12 lines under ON were identified with putative drought tolerance. Six breeding lines under AON showed promising results with yield ranging 5.72 to 7.47t/ha under drought stress condition and were advanced to Preliminary Yield Trial (PYT) to further assess their performance.

- Drought had significant effect among different genotypes as seen in the yield data. From the 33 lines under PYT, PR42967-B-B-5-1-2-B had the highest yield at 4.57t/ha, followed by tolerant check PSB Rc14 with 4.2t/ha under drought stress condition. The yield of five other genotypes (PR42967-B-B-2-1-2-B, PR42973-B-B-2-1-4-B**, PR42973-B-B-2-1-2-B, PR42967-B-B-4-1-1-B, PR42973-B-B-2-1-5-1-B*) were comparable to PSB Rc14 and NSIC Rc276 with a range of 3.54-3.94 t/ha.

- Grain yield (GY) is correlated with Percent Productive Tiller (PPT) and Biomass (BM) with positive linear relationship, implying that as the PPT and BM increase the GY also increases.

- For 2014 Wet Season, a total of 495 breeding lines composed of 56 PYT (including 3 checks: PSB Rc14, IR64 and NSIC Rc276), 58 PN, 119 ON and 262 AON were then forwarded to 2015 DS for drought tolerance screening and generation advance.

Figure 49. Overview of the field area used in drought screening.

Table 47. Drought response and agronomic traits of breeding lines under drought stress condition, 2014 DS.

Designation	GY	LR	LD	PL	FS	UFS	TS	TGW	PH	TT	PT	PPT	MAT	BM
PR42967-B-B-5-1-2-B	4.57	7	5	20.57	86.6	11.4	98	24.27	82.7	25	24.7	98.7	110	53.256
PSB Rc14	4.2	5	5	20.86	90.2	8.6	98.8	21.1	81.7	23.1	22.7	98	114.7	52.195
PR42967-B-B-2-1-2-B	3.94	5	3	21.14	93.47	7.47	95.33	19.27	87	26.2	25.8	98.5	111.7	56.573
NSIC Rc276	3.9	5	3	19.91	80.67	15.53	96.2	23.03	85.3	22.8	22.2	97.4	117.7	54.769
PR42973-B-B-2-1-4-B	3.74	3	3	20.49	71.73	5.53	77.27	21.8	81.2	29.3	28.2	96.2	113.7	52.545
PR42973-B-B-2-1-2-B	3.7	5	3	20.22	65.67	5.67	71.33	24.6	83.1	27.3	25.5	92.9	115	51.019
PR42967-B-B-4-1-1-B	3.57	5	5	20.19	97	5.4	102.4	19.65	79.4	31.3	29.9	95.7	110	58.274
PR42973-B-B-2-1-5-1-B	3.54	3	3	21.09	70.53	8.13	78.67	23.83	81.3	25.3	24.5	97	117.3	51.516
IR64	3.51	7	5	21.22	72.33	5.33	77.67	21.83	80.7	22.3	21.5	96.2	116.3	51.472
PR42967-B-B-4-1-2-B	3.42	7	5	18.87	83.87	10.73	94.6	17.43	80	31.9	30.6	95.8	109.3	55.459
11WS-ON-DRGT-46	3.39	7	3	19.96	73.47	6.67	80.13	22.37	83.7	27.1	26.6	98.1	112.33	50.552
PR39778-B-2-6-2-1-2-B	3.31	7	5	19.55	69.67	6.07	75.73	28.27	77.6	24.5	23.7	96.6	111.7	56.193
PR42967-B-B-6-1-2-B	3.29	5	3	20.54	90.73	10.07	100.8	20.77	86.3	30.7	29.2	95.2	109.7	57.612
PR42973-B-B-2-1-3-B	3.23	3	3	20.23	63.87	7.13	71	23.7	81.5	26.1	23.9	91.9	115.3	56.721
PR42973-B-B-2-1-1-B	3.21	3	3	20.21	66.53	7.87	74.4	24.63	83.8	26.1	24.9	95.4	115	53.906
PR39790-B-3-B-1-1-1-B	3.19	7	3	21.65	77.13	7.73	84.87	22.57	84.6	26.1	24.9	95.5	117.3	59.078
PR39778-B-2-5-1-1-1-B	3.19	9	5	20.09	67.4	8.47	75.87	29.17	78.3	22.9	22.2	97.1	113.3	54.901
PR42967-B-B-5-1-1-B	3.19	7	3	19.45	77.67	6.6	84.27	20.03	75.8	34.3	32.9	95.9	109.7	52.274
PR42967-B-B-4-1-3-B	3.15	7	5	18.52	71.6	4.2	75.8	17.03	76.5	32.1	31	96.5	109.7	51.653
PR42967-B-B-3-1-1-B	3.1	5	3	19.39	73.6	5.8	79.4	19	79.4	30.9	29.5	95.4	111	54.909
PR42971-B-2-1-1-1-1-B	3.04	5	3	20.71	76.2	7.53	83.73	23.73	81.4	24.5	23.6	96	113.7	54.771
PR39778-B-2-6-2-1-1-B	3.02	7	5	19.57	65.07	5.47	70.53	30.07	79	25.5	24	93.7	114	55.159
PR42967-B-B-3-1-3-B	3.02	5	5	18.52	90.8	5.8	96.6	17.5	82.1	36.3	35	96.6	110.3	55.95
PR39790-B-3-B-1-1-4-B	3.01	5	3	20.65	65.67	9.53	75.2	21.43	86.5	24.1	23.3	97	116.7	53.788
11WS-ON-DRGT-45	3.01	3	3	20.14	68.4	9	77.4	21.13	79.9	23.5	22.7	96.8	115.3	46.214
PR42967-B-B-6-1-1-B	2.96	3	3	22.01	82.93	7.6	90.53	27.53	85.2	27.8	26.5	95.5	110	60.573
PR39790-B-3-B-1-1-5-B	2.86	5	3	20.42	66.2	10.93	77.13	24.3	85.8	26.1	24.9	95.2	117	55.161
11WS-ON-DRGT-12	2.85	5	3	22.61	95.87	10.67	106.53	26.7	89.5	24.7	23.5	95.1	112.3	58.457
PR42967-B-B-4-1-4-B	2.82	7	5	19.26	79.47	6.8	86.27	21.27	78.4	33.7	32.9	97.6	110.3	48.563
PR42967-B-B-5-1-3-B	2.8	7	5	20.66	72.13	7.33	79.47	20.1	81.1	31.4	29.9	95.1	110	57.293

Table 47. Drought response and agronomic traits of breeding lines under drought stress condition, 2014 DS. (Con't...)

PR39790-B-3-B-4-1-4-B	2.78	7	5	19.95	64.6	9.93	74.53	24.53	82.7	29.2	28.8	98.7	117	50.739
11WS-ON-DRGT-45	2.66	3	3	20.47	63.93	7.47	71.4	24.3	79.1	23	21.8	94.8	114	53.341
PR39790-B-3-B-5-1-1-B	2.41	7	5	20.95	70.67	11.67	82.33	22.37	83.6	27.1	26.1	96.2	115.7	52.565
PR39790-B-3-B-1-1-3-B	2.4	5	3	19.31	65.47	9.07	74.53	22.63	84	27.8	26.7	96.2	116	52.059
PR39790-B-3-B-1-1-2-B	2.15	7	3	20.91	78.2	7.93	86.13	20.9	86	27.1	26.3	97	117.7	50.133
PR39790-B-3-B-4-1-2-B	1.91	9	7	19.54	66	9.53	75.53	23.9	81.5	29.4	28.1	95.7	116.7	45.209
Min	1.91	3	3	18.52	63.87	4.2	70.53	17.03	75.8	22.33	21.47	91.92	109.33	45.21
Max	4.57	9	7	22.61	97	15.53	106.53	30.07	89.53	36.27	35	98.7	117.67	60.57
Range	2.66	6	4	4.09	33.13	11.33	36	13.03	13.73	13.93	13.53	6.77	8.33	15.36
Mean	3.17	5.61	3.91	20.27	75.43	8.07	83.34	22.69	82.11	27.41	26.34	96.14	113.54	53.75
Stdev	0.54	1.72	1.11	0.91	10.13	2.33	10.4	3.17	3.2	3.64	3.5	1.45	2.9	3.41
V	0.29	2.93	1.22	0.8	99.79	5.35	105.3	9.79	10.05	12.88	11.92	2.17	8.2	11.6
Cv	17.2	30.65	28.53	4.48	13.43	28.91	12.47	13.99	3.9	13.28	13.3	1.51	2.55	6.35

Note:

Code / abbreviation	Description
GY	Grain Yield (t/ha)
LR	Leaf Rolling
LD	Leaf Drying
PL	Panicle length
FS	Filled Spikelets
UFS	Unfilled spikelets
TS	Total Spikelets
TGW	1000 grain wt.
PH	Plant height
TT	Total Tillers
PT	Productive Tillers
PPT	Percent Productive Tillers
MAT	Days to maturity
BM	Biomass

Table 48. Correlation coefficients between grain yield and other traits under drought stress condition 2014 DS.

Trait	LR	LD	PL	FS	UFS	TS	TGW	PH	TT	PT	PPT	MAT	BM
GY	0.00676	-0.00298	-0.10023	0.11589	-0.09431	0.06747	-0.0802	0.12979	-0.14091	-0.10217	0.23886	-0.16461	0.22381
	0.9446	0.9756	0.302	0.2323	0.3316	0.4878	0.4093	0.1806	0.1458	0.2927	0.0128*	0.0887	0.0199*
LR	1	0.86366	-0.15896	-0.10305	0.00864	-0.09179	-0.13364	0.09715	0.11938	0.12131	0.00791	-0.05326	-0.12626
		<.0001**	0.1003	0.2886	0.9293	0.3447	0.1679	0.3172	0.2185	0.2111	0.9353	0.5841	0.1929
LD		1	-0.16661	-0.21017	0.01868	-0.18917	-0.04591	0.1189	-0.00964	-0.00817	0.0023	0.01047	-0.04912
			0.0848	0.029	0.8479	0.0499	0.6371	0.2204	0.9211	0.9331	0.9812	0.9144	0.6136
PL			1	0.40169	0.27277	0.44739	0.21965	0.00553	-0.34055	-0.35208	-0.06049	0.21099	0.01301
				<.0001**	0.0043**	<.0001**	0.0224*	0.9547	0.0003**	0.0002**	0.534	0.0284*	0.8937
FS				1	0.11482	0.96159	-0.16835	0.02418	0.16568	0.18491	0.10636	-0.36637	0.07621
					0.2367	<.0001**	0.0816	0.8038	0.0866	0.0554	0.2733	<.0001**	0.4331
UFS					1	0.35872	0.09303	0.06832	-0.21828	-0.18255	0.2329	0.22462	0.0315
						0.0001**	0.3383	0.4824	0.0232*	0.0586	0.0153*	0.0194*	0.7462
TS						1	-0.11778	0.03772	0.10622	0.13159	0.14843	-0.28447	0.07438
							0.2248	0.6983	0.2739	0.1746	0.1253	0.0028**	0.4443
TGW							1	0.00104	-0.45299	-0.46051	-0.06593	0.23239	0.11136
								0.9915	<.0001**	<.0001**	0.4978	0.0155*	0.2512
PH								1	-0.07884	-0.06996	0.05788	0.03277	-0.06111
									0.4173	0.4719	0.5518	0.7363	0.5298
TT									1	0.98529	-0.08871	-0.47376	-0.0039
										<.0001**	0.3612	<.0001**	0.968
PT										1	0.08128	-0.47823	-0.0011
											0.403	<.0001**	0.991
PPT											1	-0.02642	0.02038
												0.786	0.8341
MAT												1	-0.22007
													0.0221*

* Significant at 5% level; ** significant at 1% level

XX. Improving Productivity and Livelihood of Wetlands and Flood-Prone Rice-based Communities in Region III

RG Corales, VT Dimaano, JM Rivera, AA Corpuz, LM Juliano, EJP Quilang

This project aimed to help improve the productivity and livelihood of farm families in flood-prone rice-based communities surrounding the Candaba swamp which serves as catchment basin of excess water from higher areas in Region 3. The area covers portion of the provinces of Pampanga, Nueva Ecija, Tarlac and Bulacan. A large part of the location is occasionally submerged to flooding during rainy season; hence farmers cultivate rice and other crops only once a year during the dry season. As climate change scenarios like more intense rainfall and prolonged flooding are becoming more evident, alternative opportunities to increase productivity is imperative to sustain food security and augment financial stability of the farm families in the flood-prone communities.

