Philippine Rice R&D Highlights 2013

DEVELOPING TECHNOLOGIES TO SURPASS THE DRY SEASON IRRIGATED LOWLAND RICE YIELD PLATEAU

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Developing Technologies to Surpass the Dry Season Irrigated Lowland Rice Yield Plateau

Program Leader: DA Tabanao

Executive Summary

Rice is the major and staple food of Filipinos. Most of the palay (rough rice) harvested comes from the irrigated areas that comprise 3.1M hectare of the total 4.5M planted to rice in the Philippines, making it a critically important ecosystem to the country as its population continues to increase [(i.e., 93.617 million in 2010 and 109.683 million in 2020) (BAS, 2009; PhilRice, 2010)]. Rice consumption is projected to increase at a rate corresponding to the population growth. The continuous development of high-yielding inbred and hybrid varieties resistant to pests and diseases with excellent grain qualities is essential to keep up with the increasing demand for rice.

Increasing rice yield to its maximum potential under irrigated condition, particularly during the dry season (DS), is the main purpose of the program. To achieve this, location-specific adaptability of rice varieties and use of new breeding tools and methodologies are pursued. The use of hybrid rice technology as a key approach to attaining high yield is one of the major strategies implemented. These approaches will enable PhilRice to respond appropriately to the needs of Filipino rice farmers and consumers, and significantly create a major impact in attaining and sustaining rice self-sufficiency in the country. Furthermore, the application of improved agronomic management technologies for seed production and commercial cultivation of varieties that PhilRice developed are fine- tuned. These technologies are tested under local conditions toward the promotion of location-specific recommendations and subsequent adoption by farmers.

The program comprises the following major components: (1) Breeding of new and superior inbred rice for transplanted irrigated lowland areas; (2) Development of inbred varieties for direct wet seeding; (3) Development of hybrid varieties; and (4) Development of seed production technologies and crop management strategies. During the year, the National Seed Industry Council (NSIC) approved the commercial cultivation of two inbred varieties: NSIC Rc298 (Tubigan 23) and NSIC Rc300 (Tubigan 24). NSIC Rc298 is the first PhilRice-bred variety developed purposely for direct wet seeded cultivation. It has an average yield of 5 t/ha, intermediate reaction to anaerobic germination stress, lodging, bacterial blight, and green leafhopper, and moderate resistant reaction to yellow stemborer (white heads) and brown planthopper. It has good milling recovery and comparable eating quality with IR64. NSIC Rc300 is adapted to both transplanted and direct seeded culture. As a transplanted crop, its average yield ranged from

5.6 to 5.9 t/ha, and its maximum attainable yield was recorded at 10.4 t/ha. It is moderately resistant to blast, bacterial blight, sheath blight, yellow stem borer, brown plant hopper, and green leafhopper. In adaptability tests of inbred and hybrid varieties conducted in multiple sites across the country (33 sites during DS and 47 sites during WS), the highest yields were attained by Mestiso 19 (14.0 t/ha) and NSIC Rc240 (13.2 t/ha) during DS, and by Mestiso 20 (11.0 t/ha), Mestiso 29 (12.0 t/ha), and NSIC Rc240 (12.0 t/ha) during WS. During field days, farmers have indicated their interest on these hybrids which led to the implementation of DA-funded hybrid seed production project and planting of public hybrids in 50,000 ha in 2013. Genetically pure nucleus and breeder seeds of parent lines of 12 public hybrids, namely, Mestizo 1, Mestiso 3, 7, 19, 20, 21, 25, 26, 29, and 38 were continuously produced and distributed by PhilRice CES, PhilRice Isabela, and PhilRice Los Baños.

With all these accomplishments, there is a great potential that this program may play a major role to support the national goals of achieving rice self-sufficiency and competitiveness in the country. There is, therefore, a need for a strong national funding support for breeding, seed production research, and other new initiatives of the program to continuously improve and develop new technologies for the irrigated lowland rice areas.

I. Breeding of New and Superior Inbred Rice for Transplanted Irrigated Lowland Areas

Project leader: TF Padolina

The world's rice area comprises about 50% irrigated but then it produces more than 75% of the world's rice. For the Philippines, the equivalent figures may not be parallel but there is no doubt that irrigated systems have the potential to produce the highest yields. Moreover, the varieties that are developed can also cater to the other lowlands with lesser control of water such as favorable rainfed areas. The use of improved inbred rice varieties still predominate in these highly intensive production areas. These areas are invariably market- oriented and farmers are looking to make profit by investing in their farms in ways that will maximize the returns of their investments. Hence, the breeding of new, efficient, and stable with high yielding potential and good grain quality rice varieties is a continuing pursuit to cope with increasing market demands, evolving insect pests and diseases, and shifting production constraints. Incorporating the yield enhancing traits for high yield potential; stabilizing yield by improved resistance to major biotic and abiotic stresses, better resiliency to climate change and diversified uses of rice are ways to increase productivity and income. However, strategies toward a more location-specific approach must be pursued.

Evaluation of donor germplasm

JA Orcino, LA Pautin, EC Arocena, anda TF Padolina

Rice breeding depends largely on the choice of parents. With this, the crossing block was assembled from diverse germplasm of elite lines, introductions, traditional varieties, mutant lines and derivatives of wide hybrids. These parental lines are planted in a staggered manner to allow synchronization of flowering for hybridization. The study aims to evaluate, characterize, and select donor parents with traits relevant to breeding program. Crosses involving diverse germplasm with high yield, pest resistance and good grain quality will also be generated.

Highlights:

- During the 2013 Dry Season, continued diversification of the crosses was done through conventional breeding. 442 potential donors were assembled in two staggered replicates in the crossing block.

- 384 donors were characterized based on yield-enhancing and stabilizing traits. From the yield enhancing traits gathered, Figure 1 shows the diversity of the germplasm in selected traits (% fertility, average panicle length and number of grains per panicle). Large percentage of the potential parents had the ideal traits. Half of the germplasm had fertility greater than 85%, with panicle length ranging from 24-30cm and number of grains per panicle in the range of 150-225.

- For 2013 wet season, the remaining donors will be characterized to complete the crossing block's profile.

- 160 plants from selected donors were used for the 80 new crosses by the irrigated lowland breeding team. The types of crosses used were mostly single crosses (92 %). Three-way cross (8%) was also done to improve the F1 generation. These crosses varied in terms of its breeding objective (Figure 2.). Aside from this, the crossing block provided donor germplasm to other breeding teams.

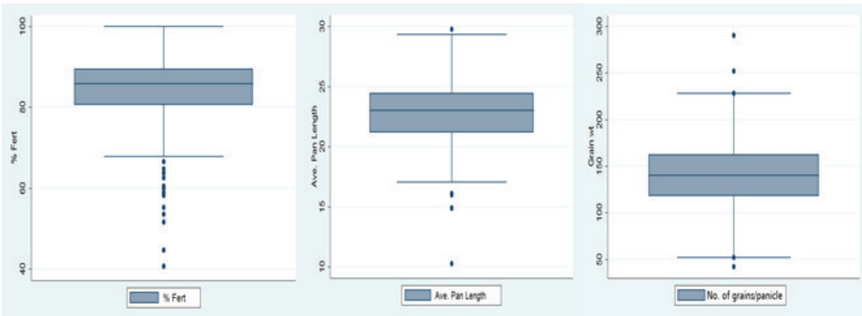
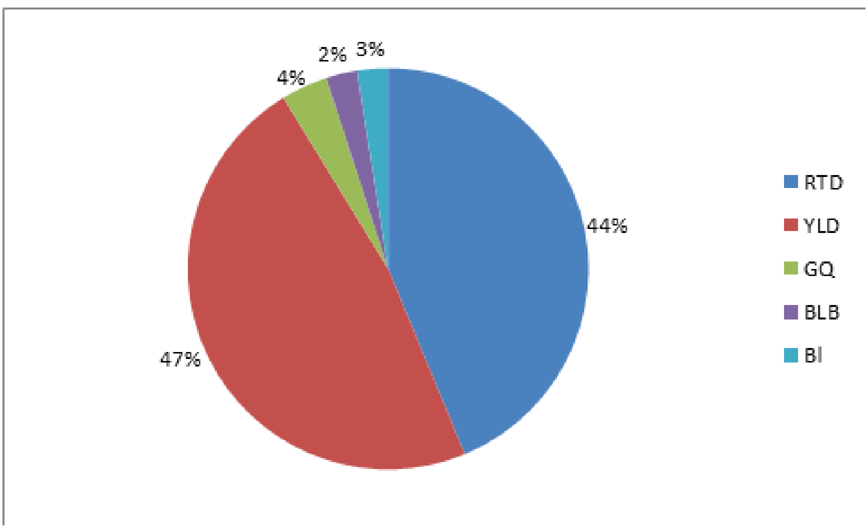


Figure 1. Diversity of donors in terms of fertility, average panicle length and number of grains per panicle, 2013, Dry Season.



RTD-rice tungro disease, Yld- yield, GQ- grain quality, BLB- bacterial leaf blight, Bl- blast

Figure 2. Classification of new crosses generated based on breeding objectives , 2013, Dry season)

Hybridization and pedigree selection

JA Orcino, LA Pautin, AQC Sabanal, RC Braceros, EC Arocena, and TF Padolina

This study aims to select plants with the desired characteristics in the segregating generations for further evaluation. It involves the line development phase of the breeding process. As such, the F1 nursery, Hybrid population for Non-Selection (HPNS), Hybrid population for Selection (HPS) and the pedigree nursery were established.

The selection was improved by incorporating two treatments in the Hybrid population for selection (HPS) in the modified bulk method (0 and 120 kg/ha Nitrogen fertilization). Identified crosses were currently advanced to F5 generations for further evaluation.

Highlights:

- The extent of materials that were evaluated this 2013 dry season ranges from the F1 to F9 which were in different nurseries (Table 1). Selection was done both in the field and in the laboratory (kernel quality).

- In the F1 nursery, 105 new crosses were evaluated, 21 of which were selected for generation advance (HPNS) while 35 crosses were advanced to hybrid population for selection. 49 crosses were discarded due to high sterility, poor plant type and susceptibility to prevalent pest and diseases.

- 100 crosses in the Hybrid population for Non-Selection (HPNS) nursery were evaluated. The selection resulted to 5 crosses advanced to HPS and 89 crosses retained. 6 crosses were shuttled in Midsayap for RTV screening.

- A total of 41 crosses were evaluated in the Hybrid population for Selection. 28 crosses were planted singly while 13 crosses were planted in bulk. After thorough observations at all growth stages, 3563 derived lines (dl) were selected in the field. Further laboratory selection (kernel quality) trimmed down the materials into 1,789 dl. These selected lines were composed of 1589dl F2's, 90dl F3's and 110dl F4's.

- In the pedigree nursery, 6025 derived lines were planted and assessed. These were composed of 888 derived lines for yield, 28 dl for RTV and 178dl and advance to PN. This resulted to 1048 plant selection and after kernel evaluation only 506 plants remained. 55 plants were identified for the advanced observational nursery (AON).

Performance trials: MET1 (AON, PYT), MET2 (MYT, GYT), MET3 (NCT1)
GM Osoteo, RC Braceros, AQC Sabanal, EC Arocena, and TF Padolina

Uniform and selected advanced lines from the nurseries will pass through rigorous field performance trials. This study is composed of the field performance trials which are Advanced Observational Nursery, Preliminary Yield Trial, and Multi-Environmental Trial (MET) Stage 0, MET Stage 1 and MET Stage 2. This aims to evaluate the advanced breeding lines' uniformity, yield and other agronomic characteristics, field reactions to prevailing pests and grain quality on-station and in multi-environments. Consequently, the best entries shall be entered to the National Cooperative Trial (NCT).

Highlights:

- Among the 436 entries in the AON, 37 were elevated to PYT. These entries had yields ranging from 8-9 t/ha with mostly medium maturity (Figure 3). The entries out-yielded the highest yielding check (PSB Rc82) from 2-27%.

- Evaluation in the preliminary yield trial resulted to 26 entries for elevation. 82 entries were retained for further testing in the PYT. The selected entries yielded from 8.9 -7.5t/ha . Yield advantages ranged from 0-15%.

- The MET 0 was established accommodating the advanced lines from IRRI and materials from different breeding teams of PhilRice. The entries were tested against 4 test locations, namely: Nueva Ecija, Isabela, Laguna and Bohol. The checks used were hybrid rice varieties: NSIC Rc124H (Mestiso 4), NSIC Rc132H (Mestizo 6), modern inbred varieties: NSIC Rc222, NSIC Rc158, NSIC Rc238 and standard inbred varieties: PSB Rc18, PSB Rc82 ,PSB Rc10. Figure 4 shows the performance of the top entries in MET 0. Among the various entries, a consistent performance across locations were exhibited by both inbreds PR39206-2B-47-1-2-1 & PR40524-2-1 (8 t/ha and 7.39 t/ha, respectively). These entries ranked first on over all mean yield computation. They also outyielded both the top yielding checks NSIC Rc124H (Mestiso 4) and NSIC Rc222.

- In MET 1, PhilRice Agusan and Midsayap were added as testing sites due to their abiotic and biotic stress pressures. Yield stability index (YSI) and AMMI stability values (ASV) were also computed aside from the average yield. Results based on the average yield across the sites showed PR37252-2-1-1-1-2-3 as the top performing entry. Its yield was comparable with the yield of both the highest yielding check (Mestiso 4 and

NSIC Rc158). However, in terms of yield stability, 3 inbred entries ranked the highest. PR37956-3B-44-1, PR37252-2-1-1-1-2-3, PR37942-3B-5-1-1 had yield stability similar with the performance of the checks NSIC Rc222 and NSIC Rc158.

- Selected advanced entries in the MET trials were assembled in the MET 2 phase. This trial had similar number of test locations and analyses done. Figure 5 shows the top early and the medium maturing inbreds that out-yielded the checks. These entries had over all yields within 6 t/ha. These entries consistently has stable yield based on the computed AMMI values and yield stability values on Table 2 and Table 3.

- With the application of the new guidelines for recommendation in the NCT, dropped inbred lines were currently reconsidered and deliberated. One inbred line was able to pass through the new criteria for location specific recommendation.

- PR35766-B-24-3 is currently for recommendation to the NSIC secretariat. This promising inbred was tested for 4 seasons (2008DS-2009WS) in the NCT phase 1 and 2 seasons (2010DS-2010WS) in the Multi-Adaptation trials.

- Through its final testing period in MAT, it registered a yield advantage of 24.0% in 2010 WS in WESMIARC (tpr); 9.6% in 2010 DS in USM (dsr); 89.7% in 2010 WS in Sultan Kudarat (dsr); 6.5% in 2010 WS in UEP (dsr) and 13.3% in 2010 WS in ASU (tpr) against the check variety, PSB Rc82. Aside from this, it exhibited intermediate to resistant reactions to major pests and diseases. It also passed the grain quality standard parameters including eating quality.

- It was decided by the RTWG to recommend for location-specific irrigated lowland areas in Mindanao provinces particularly in Zamboanga del Sur, North Cotabato, Sultan Kudarat and Agusan del Norte. This line can be planted both in transplanting and direct seeding culture in these locations. While in the Visayas, specifically in Northern Samar, it is best planted under the direct seeding system.

Table 1. Extent of materials evaluated in the breeding nursery 2013 Dry Season.

NURSERY	13WS ENTRIES	GEN	FIELD SELECTION	LABORATORY SELECTION
F1 NURSERY	105c	F1	35c (for HPS), 21c (for HPNS)	-
HYBRID POPULATION FOR NON-SELECTION (HPNS)	100c	F2-F3	5c (for HPS), 89c (retained)	-
HYBRID POPULATION FOR SELECTION (HPS)	41c	F2	3,284c	1,589c
		F3	134c	90c
		F4	145c	110c
PEDIGREE NURSERY	6025dl	F3	7c	3c
		F4	2,611c	2,204c
		F5	791c	782c
		F6	1,747c	333c
		F7	58c	51c
		F8	92c	0
		F9	14c	0

c- cross; dl- derived line

Table 2. AMMI Stability Values (ASV) and Yield Stability Index (YSI) of early maturing MET2 entries across sites 2013 Dry Season.

GENO	Fixed Name	GYmeans	GYRank	ASV	ASV Rank	YSI	YSI Rank
MT5434	NSIC Rc132H (Mestizo 6)	6.47	3	0.0621	2	5	1
MT4841	PR37246-2-3-2-1-1-2-1	6.60	2	0.1115	7	9	2
MT4622	PR37951-3B-37-1-2	6.08	12	0.0351	1	13	3
MT4720	PR35769-B-1-1-2-3-4	6.00	15	0.1086	6	21	5
MT4574	PR37951-3B-37-1	5.93	18	0.1848	15	33	10
MT4648	PR37939-3B-1-2	6.20	6	0.2804	30	36	13
MT4817	PR37921-B-3-4-2-1-2	6.17	9	0.2803	29	38	15
MT4566	PR37246-2-3-2-1-1-2-2	6.39	4	0.3678	44	48	24
MT4830	PR37921-B-3-2-2	5.87	22	0.2504	27	49	26
MT4634	PR37942-3B-5-3-2	5.46	47	0.1724	11	58	32
MT4650	PR40078-B-12-2	5.62	41	0.1987	19	60	33
MT4639	PR37139-3-1-3-1-2-1	5.74	32	0.3211	38	70	39
MT4902	PSB Rc82	5.69	37	0.2972	33	70	40
MT4641	PR37866-1B-1-4	5.62	39	0.2977	34	73	41
MT4779	PR38046-PB-10-9-4-2-1	5.50	45	0.3193	36	81	44
MT4737	PR35805-B-9-2-3-2-3	5.72	35	0.4269	50	85	46
MT4748	PR30245-10-414	5.61	42	0.3842	47	89	47
MT4712	PR37273-5-16-5-2-1-2-1	5.42	49	0.3871	48	97	49
MT4809	PR37952-B-1-1-2	5.14	54	0.3992	49	103	52
MT5433	NSIC Rc238	5.28	52	0.4580	52	104	54
MT4901	PSB Rc10	5.10	55	0.4503	51	106	55

Table 3. AMMI Stability Values (ASV) and Yield Stability Index (YSI) of medium maturing MET2 entries across sites , 2013 Dry Season

GENO	Fixed Name	GYmeans	GYRank	ASV	ASV Rank	YSI	YSI Rank
MT4874	PR36831-31-1-1-1-1-1	5.92	4	0.0345	1	5	1
MT4818	PR37704-2B-6-1-2-1-1	6.39	1	0.0927	8	9	2.5
MT4835	PR35251-2B-5-5-3-1-1	5.82	5	0.0699	4	9	2.5
MT4867	PR35786-B-3-3-2-1-1	5.67	11	0.0725	5	16	7
MT4829	PR38012-3B-3-1	6.27	2	0.1573	15	17	8
MT4886	PR36933-B-1-36-1-1-1	5.81	7	0.1193	11	18	9
MT4889	PR34859-B-4-1-1-2-1(G)	5.82	6	0.1817	18	24	10
MT4843	PR37952-B-4-1-3	5.67	12	0.2008	21	33	17
MT5435	NSIC Rc158	5.42	17	0.1742	16	33	18
MT4903	NSIC RC222	5.42	19	0.1798	17	36	19
MT5432	NSIC Rc124H (MESTIZO 4)	5.49	14	0.2870	26	40	23
MT4904	PSB Rc18	4.47	26	0.2156	22	48	26

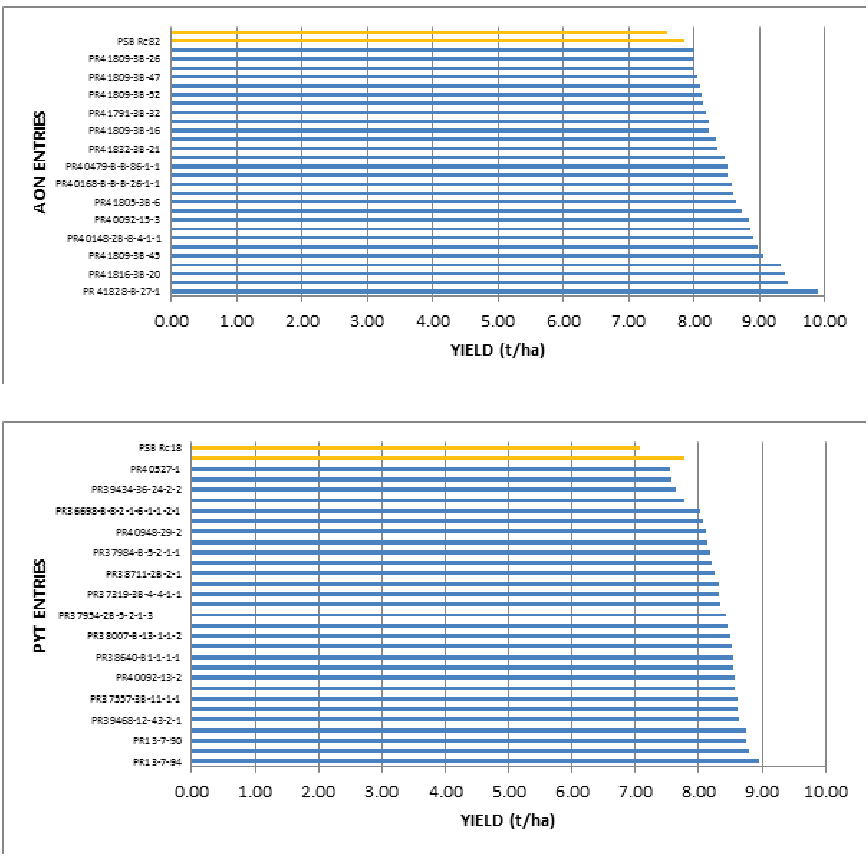


Figure 3. Yield performance of elevated AON(top) and PYT(bottom) entries compared to their respective check, 2013 Dry season).

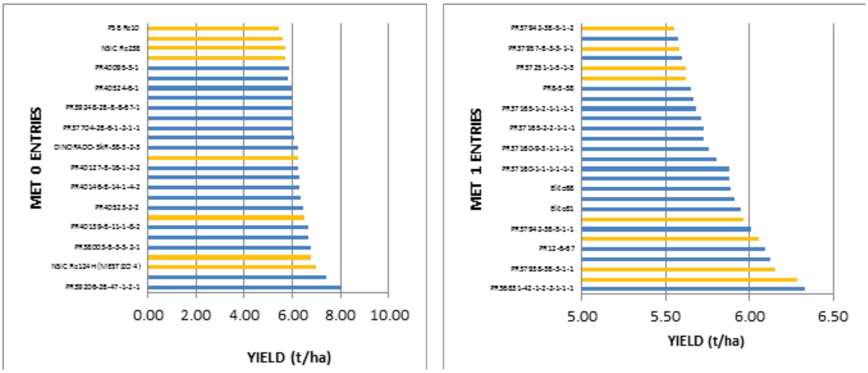


Figure 4. Top entries in the Multi Environment Trial (MET 0-1), 2013 Dry Season

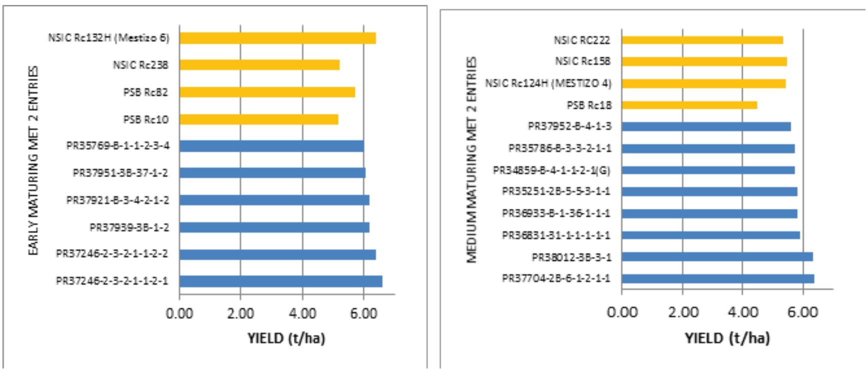


Figure 5. Top performing entries of early maturing group (left) and medium maturing group (right) in the Multi- environment Trial 2. 2013 Dry Season.

Screening for resistance to major insect pests

GdC Santiago

Breeding is a long term project and priorities may change over time. A new selection may well need to be tested in a range of environments, affected by different factors and grown under several cultural techniques. In most breeding programs, there are successive stages of testing: seedlings are initially screened and only the most promising lines go on to further testing.

Most of the important sources of resistance to major insect pests have been incorporated into lines that have improved plant types. Some lines were considered promising enough to be named varieties while others have proved to be good parents in the new crosses. Focusing on a system to facilitate screening for resistance will hasten the development of a new variety and will save on resources.

Highlights:

- Under field condition during DS 2013, a total 436 AON-R , 166 PYT-R and 36 NCT-TR entries were evaluated for resistance to stemborer. Evaluation at reproductive stage for whiteheads showed that out of these AON-R entries, 28 were Resistant (R) , 13 were Moderately Resistant (MR), 11 were Intermediate (I) and 8 were Moderately Susceptible (MS). On PYT-R, out of 166 entries, result showed that 130 were R, 27 were MR, 8 were I and 1 had MS reactions. For the NCT-TR entries, out of 36 entries, 6 had R, 9 had MR, 8 had I, 11 had MS and 2 had S reactions (Table 4). These results were valid because the susceptible check (TN1) had a damage rating of 12.36%.

- NCT-TR entries with resistant reaction to whiteheads were: #2 PR36720-17-1-2-1, #5 PR37043-B-6-3-1, #16 C9301-B-2-1-2-2, #18 C9222-B-2-2-1-2-1, #28 PR37704-2B-6-1-2-1-2 and #29 ir85820-92-3-2-3.

- Under screenhouse condition, 36 NCT-TR and 166 PYT-R entries were evaluated for resistance to brown planthopper (BPH) and green leafhopper (GLH). Result showed that out of 36 NCT-R entries, 10 were MR, 10 were I and 16 were MS to BPH. Similarly, result on GLH evaluation showed that 4 had MR, 16 had I, 12 had MS and 4 had S reactions. On PYT-R, out 166 entries, 72 were I, 49 were MS and 54 were S to BPH. The same entries were evaluated for resistance to GLH and result showed that 2 had I, 65 had MS and 99 had S reactions to the test insect (Tables 5 and 6).

Table 4. Reactions of different entries to stemborer under field condition. DS 2013.

Entries	No. of entries	R	MR	I	MS	S
NCT-TR	36	6	9	8	11	2
PYT-R	166	130	27	8	1	0
NCT-TR	436	179	80	56	119	2

Table 5. Reactions of different entries to BPH under screenhouse condition. DS 2013.

Entries	No. of entries	R	MR	I	MS	S
NCT-TR	36	0	10	10	16	0
PYT-R	166	0	0	72	40	54

Table 6. Reactions of different entries to GLH under screenhouse condition. DS 2013.

Entries	No. of entries	R	MR	I	MS	S
NCT-TR	36	0	4	16	12	4
PYT-R	166	0	0	2	65	99

Evaluation of new and superior inbred rice for disease resistance

JP Rillon and MSV Duca

There are a number of challenges to achieve the goal of increasing rice production in a sustainable manner. One of these challenges is the severe occurrence of diseases in most rice producing areas. Rice diseases are important barrier in reducing grain quality and yield. The changing environment, like heavy rainfall and hot and humid weather, leads to the occurrence and spread of diseases. Developing rice varieties resistant to major rice diseases is the most economically and environmentally sound management approach in breeding program. Disease resistance is the best control but often it is not available or brakes down after varietal release and requires constant effort to improve and maintain. The role of disease screening is important in identifying rice lines that will show resistance to the major rice diseases. Rice lines resistant to the major diseases can be used as new varieties. It is necessary that rice plants have to be continuously evaluated for disease resistance due to disease breakdown from one year to the next often with devastating results.

Highlights:

- Seven hundred ninety-two promising rice lines and check varieties were evaluated for resistance to major rice diseases (Table 7). Under induced method, 166 test entries were screened against blast, bacterial leaf blight (BLB), sheath blight (ShB), and rice tungro virus (RTV). For tungro modified field method, test plants were surrounded with TNI susceptible variety a month before planting the test plants to serve as source of inoculum. Under natural field condition, 773 rice selections were evaluated to identify the resistance to prevailing rice diseases.

- Under induced method, PYT (PR40139-B-15-1-1-2, PR40139-B-15-1-1-3, PR40139-B-15-1-1-4, PR40139-B-15-1-1-7, PR39226-2B-55, C7541WH-17-2-1-2-7-1-4-1-1-5-1, C7541WH-17-2-1-2-7-1-4-1-1-3-1, and C7541WH-17-2-1-2-7-1-4-1-1-3-1) showed resistant reaction to blast. For bacterial leaf blight, all late maturing and mutation/tropical, 24 tropical /MAS and 53 early maturing had intermediate reaction to the disease. In sheath blight, 26 late maturing, 12 mutation/tropical and 8 tropical/ MAS, had intermediate reaction to the disease. All entries were rated susceptible to tungro.

- Under natural field condition, sheath blight was the disease commonly observed. Out of 301 PYT (47 early maturing, 47 late maturing, 21 mutation /tropical and 24 tropical /MAS), 399 AON, 22 IL (tpr) and 18 Pre NCT entries did not show susceptible reaction to blast, bakanae, bacterial leaf streak, bacterial leaf blight, sheath blight and rice tungro virus.

Table 7. Total number of promising rice lines against major rice diseases.

Selection	Diseases		
Screenhouse	**Blast**	**BLB**	**ShB**
Preliminary Yield Trial (PYT)			
Early Maturing	4 (R)	53 (I)	-
Late Maturing	1 (R)	54 (I)	26 (I)
Mutation/ Tropical	2 (R)	28 (I)	12 (I)
Tropical/MAS	2 (R)	24 (I)	8 (I)
Natural Field	**Prevailing diseases**		
IL (TPR)	22 entries		
PYTR	139 entries		
AONR	399 entries		
Pre-NCT	18 entries		

Grain quality evaluation of new and superior inbred lines for transplanted irrigated areas
KB Bergonio, EH Bandonill, CT Estonilo, JD Adriano, and TF Padolina

Rice varietal development for irrigated ecosystem plays a crucial role in helping attain rice self-sufficiency in the country as it contributes to at least 60% of the total rice production. Various breeding strategies for irrigated lowland ecosystem are being implemented to develop inbred varieties with higher yield, better resistance to pests and diseases, and better adaptability to biotic and abiotic stresses. Moreover, the grain quality of the developed varieties also has to be considered. Grain quality properties of rice determine its suitability for specific end-use, thus greatly influences consumer's preference for rice. Hence, grain quality screening must be integrated in the early generation stages of varietal development for transplanted irrigated ecosystem. Early screening aids in the decision- making process for varietal development whether rice lines be discarded for further improvement or selected for special purposes or advanced for further trials, thus, saving on resources.

One hundred sixty 2013 dry season entries under the advance observational nursery-regular (AON-R) and preliminary yield trial-regular (PYT-R) were submitted by breeders for grain quality evaluation. The milling quality (% brown rice, %milled rice, and % head rice), physical attributes, and apparent eating quality (cooked texture) as predicted by starch physicochemical properties of the milled rice were determined and evaluated.

Highlights:

- Evaluation of milling recovery revealed that majority of the entries (96%, N=160) met the standard for total milled rice of grade 1 to premium, while 59% (95 entries) of these passed the head rice recovery requirement of at least 48% (grade 1 to premium) (Table 8). From each varietal development stage, 4 entries from AON-R 2013DS and 91 from PYT-R 2013DS passed the standards of milling quality.

- Majority of the entries from AON-R 2013DS and PYT-R 2013DS were found to possess the preferred dimension of at least long and slender shape. On the other hand, most (69 out of 127) entries from PYT-R 2013DS had high level of chalky grains (>5% chalkiness). Entries from AON-R 2013DS were not evaluated for chalkiness as this parameter was not required by breeders.

- Most of the entries (141 out of 160 entries) from AON-R 2013DS and PYT-R 2013DS met the preferred low to intermediate amylose content of 12-25%. Only 5 entries from AON-R 2013DS (N=33) and 14 entries from PYT-R 2013DS (N=127) were identified with high amylose content (>25.0% AC). Except for one from PYT-R 2013DS, all entries had low to high intermediate GT type (<70°C -74°C GT).

- Grain quality clustering by amylose-gelatinization temperature type showed that 95% of the entries from AON-R 2013DS and PYT-R 2013DS (152 out of 160) are presumably soft to intermediate/medium–textured upon cooking. This possibly indicates good eating quality and acceptability of most of the entries evaluated. Only 3 entries from AON-R 2013DS and 5 entries from PYT-R 2013DS are hard-textured upon cooking.

- Generally, grain quality evaluation revealed that 4 out of 33 entries from AON 2013DS and 41 out of 127 PYT-R 2013DS entries satisfied all the requirements for milling, physical, and (apparent) eating qualities as set by the Rice Varietal Improvement Group (Figure 6).

Table 8. Grain quality properties (milling potential, physical attributes, physicochemical properties, and apparent cooked texture) of 2013 dry season irrigated lowland rice lines.