Hybrid rice can improve farm yields with at least 15% increment over the best comparable inbred variety. This implies saving 15% of the arable lands for other agricultural production purposes (PhilRice, 2007). In 2014 Dry Season (DS), participatory on-farm trial was conducted in a flood-prone rice-based community in Calumpit, Bulacan. Fifty percent (18 out of 36) of the farmer beneficiaries from the pilot cluster site in Barangays Bulusan, Calizon, and Sta. Lucia, Calumpit, Bulacan continually joined the project. Additional cluster site was established in Barangay Gugo which is adjacent to the pilot cluster site. Thirty four farmer beneficiaries signified interest and enrolled in PalayCheck Farmers' Field School (FFS). A total of 52 farmer beneficiaries allotted 1.0ha each to be planted with their choice of PhilRice hybrid rice varieties; NSIC Rc202H (Mestiso 19), NSIC Rc204H (Mestiso 20), and NSIC 2011 Rc244H (Mestiso 29). Rice seeds, supplemental fertilizer, and other farm inputs were provided by the project through the roll over or plant-now-pay-later scheme.

Highlights:

- The average yield from hybrid varieties was 6.0t/ha which was 1.6t/ha or 35.7% higher than 4.4t/ha yield from the 2013 DS baseline yield using inbred varieties (Figure 50).

- The net income from hybrid rice (PhP 85,872) was 99.8% higher than the baseline net income (Php 42,970) (Figure 51). Aside from higher yield, the remarkable increase in income was attributed to the increased price of palay from Php 18/kg in 2013 DS to Php 24/kg in 2014 DS.

- Among the hybrid varieties, Mestiso 20 attained the highest yield (6.2t/ha) while Mestiso 19 and 29 had comparable yields

(5.5t/ha). Moreover, Mestiso 20 was the most preferred variety by the farmer-beneficiaries followed by Mestiso 19, conversely, Mestiso 29 was the least preferred (Table 49).

- Cost and return analysis showed that the average gross income from hybrid rice was Php 143,509 with an average net income of Php 83,617 at Php 24/kg price of palay. The Return of Investment (ROI) was recorded at 57.4%.

- Result of FFS assessment indicates 46.4 % knowledge gained from 51.9% during the pre-test to 76% during the post-test (Table 50).

- Currently, the project has further expanded to nearby households including Barangay Frances, totaling to 74 farmer adopters covering 134 hectares rice area planted with PhilRice hybrid rice varieties.

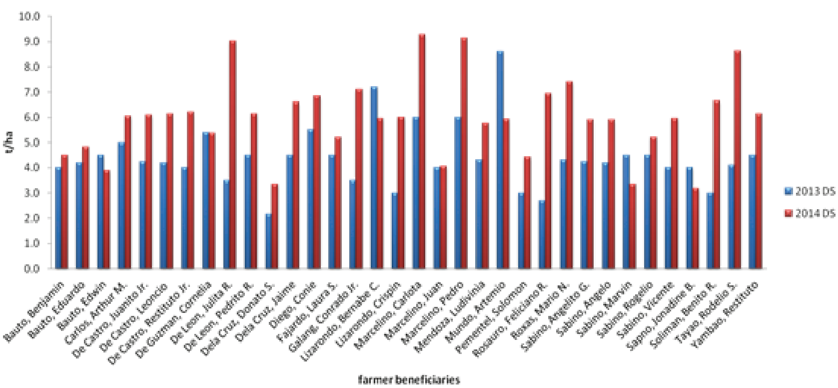

Figure 50. Comparison of yield using hybrid and inbred rice varieties. Calumpit, Bulacan. 2014 DS.

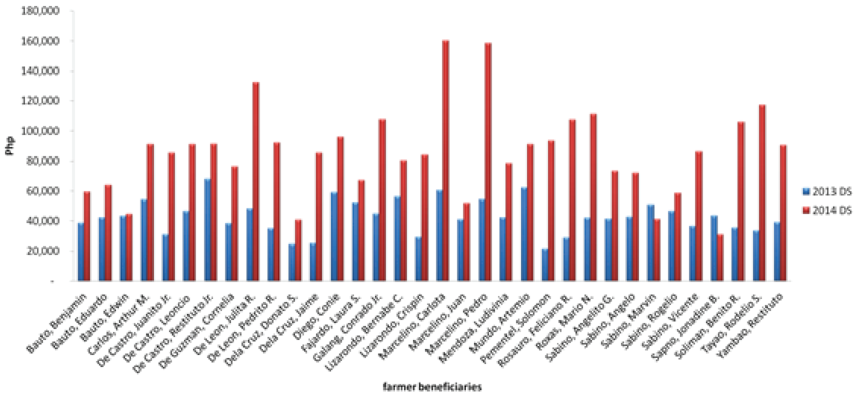

Figure 51. Comparison of net income using hybrid and inbred rice varieties. Calumpit, Bulacan. 2014 DS.

Table 49. Average yield and farmers' preference of hybrid rice varieties. Calumpit Bulacan. 2014 DS.

hybrid rice variety	average yield (t/ha)	farmers'preference (*n*)
Mestiso 19	5.5	18
Mestiso 20	6.2	33
Mestiso 29	5.5	1

Table 50. Result of FFS Assessment. Calumpit, Bulacan. 2014 DS

FFS Assessment	Raw score (20pts)	Average
Pre-test	10.4	51.9
Post-test	15.2	76.0

Figure 52. Project activities. Calumpit, Bulacan. 2014 DS.

XXI. Validation of the Regional Rice Fertilization Guide Maps via Moet Kit and MOET-Fertilizer Requirement Calculator (MOET App)

AOV Capistrano, JJE Aungon, JEG Hernandez

Rice Fertilization Guide Maps disseminated throughout the municipalities in Region III were targeted for evaluation using PhilRice' MOET kit. Soil samples based on ten color-codes in the rice fertilization maps were collected and subjected to MOET tests to determine the indigenous nutrient supplying capacity of the respective soils. The ten color-codes represent the ten largest rice area coverage in the municipality. After the MOET test, field test sites were selected per municipality based on the MOET results and through the assistance of the local government. Fertilizer recommendation experiments were conducted in these field test sites to determine the validity of recommendations from the (1) rice fertilization maps, (2) MOET kit, and (3) MOET Android App.

Highlights :

- Results of the validation experiment in the municipalities of Zambales showed promising results for the MOET App as fertilizer recommendation generator since yield outputs were found better than other fertilizer recommendation guides (Table 51).

Table 51. NSIC Rc216 yield outputs (t/ha) from the trial sites in Zambales in WS2014.

Municipality	Fertility Map	MOET App	MOET kit	Farmers' Practice
Sta. Cruz	5.45	7.97	6.95	5.31
Masinloc	7.47	7.40	7.35	6.78
Palauig	3.63	4.74	4.67	3.98
Iba	5.65	5.97	6.63	5.94
Botolan	4.71	5.98	4.71	5.37
Cabangan	5.99	9.06	7.03	6.96
San Narciso	5.19	6.22	3.15	3.76
San Antonio	6.15	6.45	5.54	4.54
Subic	5.53	7.72	5.55	6.45
Average	**5.53**	**6.83**	**5.73**	**5.45**

Note: Highlighted yields are the highest among treatments.

- An unmanned aerial vehicle (UAV) or drone c/o the Future Rice Program was used to take images of the trial sites in Subic and Botolan (Figure 53a and 53b respectively).

Figure 53a. Aerial view of site in Subic.

Figure 53b. Aerial view of site in Botolan.

- Results of the accuracy of target yield setting showed higher reliability and better proximity under the MOET App (Table 52).

Table 52. Assessment of the reliability of attaining the target yield and proximity to actual yield.

Accuracy Test	Fertility Map	MOET App	MOET kit
Reliability of attaining the target yield set	79%	63%	92%
Proximity of actual yield to target yield set	$\pm$15%	$\pm$21%	$\pm$17%

- Soil samples from Aurora province already underwent MOET testing and the indigenous nutrient supplies were already identified. The next step is to select for field test sites from the municipalities of Aurora with the assistance of their respective

LGUs.

- An android application (MOET App) was developed (Figure 54) and ready for public use once it passes the Technology Assessment Project.

Figure 54. Images of MOET App's various pages showing its content and features.

- A farm cross-visit was initiated in September 2014 to showcase the fertilization trial to the Farmer-cooperators, Rice Coordinators, MAOs and PAO of Zambales and RFU III representatives (Figures 3 onwards).

Figure 55. Project briefing at Subic site with Mr. Cris Rabaca, Provincial Rice Coordinator of Zambales.

Figure 56. Cabangan trial site showing crop stand under Fertility Map (left) and MOET App (right).

Figure 57. MOET App demonstration by Mr. Ailon Oliver Capistrano, Project Leader, during lunch at San Narciso Municipal Hall.

XXII. Evaluation of Hybrid Rice-Based Diversified and Intensified Cropping Systems

RG Corales, JM Rivera, VT Dimaano, AA Corpuz

Central Luzon is considered as the rice bowl of the country. Hybrid rice-based diversified and intensified cropping systems have great potential as a possible approach in attaining and sustaining food sufficiency and reduce poverty. However, the efficiency of cropping systems is governed by and dependent on several factors, most decisive being the type of crops, crop combinations, land use, nutrient and water management and agro-climate. Therefore, there is a need to look into their efficiency and sustainability. The study was conducted at Philippine Rice Research Institute Central Experiment Station (PhilRice CES) during 2013 Wet Season and 2014 Dry Season laid out in Randomized Completely Block Design with three replications. In Activity 1: Assessment of different hybrid rice-based cropping patterns, the treatments was (1) HR-Corn-Corn, (2) HR-Mungbean-Corn, and (3) HR-Corn-Mungbean; In Activity 2: Response of hybrid rice-based cropping system to different nutrient management (Hybrid Rice-Corn-Mungbean Cropping Pattern. The treatments were T1: Control, T2: ON+ PK, T3: Recommended Fertilizer Rate and T4: Balanced Fertilization (½ Rec. N + 10 bags Vermicompost; Activity 3: Effects of Biochar on Hybrid Rice-Corn-Corn cropping system. The treatments were (T1) Control, (T2) 350 kg Biochar/ha, (T3) 490 kg Biochar/ha and (T4) 630 kg Biochar/ha. Rice was planted during July to October, corn was planted on November to February and February to April; and Mungbean was planted in November to January and February to May. The recommended fertilizer used were rice: 90-40-40 kg NPK/ha; corn: 127-35-85 kg NPK/ha and Mungbean: 28-28-28 kg NPK/ha.This study aims to evaluate the impacts of intensified hybrid rice-based cropping systems on soil quality, productivity, profitability

Highlights:

Activity 1: Assessment of different hybrid rice-based cropping patterns

- Yield of hybrid rice ranged from 5.0 to 5.2t/ha, hybrid green corn ranged from 9.07 to 9.58t/ha and mungbean 0.356t/ha.

- Among the three cropping systems, hybrid-corn-corn has the highest total net income of PhP 243,354.00 with an ROI of 1.65 followed by hybrid rice- corn-mungbean with PhP 178,812.42 net income. Hybrid rice-mungbean cropping pattern had the lowest total net income of PhP 139,607.75 due to mungbean have low yield. This low yield may be attributed to poor growth performance of the crop. The quality of seeds used, establishment and management may consider as factor.

- Mungbean cultivation had higher yield (1.22t/ha) when planted as third crop after corn (February) than planted in November (0.35t/ha)

Activity 2: Response of hybrid rice-based cropping system to different nutrient management

- There is no significant difference in the initial yield of M19 during 2013 wet season regardless of fertilizer treatment applied though higher yields were obtained in plots fertilized with organic-based (4.60t/ha) and applied with recommended fertilizer rate (4.25t/ha).

- Higher yield and yield components of hybrid green corn (Klasika) planted after rice was observed in plots wit recommended fertilizer rate but not significantly different with organic-based treatment but significant to the control and plots without application of nitrogen (0N+PK).

- The yield of mungbean was more than 1 ton per ha from the first priming.

- Highest total net income in rice-corn-mungbean cropping system was observed in the balanced fertilization (organic-based) with PhP 174,162.00 but not significantly different to the recommended rate with PhP 173,953.00.

Activity 3: Effects of Biochar on Hybrid Rice-Corn-Corn cropping system

- In 2013 WS, M19 had higher yield in plots incorporated with 490 kg CRH/ha but not significantly different from other treatments with or without application of CRH.
- Hybrid green corn (Klasika) had no significant difference in agronomic data (yield and yield components) as affected by different rates of CRH. Hence, CRH had no effect in corn planted after hybrid rice in its two planting seasons.
- The total net income from rice-corn-corn cropping system was higher when applied with 350kg/ha biochar with PhP185,158.20 with ROI of 2.25 compared to applied with higher rates of 630kg/ha

Figure 58. Field experimental set-up planted with PhilRice CES, 2014 DS.