Grain Quality		Number of Entries	
Parameter/ Level/ Classification		AON-R 2013DS (N=33)	PYT-R 2013DS (N=127)
Milling Recovery and Physical Attributes			
Brown Rice			
>80%	Good	0	1
75.1- 79.9%	Fair	27	121
<75%	Poor	3	5
Milled Rice			
>70.1%	Premium	8	44
65.1- 70.0%	Grade 1	20	81
60.1- 65.0%	Grade 2	5	2
55.5- 60.0%	Grade 3	0	0
<55.5%	Below Standards	0	0
Head Rice			
>57%	Premium	0	29
48.0- 56.9%	Grade 1	4	62
39.0- 47.9%	Grade 2	15	23
30.0- 38.9%	Grade 3	9	10
<30.0%	Below Standards	5	3
Chalkiness			
0.1- 2.0%	Premium	n.r.	19
2.1- 5.0%	Grade 1	n.r.	39
5.1- 10.0%	Grade 2	n.r.	48
10.1- 15.0%	Grade 3	n.r.	10
>15.0%	Above Standards	n.r.	11
Grain Length			
>7.5mm	Extra Long	1	9
6.4- 7.4mm	Long	32	114
5.5- 6.3mm	Medium	0	4
<5.4mm	Short	0	0
Grain Shape			
>3	Slender	32	113
2.0- 3.0	Intermediate	1	14
<2.0	Bold	0	0
Physicochemical Properties			
Amylose Content			
0.0- 2.0%	Waxy	0	0
2.1- 10.0%	Very Low	0	0
10.1- 18.0%	Low	2	10
18.1- 25.0%	Intermediate	26	103
>25.0%	High	5	14
Gelatinization Temperature by Alkali-Spreading Value			
74.5-80.0°C	High	0	1
70.0-74.0°C	High Intermediate	12	48
70.0-74.0°C	Intermediate	7	46
<70.0°C	Low	14	32
Apparent Cooked Texture			
Grain Quality Cluster Type			
Cluster 1	Soft	18	77
Cluster 2	Medium/Intermediate	12	45
Cluster 3	Hard	3	5

Note: n.r., analysis not required as of SYP Program Workshop dated June 13, 2012.

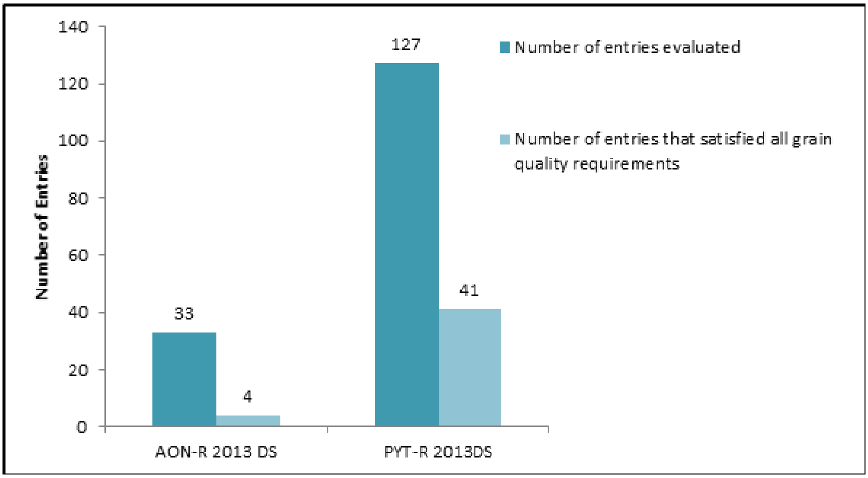


Figure 6. Number of 2013DS inbred rice lines for each of the varietal development stage that satisfied all the grain quality requirements as set by the Rice Varietal Improvement Group.

II. Breeding Direct Wet-Seeded Rice for Irrigated Lowland

Project Leader: OE Manangkil

In the Philippines, rice varieties are mainly bred for transplanting method due to its various advantages such as early seedling establishment for weed competition, low seed requirement, and controlled plant density. Nowadays, direct seeding as an alternative method of establishing rice is gaining more acceptance to the farmers due to reduced cost of farm inputs, labor and capital compared to transplanted rice. Yield is almost similar to the transplanted rice, however, there are limited varieties suited for direct seeding. To know the different requirements and environmental conditions of direct seeded rice, there is a need to focus on breeding better rice varieties for this method of crop establishment.

This project aimed to develop rice varieties adapted to direct seeded system. This project addresses these two important constraints in wet direct seeded rice through variety improvement. As main breeding objective, we will emphasize early seedling vigor, anaerobic germination resistance and lodging resistance on top of yield contributing traits that are important for irrigated lowland rice.

Development of direct wet-seeded rice varieties
OE Manangkil, W Barroga, and PN Marcelo

The objective of this study is to generate elite rice lines with traits important to direct seeded environment on top of high yield.

Highlights:

- One hundred five single crosses were generated with backgrounds of high yield, good anaerobic germination and seedling vigor, lodging resistance, pest and disease resistance and good grain quality. A total of 68 lines underwent yield trial (24 in PYT, 32 in GYT, and six entries each in NCT and MAT). From F2 to F7 generations, a total of 3,178 selections were made for advancement to the next stage (Table 9).

- One hundred six F1 materials were harvested for 2013WSF2 nursery. Twenty-two advanced Direct Wet-Seeded Rice (DWSR) lines and two check varieties (NSIC Rc240 and NSIC Rc298) were for grain yield in PhilRice Central Experiment Station under unprotected condition. Crop establishment was done on the 2nd week of January. Fertilizer rate was 120-60-60 kg NPK. Check varieties NSIC Rc240 and NSIC Rc298 yielded 4.85 t/ha and 5.42 t/ha, respectively. Yield data ranged from 4.77 t/ha to 6.66 t/ha. Average yield = 5.69 t/ha (Figure 7).

- Sixteen DWSR lines evaluated in preliminary yield trial nursery (PYT) are superior on both checks with 13% to 37% yield advantage over NSIC Rc240 and 1% to 23% over Rc298 were the following: PR39628-16-1-2-1-B (6.66 t/ha); PR40432-14-2-1-B (6.61 t/ha); PR38854-44-1-1-1-3-B-B (6.28 t/ha); PR39142-10-3-2-1-1-B (6.26 t/ha); PR39150-3-2-2-3-1-B (6.24 t/ha); PR38856-3-1-2-3-B (6.15 t/ha); PR40421-1-1-1-B (6.13 t/ha); PR40334-61-1-1-B (6.05 t/ha); PR38858-4-2-2-3-1-B-B (5.96 t/ha); PR39149-81-1-3-2-1-B (5.72 t/ha); PR38858-4-3-3-2-B (5.67 t/ha); PR38868-30-2-3-3-B (5.64 t/ha); PR39155-16-3-3-2-B-B (5.61 t/ha); PR38855-44-2-1-3-B (5.53 t/ha); PR39152-17-2-3-3-B-B (5.48 t/ha) and PR38856-2-2-1-3-B (5.47 t/ha) (Figure 7).

- Five DWSR lines have 6% to 11% yield advantage over NSIC Rc240 (lowest yielding check). These are the following: PR37801-16-3-3-1-3-3-B (5.41 t/ha); PR39149-29-2-3-B (5.32 t/ha); PR38854-30-2-3-1-B (5.17 t/ha); PR38869-17-1-3-1-B (5.15 t/ha); and PR37801-16-3-3-1-3-1-B (5.13 t/ha).

- Statistical analyses by Dunnett's t-Tests for yield at comparisons significant at the 0.05 level showed two DWSR lines are significantly better than the check NSIC Rc240 (4.85 t/ha). PR39628-16-1-2-1-B (6.66 t/ha) and PR40432-14-2-1-B (6.61 t/ha) (Table 10). Some uncontrollable factors in the field were the following: (1) lowest yielding check NSIC Rc240 has poor seedling emergence; and (2) occurrence of infestation of yellow stemborer (White Heads) across the field decreases the yield most especially at check NSIC Rc240. For other agro-morphological characteristics, maturity ranged from 101 days after sowing (DAS) to 110DAS. Plant height is 103 cm to 126 cm with productive tillers per m2 ranged from 349 to 535 (Table 10).

- Thirty advanced DWSR lines and two check varieties (NSIC Rc240 and NSIC Rc298) were evaluated for grain yield in PhilRice Central Experiment Station under unprotected condition. Crop establishment was done on the 2nd week of January. Fertilizer rate was 120-60-60 kg NPK. Check varieties NSIC Rc240 and NSIC Rc298 yielded 5.23 t/ha and 6.05 t/ha, respectively. Yield data ranged from 4.72 t/ha to 6.77 t/ha. Average yield = 5.97 t/ha (Figure 8).

- Fifteen DWSR lines in general yield trial nursery are superior on both checks with 18% to 29% yield advantage over NSIC Rc240 and 2% to 12% over Rc298 were the following: PR37625-3-1-1-2-B (6.77 t/ha); PR37541-97-2-3-2-B (6.60 t/ha); PR37605-33-1-1-3-2-3 (6.57 t/ha); PR37801-13-1-2-3-1-B-B (6.57 t/ha); PR39411-11-2-2-B (6.56 t/ha); PR37801-15-1-1-2-B (6.55 t/ha); PR37568-6-1-2-3-3-1-B (6.51 t/ha); PR37825-18-3-2-3-1-B-B (6.47 t/ha); PR37541-43-3-2-2-2-1-2-1-B-B (6.42 t/ha); PR37061-44-5-3-2-3-3-1-1-B (6.29 t/ha); PR37060-35-1-3-3-2-1-2-2-B (6.28 t/ha); PR37801-15-1-1-3-2-B-B (6.28 t/ha); PR37541-43-3-3-1-2-2-1-1 (6.26 t/ha); PR38269-6-2-2-3-B (6.22 t/ha); and PR37624-9-3-1-3-3-3-B (6.16 t/ha) (Figure 8).

- Eleven DWSR lines have 1% to 15% yield advantage over NSIC Rc240 (lowest yielding check). These are the following: PR37787-5-3-2-3-2-B-B (6.04 t/ha); PR37533-8-1-1-1-3-2-1-3-B-B (5.99 t/ha); PR37790-26-1-2-2-1-B-B (5.96 t/ha); PR37074-23-1-3-2-2MYP-1-3-2-B (5.95 t/ha); PR38269-26-3-2-3-B (5.80 t/ha); PR37586-7-2-1-3-2-B (5.72 t/ha); PR37562-25-3-1-2-1-3-B (5.66 t/ha); PR37062-27-4-2-1-2-3-1-2-B (5.63 t/ha); PR38269-39-1-3-2-B (5.54 t/ha); PR37797-26-1-3-2-1-B-B (5.51 t/ha); and PR37606-9-3-2-2-B (5.30 t/ha).

- Statistical analyses by Dunnett's t-Tests for yield at comparisons significant at the 0.01 and 0.05 level showed four DWSR lines are highly significantly better than the check NSIC Rc240 (5.23 t/ha). These are the following: PR37625-3-1-1-2-B (6.77 t/ha); PR37541.97-2-3-2-B (6.59 t/ha); PR37605-33-1-1-3-2-3 (6.57 t/ha); and PR37801-13-1-2-3-1-B-B (6.57 t/ha). Five DWSR lines are significantly better than the check NSIC Rc240 (5.23 t/ha), these are the following: PR39411-11-2-2-B (6.56 t/ha); PR37801-15-1-1-2-B (6.55 t/ha); PR37568-6-1-2-3-3-1-B (6.51 t/ha); PR37825-18-3-2-3-1-B-B (6.47 t/ha); and PR37541-43-3-2-2-2-1-2-1-B-B (6.42 t/ha) (Table 11).

- Some uncontrollable factors in the field were the following: (1) lowest yielding check NSIC Rc240 has poor seedling emergence; and (2) occurrence of infestation of yellow stemborer (White Heads) across the field decreases the yield most especially at check NSIC Rc240. For other agro-morphological characteristics, maturity ranged from 99DAS to 110DAS. Plant height is 96cm to 120 cm with productive tillers per m2 ranged from 410 to 601 (Table 11).

- Ten selected promising DWSR lines, one universal check (NSIC Rc298), and seven local check varieties (NSIC Rc9, Rc222 and Rc240; PSB Rc10, Rc14, Rc18 and Rc82) were evaluated for grain yield, crop adaptation to a specific local environment and farmer's acceptability at dry agro-climatic condition in seven locations, namely: (1) Rizal Nueva Ecija; (2) Laur, Nueva Ecija; (3) Bacarra, Ilocos Norte; (4) Rosario, La Union; (5) New Washington, Aklan; (6) Iguig, Cagayan; and (7) PhilRice Los Baños. The study was on-farm trials in farming systems research under direct seeding condition. Summary of morpho-agronomic characteristics of introduced rice cultivar are shown on Table 12

- Top five advanced DWSR lines in yield mean of all test sites were the following: PR37801-15-1-1-2-B (5.44 t/ha); PR37062-27-4-2-1-2-3-1-2 (5.42 t/ha); PR37541-43-3-2-2-2-1-2-1-B-B (5.29 t/ha); PR37825-18-3-2-3-1-B-B (5.18 t/ha) and PR39411-11-2-2-B (5.01 t/ha) (Figure 9).

- Rizal, Nueva Ecija Highlights: Check varieties NSIC Rc298, PSB Rc82, NSIC Rc240, and Rc18 yielded 6.92t/ha, 6.62t/ha, 4.51t/ha, and 0.00t/ha, respectively. Yield data ranged from 0.00t/ha to 6.92t/ha. Average yield = 5.00t/ha.

- Eight DWSR lines have 7% to 40% yield advantage over NSIC Rc240 (lowest yielding check). These are the following: PR37062-27-4-2-1-2-3-1-2 (6.32 t/ha); PR37801-13-1-2-3-1-B-B (6.02 t/ha); PR37787-5-3-2-3-2-B-B (5.71 t/ha); PR39411-11-2-2-B (5.71 t/ha); PR37541-43-3-2-2-2-1-2-1-B-B (5.11 t/ha); PR37801-15-1-1-2-B (5.11 t/ha); PR37825-18-3-2-3-1-B-B (4.81 t/ha); and PR37062-27-4-2-2-3-2-2-3 (4.81 t/ha).

- For other agro-morphological characteristics, maturity ranged from 96DAS to 107DAS. Plant height is 87cm to 109 cm with productive tillers ranging from 384 to 578. Pest and diseases were not a major problem; however, water shortage at grain filling stage had affected the grain yield of medium late and late maturing check NSIC Rc240 and PSB Rc18.

- Participatory Varietal Selection (PVS) activity was done at 94DAS age of the rice crop. Total number of farmer-participants was 39 who were grouped into two: male = 21 and female = 18. Top three most preferred DWSR lines with preferential analysis of 0.439; 0.268; and 0.073, respectively, are the following: NSIC Rc240, NSIC Rc298 and PR37801-13-1-2-3-1-B-B. General positive comments of these lines are having high number of grains per panicle; long and compact type of panicle; strong and sturdy culms; high number of productive tillers; resistant to lodging; erect type of flag leaf; and late and slow-type of leaf senescence.

- Top three least preferred plots with preferential analysis of -0.854; and 0.000 are the following: PSB Rc18 and PR39411-11-2-2-B. General negative comments of these lines are late maturity, susceptible to yellow stem borer, light type of secondary branching of panicles, and susceptible to lodging.

- Generally, according to the farmers, almost all DWSR lines were good, of high-quality and have passed based on their standards. However, some plots (e.g. plot 23, 25, and 27) were also equally good but they were not chosen due to limited times of casting of votes. All plots were better than their current variety planted in the field. Laur, Nueva Ecija Highlights: Check varieties PSB Rc82, NSIC Rc298, NSIC Rc240, and Rc18 yielded 4.75t/ha,4.51t/ha,3.25t/ha and 2.77t/ha, respectively. Yield data ranged from 2.77t/ha to 5.41t/ha. Average yield = 4.38t/ha.

- Four DWSR lines have 4% to 14% yield advantage over PSB Rc82 (highest yielding check). These are the following:

PR37062-27-4-2-1-2-3-1-2 (5.41 t/ha); PR37801-13-1-2-3-1-B-B (5.41 t/ha); PR37825-18-3-2-3-1-B-B (5.41 t/ha and PR37787-5-3-2-3-2-B-B (4.93 t/ha). For other agro-morphological characteristics, maturity ranged from 101DASto 108DAS. Plant height is 86cm to 104 cm with productive tillers ranging from 361 to 495.

- Bacarra, Ilocos Norte Highlights: Check varieties PSB Rc82, NSIC Rc298, PSB Rc18andNSICRc240 yielded 5.68t/ha,5.44t/ha,5.26t/ha and 5.11t/ha, respectively. Yield data ranged from 5.05t/ha to 6.98t/ha. Average yield = 5.83t/ha.

- Eight DWSR lines are superior on all checks with 3% to 36% yield advantage over NSIC Rc240;3% to 33% over PSB Rc18; 4% to 28% yield advantage over NSIC Rc298 and 3% to 23% over Rc82 were the following: PR37062-27-4-2-1-2-3-1-2 (6.98 t/ha); PR37801-13-1-2-3-1-B-B (6.32 t/ha); PR37825-18-3-2-3-1-B-B (6.32 t/ha); PR37541-43-3-2-2-2-1-2-1-B-B (6.32 t/ha); PR37787-5-3-2-3-2-B-B (6.02 t/ha); PR39411-11-2-2-B (6.02 t/ha); PR37801-15-1-1-2-B (6.02 t/ha); and PR37062-27-4-2-2-3-2-2-3 (5.86 t/ha). For other agro-morphological characteristics, maturity ranged from 99DASto 108DAS. Plant height is 84cm to 94 cm with productive tillers ranged from 363 to 494. Pest and diseases were not a major problem; however, minimal occurrence of bacterial leaf streak (bls), bacterial leaf blight (blb), brown spot and yellow stem borer (ysb) across the plot was present.

- Participatory Varietal Selection (PVS) activity was done at 100DAS age of the rice crop. Total number of farmer-participants was 32 who were grouped into two: male = 24 and female = 8. Top three most preferred DWSR lines with preferential analysis of 0.415; 0.146; and 0.073, respectively are the following: PR37062-27-4-2-1-2-3-1-2, PR37801-13-1-2-3-1-B-B and NSIC Rc240. General positive comments of these lines are having high number of grains per panicle; long and compact type of panicle; strong and sturdy culms; high number of productive tillers; long and slender spikelet; and late and slow leaf senescence.

- Top three least preferred plots with preferential analysis of -0.561; -0.122 and 0.000 are the following: PSB Rc18, PR37541-43-3-2-2-2-1-2-1-B-B and PR37062-27-4-2-2-3-2-2-3. General negative comments of these lines are late maturity; susceptible to rice common diseases; thin and weak culms; short panicle; susceptible to yellow stem borer; and leaf with discoloration.

- Generally, according to the farmers, almost all DWSR lines were good, of high-quality and have passed based on their standards. All plots were better than their current variety planted in the field. Rosario, La Union Highlights: Check varieties NSIC Rc9, PSB Rc82, PSB Rc18andNSICRc298 yielded 6.32t/ha,3.61t/ha,2.42t/ha and 1.50t/ha respectively. Yield data ranged from 1.50t/ha to 6.32t/ha. Average yield = 3.80t/ha.

- Six DWSR lines are superior on all checks with 20% to 320% yield advantage over NSIC Rc298; 25% to 163% over PSB Rc18; and 8% to 75% over Rc82 were the following: PR37598-9-3-2-3-2-B (6.32 t/ha); PR37801-15-1-1-2-B (5.42 t/ha); PR37541-43-3-2-2-2-1-2-1-B-B (5.11 t/ha); PR37062-27-4-2-2-3-2-2-3 (4.51 t/ha); PR37825-18-3-2-3-1-B-B (4.21 t/ha); and PR37062-27-4-2-1-2-3-1-2 (3.91 t/ha).

- For other agro-morphological characteristics, maturity ranged from 102DAS to 108DAS. Plant height is 77cm to 117 cm with productive tillers ranging from 354 to 482. Incident of attack of pest, occurrences of diseases and scarcity of water significantly contributed to the observed decreased in yield and unpleasant plant appearance of introduced rice plants. Examples are the following: (1) severe leaf and panicle blast, brown spot, and white heads; (2) unfilled grains across the field; and (3) insufficient water at early vegetative stage up to maturity.

  New Washington, Aklan Highlights: Check varieties PSB Rc10, PSB Rc14, PSB Rc82andNSICRc298 yielded 6.87t/ha,6.26t/ha,5.90t/ha and 5.58t/ha respectively. Yield data ranged from 4.14t/ha to 6.88t/ha. Average yield = 5.88t/ha.

- PR37825-18-3-2-3-1-B-B (6.88 t/ha) are superior on all checks with 1% yield advantage over PSB Rc10;10% over PSB Rc14; 17% yield advantage over PSB Rc82 and 23% over NSIC Rc298. Maturity was 93DAS with mean plant height of 93 cm and 475 productive tillers/m2.

- Six DWSR lines have 1% to 23% yield advantage over NSIC Rc298 (lowest yielding check). These are the following: PR37825-18-3-2-3-1-B-B (6.88 t/ha); PR39411-11-2-2-B (6.57 t/ha); PR37062-27-4-2-1-2-3-1-2 (6.18 t/ha); PR37541-43-3-2-2-2-1-2-1-B-B (5.84 t/ha); PR37801-15-1-1-2-B (5.81

t/ha); and PR37787-5-3-2-3-2-B-B (5.64 t/ha). For other agro-morphological characteristics, maturity ranged from 90DAS to 96DAS. Plant height is 89cm to 108 cm with productive tillers ranging from 344 to 640.

- Participatory Varietal Selection (PVS) activity was done at 100DAS age of the rice crop. Total number of farmer-participants was to 61 who were grouped into two: male = 25 and female = 36. Top three most preferred DWSR lines with preferential analysis of 0.634; 0.610; and 0.024, respectively, are the following: PR37541-43-3-2-2-2-1-2-1-B-B, PR37598-9-3-2-3-2-B and PR37062-27-4-2-1-2-3-1-2. General positive comments of these lines are having high number of grains per panicle; long and compact type of panicle; strong and sturdy culms; high number of productive tillers; long and slender spikelet; resistant to common rice diseases and uniform and clean spikelet. Top two least preferred plots with preferential analysis of -1.244; and -0.024 are the following: PSB Rc10 and PSB Rc14. General negative comments of these lines are susceptible to rice common diseases; short panicle; susceptible to yellow stem borer; high grain shattering; and light type of secondary branching.

- Generally, according to the farmers, almost all DWSR lines were good, of high-quality and have passed based on their standards. All plots were better than their current variety planted in the field. Iguig, Cagayan Highlights: Check varieties PSB Rc82, PSB Rc18, NSIC Rc222and NSICRc298 yielded 6.11t/ha,5.29t/ha, 5.04t/ha and 4.91t/ha, respectively. Yield data ranged from 4.66t/ha to 6.11t/ha. Average yield = 5.49t/ha. PSB Rc82 produced the best yield of 6.11 t/ha. Maturity was 101DAS with mean plant height of 98 cm and 448 productive tillers per m2.

- Eight DWSR lines have 1% to 14% yield advantage over PSB Rc18, 6% to 21% over NSIC Rc222 and 9% to 24% yield advantage over NSIC Rc298. These are the following: PR37541-43-3-2-2-2-1-2-1-B-B (6.04 t/ha); PR39411-11-2-2-B (5.98 t/ha); PR37801-15-1-1-2-B (5.98 t/ha); PR37062-27-4-2-1-2-3-1-2 (5.67 t/ha); PR37787-5-3-2-3-2-B-B (5.67 t/ha); PR37562-48-3-2-3-2-1-B-B (5.67 t/ha); PR37825-18-3-2-3-1-B-B (5.41 t/ha) and PR37801-13-1-2-3-1-B-B (5.35 t/ha). For other agro-morphological characteristics, maturity ranged from 101DAS to 111DAS. Plant height is 88cm to 117 cm with productive tillers ranging from 354 to 475.

- Participatory Varietal Selection (PVS) activity was done at 100DAS age of the rice crop. Total number of farmer-participants was 31 who were, grouped into two: male = 17 and female = 14. Top three most preferred DWSR lines with preferential analysis of 0.366; 0.171; and 0.049, respectively, are the following: NSIC Rc222, PR37787-5-3-2-3-2-B-B and PR37801-13-1-2-3-1-B-B. General positive comments of these lines are high number of productive tillers; long and compact type of panicle; long and slender type of grain; resistant to common rice diseases and medium maturing. Top three least preferred plots with preferential analysis of -0.439; -0.073 and -0.049 are the following: PR37598-9-3-2-3-2-B; NSIC Rc298 and PSB Rc18. General negative comments of these lines are susceptible to rice common diseases; bold type of grains; short panicle; small grains; and late maturity.

- Generally, according to the farmers, almost all DWSR lines were good, of high-quality and have passed based on their standards. All plots were better than their current variety planted in the field.

- PhilRice Los Banos Highlight: Check varieties NSIC Rc9, PSB Rc82, NSIC Rc298 and PSBRc18 yielded 4.68t/ha, 3.99t/ha,3.48t/ha and 0.00t/ha, respectively. Yield data ranged from 1.99t/ha to 4.68t/ha. Average yield = 3.30t/ha.

- NSIC Rc9 produced the best yield of 4.68 t/ha. Maturity was 101DAS with mean plant height of 114 cm and 392 productive tillers per m2.

- Three DWSR lines have 4% to 12% yield advantage over PSB Rc82 and20% to 29% over NSIC Rc298. These are the following: PR37801-15-1-1-2-B (4.47 t/ha); PR37562-48-3-2-3-2-1-B-B (4.18 t/ha) and PR37598-9-3-2-3-2-B (4.16 t/ha). For other agro-morphological characteristics, maturity ranged from 101DAS to 111DAS. Plant height is 82cm to 114 cm with productive tillers ranging from 361 to 537.

Table 9. Selections in the Pedigree Nurseries and Yield Trials.

Nursery	Entries	Selections
F2	92	1954 plants
F3	1817	216 Lines (L)
F4	735	152 L; 3 Bulk (B)
F5	309	52 L; 26 Bulk (B)
F6	171	18 L; 35 B
F7	54	11 L; 4 B
DSRSVF7	87	2 L; 17 B
ON	151	68for WS evaluation; 46 will be seed increased awaiting slots for MET, PYT/GYT
PYT	24	
GYT	32	
NCT	6	On-going trial
MAT	6	No lines recommended for MAT

Table 10. Morpho-agronomic characteristics of advanced direct wet-seeded rice lines at preliminary yield trial nursery, 2013 DS.

Index No.	Variety / Line Designation	Grain Yield (t/ha)	Maturity (DAS)	Plant Height (cm)	Tiller Number / m²
1	PR39628-16-1-2-1-B	6.66*	107	104	404
2	PR40432-14-2-1-B	6.61	107	115	491
3	PR38854-44-1-1-1-3-B-B	6.28	109	108	448
4	PR39142-10-3-2-1-1-B	6.26	105	126	452
5	PR39150-3-2-2-3-1-B	6.25	106	117	380
6	PR38856-3-1-2-3-B	6.15	101	118	349
7	PR40421-1-1-1-B	6.13	104	108	405
8	PR40334-61-1-1-B	6.05	103	109	482
9	PR38858-4-2-2-3-1-B-B	5.96	104	115	500
10	PR39149-81-1-3-2-1-B	5.72	104	109	481
11	PR38858-4-3-3-2-B	5.67	102	115	478
12	PR38868-30-2-3-3-B	5.64	106	108	434
13	PR39155-16-3-3-2-B-B	5.61	107	111	438
14	PR38855-44-2-1-3-B	5.53	107	103	511
15	PR39152-17-2-3-3-B-B	5.48	108	125	535
16	PR38856-2-2-1-3-B	5.47	101	117	401
17	NSIC Rc298 (Tubigan 23)	5.42	107	110	450
18	PR37801-16-3-3-1-3-3-B	5.41	109	110	476
19	PR39149-29-2-3-B	5.32	105	113	438
20	PR38854-30-2-3-1-B	5.17	109	117	441
21	PR38869-17-1-3-1-B	5.15	105	109	525
22	PR37801-16-3-3-1-3-1-B	5.13	108	123	472
23	NSIC Rc240 (Tubigan 22)	4.85	110	119	411
24	PR39153-20-3-2-3-B-B	4.77	109	119	424

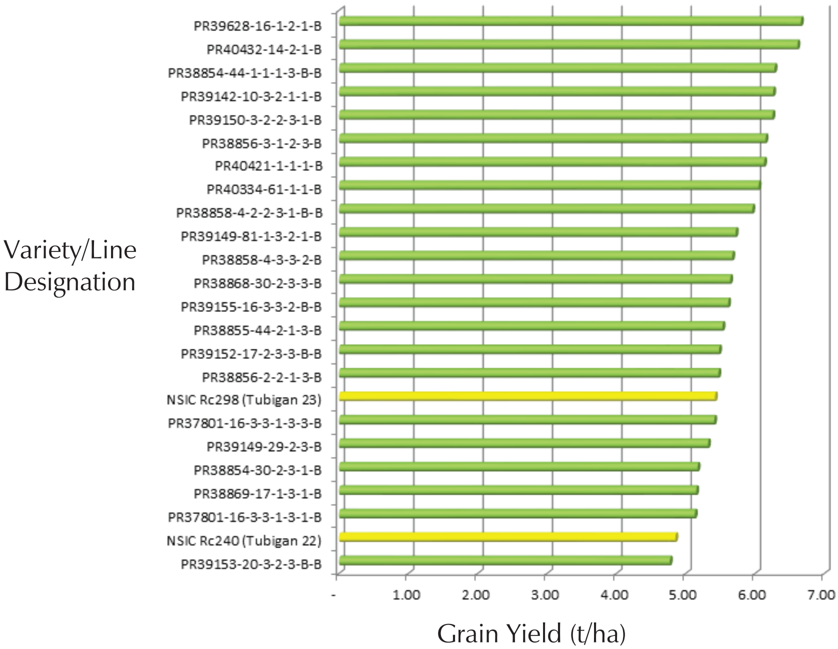


Figure 7. Comparison of yield data in tons per hectare of advanced direct wet-seeded rice lines at preliminary yield trial nursery 2013 DS.

Table 11. Morpho-agronomic characteristics of advanced direct wet-seeded rice lines at general yield trial nursery, 2013 DS.

Index No.	Variety / Line Designation	Grain Yield (t/ha)	Maturity (DAS)	Plant Height (cm)	Tiller Number / m²
1	PR37625-3-1-1-2-B	6.77	102	118	508
2	PR37541-97-2-3-2-B	6.59	102	112	495
3	PR37605-33-1-1-3-2-3	6.57	104	104	488
4	PR37801-13-1-2-3-1-B-B	6.57	100	111	523
5	PR39411-11-2-2-B	6.56	107	108	444
6	PR37801-15-1-1-2-B	6.55	105	107	478
7	PR37568-6-1-2-3-3-1-B	6.51	100	118	450
8	PR37825-18-3-2-3-1-B-B	6.47	101	100	443
9	PR37541-43-3-2-2-2-1-2-1-B-B	6.42	109	96	474
10	PR37061-44-5-3-2-3-3-1-1-B	6.29	110	120	470
11	PR37060-35-1-3-3-2-1-2-2-B	6.28	102	110	472
12	PR37801-15-1-1-3-2-B-B	6.28	103	114	438
13	PR37541-43-3-3-1-2-2-1-1	6.26	103	107	534
14	PR38269-6-2-2-3-B	6.22	105	106	495
15	PR37624-9-3-1-3-3-3-B	6.16	106	103	439
16	NSIC Rc298	6.05	101	104	503
17	PR37787-5-3-2-3-2-B-B	6.04	100	105	501
18	PR37533-8-1-1-1-3-2-1-3-B-B	5.99	103	107	534
19	PR37790-26-1-2-2-1-B-B	5.96	108	110	601
20	PR37074-23-1-3-2-2MYP-1-3-2-B	5.95	102	105	512
21	PR38269-26-3-2-3-B	5.80	101	97	453
22	PR37586-7-2-1-3-2-B	5.72	104	110	471
23	PR37562-25-3-1-2-1-3-B	5.66	102	110	486
24	PR37062-27-4-2-1-2-3-1-2-B	5.63	101	109	464
25	PR38269-39-1-3-2-B	5.54	106	111	525
26	PR37797-26-1-3-2-1-B-B	5.51	101	111	507
27	PR37606-9-3-2-2-B	5.30	100	108	410
28	NSIC Rc240 (Tubigan 22)	5.23	108	110	518
29	PR38293-13-3-2-1-B-B	5.23	100	105	432
30	PR37811-3-1-3-2-2-B-B	5.18	102	113	528
31	PR37606-42-3-3-2-2-1-B-B	4.90	103	111	447
32	PR37562-48-3-2-3-2-1-B-B	4.72	99	113	496

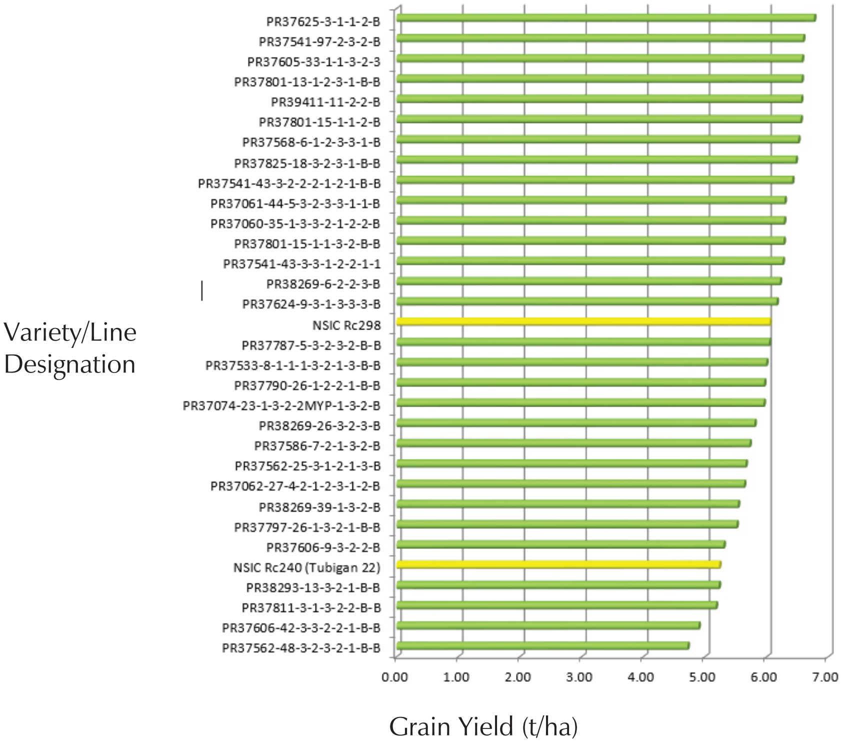


Figure 8. Comparison of yield data in tons per hectare of advanced direct wet-seeded rice lines at general yield trial nursery, 2013 DS.