XXIV. Pilot Testing of the Fermentation and Distillation Plant for Hydrous Ethanol Production from Nipa Sap and Other Plant Sources

ML Rafael, PM Reyes, KC Villota, AT Belonio

Bioethanol is a form of renewable energy that can be produced by fermentation of sugars available in agricultural crops like sugar cane, potato, corn, and other plant sources. To facilitate the conduct of the study on bioethanol production, PhilRice has designed and developed fermentation and distillation units to produce hydrous ethanol from molasses and other plant sources. Molasses is the residue or by-product in processing sugarcane to produce sugar. This material is an excellent source of ethanol. Fermentation and distillation of molasses for hydrous bioethanol production were carried out in laboratory as well as in actual field testing. Laboratory testing was done at PhilRice Rice Chemistry and Food Division in which molasses diluted with sterile distilled water at different ratios (i.e., molasses:water), having 140 ml total volume mixed well in a 250-ml Erlenmeyer flask, and with different amount of active dry yeast was allowed to ferment for 5 days. A simple distillation apparatus was used in distilling the fermented molasses. The treatment with the highest production of alcohol during the laboratory testing was applied in the actual field testing. A 200-liter-capacity distiller was used to produce crude bioethanol with conical-grate rice husk furnace as the heat source. Preliminary testing of hydrous bioethanol distiller with rice husk gasifier as heat source is still on going.

Highlights:

- Results of the tests on fermentation showed that the use of 1g yeast in fermenting 1:3 dilution of molasses medium produced the highest value of alcohol content, though comparable with the alcohol content values using 2, 3, and 4g of yeast in the same molasses dilution, and using 2, 3, and 4g of yeast in 1:2 dilution (Table 53).

Table 53. Physicochemical analysis of molasses after 5 days fermentation with different amounts of active dry yeast.

Physicochemical analysis	Weight of active dry yeast (g)			
	1	2	3	4
*1:1 Molasses:water**				
Alcohol content (%)	6.23^{a}	6.09^{a}	6.62^{a}	6.99^{a}
*1:2 Molasses:water**				
Alcohol content (%)	8.77^{a}	9.49^{a}	9.48^{a}	9.86^{a}
*1:3 Molasses:water**				
Alcohol content (%)	10.53^{a}	10.08^{ab}	9.72^{b}	10.36^{a}
*1:4 Molasses:water**				
Alcohol content (%)	8.13^{a}	7.95^{a}	8.16^{a}	7.59^{a}

Mean values with the same letter within a row are not significantly different at =0.05 (n=2).
140 ml total volume of diluted molasses

- Results of the tests on distillation, on the other hand, reveal that the crude bioethanol distiller can process 7.98 to 11.19% alcohol feedstock sample or fermented molasses producing 44 to 54% crude ethanol within 39 to 50 min of heating the boiler. The computed alcohol recovery of the distiller ranges from 54.8 to 113 %.

- A 400-liter-capacity hydrous bioethanol distiller is under development to process feedstock to produce 90 to 95% bioethanol.

XXV. Accelerating the Development and Dissemination of Associated Technologies on Rice Production that are Resource Use Efficient

EB Sibayan

Component 1.Accelerating the dissemination of associated technologies for increasing yield and profitability in irrigated and rainfed ecosystem

PhilRice CES: LMJuliano, KSPascual, PSRamos, RSMartin, DPManumbali, ECmartin, APSabasaje,GBFlancia; PhilRice-Isabela: H Pasicolan, J Tapec PhilRice Agusan: G Estoy, R Tabudlong; PhilRice-Midsayap: O Abdulkadil, R Salazar

Highlights:

- Conducted ten batches of appreciation seminars cum workshop on S&T updates on rice production that are resource-use efficient with emphasis on water management in Regions 1, II, III, V, VI, IX, X, X1,XII and XIII. There were 453 participants attended by NIA, DA-Region, Provincial and Municipal officers. The appreciation seminar tackled about Paycheck Recommendations for rice production, with emphasis on alternate-wetting-and drying technique. It also incorporated planning workshop about the establishment of technology demonstration farms in the different area in the region for irrigated and rainfed. Table 54 shows details of the appreciation seminars conducted in 2014.

- Conducted 33 on-site briefings to 1338 farmers on the implementation of technology demonstration farm (TDF) in the identified area. The said activity oriented farmer cooperators about the establishment of TDF with emphasis on AWD for irrigated, and ssociated technologies in rain-fed area.

- Established a total of 193 technology demonstration farm (TDF) that showcased variety trials, AWD, crop manager and the use of drum seeder for row seeding. For irrigated, there were 170 TDFs per IA with emphasis on AWD, as well as crop management using the Crop Manager in the national and communal irrigation system. In rainfed, there were 23 PTDs on variety trial ,AWD and the use of drum seeder. The actual number of TDFs established was 93 and 45% of the total identified targeted number in irrigated and rainfed ecosystem, respectively because some farmers had already established their crops earlier than what was expected.

- Conducted farmers' field day on TDF that showcased variety trials, AWD, crop manager and the use of drum seeder for row seeding with farmer participants of 390 in Sultan Kudarat, South Cotabato, La Union, Isabela and Cagayan.

- Distributed a total of 861 observation wells to farmers for the adoption of AWD in selected river and communal irrigation system, as well as those who are using shallow tube well in rainfed area. The observation well was installed at 15 and 20 cm below soil surface to help farmers when to irrigate their field. When there was no water inside the tube, it tells the farmer to irrigate. During flowering, and fertilizer application, farmers were encouraged to practice continuously flooding to prevent yield loss.

Table 54. Number of techno-demonstration farm (TDF) established in 2014.

Region	Province	No. Of TDF established	
		Irrigated	Rainfed
	Ilocos Norte	-	
I	La Union	2	-
	Pangasinan	3	-
	Cagayan	4	2
II	Isabela	5	1
	Quirino	2	1
	Nueva Vizcaya	-	3
III	Tarlac	15	2
	Aurora	1	-
	Pampanga	19	2
	Bulacan	22	3
	Bataan		2
	Zambales	2	2
V1	Aklan	8	3
	Antique	-	1
	Capiz	4	-
	Iloilo	6	-
	South Cotabato	28	1
	North Cotabato	20	-
XII	General Santos City	1	-
	Sarangani	16	-
	Sultan Kudarat	9	-
	Maguindanao	3	
	TOTAL	170	23

In Irrigated- the TDF was established by Irrigators' Associations with more than 3 or more farmer Cooperators (FCs) per IA and in rainfed area by municipality with more than 2 FCs.

Component 2.1:Weed Shift in Rice Grown in Water-Saving Technology

EC Martin, KSPascual, CP Ariola

Weed populations are usually mixed and composed of a number of different species in any given field. Weed management practices (any practice, not just herbicides) will have a slightly different effect on the individual species in the population mixture. Over time, continued use of one practice can lead to the population being dominated by one species or group of species. Any cultural, physiological, biological, or chemical practice that modifies the growing environment without controlling all species equally can result in a weed shift. This study aims to identify potential weed problems in water-saving technology for rice; and determine the effect of water-saving technology and weed management on the yield of rice. The experiments were conducted during the 2014 wet and dry seasons at the Central Experiment Station (CES) in Muñoz, Nueva Ecija. Three water management techniques were designated as the main plot and consisted of alternate wetting and drying (AWD); saturated soil condition (SSC); and continuously flooded (CF). Sub-plot consisted of weed management which included unweeded; hand weeding at 21 and 42 DAS; use of pre-emergence herbicide at 2 to 5 DAS; and use of post-emergence herbicide at 15 DAS. The field experiments were laid-out in split plot RCBD design with four replications.

Highlights:

- Grain yields were significantly affected by weed management and not by irrigation techniques, or the interacting effects of the treatments in both seasons. In the wet season, average grain yields across irrigation techniques ranged from 3.66 to 3.98t/ha, while in the dry season, average grain yields ranged from 6.61 to 7.25t/ha;

- Among weed management, which significantly ($P < 0.05$) influenced grain yields, un-weeded plots consistently obtained the lowest grain yields in both seasons. The same trend was also observed in the plant height at maturity and number of grains per panicle ($P<0.05$) during wet and dry seasons, respectively.

- During the dry season, all weed control treatments, obtained grain yields ranged from 7.61 to 7.92t/ha with hand weeding at 21 and 42 DAS obtained the highest grain yield. In the wet season, grain yields ranged from 3.87 to 4.10t/ha with the application of post emergence herbicide at 15 DAS obtained the highest grain yield.

- Weed flora are mostly composed of grasses that accounted for more than 95% of the total weed population. In both seasons, un-weeded plots had the most number of grasses than all the weed control treatments. At 28 DAS during dry season, predominant grasses were Ischaeum rogusum, Echinochloa crus-gali and Leptocholoa chinensis (L) Nees. In wet season, the same species thrived under unweeded but 50% lesser than during the dry season. In the 56 DAS during DS, weeds escalated in the UW plots with the same specie as in 28 DAS, but additional specie such as Echinocloa glabrescence was noted.

- In the wet season, weed population was significantly lesser than in the dry season, but more grasses were noted such as the Echinocloa colona, and Fimbristylis milliacea. Sedges such as Hydrolea zeylanica and Ludwigia octovalvis were also observed. At 84 DAS, weeds under unweeded plots significantly decreased but profused weeds were observed in the other control treatments such as in the application of pre- and post emergence herbicides under CF and SSC, respectively.

- Among the weed management treatments, hand weeding twice and application of post-emergence herbicide at 15 DAS demonstrated to be the most effective way of controlling weeds in both seasons.

Component 2.2 Evaluation of agronomic and energy efficiencies of mechanical direct-seeded rice crop establishment in combination with reduced tillage

MJC Regalado, KS Pascual, and CPM Ariola (Philrice-CES)

Field experiments were conducted at PhilRice-CES in Nueva Ecija during the 2014 dry and wet seasons to evaluate the agronomic and energy efficiencies of mechanical direct-seeded rice crop establishment in combination with reduced tillage (RT). Rice varieties such as NSIC Rc9 and M19 were used as test varieties. Field experiments were laid out in split-split-plot in RCBD with tillage x seeding method x variety as treatments in four replications. The tillage and seeding method were evaluated in terms of over-all energy efficiency (ratio of energy equivalent of paddy output to the energy equivalent of inputs), including yield and yield components for the variety treatments. The reduced tillage technique consisted of one-pass dry rotavation using a 4-wheel tractor with rotary tiller (rotavator). In the conventional technique (CT), the soil was dry-tilled three times at one week interval and leveled once using the same machines as in the reduced tillage. For the seeding method, row seeding was done using different mechanical seeders such as plastic drum seeder(S1), push-type Korean seeder (S2), and Indian multi-crop zero-till planter (S3). Manual seeding by dibbling method (S4) using improvised lithao was also used in 2013 DS. While in 2013 and 2014 WS, hand dibbling was used. Seeds were sown at 40kg/ha to all mechanical seeder, and 2 to 3 seeds per hole at 20 x 20 spacing for dibbling. Pre-emergence herbicide was applied 3 days after sowing, and occasional manual weeding during crop growth duration. Flush irrigation was employed once a week.

Highlights:

- Conventional tillage (5.26t/ha) obtained higher mean grain yield than reduced tillage (5.21t/ha) in the dry season; while RT (4.24t/ha) obtained the higher grain yield in the wet season;

- Total production cost per hectare was lower in RT with PhP 6.91 to 9.00 per kg unit production cost compared with PhP 7.03 to 9.95 per kg for CT;

- The total energy equivalent of external inputs, such as seeds, fertilizers, chemicals, fuel, human labor, tractor-hours and other machine-hours were significantly lower in RT than CT;

- The overall energy efficiency of RT (3.44 to 5.86) was higher than CT (2.46-4.11) due to higher energy output equivalent (Figure 59).

- Reduced tillage can produce about 16 to 25% more kilograms of paddy per man-day than conventional tillage. It is also more energy efficient that could reduce 10 to 12% unit production cost than CT without significant effect in the mean grain yield.

- Mechanical seeders such as plastic drum seeder and Korean seeder may be a better option to reduce labor input cost.

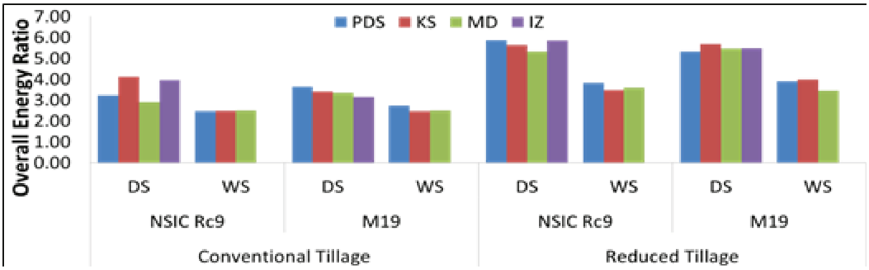

Figure 59. Over-all energy ratio of the different tillage, seeding method and variety during dry (DS) and wet (WS) seasons, 2014 at PhilRice-CES.

Sub Component 2.3. Development and dissemination of zero-till planter with fertilizer applicator for direct seeding.
MJC Regalado, CPM Ariola and HVValdez

- Fabricated and assembled the component parts of the 9-row zero till planter such as the main frame, seed hopper with cover, fertilizer hopper with cover, furrow opener, seed metering plate with housing, shafting and bushing, fertilizer hopper adjustment assembly, seed hopper mounting brackets, hitch assembly, fertilizer metering chute, depth guide with axle and connector assembly and ground wheel (Figure 60b);

- Conducted a laboratory testing on the seed metering plate of the seeder. Results showed that increasing the speed of the conveyor belt, achieved decreasing hill spacing of rice. To achieve the recommended seeding rate of 40 kg/ha and from 3 to 4 seeds/hill at a distance of 10 cm in between hills a metering plate with 14.5rpm was used as a speed of the seed plate of the prototype.

- The performance of the prototype will be evaluated on-farm.

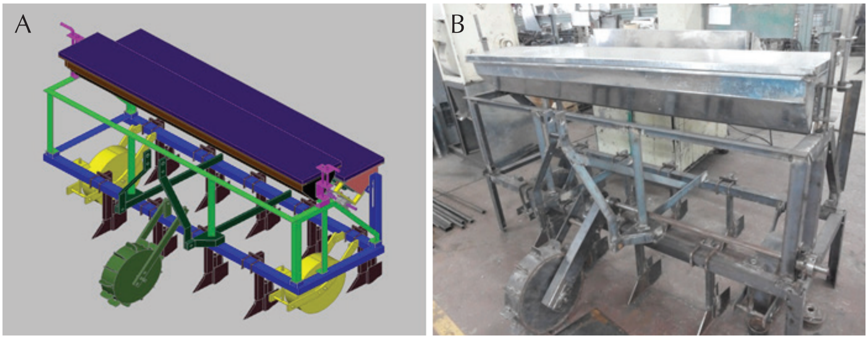

Figure 60. (a) 3D view of the 9-row zero till planter and (b) fabricated prototype.

XXVI. Application of Nuclear Analytical Technique for Efficient Nutrient and Water Management in Rice Production

Project Leader: EB Sibayan

Assessing water-use efficiency of rice in different water-saving technologies using stable isotope techniques

KS Pascual, AP Sabasaje, FS Grospe, EB Sibayan

Nuclear and isotopic techniques are very valuable tools in assessing the soil nutrient and water productivity in rice production. This study aims to increase the water-use efficiency of the different irrigation techniques in rice using smart-farming technologies through nuclear analytical techniques. Stable isotopes as tracers were used to measure the rate of uptake, storage, and cycling of water in the soil and plants. There were 4 water management techniques laid out in RCBD with 4 replication were established during the 2014 dry and wet seasons. The treatments consisted of continuously flooding or CF (maintained water level at 2 to 5 cm depth); Alternate-wetting and drying or AWD (-irrigated the field when water depth reached 15cm below soil surface); Mid-season drainage or MSD (withrawn flood water 7 to 10 days before panicle initiation); and Saturated condition or SSC (irrigated the field at 2 to 3cm water depth when there is no visible surface water). For the isotopic analysis, crop and water samples were collected based on established protocol and were sent to the Philippine Nuclear Research Institute (PNRI) for the analysis.

Highlights:

- In 2014 DS, 35% water savings was generated using AWD when compared with CF with irrigation water use of 342mm in AWD and 523 in CF; During wet season, more than 80%

of the total irrigation used came from rainfall (Table 55).

- A significant lower irrigation frequency (number of irrigation events) was obtained in AWD when compared with CF and SSC in which the reduction was almost double from the traditional practice (CF);

- Grain yield was not significantly affected by water management with grain yield ranged from 6.2 to 6.7 and 5.4 to 5.6t/ha in dry and wet seasons, respectively;

- A significant high water productivity with respect to irrigation input was obtained in AWD (1.8 g grain per kg water) compared with CF and SSC (1.2 g grain/ kg water). The water productivity was attributed by high grain yield but lower irrigation input. The same trend was also observed in the water productivity with respect to irrigation plus rainfall;

- Cro pand water samples were sent to PNRI for the isotopic analyses.

Table 55. Irrigation frequency, water use, grain yield and water productivity of rice under different irrigation techniques, 2014

Water Management Techniques	Irrigation Frequency	Irrigation (I) mm	Irrigation+Rainfal (I+R) mm	Water Savings (%)	Grain yield (ton/ha))	WP (I) (g grain/kg water)	WP(I+R) (g grain/kg water)
Dry Season							
CF	15^{b}	523^{a}	523^{a}	control	6.5^{a}	1.2^{b}	1.2^{b}
AWD	8^{d}	342^{b}	342^{b}	35	6.2^{a}	1.8^{a}	1.8^{a}
SSC	17^{a}	527^{a}	527^{a}	-1	6.3^{a}	1.2^{b}	1.2^{b}
MSD	14^{c}	496^{a}	496^{a}	5	6.7^{a}	1.4^{b}	1.4^{b}
Wet Season							
CF	3^{a}	105^{a}	636^{a}	control	5.4^{a}	5.3	0.9^{a}
AWD	1^{b}	25^{c}	556^{c}	76	5.4^{a}	14.6	1.0^{a}
SSC	3^{a}	82^{b}	613^{b}	22	5.6^{a}	7.1	0.9^{a}
MSD	3^{a}	94a^{b}	625^{ab}	11	5.5^{a}	6.4	0.9^{a}

Means within column followed by the same letters are not significantly different at 5% level using LSD. CF- continuously flooding; AWD- alternate-wetting and drying; SSC-saturated soil culture; and MSD-mid-season drainage; WP -Water Productivity

XXVII. Use of Stable Isotope Technique in Improving the Soil Tests Calibration and Fertilizer Recommendation for Rice

FS Grospe, AP Sabasaje, GDGracia and Evangeline B. Sibayan

With the increasing cost of fertilizer, one of the major challenges is to increase nutrient-use efficiency in rice production system. Major improvements in fertilizer efficiency are likely to come from improvements in the rice plant, which will enable it to gather nutrients more efficiently or by changing the fertilizer formulation and the methods of application used by farmers. Thus, developing a nutrient management program that takes into account the following aspects such as the indigenous nutrient supply at each site (site-specific), the temporal variability in plant nitrogen status occurring within one growing season (season-specific), and medium-term changes in soil P and K supply based on the cumulative nutrient balance are very important. This study will determine the nutrient use efficiency at different soil fertility levels using the nuclear analytical technique.

Highlights:

Dry Season

- Application of different rate of N fertilizer did not significantly affect the grain yield in soil with low N level. The highest efficiency of applied N was observed at 45 kg N/ha with 50% savings from applied N fertilizer with higher grain yield produced per kg N applied compared with the application of 90kg N/ha (Table 56);

- Grain yield in medium N soil was significantly affected by different N fertilizer applied. Highest yield was obtained at 135kg N/ha and 180kg N/ha. Savings of 33% of N fertilizer applied with higher grain yield produced per kg N applied at 90kg N/ha were obtained compared with 135kg N/ha. Although the yield at 135kg N was higher than 90kg N/ha, the productivity was lower;

- In high N level soil, yield did not respond to increasing N fertilizer rate. There was no significant difference observed between control and the treated plots. It showed that the inherent soil N was adequate to achieve maximum yield.

- In low P soil, the yield of control plot was not significantly different with those treated plots. This may due to adequate amount of available P in the soil owing to residual P build up after two cropping seasons in the area.

- In medium soil P, highest grain yield was obtained from applied 120kg P/ha. All other treatments (30, 60, 90 Pkg/ ha) produced relatively the same grain yields. application of 30kg P/ha obtained higher ANUE than 60kg P/ha. This can be translated to 50% savings from P fertilizer applied to increased grain yield per kg of P fertilizer applied;

- For high soil P, there were no significant yield differences that were noted among treatments. Maximum yield can be attained even without P fertilizer applied.

- In low K soil level, there was no significant yield differences among treated plots compared to the control. In terms of ANUE, application of 30kg K/ha was significantly higher compared with other treatments. This could be translated to 50% savings of fertilizer K to increased grain yield per kg of grain compared to 60 kg K/ha. More so, 100% savings when compared to 90kg /ha application.

- In medium K soil, grain yields of rice with K application did not significantly differ with the control treatment (0kg K/ha) . This means that comparatively high yield can be achieved even without K fertilizer application. In terms of ANUE based from the control, 30 kg K/ha obtained the highest with 66% savings when compared from K w/ higher grain yield produced per kg K applied.

- Results of the nuclear analytical analysis for better understanding on the crop uptake from the fertilizers applied and relate this to grain yield, and nutrient use efficiency will be analyzed in collaboration with PNRI.

Table 56. Grain yield of rice (t/ha), agronomic nitrogen use efficiency (ANUE) in soils with different fertility levels and varying rate of N applied in Region 3, 2014DS.

	Low N		**Medium N**		**High N**	
N rate (kg/ha)	**Yield (t/ha)**	**ANUE**	**Yield (t/ha)**	**ANUE**	**Yield (t/ha)**	**ANUE**
0	5.0 b	-	3.9 d	-	6.7 a	-
45	6.3 a	27.4 a	5.6 c	39.2 ab	8.0 a	28.9 a
90	6.9 a	19.1 abs	7.6 b	44.0 a	7.4 a	14.6 b
135	7.1 a	15.6 abs	8.6 a	35.0 ab	6.7 a	-0.07 b
180	7.0 a	10.8 abs	8.6 a	26.4 b	6.5 a	-1.2 b
210	7.2 a	10.4 b	8.4 ab	28.9 b	6.5 a	-1.1 b

Wet Season

- Application of high rate of N fertilizer in low N soil during wet season did not significantly increased grain yield. there was no significant difference was noted in the utilization of applied N fertilizer. This indicates that applied N were not fully utilize during wet season probably due to rainfall low solar radiation (Table 57).

- Grain yield in medium soil N level was affected by varying the level of N fertilizer. Application of 45kg N and 90kg N /ha obtained a significantly higher yield than the control and those with 180kg N and 210kg N/ha; Savings of 50% in N fertilizer under low rate N can be achieved when compared with 90kg N/ha application.

- At soils with high medium and low N level, the yield obtained in all treated plots did not significantly differ with the control. Optimum grain yield could also be attained even without application of N fertilizer due to low utilization of applied N in the wet season.

- Optimum yield can achieved even without P fertilizer application.

- There was no significant yield difference observed between the control and the treated plots in soil with low K fertility.

- Results of the nuclear analytical analysis for better understanding on the crop uptake from the fertilizers applied and relate this to grain yield, and nutrient use efficiency will be analyzed in collaboration with PNRI.

Table 57. Grain yield of rice (t/ha), agronomic nitrogen use efficiency (ANUE) in soils with different fertility levels and varying rate of N applied in Region 3, 2014WS.

	Low N		Medium N		High N	
N rate (kg/ha)	Yield (t/ha)	ANUE	Yield (t/ha)	ANUE	Yield (t/ha)	ANUE
0	3.2 ab	-	4.3 b	-	5.0 ab	
45	3.7 a	12.02 a	5.3 a	21.3 a	5.7 a	15.2 a
90	4.3 a	12.42 a	5.4 a	12.3 a	5.7 a	8.0 a
135	3.4 ab	1.81 a	4.5 ab	1.26 a	5.8 a	6.0 a
180	2.8 b	-1.9 a	4.3 b	- .10 a	4.7 b	1.5 a
210	2.5 b	-3.1 a	3.8 b	- 2.3 a	4.7 b	-1.2 a

Means within column followed by a small letter are not significantly different at 5% probability using LSD. ANUE-agronomic nutrient-use efficiency. All N rate had a blanket application of 40kg P and 40kg K/ha in each treatment plot.