Table 12. Grain yield of selected promising DWSR lines and check varieties of on-farm yield test in all location, 2013 DS.

Index No.	Variety / Line Designation	Grain Yield (t/ha)							
		Rizal, Nueva Ecija	Laur, Nueva Ecija	Bacarra, Ilocos Norte	Rosario, La Union	New Washington, Aklan	Iguig, Cagayan	PhilRice Los Baños	G.Mean
1	PR37801-15-1-1-2-B	5.11	4.57	6.02	5.22	5.81	5.98	4.47	5.44
2	PR37062-27-4-2-1-2-3-1-2	6.32	5.41	6.98	3.91	6.18	5.67	3.49	5.42
3	PR37541-43-3-2-2-2-1-2-1-B-B	5.11	3.91	6.32	5.11	5.84	6.04	3.29	5.29
4	PR37825-18-3-2-3-1-B-B	4.81	5.41	6.32	4.21	6.88	5.41	3.42	5.18
5	PR39411-11-2-2-B	5.71	4.21	6.02	3.01	6.57	5.98	2.78	5.01
6	PR37598-9-3-2-3-2-B	4.51	4.27	5.05	6.09	5.54	4.66	4.16	5.00
7	PR37062-27-4-2-2-3-2-2-3	4.81	3.91	5.86	4.35	5.53	5.16	3.76	4.91
8	PR37801-13-1-2-3-1-B-B	6.02	5.41	6.32	2.11	5.54	5.35	2.51	4.64
9	PR37787-5-3-2-3-2-B-B	5.71	4.93	6.02	1.80	5.64	5.67	2.00	4.47
10	PR37562-48-3-2-3-2-1-B-B	3.91	4.03	5.26	2.90	4.14	5.67	4.18	4.34
11	NSIC Rc298 (Tubigan 23)	6.92	4.51	5.44	1.50	5.58	4.91	3.48	4.64
12	NSIC Rc240 (Tubigan 22)	4.51	3.25	5.11	-	-	-	-	4.81
13	NSIC Rc222 (Tubigan 18)	-	-	-	-	-	5.04	-	5.04
14	NSIC Rc9 (Apo)	-	-	-	6.09	-	-	4.68	5.39
15	PSB Rc82 (Peñaranda)	6.62	4.75	5.68	3.61	5.90	6.11	3.99	5.32
16	PSB Rc18 (Ala)	0.00	2.77	5.26	2.41	-	5.29	0.00	2.59
17	PSB Rc10 (Pagsanjan)	-	-	-	-	6.87	-	-	6.87
18	PSB Rc14 (Rio Grande)	-	-	-	-	6.27	-	-	6.27
	Location Mean	5.01	4.38	5.83	3.74	5.88	5.50	3.30	

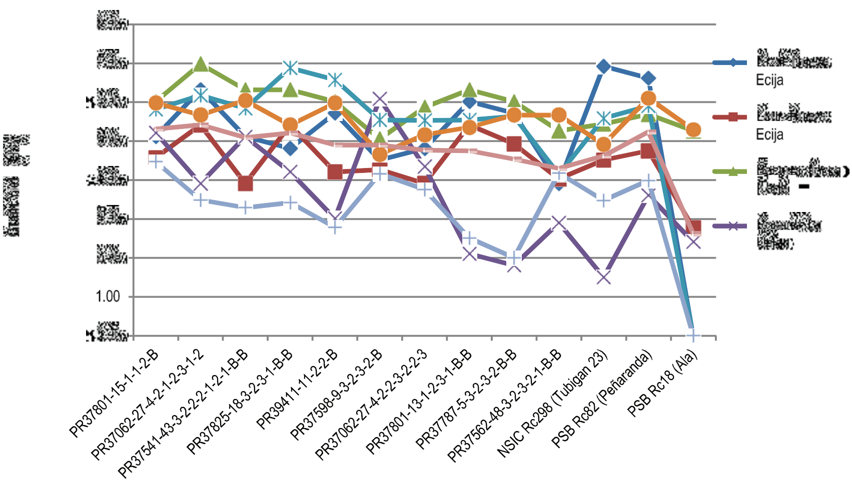


Figure 9. Comparison of yield data in tons per hectare of advanced direct wet-seeded rice lines at on-farm yield trial.

Screening of breeding lines for early seedling vigor and anaerobic germination tolerance

OE Manangkil, W Barroga, and PN Marcelo

Objectives of this study are the following: to screen introduction and lines for early seedling vigor and anaerobic germination tolerance; identify lines and introduction with anaerobic germination tolerance and high seedling vigor; assemble donor lines with desirable traits; and screen advance lines prior to yield trials.

Highlights:

- Ninety-two F2 populations were dry seeded and submerged in seedbed for 10 days. Sixty-two populations survived after 10 days of submergence. Six populations had excellent germination.

- Forty-six advanced breeding lines were seeded in paddy soil and covered with garden soil. Materials were submerged 5cm in steel tray for 14 days to identify entries with good anaerobic germination and seedling vigor. Twenty breeding lines were resistant and 19 were intermediate to anaerobic condition. Sixteen breeding lines had higher biomass compared with KhaoHlan On.

Evaluation of breeding lines for lodging tolerance

OE Manangkil, W Barroga, and PN Marcelo

Objectives of this project are to develop a lodging protocol for screening breeding material, focusing on when to apply the artificial lodging treatment, and the optimum seeding rate for inducing stem lodging. This project will also seek to determine the effect of stem size on lodging in rice plants.

Highlights:

- One hundred fifty-four ON materials were evaluated for pushing resistance using push/pull gauge. The checks were: NSIC Rc240 and PR40589-HY-1 (resistant), NSIC Rc298 (intermediate) and Luyin (susceptible). The value ranged from 0.42 to1.70 kgf. Twenty entries had higher value than the checks NSIC Rc240 and were identified as potential lodging resistant lines.

- Fifty-two advanced DWSR lines, one resistant check NSIC Rc240, four intermediate check (NSIC Rc222, Rc298, PSB Rc10 and Rc74) and two susceptible check (Luyin 46 J and NSIC Rc170) are evaluated for lodging resistance by measuring its pushing resistance in Kilogram Force (kgf) unit using a force gauge meter.

- Pushing Resistance (PR) of check varieties ranged from 0.65 kgf to 1.17 kgf. These are the following: Luyin 46 J (0.65 kgf), NSIC Rc170 (0.67 kgf), PSB Rc74 (0.85 kgf), PSB Rc10 (0.93 kgf), NSIC Rc298 (0.99kgf), NSIC Rc222 (1.04 kgf) and NSIC Rc240 (1.17 kgf). PR data ranges from 0.65 kgf to 1.62 kgf. PR mean = 1.08 kgf (Table 13). PR37624-9-3-1-3-3-3-B (1.62 kgf) has highly significant genotype comparison over all check varieties by Dunnetts's t-Test for pushing resistance. Phenotypic appearances of best five lodging resistant DWSR lines are shown in figure 10.

- Genotype comparison over the susceptible check Luyin 46 J (0.65 kgf) and NSIC Rc170 (0.67 kgf) using Dunnett's t-Test for pushing resistance. Sixteen DWSR lines are highly significant, compared to both checks. These are the following: PR37624-9-3-1-3-3-3-B (1.62 kgf); PR37562-48-3-2-3-2-1-B-B (1.56 kgf); PR38269-39-1-3-2-B (1.37 kgf); PR37801-

16-3-3-1-3-1-B (1.36 kgf); PR39152-17-2-3-3-B-B (1.34 kgf); PR38854-44-1-1-1-3-B-B (1.31 kgf); PR39142-10-3-2-1-1-B (1.28 kgf); PR37541-43-3-2-2-2-1-2-1-B-B (1.28 kgf); PR37061-44-5-3-2-3-3-1-1-B (1.26 kgf); PR38869-17-1-3-1-B (1.24 kgf); PR38856-2-2-1-3-B (1.23 kgf); PR37787-5-3-2-3-2-B-B (1.23 kgf); PR38269-26-3-2-3-B (1.19 kgf); PR37562-25-3-1-2-1-3-B (1.19 kgf); PR37605-33-1-1-3-2-3 (1.18 kgf); and PR40421-1-1-1-B (1.17 kgf). Eight DWSR lines are significantly better than both checks, these are the following: PR40334-61-1-1-B (1.16 kgf); PR38858-4-3-3-2-B (1.14 kgf); PR39149-29-2-3-B (1.13 kgf); PR37801-15-1-1-2-B (1.13 kgf); PR37541-43-3-3-1-2-2-1-1 (1.12 kgf); PR39155-16-3-3-2-B-B (1.10 kgf); PR39150-3-2-2-3-1-B (1.10 kgf); and PR37062-27-4-2-1-2-3-1-2-B (1.10 kgf) (Table 13).

- Advanced lines at Preliminary Yield Trial (PYT) and General Yield Trial (GYT) nurseries are evaluated for lodging tolerance. Lodging tolerant lines and parents; resistant checks and susceptible checks are identified before the yield trials. Fifty-two advanced DWSR lines, one resistant check NSIC Rc240, four intermediate check (NSIC Rc222, Rc298, PSB Rc10 and Rc74) and two susceptible check (Luyin 46 J and NSIC Rc170) are evaluated for lodging resistance using actual percent lodging incidence in the field at heading, 2-weeks after heading, and maturity stages (Table 14).

- Forty-five lines and NSIC Rc240 are observed to have strong culms (no bending). These are the following lines: PR37624-9-3-1-3-3-3-B, PR37562-48-3-2-3-2-1-B-B, PR38269-39-1-3-2-B, PR37801-16-3-3-1-3-1-B, PR39152-17-2-3-3-B-B, PR38854-44-1-1-1-3-B-B, PR39142-10-3-2-1-1-B, PR37541-43-3-2-2-2-1-2-1-B-B, PR37061-44-5-3-

2-3-3-1-1-B, PR38869-17-1-3-1-B, PR38856-2-2-1-3-B, PR37787-5-3-2-3-2-B-B, PR38269-26-3-2-3-B, PR37562-25-3-1-2-1-3-B, PR37605-33-1-1-3-2-3, PR40421-1-1-1-B, PR40334-61-1-1-B, PR38858-4-3-3-2-B, PR39149-29-2-3-B, PR37801-15-1-1-2-B, PR37541-43-3-3-1-2-2-1-1, PR39155-16-3-3-2-B-B, PR39150-3-2-2-3-1-B, PR37062-27-4-2-1-2-3-1-2-B, PR38293-13-3-2-1-B-B, PR38855-44-2-1-3-B, PR39153-20-3-2-3-B-B, PR37586-7-2-1-3-2-B, PR39628-16-1-2-1-B, PR38856-3-1-2-3-B, PR37568-6-1-2-3-3-1-B, PR37533-8-1-1-1-3-2-1-3-B-B, PR37801-15-1-1-3-2-B-B, PR37606-9-3-2-2-B, PR37811-3-1-3-2-2-B-B, PR37606-42-3-3-2-2-1-B-B, PR38858-4-2-2-3-1-B-B, PR37825-18-3-2-3-1-B-B, PR38868-30-2-3-3-B, PR37797-26-1-3-2-1-B-B, PR37801-16-3-3-1-3-3-B, PR39149-81-1-3-2-1-B, PR40432-14-2-1-B, PR37625-3-1-1-2-B, and PR38854-30-2-3-1-B. Five lines, NSIC Rc222 and NSIC Rc298 are rated moderately strong at maturity (most plants bending). These are the following: PR37801-13-1-2-3-1-B-B, PR37074-23-1-3-2-2MYP-1-3-2-B, PR39411-11-2-2-B, PR37541-97-2-3-2-B, and PR37790-26-1-2-2-1-B-B. Two lines and PSB Rc10 are intermediate at maturity (most plants moderately bending) and these are: PR38269-6-2-2-3-B, and PR37060-35-1-3-3-2-1-2-2-B. Luyin 46 J and NSIC Rc170 are weak at maturity (most plants nearly flat).

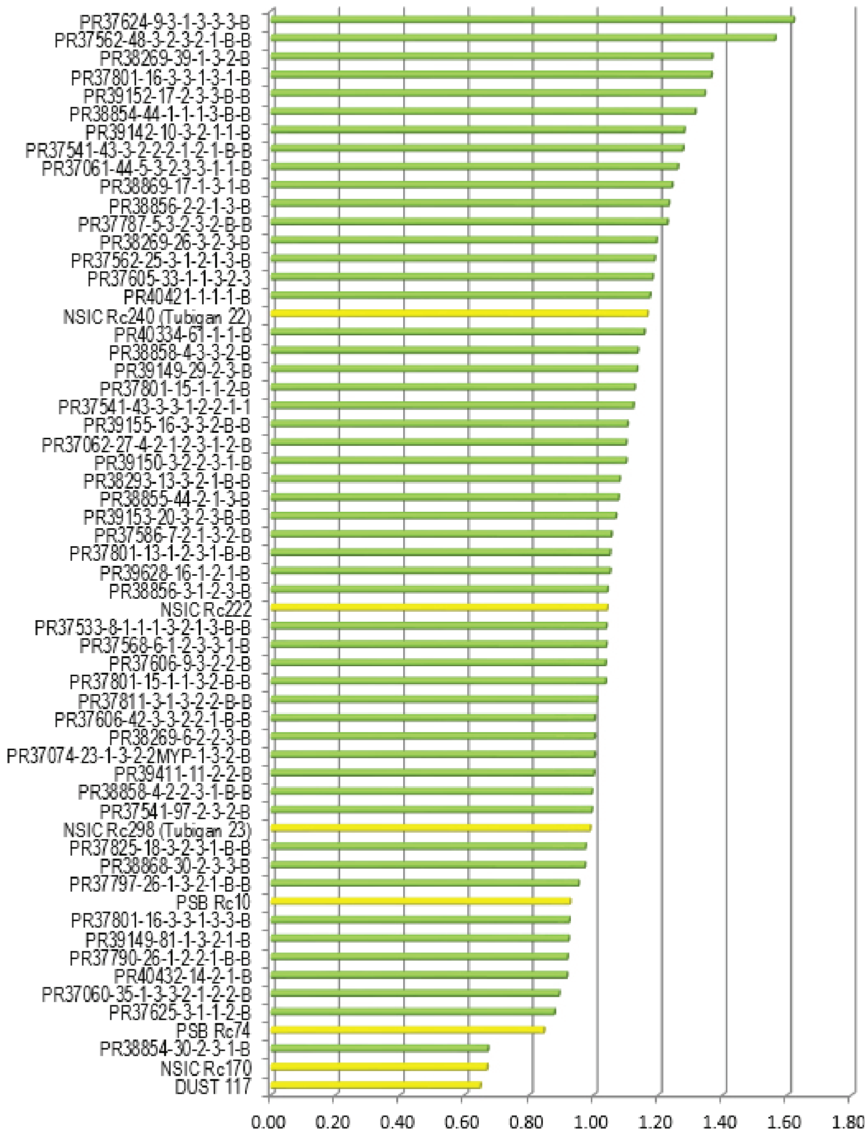


Figure 10. Comparison of pushing resistance of advanced direct wet-seeded rice lines.