XXVIII. Greenhouse Gas Mitigation Potentials of Water Saving Technologies for Rice Fields in Central Luzon

Project Leader: EB Sibayan
Researchers: KS Pascual, ME Casil, F Grospe

The promotion of alternate wetting and drying (AWD) technique in the national irrigation system in the Philippines has markedly reduced irrigation water requirement in rice production. Consequently, the mitigation potential of such water management technique characterized by multiple aerations had been reported to reduce greenhouse gas emission in the rice field. In this study, methane emission (emissions) were evaluated in selected rice farms in Central Luzon, Philippines covering canal and pump irrigation systems during the 2014 dry season. On-farm field measurements were conducted in three sites in Central Luzon. Target farms involving clustered 30-50 hectares (or the service area of a turn out, the smallest group of water users in an irrigated system) are those from the national irrigation system operating under the gravity and pump irrigation system. Irrigators associations were identified, and farmer cooperators were selected within the turn-out servise area (TSA), to adopt alternate-wetting and drying (AWD) technique. Near the TSA is continously flooding (CF) farmers' parcticed. In the TSA, three field plots of at least 500 square meters were designated for the GHG flux measurement. For all sites, the crop managements were up to the farmers' practice, and only the AWD was introduced. Table 58 shows some of the details of the irrigators assosciations (IAs) involved in the AWD adoption. Methane emissions from each AWD and CF plots were measured once a week using an improvised closed chamber based on established protocol. The analyses of gas samples were done using with gas chromatograph equipped with equipped with a flame ionization detector (FID) and electron capture detector (ECD)..

Table 58. Profile of Irrigators Associations involved in the AWD implementation in the field.

Details	Irrigators Association		
	Doña Sagrada	TG-59 ISC	Kapatiran
Address	Sta. Maria, Licab Nueva Ecija **(Site 1)**	Carmen, Anao Tarlac **(Site 2)**	Sampaloc, San Rafael Bulacan **(Site 3)**
Service Area (ha)	361.64	53.50	168.00
Farmer Beneficiaries	221	24	142
Number of TSA	4	8	8
Canal Length (km)	2.42	2.28	7.37
Type of Irrigation System	Gravity	Pump-driven (STW)	Pump-driven (Low-lift pump)

TSA= turn-out service area; STW= shallow tube well; Dry season: Sites 1 to 3; Wet Season: site 1 and 2

Highlights:

- Large variation of CH4 emission was observed between CF and AWD plots during the crop growth period. For CF plots, an increasing trend was observed from 27 to 48 DAT, but a large drop was observed at 58 DAT, and increases again at 63 DAT. The difference of CH4 emission between CF and AWD plots could be attributed to some soil aerations observed in the AWD plots, especially at 55 DAT wherein the threshold level of AWD was achieved (Figure 61, Site 1). The implementation of AWD could be further explained by the limitation of irrigation water in the area, because the location is at the tail end of an irrigation system. On the average seasonal variation of the emission rate of CH4 in CF and AWD are 12.36 and 1.23mg CH4/h*m^2, respectively.

- In site 2, large difference of CH4 flux emission was observed between AWD and CF plots during the early tillering stage (27 to 34 DAT) of the rice plant. This could also be confirmed in the water level in the field during the gas measurement (Figure 61, Site 2). Towards the reproductive stage (48to 77 DAT), lower trend was observed under the CF plots, and almost similar to AWD plots. The same trend as in site 1, the AWD plots maintained a lower trend of CH4 emission, and almost negligible throughout the rice growing duration. The use of STW where farmers needed to pump water for irrigation could have attributed to the almost the same trend of CH4 flux in both CF and AWD plots at 42 to 82 DAT. Continuous irrigation in CF plots was also interrupted, while in AWD plots, a mid-season drainage (42 DAT) was achieved (Figure 61, Site 2). On the average, seasonal variation of CH4 flux of CF and AWD are 3.25 and 0.12mg CH4/h*m^2, respectively.

- In site 3, AWD plots showed high variability of CH4 emission rate, and even achieved higher rate as compared to CF plots at tillering to panicle initiation stages (25 to 46 DAS). The high flux in AWD plots could have attributed to the chicken manure as organic fertilizer incorporated into the soil as basal application. In the CF plots starting at 54 DAS, large variation of flux was observed with high peak at 88 DAT but decreases towards maturity. At 61 to 81 DAT, a relatively the same trend of CH4 emissions were observed in both CF and AWD plots. On the average, seasonal variation of CH4 flux of CF and AWD are 4.55 and 5.74mg CH4/h*m^2, respectively.

- The seasonal variation of emission rates of N20 in all sites for CF and AWD were marginal (data not shown).

- In all sites, CF achieved higher grain yields than AWD by 17 to 54%. The higher yields of CF in sites 1 and 2, could have attributed by higher number of panicle and productive tillers per meter square and high percent filled grain at maturity as compared to AWD. In site 3, the higher yields in CF plots could have attributed to higher percentage of filled grains and 1000 grain weight. Average grain yields ranged from 2.14 to 6.08 t/ha for inbred varieties, and 4.01 to 5.28t/ha for hybrid.

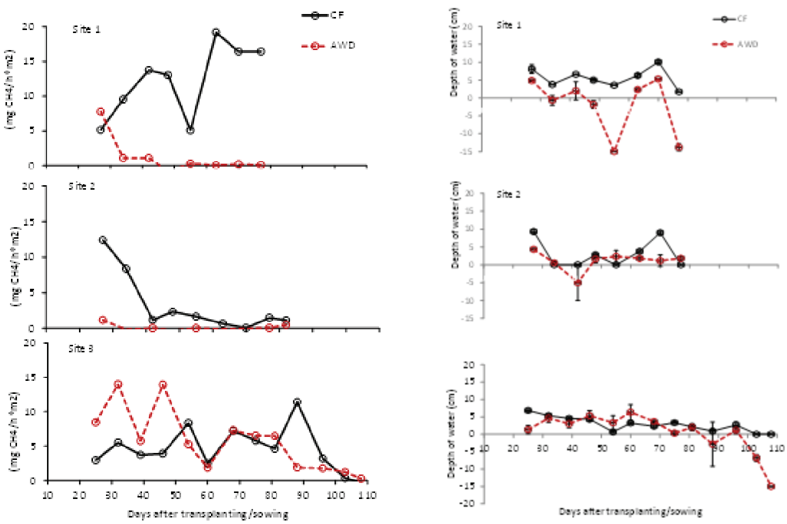

Figure 61. (a) Seasonal variation of CH4 flux and (b) field water depth in the 3 sites in Central Luzon, 2014 DS

XXIX. Genetic Diversity of RTBV and RTSV Isolates from Different Rice Tungro-infected Areas in the Philippines and Screen the Reaction of a Different Set of Varieties

XGI Caguiat

There are two viruses, rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) that could occur singly or combined to cause the rice tungro disease (RTD). RTD has been known to cause devastating impact in rice industry worldwide. It is important to know that different strains of these two viruses could affect different high-yielding varieties. However, in order to determine which strains affects which varieties, identification of the different strains of the viruses and their genetics should be considered.

In the long run, knowledge on the genetic variation present in these organisms will help in disease management and development of rice tungro disease-resistant varieties. Through this study, exploring the differences in nucleotide and protein variation of the tungro viruses will provide information on how much genetic differentiation exists in the pathogen population in the country, and may provide clues as to why the disease is more severe in some places than in others. This would help researchers to determine the right type of resistance genes for the different virus strains to be used in developing new rice varieties. By planting the right variety, farmers will no longer suffer the destructive disease, and they will produce enough rice which may lead to sustainable development. Another thing is that the composition and structure of virus population is not stable, and its genotype differ significantly over time, so by continuously monitoring virus populations, we can better understand and identify the factors why there is tungro outbreak or extinction of the current prevailing tungro virus populations and by this, it may lead for us to achieve durable virus resistance genes and varieties of rice. In bridging the gap of using nucleotide sequence data of each isolates, differential varietal responses on different RTBV and RTSV strains in a particular region would aim in selecting possible accession that could be as source of resistance gene per isolate per location.
The study aims to determine the genetic variability of RTBV and RTSV isolates from different rice tungro-infected areas in the Philippines through the use of molecular markers and screen the reaction of a differential set of rice varieties.

Highlights:

- 200 tungro-infected plants were obtained from five rice-growing provinces: Isabela, Nueva Ecija, Negros Occidental, North Cotabato, Camarines Sur and Laguna (Figure 62). PCR Analysis confirms CP1 amplification (Figures 63)

- 4 conserved regions were found in Isabela (regions 319-326, 337-355, 361—377 and 448-462) while there was none from the other provinces indicating stability of RTBV isolates in Isabela.

- Selection pressure on the RTBV CP1 gene at the province and national level could be absent as indicative of non-significant Tajima's D values. The differences in the patterns of nucleotide diversity in RTBV across geographic regions may imply that the factors affecting nucleotide diversity could also vary within provinces. This information will be used in conjunction with varietal reaction patterns, spatial and genomic diversity monitoring to understand RTBV evolution

- At the national level, nucleotide diversity levels of RTBV (π=0.0662, π=0.0712) were slightly higher than RTSV (π=0.0599, π=0.0632). Among the different provinces, nucleotide diversity of RTBV was highest in ISA (π=0.0564, π=0.0588) and NOC (π=0.0553, π=0.0637), and lowest in COT (π=0.0297, π=0.0265). For RTSV, the nucleotide diversity levels were generally lower in magnitude among the different provinces, except in NOC (π=0.0720, π=0.0711). The high levels of nucleotide diversity of both RTBV and RTSV in NOC may imply that the extent of the diversity of tungro viruses across the country is present in this particular province because of different environmental factors present in the particular area which affect the genome. There was no indication of selection pressure acting on the coat protein genes at the province and national levels, as the Tajima's D values (Tajima, 1989) were all not statistically significant. The differences in the patterns of nucleotide diversity between RTBV and RTSV across geographic regions may imply that the factors affecting nucleotide diversity are affecting the two viruses independently.

- The degree of genetic differentiation among provinces was generally lower in RTBV than in RTSV. In RTBV, pairwise FST (fixation index) tended to be lower for NOC with other provinces (0.2073 to 0.2878), except between ISA and NEC (0.1261). In RTSV, the same trend was observed for NOC with other provinces: FST ranged from 0.2422 to 0.4728. In contrast, genetic differentiation was very high for the other provinces (0.7703 to 0.9214). Apparently, the amount of distance between any two provinces seemed to have the general effect of increasing the divergence of isolates between them. Two distinct clusters of RTBV isolates were reported by Cabauatan et al. (1999), whereas three lineages of RTSV isolates from Indonesia and the Philippines were inferred by Azzam and Chancellor (2000).

- The amount of heterogeneity among isolates from the same province and the degree of genetic differentiation between provinces were reflected in the phylogenetic trees. In both RTBV and RTSV, the NOC isolates tended to form a less tight cluster compared to other provinces. The star-like topology of the RTBV dendrogram (Figure 65A) was due to higher nucleotide diversity levels within provinces and less genetic differentiation of RTBV CP1 sequences among different provinces. Having the highest FST values and lower nucleotide diversity levels within provinces, the RTSV dendrogram (Figure 65B) was deeply bifurcated with very tightly clustered branches that corresponded to provinces.

Figure 62. Geo-tagged of provinces where tungro-infected plants were collected. These areas included sites of outbreak reported in the past.

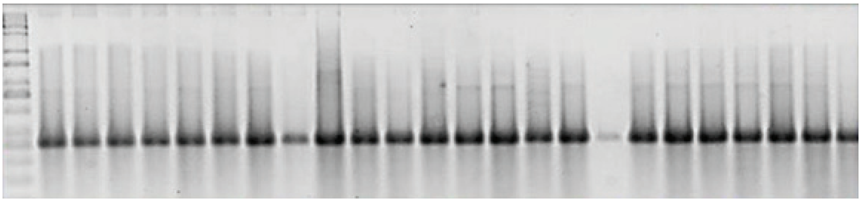

Figure 63. Representative gel showing amplification of RTBV CP1 gene at 618 bp.

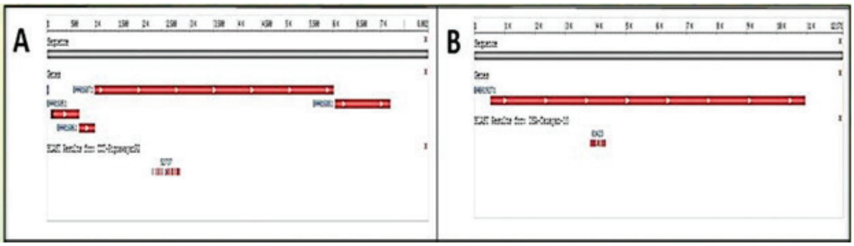

Figure 64. Sample BLAST result showing position of the CP1 from a representative isolate in the complete RTBV genome (GenBank accession D10774.1).