Table 13. Dunnett's t-tests for pushing resistance at comparison significant at the 0.05 and 0.01 levels.

[illegible]

*/*** Rice selections significantly higher than the check at 0.05 and 0.01 probability levels, respectively.
#/### Rice selections significantly lower than the check at 0.05 and 0.01 probability levels, respectively.

Table 14. Pushing Resistance, % lodging Incidence, plant height and maturity of advanced direct wet-seeded rice lines at preliminary and general yield trial nurseries.

Index No.	Variety / Line Designation	Pushing Resistance (kgf)	Plant Height (cm)	Maturity (DAS)	% Lodging Incidence		
					at Heading	2-wks after Heading	at MAT
1	PR37624-9-3-1-3-3-3-B	1.62	115	103	0	0	0
2	PR37562-48-3-2-3-2-1-B-B	1.56	91	109	0	0	0
3	PR38269-39-1-3-2-B	1.37	110	104	0	0	0
4	PR37801-16-3-3-1-3-1-B	1.36	118	108	0	0	0
5	PR39152-17-2-3-3-B-B	1.34	123	108	0	0	0
6	PR38854-44-1-1-1-3-B-B	1.31	108	109	0	0	0
7	PR39142-10-3-2-1-1-B	1.28	127	105	0	0	0
8	PR37541-43-3-2-2-2-1-2-1-B-B	1.28	99	105	0	0	0
9	PR37061-44-5-3-2-3-3-1-1-B	1.26	98	102	0	0	0
10	PR38869-17-1-3-1-B	1.24	108	105	0	0	0
11	PR38856-2-2-1-3-B	1.23	114	100	0	0	0
12	PR37787-5-3-2-3-2-B-B	1.23	101	104	0	0	0
13	PR38269-26-3-2-3-B	1.19	115	102	0	0	0
14	PR37562-25-3-1-2-1-3-B	1.19	116	102	0	0	0
15	PR37605-33-1-1-3-2-3	1.18	102	104	0	0	0
16	PR40421-1-1-1-B	1.17	111	104	0	0	0
17	NSIC Rc240 (Tubigan 22)	1.17	122	111	0	0	0
18	PR40334-61-1-1-B	1.16	106	104	0	0	0
19	PR38858-4-3-3-2-B	1.14	113	101	0	0	0
20	PR39149-29-2-3-B	1.13	113	104	0	0	0
21	PR37801-15-1-1-2-B	1.13	100	101	0	0	10
22	PR37541-43-3-3-1-2-2-1-1	1.12	113	99	0	0	0
23	PR39155-16-3-3-2-B-B	1.10	112	106	0	0	0
24	PR39150-3-2-2-3-1-B	1.10	121	106	0	0	0
25	PR37062-27-4-2-1-2-3-1-2-B	1.10	113	102	0	0	0
26	PR38293-13-3-2-1-B-B	1.08	103	106	0	0	0
27	PR38855-44-2-1-3-B	1.08	104	106	0	0	0
28	PR39153-20-3-2-3-B-B	1.07	117	108	0	0	0
29	PR37586-7-2-1-3-2-B	1.05	102	100	0	0	0
30	PR39628-16-1-2-1-B	1.05	106	108	0	0	0
31	PR37801-13-1-2-3-1-B-B	1.05	110	101	0	0	10
32	PR38856-3-1-2-3-B	1.04	122	101	0	0	0
33	NSIC Rc222	1.04	108	107	0	0	0
34	PR37568-6-1-2-3-3-1-B	1.04	108	100	0	0	0
35	PR37533-8-1-1-1-3-2-1-3-B-B	1.04	110	100	0	0	0
36	PR37801-15-1-1-3-2-B-B	1.04	105	103	0	0	0
37	PR37606-9-3-2-2-B	1.04	111	106	0	0	0
38	PR37811-3-1-3-2-2-B-B	1.01	105	108	0	0	0
39	PR38269-6-2-2-3-B	1.00	107	100	0	0	20
40	PR37606-42-3-3-2-2-1-B-B	1.00	109	109	0	0	0
41	PR37074-23-1-3-2-2MYP-1-3-2-B	1.00	116	101	0	0	10
42	PR39411-11-2-2-B	1.00	107	101	0	0	10
43	PR38858-4-2-2-3-1-B-B	0.99	115	104	0	0	0
44	PR37541-97-2-3-2-B	0.99	95	101	0	0	10
45	NSIC Rc298 (Tubigan 23)	0.99	97	106	0	0	0
46	PR37825-18-3-2-3-1-B-B	0.97	103	100	0	0	0
47	PR38868-30-2-3-3-B	0.97	111	105	0	0	0

Grain quality evaluation of DWSR materials

- The grain quality (milling recovery, physical attributes and physicochemical properties) is evaluated. Breeding lines from PYT and GYT are submitted for grain quality evaluation at Rice Chemistry and Food Science Division (RCFSD).

- Four advanced DWSR lines satisfied all grain quality requirements as set by National Seed Industry Council (NSIC). These are the following: PR37579-7-2-2-1-3-B, PR37579-7-2-2-1-B, PR37533-8-1-1-1-3-2-1-3-B-B and PR37797-26-1-3-2-1-B-B.

- Most if not all are evaluated with low head rice percentage and high percent of chalky grains at around 14% moisture content. The group is currently checking the possible cause of the poor grain score, whether caused by factors other than genetics.

- Three promising lines (PR39566-11-2-1-1-B, PR39142-10-3-2-1-1-B, and PR40432-14-2-1-B-B) were identified with AG tolerance, pushing resistance, and good grain quality. PR40432-14-2-1-B-B (IR64xNSIC Rc146) has intermediate reactions to BLB, Blast and Sheath Blight. The lines are seed increased awaiting slot for yield trials and will be used in crossing works.

Database management

- Generation of field book using ICIS (International Crop Information System) software is implemented in the project. Information of DWSR breeding lines is stored in the ICIS software. This information is useful not only to breeders within the institute but also with other scientists who would like to get information about the materials used. ICIS software is user friendly and can generate crosses and selections made by the breeder. The information generated in this software can be stored in the local database within the institute and can be shared in the central data base outside PhilRice like IRRI.

III. Development of Hybrid Rice Varieties

Project Leader: DA Tabanao

The success of hybrid rice technology lies mainly in the development of high-yielding varieties adapted to local conditions. Between 1994 and 2011, the National Seed Industry Council has approved a total of 44 hybrid varieties for commercial cultivation in the Philippines. Seventeen of these varieties were bred and developed by the public sector, of which six were bred by PhilRice together with its partners UPLB and PhilSCAT. To date, PhilRice breeders at its Central Experiment Station and branch stations in Los Baños (in collaboration with UPLB) and San Mateo, have maintained specialized breeding activities despite the steady rise of private sector participation in this particular enterprise.

The continuous development of high-yielding hybrid varieties that are resistant to pests and diseases and possessing excellent grain qualities is essential to keep up with the increasing demand for rice and the changing environment. As such, there is a need for a strong national public breeding and research on hybrid rice.

The main purpose of this project is to increase rice productivity in the irrigated lowland ecosystem. This project covers the development of parent lines and F1 hybrids, breeding methodology and seed production research, and screening and testing of hybrids in various target environments.

Development of hybrid parent lines

LV Gramaje, JE Carampatana, KA Garcia, MSF Ablaza, EP Rico, VP Luciano, MM Rosario, JM Domingo, and DA Tabanao

One of the challenges in hybrid breeding is the selection, development and improvement of suitable parental lines that can be used for developing hybrids. In hybrid rice breeding, the cytoplasmic male sterile (CMS) line is considered as the heart in the development of F1 hybrids because failure in purity of this will result to poor hybrid. Therefore, CMS line development is a very essential component in the development of hybrid rice. Because of its great role and importance, diverse CMS lines with good qualitative and quantitative traits must be developed. Introduced CMS lines often are not adapted to local conditions, with very low resistance to biotic stresses and poor grain quality.

Maintainer and restorer lines are very essential components in the development of hybrid rice as well. Without maintainer and restorer lines, multiplication of CMS lines and production of F1 are not possible. Continuous research on the identification of inbred cultivars that can either maintain the sterility or restore the fertility of CMS lines plays an important role in developing high-yielding germplasm pools. Therefore, there is a need to develop new maintainer and restorer lines and to improve existing ones.

The study aimed to: (1) develop new diverse and stable CMS lines with good morphological traits and flowering behavior; (2) to develop and improve maintainer lines with good maintaining ability and desired plant morphology and grain quality; (3) to develop and improve restorer lines with desirable morphological traits, moderate resistance to pest and diseases and acceptable grain quality, and (4) to develop new Thermo-sensitive Genetic Male Sterile (TGMS) line with good agronomic traits, flowering behavior, moderate resistance to pest and diseases, adaptable to local condition and good grain quality.

Highlights:

- Ten elite advanced lines from the maintainer line nursery were used to re-test cross the upcoming CMS lines developed in the backcross nursery (BCN). A total of 15 crosses were generated which constituted the BC1F1. Their maintaining ability will be validated in the succeeding season through pollen sterility evaluation of the F1 generation.

- Sixteen out of 62 BC1F1, 4 out of 14 BC2F1, 14 out of 45 BC3F1, 11 out of 66 BC4F1, and 1 out of 9 BC5F1 lines showed 100% sterility and will be advanced to BC2F1, BC3F1, BC4F1, BC5F1, and BC6F1, respectively. From the advanced lines, 28 BC1F1, 7 BC2F1, 34 BC3F1, 31 BC4F1, and 3 BC5F1 crosses were generated which will be evaluated during the 2013 WS (Table 15). The detailed paired cross combination including the number of crosses generated in each entry from BC1F1 to BC5F1 is shown in Table 16. Progeny lines are repeatedly backcrossed up to its fifth or sixth generation and CMS lines that will be found to have stable sterility and good agronomic characters will be declared as new female parent.

- A new CMS line with PR35746-HY-6-6-2-1-1-1 background was selected based on the outcrossing trait and shall be further evaluated during the 2013 WS (Figure 11). Elite outcrossing traits were gathered by observing the flowering behavior and floral structure, normal flowering time in the day, good synchronization with its male parent, well-developed and exserted stigma during and after flowering and long duration of glume opening with a wide angle.

- Fourteen combinations of known maintainer lines were generated through BxB crosses for the improvement of maintainer lines. Five F1, 122 F2, 495 F3, 317 F4, 629 F5, and 220 F6 entries were evaluated. Two panicles were taken from each entry to be established in 2013 WS with the exception of F6 where only the best from each cross combination were advanced to the next generation (Table 17). The detailed cross combination including the number of crosses generated in each entry from F1 to F6 is shown in Table 18. Further evaluation of these lines based on phenotypic acceptability and uniformity will be done on 2013 WS.

- Established in the source nursery for TGMS two line development on 2012 WS were 166 inbred pollen parents. Used as male parental parents, these entries were crossed with three S–lines PR41917S, PR41918S and PR41919S. From these crosses, a total of 248 F1 were generated and evaluated including the 115 pollen parents on 2013 DS. Based on their phenotypic acceptability, 30 entries were selected at the testcross for two-line nursery (TCS). These will be elevated to seed production for observational nursery (SPON) on 2013 WS.

- For the development of TGMS lines, 163 sterile plants with good morpho-agronomic characters were evaluated and selected at Male Sterile Environment (MSE) in PhilRice CES on 2013 DS. Sterile plants were ratooned and planted at Male Fertile Environment (MFE) in Kayapa, Nueva Vizcaya for evaluation and seed multiplication (Figure 12). Out of 163, 77 plants were selected based on their fertility behavior and phenotypic acceptability. These plants will be advanced in the pedigree nursery (PN) this 2013 WS for selection of completely male sterile at MSE. The seed multiplication and evaluation of the three TGMS lines: PR41917S, PR41918S and PR41919S were also done at MFE in NEUST Gabaldon, Nueva Ecija, Kayapa, Nueva Vizcaya and Sablan, Benguet. Stunted growth of plants was observed during vegetative stage because of very low temperature; however, 12.90kg of seeds were harvested (6.30 kg from PR41917S, 5.15 kg from PR41918S and 1.45 kg from PR41919S). The harvested TGMS lines will be used for testcrossing of selected pollen parent this 2013 WS at MSE.

- For the development and improvement of restorer lines, a total of 1310 entries were evaluated (Table 19). Five entries from 5 F1, 79 from 240 F2, 100 from 360 F3, 58 from 108 F4-F5, and 203 plants from 597 F6-F7 entries were selected based on the phenotypic acceptability (Figure 13). These plants will be advanced to the next generation on 2013 WS.

Table 15. CMS lines evaluated in 2013 DS.

CMS Backcross Nursery	No. of plants evaluated (2012WS)	No. of selected sterile entries (2013DS)	No. of plants to be advanced (2013WS)
BC_1F_1	62	16	28
BC_2F_1	14	4	7
BC_3F_1	45	14	34
BC_4F_1	66	11	31
BC_5F_1	9	1	3

Table 16. Paired crosses generated and advanced from the CMS conversion nursery.

2013 DS				Number of entries (2013 WS)
Generation	Cross Combination		Number of Crosses	
BC_5F_1	PR15A	PR37130-HY-3-3-1-2-1-1	53	3
BC_4F_1	IR68897A	PR35746-HY-6-6-2-1-1-1	71	22
	PR21A	PR35746-2-2-2-1-4-2	25	8
	IR73328A	C7176-B-2-3	3	1
BC_3F_1	IR79128A	PR40569-HY-1-3	52	16
	IR79128A	PR40569-HY-1-11	34	13
	IR79128A	PR40569-HY-3-4	26	5
BC_2F_1	IR79128A	PR40569-HY-3-4	41	4
	PR9A	BB-25 (2012 DS)	1	1
	V20A	BB-25 (2012 DS)	9	2
BC_1F_1	IR68897A	HY-553 F4 (2012 DS)	6	2
	IR68897A	PC-8 (2012 WS)	7	1
	IR68897A	PC-22 (2012 WS)	15	2
	IR68897A	PC-25 (2012 WS)	5	2
	PRH1	Nipponbare-orig-6-2-1	1	1
	PR2A	Nipponbare-orig-AC-2-1-10-1-1	9	2
	PR2A	Nipponbare (GEMS)-29-7	7	2
	PR2A	PR28550-30kr-4-1	2	2
	PR2A	PR36831-55-2-1-1-1-1-1	27	4
	IR68897A	PR34131-B-20-1	2	2
	PR21A	PR37926-22	2	2
	PR15A	GSR 301	9	2
	PRH1	PR35784-B-16-4-3	3	2
	IR68897A	PR39407-70-39-1	5	2
	IR68897 A	PC-9 (2013 DS)	2	2
	IR68897 A	PC-12 (2013 DS)	2	2
	IR68897 A	PC-17 (2013 DS)	2	2
	IR68897 A	PC-25 (2013 DS)	2	2
	IR68897 A	PC-26 (2013 DS)	1	1
	IR68897 A	PC-27 (2013 DS)	1	1
	IR68897 A	PC-29 (2013 DS)	1	1
	IR68897 A	PC-30 (2013 DS)	1	1
	IR68897 A	PC-34 (2013 DS)	1	1
	IR68897 A	PC-38 (2013 DS)	2	2
TOTAL			430	118

Table 17. Maintainer lines evaluated in 2013 DS.

B line development	No. of plants evaluated (2012WS)	No. of plants evaluated (2013DS)	No. of entries to be advanced (2013WS)*
F_1	5	5	39
F_2	122	122	182
F_3	495	495	484
F_4	317	317	632
F_5	629	629	812
F_6	220	220	12

* panicle selection was done from F_1-F_5

Table 18. Paired crosses and advanced lines in the maintainer line nursery.

2013 DS				2013 WS
Gen	Cross Combination		Number of Crosses	Number of lines
F_6	PR35736 B (PR 9 B)	PR35472 B (PR19 B)		4
	B38	IR70369 B		4
	CMB	PR24069 B (PR3 B)		4
F_5	PR15 B	IR73328 B		8
	PR9 B	PRH1 B		56
	PR9 B	PR21 B		158
	PRH1 B	PR21 B		163
	PR21 B	PRH1 B		101
	CMB	PRH1 B		177
	PR3 B	BCN 28 2009 WS		27
	Maybelle	BP		86
	V20 B	IR58025 B		20
	IR68280 B	V20 B		4
	IR68280 B	IR58025 B		4
	PR45961 B			4
	PR1 B	PR19 B		4
F_4	PR2 B	PRH1 B		180
	PR2 B	JINANTE B		12
	PR3 B	IR80151 B		42
	PR3 B	PRH1 B		152
	PR3 B	JINANTE B		20
	PR3 B	PR9 B		96
	PR4 B	PRH1 B		8
	PR37130-HY-3-3-1-2-1-1(B38)	PRH1 B		102
	PRH1 B	PR37130-HY-3-3-1-2-1-1(B38)		20
F_3	IR58025 B	PR9 B		45
	JX316 B	PR9 B		69
	PR4 B	IR58025 B		18
	PR4 B	B38		4
	IR58025 B	IR73328 B		45
	PR4 B	PR9 B		113
	IR70369 B	JX316 B		13
	IR70369 B	PR4 B		12
	IR70369 B	B38		16
	PR45962 B			68
	PR45963 B			81
F_2	BB-28	PR21 B		11
	BB-26	PR35746-6-6-2-1-1		7
	BB-29	PR21 B		5
	BB-26	PR24 B		10
	PRH1 B	BB-26		5
	PRH1 B	JX 316 B		3
	BB-26	IR68897 B		4
	IR58025 B	PR21 B		11
	IR68897 B	BB-25		12
	PRH1 B	BB-8		12
	IR79128 B	PR9 B		11
	BB-29	IR58025 B		10
	IR79128 B	IR58025 B		10
	BB-8	?		11
	CMS-1B	?		5

Table 19. Evaluation of restorer lines based on phenotypic acceptability (2013 DS).

Generation	# of entries evaluated	# of entries selected	# of plants to be advanced (WS 2013)
F_1	5	5	5
F_2	240	79	237
F_3	360	100	300
F_4-F_5	108	58	166
F_6-F_7	597	203	271
Total	1310	445	979

Figure 11. CMS line with PR35746-HY-6-6-2-1-1-1 background and its male parent.

Figure 12. Male Fertile Environment (MFE) in Kayapa, Nueva Vizcaya

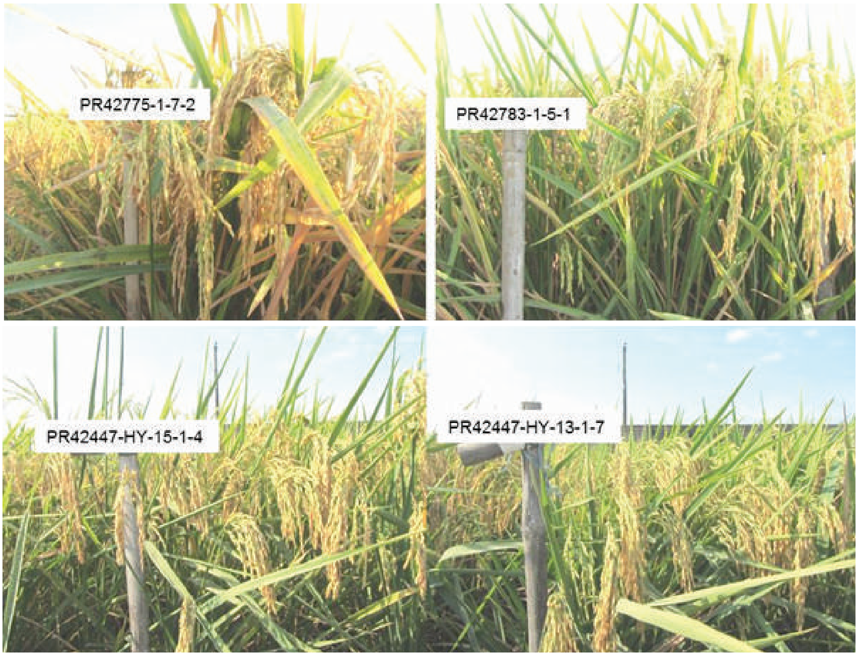


Figure 13. Selected restorer lines evaluated in 2013 DS.

Development of F1 hybrids
MM Rosario, EP Rico, VP Luciano, MSF Ablaza, JM Domingo, and DA Tabanao

The three-line system in hybrid breeding is a key approach to help attain rice self-sufficiency in the country. Hybrid rice is one technology with a lot of promise to contribute greatly to this goal because of its 15-20% yield advantage over inbreds. Heterotic hybrids also offer high income opportunities to the farmers. This is either through F1 cultivation or parental seed production. The success of hybrid rice breeding depends to a great extent on the quality and diversity of elite lines used as parents in developing new hybrids. New approaches such as the use of excellent inbreds and promising lines from Optimum Plant Morphology (OPM), Tropical Japonica (TJ) breeding, and doubled haploid (DH), are essential in discovering promising new hybrid combinations.

Thus, the main goal of the study was to identify superior F1 combinations as well as to determine the combining ability of newly-developed parent lines. Specifically, the study aimed to (1) identify potential maintainer lines (B) or restorer lines (R) from the early generation and elite breeding lines of irrigated lowland inbred rice breeding project, (2) to develop F1 hybrids from a cross between cytoplasmic male sterile (CMS) lines, and OPM and TJ lines from the inbred rice breeding project, (3) to convert potential B lines into new A lines and utilize potential R lines in further enhancing the restorer line genepool of hybrid breeding program of PhilRice, and (4) to integrate DH and molecular marker technologies to select for high grain yield and yield components in hybrid rice breeding.

Highlights:

- Established in the Source Nursery (SN) in 2013 Dry Season (DS) were 343 breeding lines. These comprised of 161 Tropical Japonica (TJ) and Optimized Plant Morphology (OPM), 150 Irrigated Lowland (IL) and 32 Double Haploids (DH) materials (Table 20). The OPM, TJ and IL breeding lines were test crossed to three CMS lines: PR2A, IR68897A, IR58025A and one TGMS line TG101S. The DH was crossed to available tester lines: IR68897A, IR58025A, PR2A, PR9A, PR21A, PR15 and PR24A. Cross combinations generated 398 test crosses from IL lines, 419 test crosses from OPM and TJ lines and 39 test crosses from DH lines (Table 20). The generated crosses will be evaluated along with their parent lines in the test cross nursery (TCN) in 2013 WS.

- As shown in Table 21, a total of 1145 entries were established and assessed in the Testcross Nursery (TCN) which was composed of 603 OPM and TJ, 398 IL, and 144 DH. There were 40 lines identified as potential restorer and pollen parents (R/P) while 90 lines were identified as potential maintainers. The potential restorer lines will undergo re-testcrossing for their combining ability test while the potential maintainers will be elevated to the backcross nursery.
  In addition, breeding lines selected based on their yield performance in TCN on 2012DS were re-testcrossed to 8 tester lines (IR68897A, IR58025A, PR2A, PR9A, PR15A, PR21A, TGMS71, PR19A) on 2012WS. A sum of 1146 entries, consisting of 212 breeding lines and 934 re-testcrosses were evaluated this 2013DS, 22 breeding lines out-performed the four checks (NSIC Rc240, NSIC Rc222, NSIC Rc82 and NSIC Rc18) with a percent yield advantage ranging from 15%–164.3%. The entry TCN 1761, testcross between MET-3309 and tester PR24A had the highest yield advantage of 72.9-100.3%, followed by entry TCN2478, TCN2202 and TCN215 (Table 22). The selected breeding lines will be elevated to Seed Production Observational Nursery (SPON) for further evaluation.

- The per se performance of the 325 individual parent lines along with their experimental hybrids (820) was evaluated in

TCN. The IL parent lines AB-30, AB-16, MB-223, MB-169 and AB-37 have 15.1-118% yield advantage against all the check varieties. PR45604HY-AC, PR45607HY-AC, PR45598HY-AC, PR45596HY-AC and PR45594HY-AC were among the top five highest yielding entries from DH parent lines with 112.2-205% yield advantage. The parent lines PR40511-14, PR40510-19, PR4-2-3, and PR40511-14-3-2 were among the top four highest yielding from OPM/TJ with 15.9-230.1% yield advantage over the check varieties (Table 23). Based on their F1 performance, these selected entries will be re-testcrossed with at least 8 CMS lines to determine their combining ability and F1 grain yield. In addition, selected DHL's will be screened for pest and disease resistance at three different PhilRice branch stations (shuttle breeding).

- Out of 820 hybrids, 19 from DH, 101 from IL and 34 from OPM/TJ were identified to surpass the yield of four check varieties NSIC Rc240, NSIC Rc222, NSIC Rc82 and NSIC Rc18. The top five hybrids each generated from IL, DH, OPM and TJ is shown in Table 24 with 15.7-253.7% yield advantage over the four check varieties and with 51.0-240.2% yield advantage over its parent. The parent lines of the high yielding selected hybrids will be brought back to the SN for re-testcrossing to 8 CMS lines for further evaluation and yield trial.

- For the anther culture activity on 2013 DS, rice boots were collected from 95 genotypes and subjected to anther culture (AC). Eighteen generated 28 DH plants with entry HY-12 having the most number of regenerants (11), 0.17% anthers plated (AP), 7.75% of callused anthers (CA), and 2.15% callus formation (CF) (Table 25). We have also established a set of 402 plant selection from doubled haploid cycle 1 (DHC1) R4 generation and selected 275 DHC1 (R5 generation). The selected plants will be evaluated on 2013 WS based on yield, phenotypic acceptability and agro-morphological traits.

- Three posters were presented during the 22nd FCSSP Scientific Conference held on March 11-16, 2013 at Pearlmont Inn, Cagayan de Oro. The posters were titled "Use of Optimized Plant Morphology (OPM) and Tropical Japonica Breeding Lines of PhilRice in Hybrid Breeding", "Combining Ability Test of Doubled Haploid to Different Cytoplasmic Male Sterile (CMS) Lines" and "Prospecting for New B or R Lines from Early Generation and Elite Breeding Lines for Irrigated Lowland Rice Breeding Germplasm".

Table 20. Breeding materials assembled in the Source Nursery (SN) PhilRice CES, 2013DS.

Breeding lines	# of parents	# of testcrosses (F1)	Total
OPM/TJ	161	419	580
IL	150	398	548
DH	32	39	71
Total	343	856	1199

Table 21. Breeding lines and hybrids established in the Testcross Nursery (TCN) at PhilRice CES.

Breeding lines	# Parents	# of hybrids (F_1)	Total	# of Potential	
				R/P	B
OPM/TJ	130	473	603	40	60
IL	123	275	398	0	30
DH	72	72	144		
Total	325	820	1145	40	90

Table 22. Performance of re-testcross breeding lines at PhilRice CES, 2013DS.

Field Code		Male parent	Tester line	Yield	Yield advantage (%)			
SN 2012WS	TCN 2013DS				NSIC Rc18	NSIC Rc82	NSIC Rc222	NSIC Rc240
SN- 321	1761	MET-3309	PR24A	289.35	100.3	164.3	72.9	74.6
SN- 489	2478	ILMAS-785	TGMS71	233.32	61.5	113.2	39.4	40.8
SN- 418	2202	PR41193-24-1-2	TGMS71	230.68	59.7	110.7	37.8	39.2
SN- 403	2157	PR41184-82-1-1	IR68897A	223.76	54.9	104.4	33.7	35.0
SN- 341	1878	PR41187-1-1-3	TGMS71	220.76	52.8	101.7	31.9	33.2
SN- 402	2144	PR41184-67-1-1	IR68897A	219.72	52.1	100.7	31.3	32.6
SN- 374	2019	PR41083-28-1-1	TGMS71	204.24	41.4	86.6	22.0	23.3
SN- 376	2032	PR41083-28-1-3	IR68897A	203.43	40.8	85.8	21.5	22.8
SN- 490	2483	ILMAS-787	51A	200.66	38.9	83.3	19.9	21.1
SN- 443	2295	PR3-1-4	TGMS71	199.75	38.3	82.5	19.3	20.6
SN- 446	2313	PR4-2-21	IR58025A	198.69	37.5	81.5	18.7	19.9
SN- 340	1872	PR41187-1-1-2	PR24A	194.73	34.8	77.9	16.3	17.5
SN- 488	2476	ILMAS-771	TGMS71	192.55	33.3	75.9	15.0	16.2
SN- 284	1606	PTCN 69	IR68897A	192.4	33.2	75.8	14.9	16.1
SN- 311	1711	PYT-R-127	IR58025A	190.49	31.9	74.0	13.8	15.0
SN- 469	2411	PR37984-B-8-1-1	TGMS71	189.53	31.2	73.2	13.2	14.4
SN- 344	1898	PR41187-6-1-3	PR2A	174.09	20.5	59.0	4.0	5.1
SN- 438	2274	PR37160-8-5-1-1-1-1	IR58025A	173.33	20.0	58.4	3.5	4.6
SN- 267	1546	TJ ON 29	PR21A	168.38	16.5	53.8	0.6	1.6
SN- 486	2465	ILMAS-761	51A	167.14	15.7	52.7	-0.1	0.9
SN- 369	2002	PR41188-85-1-3	TGMS71	164.78	14.1	50.5	-1.6	-0.6
SN- 331	1821	Elite-29	51A	162.02	12.1	48.0	-3.2	-2.2

Table 23. Parent lines with high yielding advantage over the check varieties (2013 DS).

Entry No.	Designation	Yield (g)	Yield advantage (%)			
			NSIC Rc240	NSIC Rc222	NSIC Rc82	NSIC Rc18
Irrigated lowland lines						
TCN 722	AB-30	218.0	118.0	30.2	99.1	50.9
TCN 673	AB-16	210.0	26.8	25.5	91.9	45.4
TCN 1094	MB-223	201.4	21.5	20.3	84.0	39.4
TCN 1055	MB-169	197.6	19.3	18.1	80.5	36.8
TCN 748	AB-37	192.7	16.3	15.1	76.0	33.4
Double haploids						
TCN 1437	PR45604HY-AC	932.0	166.1	205.0	154.7	146.3
TCN 1451	PR45607HY-AC	913.0	160.7	198.8	149.5	141.3
TCN 1405	PR45598HY-AC	898.0	156.5	194.0	145.5	137.4
TCN 1401	PR45596HY-AC	890.0	154.0	191.1	143.0	135.0
TCN 1397	PR45594HY-AC	803.0	129.3	162.8	119.4	112.2
Optimized Plant Morphology						
TCN 343	PR40511-14	230.1	38.9	37.5	110.2	59.3
TCN 165	PR40510-19	210.9	27.3	26.0	92.7	46.0
TCN 242	PR4-2-3	201.5	21.6	20.4	84.1	39.5
TCN 315	PR40511-14-3-2	198.8	20.0	18.8	81.6	37.6

Table 24. Testcrosses with high yielding advantage over the check varieties.

F1	Tester	Yield (g)	Yield advantage (%)				
		F1	NSIC Rc240	NSIC Rc222	NSIC Rc82	NSIC Rc18	Parent
Irrigated lowland lines							
TCN 798	IR58025A	214.8	29.6	28.3	96.2	48.6	240.2
TCN 988	IR68897A	214.0	29.2	27.8	95.5	48.1	165.8
TCN 927	PR2A	296.9	79.2	77.4	171.3	105.5	131.4
TCN 1138	IR68897A	218.6	31.9	30.6	99.7	51.3	128.6
TCN 957	IR68897A	219.9	32.7	31.4	100.9	52.2	103.5
Double haploids							
TCN 1376	PR2A	524.0	49.6	71.5	43.2	38.4	-8.7
TCN 1398	IR68897A	481.0	37.3	57.3	31.4	27.0	-40.1
TCN 1394	PR2A	474.0	35.3	55.1	29.5	25.2	51.0
TCN 1370	PR2A	438.0	25.1	43.3	19.7	15.7	-18.7
TCN 1404	PR2A	438.0	25.1	43.3	19.7	15.7	-23.0
Optimized Plant Morphology							
TCN 298	IR58025A	387.2	133.7	131.3	253.7	168.0	211.0
TCN 414	TGMS71	265.4	60.2	58.6	142.5	83.7	130.4
TCN 216	IR58025A	286.7	73.0	71.3	161.9	98.4	123.5
TCN 16	PR21A	292.5	76.5	74.7	167.2	102.5	112.1
TCN 455	TGMS71	266.8	61.0	59.4	143.7	84.7	109.4

Table 25. Response of hybrid parent lines to anther culture, PhilRice CES, 2013DS.