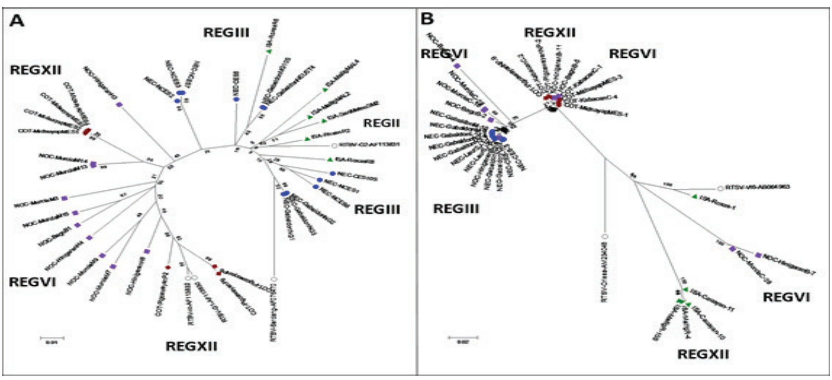

Figure 65. (A) Rooted maximum likelihood tree of RTBV isolates based on Tamura-Nei distance. (B) Rooted maximum likelihood tree of RTSV isolates based on Kimura two-parameter distance.

XXX. Pre-MET (Multi-environment Test) Evaluation of Elite Irrigated Rice Breeding Lines under the Project 'Transforming Rice Breeding'

NL Manigbas, MB Magat

Preliminary yield trial (PYT) is ubiquitous in the rice breeding program. It is an important feature which could be better conducted through the use of the Multi-environmental trials (MET). Multi-environmental Trials are experiments carried out in multiple environments. Hence the leading interest of the plant breeding program is pursuing selection of variety to its environment, genotype yield stability performance evaluation across different sites are usually performed through Multi-environmental Trials (MET). Studies show that results are rarely exactly repeatable because they depend on the environment. METs are used for finding out what is repeatable across a set of environment and could also be used to understand the mechanisms and other possible reasons of interaction with the environment. These trials are conducted in order to confirm the performance and stability of crop varieties for recommendation to farmers. This study aim to generate database of breeding lines and identify high yielding genotypes that are useful for the plant breeding program and varietal release.

Highlights:

- A total of 1,625 elite irrigated breeding lines including 95 entries from PhilRice were used in the study. The highest yield at PhilRice station was obtained from IR103806:26-BRGA with 8.6 t/ha and PR42062 with 7.2 t/ha.

- Three lines; IR 94090-74-1-1-2-B, IR 98417-B-B-6 and IR103806:26-BRGA, had 8.2, 8.3 and 8.6 t/ha yield respectively (Figure 66). Sixteen lines; two PR and twelve IR lines had range yield of 7.0 to 7.8 t/ha, sixty-four lines with 6.0 to 6.9 t/ha and 230 entries had range yield of 5.0 to 5.9 t/ha.

- Mean data for plant height and days to 50% flowering were also gathered as shown below (Table 59 and Table 60). Data for days to flowering are used in grouping the elite lines according to maturity.

- Forty elite lines were selected having high phenotypic acceptance. Promising entries are being evaluated hence the more entries that are selected in the PYT stage the greater the probability of finding superior entry in advanced testing.

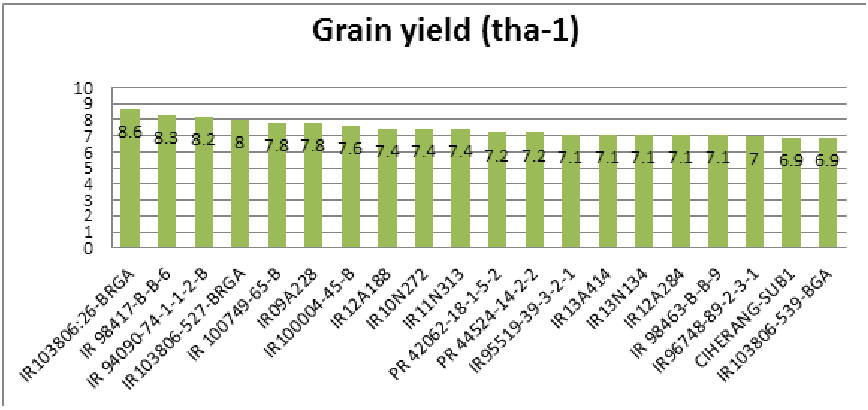

Figure 66. High yielding elite lines during 2014 wet season.

Table 59. Mean data of plant height at maturity.

Designation	Plant Height (cm)
IR93339:39-B-6-5-B-B-B-31	156.5
IR 99119-B-B-45	155
IR09N542	155
IR10A234	153.5
IR93339:29-B-7-7-B-B-B-21	153.25
IR103806:26-BRGA	152.5
IR 99054-B-B-29	152.5
IRRI162	151.5
IR93339:39-B-6-5-B-B-B-47	150
IR 99056-B-B-15	149.5
IR 93339:39-B-6-5-B-B-B-9	149
IR 99077-B-B-6	149
IR 98462-B-B-1	149
IR 93339:29-B-7-7-B-B-27	147.5
IR13A194	147.5
IR11A282	147.5
IR93339:39-B-6-5-B-B-B-45	147.5
IRRI117	147.5
IR 93339:39-B-6-5-B-B-B-38	147
IR96774-21-1-2-1	147

Table 60. Days to flowering of some entries.

Designation	Plant Height (cm)
IR93339:39-B-6-5-B-B-B-31	156.5
IR 99119-B-B-45	155
IR09N542	155
IR10A234	153.5
IR93339:29-B-7-7-B-B-B-21	153.25
IR103806:26-BRGA	152.5
IR 99054-B-B-29	152.5
IRRI162	151.5
IR93339:39-B-6-5-B-B-B-47	150
IR 99056-B-B-15	149.5
IR 93339:39-B-6-5-B-B-B-9	149
IR 99077-B-B-6	149
IR 98462-B-B-1	149
IR 93339:29-B-7-7-B-B-27	147.5
IR13A194	147.5
IR11A282	147.5
IR93339:39-B-6-5-B-B-B-45	147.5
IRRI117	147.5
IR 93339:39-B-6-5-B-B-B-38	147
IR96774-21-1-2-1	147

XXXI. Monitoring for Clarification of Near Canopy Environment & Hiss of Rice Under Various Types of Climates - Japan & Philippines

NL Manigbas, LB Madrid

Since the 1980s, an increase in the concentration of greenhouse gases, such as carbon dioxide in the atmosphere is thought to have been responsible for increasing the air temperature (Hansen et al. 1984). However, crop problems with regard to heat-stress are intensified by factors other than temperature increase. The National Institute for Agro-Environmental Sciences (NIAES) Japan established a multilateral network for monitoring the canopy thermal network environment in paddy fields and to collect other crop data. A force ventilated measurement system of micrometeorology called Micrometeorological Instrument for Near Canopy Environment of Rice (MINCER) was given to all country partners with aims to create database of environmental and crop variables and to assess and evaluate heat-stress in rice under field condition.

Highlights:

- Experiment and data gathering were conducted only during dry season. Four genotypes namely IR72, NSIC Rc122, IR 64 and N22 were used. Temperature and relative humidity were monitored using Micrometeorological Instrument for Near Canopy Environment for Rice (MINCER), set to record every two minutes. Two sets were established. Without stress set –up was during normal dry season planting, and with stress was established a month late and planted staggered for flowering to occur simultaneously.

- Recorded temperature during flowering in February 19 to April 22, 2014, did not exceed critical level or above 35^{o}C. Except on March 28 when temperature suddenly rose to 40^{o}C at 1 in the afternoon. But dehiscence or flowering ends before 12noon so flowering especially of Angelica was not stress, hence all genotypes planted under normal condition were not heat-stressed.

- Agronomic data gathered from genotypes planted under normal condition showed that Angelica had the highest yield and spikelet sterility (Table 61). IR72 on the other hand, had the highest grain weight and number of spikelet per panicle. However, chalky grains were also highest in IR72. Genotype with lowest chalky grains and sterility was N22.

- Temperature from April 14 to May 28, 2015 reached critical level (Figure 67 and 68). All four genotypes flowered during these days thus expected to be heat-stressed.

- Based on agronomic data collected, yield and number of spikelet per panicle decreased in all genotypes by more than 67%. Grain weight also decreased except for Angelica with retained value of 0.024g. Sterility also increased in all genotypes but IR64 had the highest sterility increase of up to 81.7%.

Table 61. 2014 dry season agronomic data under normal or without stress set-up.

Variety	Panicles /hill (25hills)	Spikelets/ panicle (2 hills)	Grain wt. (g)	Grain Yield (t/ha)	Chalky Grains (%)	Sterility (%)
IR72	15	289	0.029	7.76	11.55	14.65
Angelica	16	250	0.024	9.28	5.87	16.55
IR64	15	210	0.028	6.14	2.83	6.67
N22	15	141	0.022	2.36	0.66	8.46

Table 62. 2014 dry season agronomic data under with stress set-up.

Variety	Panicles /hill (25hills)	Spikelets/ panicle (2 hills)	Grain wt.	Grain Yield (t/ha)	Chalky Grains (%)	Sterility (%)
IR72	19	101	0.021	1.84	27.90	19.70
Angelica	18	103	0.024	2.55	18.29	33.03
IR64	19	85	0.021	1.96	20.08	36.47
N22	12	95	0.017	0.66	17.38	15.23

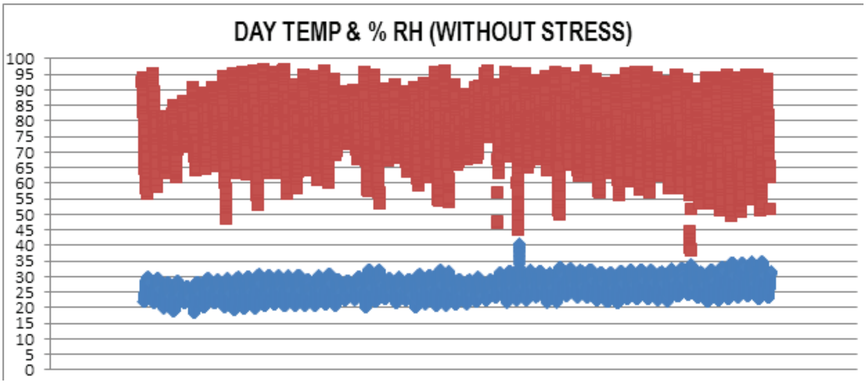

Figure 67. Temperature and relative humidity under field conditions at Philrice, Nueva Ecija from February 19 to April 22, 2015.

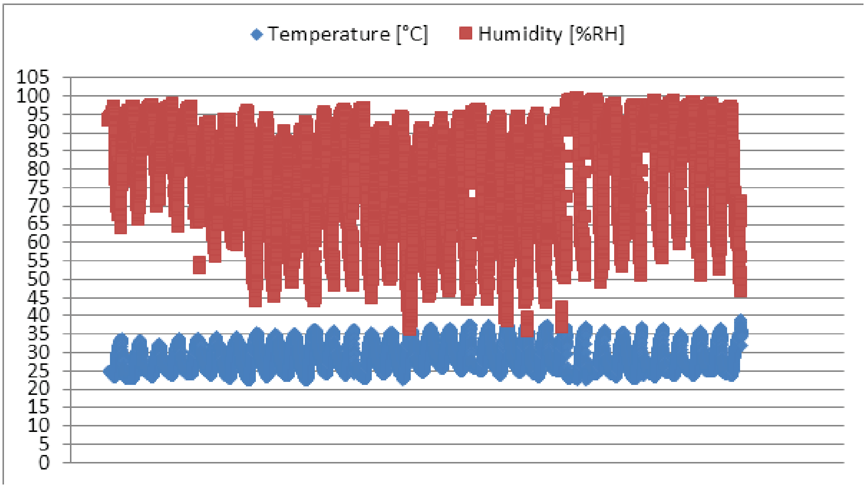

Figure 68. Temperature and relative humidity under field conditions at PhilRice, Nueva Ecija from April 14 to May 28, 2014.

XXXII. Korea Project on International Agriculture

Component 1: Variety Development and Improvement

Project Leader: Dr. Norvie L. Manigbas

In general, during the 2014 experiments, the project was able to select the best varieties for further evaluation and demonstration of bigger areas in the selected sites. The best performing Korean cultivars are now being planted in Tarlac, Nueva Ecija, Pangasinan, Aurora, Bataan, Pampanga, Oriental Mindoro, Bohol, Leyte and more farmers are interested to test the performance of these varieties in their farms. Farmers are more aware now of the good eating quality of the Korean cultivars and they can sell the milled rice to their neighbors and Korean consumers in their area. The Fit Corea Inc, company is now helping the farmers in Bantug, Nueva Ecija to market their produce at a very reasonable price (usually 1-2 Pesos higher than the current price in the market) especially in Bohol province. New breeding materials are generated to improve the pests and diseases resistance of the Korean cultivars with better yields. These advance breeding lines are being tested for anaerobic germination, seedling vigor, and lodging tolerance for direct seeding purposes. The best materials can also be used for transplanted culture. Yield evaluation and grain quality is continuously being done.

Study 1: Adaptability Test and Yield Performance of Korean Cultivars

NL Manigbas, LB Madrid

Rice variety development and improvement is one of the key elements in successful rice production system. A suitable variety in an environment where it is grown optimizes its yield potential thus increasing farmers' income and obtains additional value of the crop they are growing. A variety should be tested in different locations so that its full potential can be observed and evaluated. Not all varieties perform very well in all kinds of environments especially when soil, weather and climate, management practices, etc vary especially in an archipelagic country like the Philippines. This concept leads to what the breeders say about location specific recommendation of the varieties or location specific varieties. When a variety is most adapted to the local conditions, success is inevitable to rice production.

This study aims to screen and identify Korean rice cultivars that are well adapted to Philippine conditions and to promote Korean cultivars that is high yielding and acceptable to Philippine markets.

Highlights:

- Two spacing methods were evaluated using Korean cultivars, one is the recommended spacing of 20cm x 20cm and the other is the modified Indonesian row spacing (also 20cm x 20cm) but there is a one row space after six rows equivalent to 40 cm. Results show in 2014 dry season that only Namcheonbyeo and IR64 had more than one ton per hectare yield advantage in the border effect row spacing compared to recommended 20cm x 20cm spacing. In 2014 wet season, more than 1 ton more yield was achieved by Dasanbyeo, Gayabyeo, Hanareumbyeo, Milyang 249, Namilbyeo, and Saegyejinmi under the row spacing treatment. NSIC Rc242 (Japonica 2), Milyang 249, Hangangchal 1, and Hanareumbyeo increased in yields by 0.5 to 1.0 t/ha under the recommended spacing. Other cultivars responded similarly across the recommended spacing treatments.

- Overall, the dry season had a very good harvest with very minimal occurrence of hopper burn and other diseases. The lowest yield was 4.3 to 4.7 t/ha that includes Jinmibyeo, Namilbyeo, NSIC Rc220 (Japonica 1), and NSIC Rc170 (MS11) and the highest yield was IR64 under the border row spacing method with 9.2 t/ha, Hangangchal 1 and Hanareumbyeo under the recommended spacing with yields of 8.5 t/ha. In 2014 wet season, Taebaegbyeo consistently produced 7.11 t/ha with 20cm x 20cm spacing. Other varieties and the check varieties had an average of 4 t/ha. The wet season test had relatively low yield compared to the dry season in general.

- In Calapan, Oriental Mindoro, 13 Korean and five Philippine-bred cultivars were included in the 2014 dry season adaptability test. Results showed that NSIC Rc240, Milyang 248 had the highest yield of 4 t/ha followed by Milyang 23 (3.8 t/ha), Hanareumbyeo (3.5 t/ha), NSIC Rc160 (3.5 t/ha), IR79042 (3.4 t/ha), Hangangchal 1 (3.4 t/ha), Taebaegbyeo (3.2 t/ha), and Namcheonbyeo (3.2 t/ha). Among the lowest yielders were Jinmibyeo (2.1 t/ha), NSIC Rc170 or MS11 (2.2 t/ha), and NSIC Rc220 or Jap 1 (2.4 t/ha). On the other hand, only five Korean cultivars and two Philippine check varieties popular in the area were planted. The highest yielding varieties were Hanareumbyeo with 8.5 t/ha, Milyang 248 with 8.1 t/ha, followed by Milyang 23 with 7.8 t/ha, and Hangangchal 1 with 7.1 t/ha and Dasanbyeo 6.5 t/ha. The check varieties had 5.7 t/ha for NSIC Rc218 and 5.4 t/ha for NSIC Rc238.

- Adaptability test in Ubay and Talibon, Bohol consisted of 8 Korean and two Philippine bred varieties. Yield in Ubay, Bohol in 2014 dry season was better compared to Talibon, Bohol. Highest yield obtained in Ubay was observed from

NSIC Rc222 which is 5.8 t/ha, while in Talibon, Hyangmibyeo 2 had the highest yield of 1 t/ha. Both sites were affected by sheath blight, BLB, BLS, blast and rice black bug. However, in 2014 wet season Talibon, Bohol became favorable for the adaptability test. The highest yield was obtained by Hyangmibyeo 2 with 10 t/ha followed by a high yielding check NSIC Rc222 with 7.5 t/ha yield. Hanareumbyeo had 7 t/ha, Milyang 248 had 6.8 t/ha, Hangangchal 1 and Saegyejinmi had both 6.5 t/ha. The lowest yield was obtained by Dasanbyeo with 4.8 t/ha. The 2014 wet season was not good for Ubay, Bohol because of severe infestation of diseases and rats. The highest yield was obtained by check NSIC Rc222 with 5.6 t/ha, followed by Milyang 248 with 3.5 t/ha. The lowest yield was obtained by NSIC Rc170 (MS11) with 1.9 t/ha.

- On-going test of Dasanbyeo and Hangangchal 1 in the National Cooperative test for multi-location testing in the Philippines. This test is considered very important for future release of the Korean cultivar in the Philippines. Hangangchal 1 ranked first in the Special Rice category of the Japonica group. However, it will be transferred to the glutinous group of the Special Rice category as discussed in the recent Rice Varietal Improvement Group Meeting in Dumaguete City on June 2014. Dasanbyeo data is still on the process. The 2014 wet season was good for Hangangchal 1 as mentioned above. It ranked 2nd in this test. It is hoped that Hangangchal 1 will be the first Korean variety under the KOPIA project that will be released in the Philippines.

- Market has been identified for the farmers in Nueva Ecija who are growing Dasanbyeo and Hangangchal 1. The harvested seeds by these farmers will be marketed to the KAMICO through the FIT Corea Philippines, Incorporated. In the past, farmers who are growing these cultivars have nowhere to find market for the Korean cultivars because traders do not know the quality of the Korean cultivars and there was no demand for the Korean milled rice. So, the farmers were forced to sell the palay at a normal price in the market or mill the palay for their home consumption because this variety has a very good eating quality. But through the assistance of the Fit Corea Philippines Incorporated, farmers now can sell their palay at Php 1 to 2 above the current price in the market. This is the newly harvested palay so farmers have nothing to worry about drying facilities because they can sell their palay from the farm directly to the Fit Corea Company. Through the assistance of the Fit Corea Philippines Incorporated and with a collaborative agreement with the Bantug Multi-purpose Cooperative and the KOPIA-PhilRice partnership, the farmers can benefit and increase their income. Farm machineries are being demonstrated by the KAMICO through FIT COrea in the farmers' farm so that farmers in the community can use, buy, or rent the machines they need for particular farm operations especially the transplanting and milling machines. Seeds of Dasanbyeo and Hangangchal 1 are freely distributed to the farmers who are members of the association.

Study 2: Varietal Adaptation of Philippine and Korean-Bred Rice Cultivars to Organic Farming System

Organic agriculture is all about environmental conservation, resource recycling, promotion of soil fertility; avoidance of high cost chemical inputs, production methods applicable and adapted to the local community, and thus contributes to meaningful socio-economic and ecologically sustainable development among others. The use of appropriate rice varieties for organic farming system becomes more important since all of the current released and introduced rice cultivars were developed using conventional system which uses high input and chemical intensive agricultural system. All NSIC released varieties in the Philippines that are being grown by farmers today and cultivars from Korea were mostly bred in an environment where high inorganic chemical inputs have been used. Current hypothesis that rice varieties (inbred and hybrid) bred under conventional system will also adapt or 'forced to adapt' under organic system. The alternative hypothesis is that the rice varieties bred and selected under conventional system will not produce high yields under organic system. This would suggest the need for breeding and selection under organic conditions. When breeding is done in organic systems, can direct selection for organic system as target environment obtain higher yields compared to indirect selection where selection is done in the conventional system? In the other scenario, can selection for specific traits suitable to organic systems possible within an existing conventional breeding program?

The ultimate success of variety development programs rests on released varieties highly accepted by farmers and adapted to their local conditions. It is important especially those farmers who want to shift from conventional high-chemical input agriculture to organic farming because of food safety and health issues. To validate the suitability and adaptation of these rice varieties grown in an organic agriculture system, testing is necessary.

The study aims to: 1) determine and evaluate the performance of Philippines and Korea-bred rice cultivars, which were bred and selected under conventional system, in organic farming system, and to 2) to identify specific traits in the variety suitable for organic system .

Highlights:*

- Twenty genotypes were planted in five locations. Under inorganic system, the highest yield obtained was 7.2 t/ha obtained from a hybrid variety NSIC Rc204H. On the other hand, PSB Rc18 had the highest yield of 5.4 t/ha under organic. In terms of maturity, it was delayed for more than ten days in genotypes planted under organic although 50% flowering difference of both systems was only 2 to 4 days.

- Yield in Pila, Laguna ranged from 1.62 to 4.29 t/ha. The highest was PSB Rc18 and the lowest was a traditional variety Iniput-ibon.

- Presently, a paper was already drafted and ready for submission for publication. Data generated from CLSU trials were used.

**Note: This study was terminated during 2014 dry season. Highlights were taken from 2013 results.*

Study 2: Field Monitoring of Kopia Rice Varieties to Major Insect Pests and Diseases
EC Martin

No matter how high yielding a variety could be when it is beset with pest problems; sustainability in rice yields and profitability in rice production could never be attained. Clear understanding of the complex interactions between the pest and beneficial organisms at the macro-scale level and the farmer's farm practices and technologies being adapted are of utmost importance in developing a strategic pest management scheme. This can be done through proper identification of the pest, estimate the population density present in the field and determine if significant yield loss could occur with the given pest population, hence, the knowledge on the profile of pests and natural enemies and diseases in a particular area is necessary for an effective pest management program.

Highlights:

- Three hundred and seven (307) PK entries were evaluated during 2014 WS in PhilRice-CES for resistance to stem borer (SB) under natural field condition and for green leafhopper (GLH) and brown plant hopper (BPH) under screen house condition. The same entries were evaluated against blast, bacterial leaf blight, sheath blight and RTV (tungro) under induced method. Forty five (45) PK entries were found to be resistant to blast and 40 to stemborer. About 84 entries were moderately resistant to stemborer. Seventy one (71) have intermediate resistance to blast, 37 to BLB, 3 to BPH and 48 to stemborer. All the 307 entries were found to be susceptible to Sheath blight and Tungro.

- For field monitoring fifteen Korean varieties and 8 Philippine varieties were monitored in PhilRice-CES, Muñoz, Pangasinan and Mindoro during 2014 wet season. None of the varieties monitored had reached ETL for GLH from 30 to 75 DAT. Numbers of GLH per varieties varies but they were too low to cause any damage to the crop based on ETL. The same trend was observed for BPH and WBPH. None of the varieties monitored had reached ETL from 60 to 75.

- With respect to diseases, Bacterial leaf blight (BLB) was negligible in PhilRice-CES during 60 and 75. Hangangchal 1 planted in Bantug had 15% incidence of BLB at 75 DAT while Taebaegbyeo in Pangasinan had 20% incidence of BLB at 60 DAT but it gradually decline at 75 DAT. Taebaegbyeo had 15% incidence of Sheath blight at 75 DAT in PhilRice-CES. Dasanbyeo had 27% and Hangangchal 1 had 26% incidence of sheath blight in Bantug at 75 DAT. Milyang 23 had 11% incidence at 60 DAT in Pangasinan while Hangangchal 1 had about 10% incidence at 60 DAT in Mindoro.

Study 2: Grain Quality Evaluation of Korean Rice Cultivars Adaptable under Philippine Conditions

MV Romero

Although yield is still considered the most important criterion, grain quality also plays a major role because this is extremely important to the consumers. Korean rice cultivars are recognized for their good eating quality thus commanding premium price in the market. They have characteristic medium-grains which are translucent and glossy. Most of the Korean rice cultivars tend to have soft and sticky cooked grains due to low amylose fraction in the starchy endosperm. These rices can also be utilized as good genetic materials in the development of new rice varieties with excellent grain quality. However, Korean rice cultivars are usually grown under temperate climate. Therefore, there is a need to evaluate not only the yield parameters of Korean rice cultivars grown under different Philippine agro-climatic conditions but also their grain quality characteristics. This will help determine the acceptability and marketability of these rices.

Highlights:

- All samples passed the recommended value for BR recovery with fair to good classification (75.4 to 80.4%). Namilbyeo and Gayabyeo had the highest BR recovery. All the samples had premium TMR recovery which ranged from 70.5 to 74.4%. For the HR recovery, only four (Dasanbyeo, Gayabyeo, Hanareumbyeo 2 and Hangangchal 1) out of 14 Korean rice cultivars had lower values than the prescribed recommendations. The remaining samples were classified as grade 1 to premium.

- All Korean rice cultivars grown in Philrice CES samples had Premium total milled rice recovery and passed the recommended value set by the RVIG group. Highest and lowest total milled rice yield was observed in Milyang 249 and Taebaegbyeo, respectively. Milling recoveries had premium total milled recovery and passed the recommended value set by the RVIG group. Except for Milyang 249 with the highest value, all the samples had Fair brown rice yield which ranged from 76.4 to 78.8%. In terms of head rice yield, only 6 out of 14 Korean rice cultivars obtained Grade 1 to Premium (>48%) classification. Overall, Jinmibyeo, Milyang 249, Namcheonbyeo, Namilbyeo, Saegyejinmi, Taebaegbyeo had good milling recoveries among the Korean rice cultivars.

- In Bohol, a total of eight Korean rice varieties were harvested during the 14DS. Generally, all the samples had good milling potentials. Brown rice recovery of the samples ranged from 76.6 to 80.2% and was highest for Dasanbyeo. All samples passed the recommended value (75.0 % and above) for brown rice recovery. The total milled rice recoveries of the samples varied from 71.0 to 73.6% and were all classified as Premium. For head rice recovery, all samples had Grade 1 to Premium classification except Hanareumbyeo and Hangangchal 1. Highest head rice yield (58.5%) was noted in Saegyejinmi.

- Jinmibyeo, Milyang 249, Namcheonbyeo, and Saegyejinmi had fewer percentages of chalky grains (<5.0%) among the

Korean rice cultivars planted in PhilRice CES. However, higher amount of chalky grains was noted for Dasanbyeo, Gayabyeo, Hanareumbyeo, Hanareumbyeo2, Hyangmibyeo, Milyang 23, and Milyang 248. Same trend was observed for those samples grown in Bohol. In both locations, Saegyejinmi had the lowest chalky grains. Korean rice varieties grown in PhilRice CES had higher chalky grains than those planted in Bohol.

- In PhilRice CES, all samples had low amylose content ranging from 15.1 to 16.7% except for Hangangchal 1, a waxy/glutinous variety, and Gayabyeo and Namilbyeo which fell under the intermediate amylose type. The amylose content of all Bohol samples was classified as low amylose type except for Hangangchal 1 and Milyang 248. Although the classification was the same, the amylose content of the PhilRice samples was slightly higher than that of the Bohol samples. This might also explain why PhilRice CES samples had relatively higher Instron harndess values than Bohol samples.

- In terms of gelatinization temperature, all samples planted in both sites had intermediate to low GT with alkali-spreading values of 5.0 to 6.0, except for Hyangmibyeo 2. The values were relatively comparable for both locations. The starch of these rice varieties gelatinizes at lower temperature and cook easily than high GT rices.

- Crude protein content was 6.9 to 8.7% for PhilRice CES samples and was 7.5 to 8.8% for Bohol samples. These values fall within the mean protein range (6.0 to 9.0%) of rice samples from different Asian countries. In general, higher protein content was observed in Bohol samples than PhilRice CES samples.

- To determine the acceptability of Korean rice cultivars grown during 2013 WS, four samples were subjected to consumer panel sensory evaluation during the 2014 DS Lakbay Palay at PhilRice CES on April 2, 2014. A total of 100 farmers and consumers from different regions served as panelists. Results showed that Dasanbyeo and Milyang 248 obtained the highest percentage acceptability (86.7%) among the panelists. Except for Tabaegbyeo, all the Korean rice cultivars had higher scores for acceptability compared to the check variety (IR 64).

- For 2014 DS samples, consumer panel sensory evaluation was conducted at Paniqui, Tarlac last October 01, 2014 during the Farmer's Field Day and Forum. A total of 50 farmers/

participants were utilized as panelists to evaluate the sensory characteristics of cooked rice samples. Results showed that Milyang 23 obtained the highest percentage of acceptability among the panelists and followed by Hanareumbyeo 2 and Saegyejinmi, respectively. The percentage acceptability of raw and cooked rice of the three Korean rice varieties was relatively higher compared to the check variety (IR 64).

- A total of 208 new advanced breeding lines were submitted for amylose content analysis to identify which among the rice entries will be acceptable for grain quality. Result of amylose content determination revealed that 75% of the breeding materials were classified into intermediate amylose type. Only 43 out of the 208 breeding materials had low amylose classification which is common to all Korean rice cultivars or japonica-type rices. Meanwhile, a total of 8 and 2 rice entries were classified as high and very low amylose type, respectively.

Component II: Improvement in Seeding and Seedling Emergence in Direct Wet Seeded Rice System

Study 2: Development of Tropical Japonica Rice for Direct Seeding

NL Manigbas, LB Madrid

It is expected that future farming will utilize direct seeding technologies as an alternative to transplanted culture because of various advantages and cost benefits to farmers and environment. Under irrigated lowland environments where almost 74% of the total rice production in the Philippines comes from, direct seeding is most appropriate because it reduces drudgery and farmers are not burdened by high labor costs. Not all varieties are adapted to direct seeding and therefore crop improvement for direct seeding is needed. New cultivars should possess very good seedling vigor, rapid coleoptile growth, can compete weeds at the early stage of growth, and with lodging resistance. Resistance to pests and diseases is a major concern for breeding. By combining traits that indica and tropical japonica rices possess for direct seeding culture, especially for japonica's longer coleoptile, good seedling vigor, and excellent grain quality, new rice cultivars for direct seeding should make an impact to many poor farmers in the Philippines.

The following objectives of the study are aligned with the mandate, goals and objectives of the new strategic plan of PhilRice in attaining rice self-sufficiency: (1)To develop new rice cultivars adapted to Philippine and/

or Korean climatic conditions for direct seeding under irrigated lowland conditions; (2) To establish a more effective collaboration and partnership between RDA and PhilRice in terms of rice improvement and germplasm resource utilization; (3)To increase the yield and improve eating quality of Philippine rice varieties under direct seeding practices.

Highlights:

- For 2014 dry season, thirty new crosses were generated and out of 4,169 entries planted, 3,559 were selected and to be planted on 2015 wet season (Table 1). One hundred thirty five advanced lines were evaluated uniform and to be planted in observational nursery for initial characterization and yield test. One hundred advanced uniform lines were also submitted for multi-environment test in three major sites in the Philippines.

- Entries from early generation were subjected to anaerobic germination screening for direct-seeding culture selection (Figure 63). Ninety-two breeding lines and thirty released varieties were screened during 2014 dry season. Initial scores of anaerobic germination (to be validated in the next 2014 wet season test) are as follows: >3% survived= Resistant, 1-2.9% survived = Intermediate, <1% survived = Susceptible.

Table 63. Breeding materials planted and selected during 2014 dry season, advanced and selected during 2014 wet season.

2014 Dry Season				2014 Wet Season	
Planted		Selections		Selections	
Bulk	Plant Selections	No. of Bulk Selections	No. of Plant Selections	No. of Bulk Selections	No. of Plant Selections
125	4044	281	3308	211	3264

Figure 69. Anaerobic germination test at PHilrice-CES

Abbreviations and acronymns

ABA – Abscicic acid
Ac – anther culture
AC – amylose content
AESA – Agro-ecosystems Analysis
AEW – agricultural extension workers
AG – anaerobic germination
AIS – Agricultural Information System
ANOVA – analysis of variance
AON – advance observation nursery
AT – agricultural technologist
AYT – advanced yield trial
BCA – biological control agent
BLB – bacterial leaf blight
BLS – bacterial leaf streak
BPH – brown planthopper
Bo - boron
BR – brown rice
BSWM – Bureau of Soils and Water Management
Ca - Calcium
CARP – Comprehensive Agrarian Reform Program
cav – cavan, usually 50 kg
CBFM – community-based forestry management
CLSU – Central Luzon State University
cm – centimeter
CMS – cystoplasmic male sterile
CP – protein content
CRH – carbonized rice hull
CTRHC – continuous-type rice hull carbonizer
CT – conventional tillage
Cu – copper
DA – Department of Agriculture
DA-RFU – Department of Agriculture-Regional Field Units
DAE – days after emergence
DAS – days after seeding
DAT – days after transplanting
DBMS – database management system
DDTK – disease diagnostic tool kit
DENR – Department of Environment and Natural Resources
DH L– double haploid lines
DRR – drought recovery rate
DS – dry season
DSA - diversity and stress adaptation
DSR – direct seeded rice
DUST – distinctness, uniformity and stability trial
DWSR – direct wet-seeded rice
EGS – early generation screening
EH – early heading
EMBI – effective microorganism-based inoculant
EPI – early panicle initiation
ET – early tillering
FAO – Food and Agriculture Organization
Fe – Iron
FFA – free fatty acid
FFP – farmer's fertilizer practice
FFS – farmers' field school
FGD – focus group discussion
FI – farmer innovator
FSSP – Food Staples Self-sufficiency Plan
g – gram
GAS – golden apple snail
GC – gel consistency
GIS – geographic information system
GHG – greenhouse gas
GLH – green leafhopper
GPS – global positioning system
GQ – grain quality
GUI – graphical user interface
GWS – genomwide selection
GYT – general yield trial
h – hour
ha – hectare
HIP - high inorganic phosphate
HPL – hybrid parental line
I - intermediate
ICIS – International Crop Information System
ICT – information and communication technology
IMO – indigenous microorganism
IF – inorganic fertilizer
INGER - International Network for Genetic Evaluation of Rice
IP – insect pest
IPDTK – insect pest diagnostic tool kit
IPM – Integrated Pest Management
IRRI – International Rice Research Institute
IVC – in vitro culture
IVM – in vitro mutagenesis
IWM – integrated weed management
JICA – Japan International Cooperation Agency
K – potassium
kg – kilogram
KP – knowledge product
KSL – knowledge sharing and learning
LCC – leaf color chart
LDIS – low-cost drip irrigation system
LeD – leaf drying
LeR – leaf rolling
lpa – low phytic acid
LGU – local government unit

LSTD – location specific technology development
m – meter
MAS – marker-assisted selection
MAT – Multi-Adaption Trial
MC – moisture content
MDDST – modified dry direct seeding technique
MET – multi-environment trial
MFE – male fertile environment
MLM – mixed-effects linear model
Mg – magnesium
Mn – Manganese
MDDST – Modified Dry Direct Seeding Technique
MOET – minus one element technique
MR – moderately resistant
MRT – Mobile Rice TeknoKlinik
MSE – male-sterile environment
MT – minimum tillage
$mtha^{-1}$ - metric ton per hectare
MYT – multi-location yield trials
N – nitrogen
NAFC – National Agricultural and Fishery Council
NBS – narrow brown spot
NCT – National Cooperative Testing
NFA – National Food Authority
NGO – non-government organization
NE – natural enemies
NIL – near isogenic line
NM – Nutrient Manager
NOPT – Nutrient Omission Plot Technique
NR – new reagent
NSIC – National Seed Industry Council
NSQCS – National Seed Quality Control Services
OF – organic fertilizer
OFT – on-farm trial
OM – organic matter
ON – observational nursery
OPAg – Office of Provincial Agriculturist
OpAPA – Open Academy for Philippine Agriculture
P – phosphorus
PA – phytic acid
PCR – Polymerase chain reaction
PDW – plant dry weight
PF – participating farmer
PFS – PalayCheck field school
PhilRice – Philippine Rice Research Institute
PhilSCAT – Philippine-Sino Center for Agricultural Technology
PHilMech – Philippine Center for Postharvest Development and Mechanization
PCA – principal component analysis
PI – panicle initiation
PN – pedigree nursery
PRKB – Pinoy Rice Knowledge Bank
PTD – participatory technology development
PYT – preliminary yield trial
QTL – quantitative trait loci
R - resistant
RBB – rice black bug
RCBD – randomized complete block design
RDI – regulated deficit irrigation
RF – rainfed
RP – resource person
RPM – revolution per minute
RQCS – Rice Quality Classification Software
RS4D – Rice Science for Development
RSO – rice sufficiency officer
RFL – Rainfed lowland
RTV – rice tungro virus
RTWG – Rice Technical Working Group
S – sulfur
SACLOB – Sealed Storage Enclosure for Rice Seeds
SALT – Sloping Agricultural Land Technology
SB – sheath blight
SFR – small farm reservoir
SME – small-medium enterprise
SMS – short message service
SN – source nursery
SSNM – site-specific nutrient management
SSR – simple sequence repeat
STK – soil test kit
STR – sequence tandem repeat
SV – seedling vigor
t – ton
TCN – testcross nursery
TCP – technical cooperation project
TGMS – thermo-sensitive genetic male sterile
TN – testcross nursery
TOT – training of trainers
TPR – transplanted rice
TRV – traditional variety
TSS – total soluble solid
UEM – ultra-early maturing
UPLB – University of the Philippines Los Baños
VSU – Visayas State University
WBPH – white-backed planthopper
WEPP – water erosion prediction project
WHC – water holding capacity
WHO – World Health Organization
WS – wet season
WT – weed tolerance
YA – yield advantage
Zn – zinc
ZT – zero tillage

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