Field Code (2013DS)	Cross Combination	Total # of anthers plated (AP)	Total # of callused anthers (CA)	% callused formation (CF)	# of regen-erants	% AP	% CA
	B improvement (elite)						
	IR68897B/IR79156B	7200	60	0.83			
	IR79156B/IR73328B	52,920	359	0.68			
	R improvement						
	PR340302R/TG101	1800	114	6.33			
	PR36546-HY-1-19/PR340302R	16920	86	0.51			
	TG101/PR36546-HY-1-19	6480	170	2.62			
	BF2 population						
HY-12	IR68897B/PR9B	6600	142	2.15	11	0.17	7.75
HY-17	BB29/PR21B	4680	197	4.21	1	0.02	0.51
HY-18	BB27/JAASB	4500	145	3.22	6	0.13	4.14
HY-19	BB26/PR24B	4860	58	1.19	2	0.04	3.45
HY-23	JAASB/JX316B	720	78	10.83	2	0.28	2.56
HY-50	IR80151B/BCN 127 B (2012DS)	7740	70	0.90	2	0.03	2.86
	RF2 population						
RS 3	PR36620C-HY-1/PR36248-HY-2-4-4	1800	58	3.22	1	0.06	1.72
RS 4	PR36620C-HY-14/RB 100-1	2700	176	6.52	1	0.04	0.57
	RU 252	5760	297	5.16	2	0.03	0.67
	RF1 generation						
	PR36244-HY-1-2-2/PJ23	1980	101	5.10			
	PR36502/PR36244-HY-1-2-2	1080	92	8.52			
	Minghui 63/PR31885-HY-3-1	900	78	8.67			
	Minghui 63/PR36244-HY-10-1-3	720	53	7.36			
TOTAL					28		

Performance test of experimental hybrids

MSF Ablaza, LV Gramaje, JE Carampatana, and DA Tabanao

Heterosis breeding is one complementary strategy to negate the growing rice shortage in the country, as it promises a 15% yield advantage compared to conventional varieties under the same input levels. The increases in yield are a result of hybrid vigor that breeders aim to exploit.

Good hybrids identified in the different yield trials provide the mechanisms for scientifically investigating the performance of promising hybrids for yield, level of their heterosis and resistance to pests and diseases over designated check cultivars under local conditions. This information is important in selecting the best hybrids for multi-location national trials for hybrids under the National Cooperative Test.

The objectives of the study were: (1) to evaluate the performance of promising hybrid combinations in different nurseries for yield, reaction to biotic stresses and other desirable traits; (2) to identify hybrids with broad range of adaption and stable performance across location; and, (3) to identify location/season specific hybrids.

Highlights:

- During 2013 DS, 105 entries and 5 check varieties were established and evaluated in the Observational Nursery (ON). The experiment was laid out in an augmented design. Check varieties were replicated in each block while the test entries were not replicated but assigned to the plots randomly. The F1 hybrids were evaluated along with their male parent for comparison of the agro-morphological characters (Figure 14). Ten hybrids out of 105 were selected based on good phenotypic acceptability and high yielding ability against the check varieties PSB Rc82, PSB Rc18, NSIC Rc240, Mestizo 1 and Mestiso 29. Three hybrids, PR45209H, PR45180H, and PR45204H, consistently had 15.1-20.9 % yield advantage over the three check varieties PSB Rc82, PSB Rc18 and Mestizo 1 (Table 26).

- The Preliminary Yield Trial (PYT) consisted of promising selected hybrids from the ON. The 42 hybrids with 5 check varieties were established and evaluated in randomized complete block design (RCBD), replicated 3 times with 10 rows and 25 hills. Seven hybrids were noted to have 15.1%-25.5% yield advantage against the check varieties PSB Rc18, NSIC Rc240 and Mestiso 29. These hybrids were PR44123H, PR44121H, PR36436H, PR36653H, PR39032H, PR44146H and PR39006H (Figure 15). Most of these hybrids have only 3.63%-6.31% yield advantage over PSB Rc82 and 5.17%-7.89% over Mestizo 1 (Table 26). All identified best hybrid entries in the trial will be advanced to Seed Production for National Cooperative Test (SPNCT) prior to National Cooperative Test (NCT) evaluation.

- Multi-location yield trials (MYT) served to evaluate the extent of adaptation of experimental and released hybrids in varied environmental conditions, primarily determined by grain yield. The MYT during 2013 DS consisted of 20 entries including two check varieties, namely: NSIC Rc240 and PSB Rc82. The tests were conducted in PhilRice CES and PhilRice Isabela Branch Station. For PhilRice CES, the five top performing entries in descending order include PR36653H (7.17 t/ha), PR40638H (7.03 t/h), Mestizo 1 (6.98 t/ha), Mestiso 31 (6.93 t/ha), and Mestiso 21 (6.92 t/ha), with yield advantage ranging from 8.29% to 6.70% over NSIC Rc240 and 8.29% to 12.21% over

PSB Rc82 (Table 27). Thirteen test entries out-yielded NSIC Rc240 (6.72 t/ha) while 18 entries outyielded PSB Rc82 (6.39 t/ha). On the other hand, still in descending order, Mestizo 1 (6.82 t/ha), Mestiso 31 (5.84 t/ha), PR42214 (5.65 t/ha), Mestiso 19 (5.52 t/ha), and Mestiso 30 (5.50 t/ha) composed the top five entries in PhilRice Isabela (Table 27). Yield advantage of the top entries ranged from 20.88% to 49.89% over NSIC Rc240 (4.55 t/ha) and from 27.91% to 58.60% over PSB Rc82 (4.30 t/ha).

Table 26. Selected entries from Observational Nursery (ON) and Preliminary Yield Trial (PYT).2013DS.

Entries	Yield (tha^{-1})	Yield advantage over check varieties (%)				
		PSB RC 82	PSB Rc 18	Mestizo 1	Mestiso 29	NSIC Rc240
Observational Nursery (ON)						
PR45209H	12.1	20.9	15.3	15.3	14.3	13.1
PR45180H	12.1	20.9	15.3	15.3	14.3	13.1
PR45204H	12.0	20.8	15.1	15.1	14.2	13.0
PR45211H	11.8	20.4	14.9	14.9	13.9	12.8
PR45208H	11.3	19.6	14.3	14.3	13.4	12.3
PR45205H	11.2	19.4	14.1	14.1	13.2	12.2
PR45178H	10.7	18.5	13.5	13.5	12.6	11.6
PR45193H	10.5	18.2	13.3	13.3	12.4	11.4
PR45199H	10.5	18.2	13.3	13.3	12.4	11.4
PR45200H	10.3	17.8	13.0	13.0	12.2	11.2
Preliminary Yield Trial (PYT)						
PR44123H	9.5	6.31	22.3	7.89	16.1	25.5
PR44121H	9.4	6.19	22.2	7.78	15.9	25.3
PR36436H	9.4	6.08	22.1	7.66	15.8	25.2
PR36653H	9.3	5.09	20.9	6.65	14.7	24.0
PR39032H	9.2	4.29	20.0	5.84	15.9	23.1
PR44146H	9.2	4.05	19.8	5.60	15.6	22.8
PR39006H	9.2	3.63	19.3	5.17	15.1	22.3

Table 27. Grain yield (t/ha) of the five top performing entries and their yield advantage over the check varieties for Multi-location yield trial during the 2013 dry season in the two test sites.

PhilRice CES				PhilRice Isabela			
Entry	**Yield (t/ha)**	**Yield Advantage (%)**		**Entry**	**Yield (t/ha)**	**Yield Advantage (%)**	
		NSIC Rc240	**PSB Rc82**			**NSIC Rc240**	**PSB Rc82**
36653H	7.17	6.70	12.21	Mestizo 1	6.82	49.89	58.60
40638H	7.02	4.46	9.86	Mestiso 31	5.84	28.35	35.81
estiso 1	6.97	3.72	9.08	PR42214H	5.65	24.18	31.40
estiso 31	6.93	3.13	8.45	Mestiso 19	5.52	21.32	28.37
estiso 21	6.92	2.98	8.29	Mestiso 30	5.5	20.88	27.91
IC Rc240	6.72			NSIC Rc240	4.55		
B Rc82	6.39			PSB Rc82	4.30		

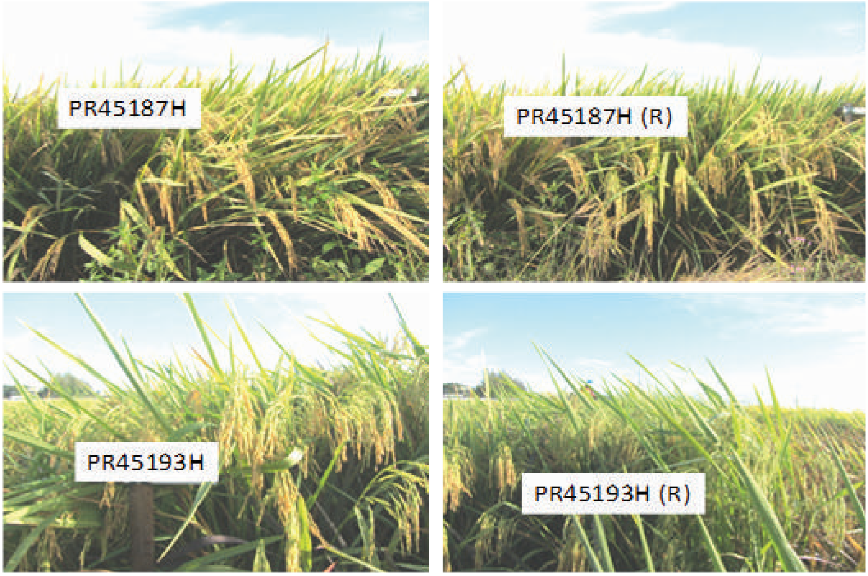


Figure 14. Selected hybrids and their corresponding R Lines in Observational Nursery.

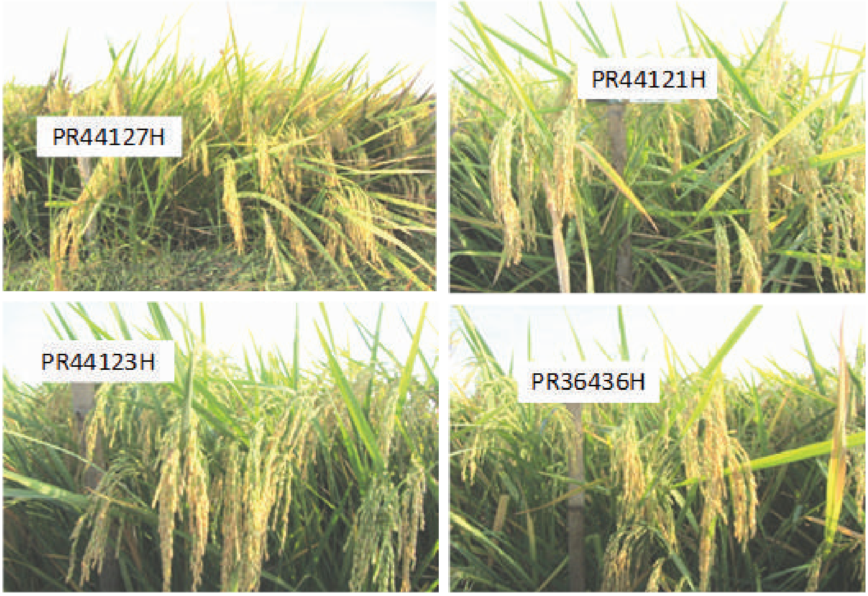


Figure 15. Selected hybrids in Preliminary Yield Trial (PYT) on 2013 DS.

Seed production of experimental and released hybrids

LV Gramaje, CD del Rosario, VP Luciano, JE Carampatana, and DA Tabanao

Hybrid rice variety development needs enough pure seeds to cover various experiments. F1 seed production plays an important role in the Observation Nursery (ON), Preliminary Yield Trial (PYT), National Cooperative Test (NCT), and Technology Demonstration of released hybrids because its life will depend on the availability of the seeds needed for the study and commercial production. The production of hybrid seeds differs from that of inbred rice seed. It involves two steps: the multiplication of CMS lines (A × B) and the production of hybrid seeds (A × R). The genetic purity of the CMS (A), maintainer (B) and restorer (R) lines, which are hybrid parental, is essential in the development and commercialization of hybrid varieties since the yield of hybrid rice will decrease by 100 kg/ha when the purity of hybrid seeds decreases by one percent.

The main objective of the study was to produce enough pure seeds for experimental and released hybrids and to scout and validate suitable areas for seed production.

Highlights:

- Progeny of the paired crosses involving seven A × B combinations from the previous season was established during the 2013 dry season, for purity and sterility evaluation and nucleus seed production. In particular, the cross combinations were: IR73328A × IR73328B, IR80151A × IR80151B, IR70369A × IR70369B, PR20A × PR20B, PR40591H A × PR40591H B, PR15A × NJ15B and PR15A × NJ30B. A total of 24 paired crosses were generated from the setup, 22 from IR73328A × IR73328B and two from PR15A × NJ29B. Yield of the entries ranged from 399 g to 15,060 g (Table 28).

- Lines evaluated as pure with 96%-100% sterility during the 2012 WS evaluation of paired crosses (EPC) constituted the 2013 DS breeder seed production (BSP) setup. Four lines were seed produced, namely: IR79128A, IR80151A, PR20A and PR40591H A, with each of their corresponding maintainer lines. On a 50-hill basis, breeder A line seeds production ranged from 838.70 g (PR40591H A) to 7,557.90 g (IR79128A). Bulk yield on the other hand ranged from 267.90 g (PR40591H A) to 26,442.80 (IR79128A). In all, 94 paired crosses were generated. In tons/ha, total yield per entry ranged from 0.18 (PR40591H A) to 0.93 (IR79128A). IR68897A was grown for foundation seed production (FSP). For a 0.50-ha area, the yield attained was 0.45 t/ha with 150 generated paired crosses (Table 28). The seed yield will be used for A

× R seed production of experimental hybrids entered in the observation nursery (ON), preliminary yield trial (PYT), and national cooperative test (NCT).

- A set of six IRRI-bred hybrids, namely; Mestiso 21, Mestiso 25, Mestiso 26, Mestiso 30, Mestiso 31, and Mestiso 32 were seed produced during the 2013 DS. F1 seed yield on a 50-hill basis ranged from 258.20 g (Mestiso 32) to 1,861.90 g (Mestiso 30). Bulk yield ranged from 647.70g (Mestiso 31) to 14,749.50 (Mestiso 30). In tons per hectare, total yield of the entries ranged from 0.08 (Mestiso 31) to 2.19 (Mestiso 30). The lowest recorded yield was due to non-synchronization between the A and R lines. For the six cross combinations, all 87 paired crosses generated will be forwarded to R-line development and improvement. Three experimental hybrids were seed produced for the National Cooperative Tests, namely: PR39342H, PR39383H, and PR36577H. Mestiso 29 seed production during the season also yielded 0.09 t/ha. The F1 seed yield among the hybrids was at least 6 kg (0.27 t/ha) (Table 29).

Table 28. Yield in grams and number of paired crosses (PC`s) generated from evaluation of paired crosses (EPC), breeder seed production (BSP), and foundation seed production (FSP) of various A × B cross combinations, PhilRice CES, 2013 dry season.

y	Cross Combination		Yield			PC`s Generated
	A Line	B Line	grams		t/ha	
5	IR73328A	IR73328B	1,740.50			22
30	IR80559A	IR80559B	15,060.00			0
	IR70369A	IR70369B	399.00			0
	PR20A	PR20B	1,022.40			0
	PR40591H A	PR40591H B	503.10			0
	PR15A	NJ29B	Not synchronized			2
	PR15A	NJ30B	Not synchronized			0
			50 Hills	Bulk		
	IR79128A	IR79128B	7,554.90	26,442.80	0.93	37
	IR80151A	IR80151B	4,817.40	15,438.70	0.55	14
	PR20A	PR20B	2,462.50	3,643.20	0.36	13
	PR40591H A	PR40591H B	838.70	267.90	0.18	30
	IR68897A	IR68897B	202,290		0.45	150

Table 29. Yield in grams and number of paired crosses (PC`s) generated from F1 seed production (F1 SP) of various A × R cross combinations, PhilRice CES, 2013 dry season.

Cross Combination		Hybrid	Yield			PC`s Generated	Remarks
A Line	R Line		50 Hills (g)	Bulk (g)	t/ha		
58897A	IR73013-95-1-3-2R	Mestiso 32	258.20	2,542.10	0.37	8	synchronized
	SRT3R	Mestiso 25	1,180.90	2,200.70	0.44	17	synchronized
30559A	IR60819-34-2R	Mestiso 30	1,861.90	14,749.50	2.19	10	synchronized
73328A	IR73385-1-4-3-2-1-10R	Mestiso 26	1,350.50	4,671.20	1.65	20	synchronized
	IR60912-93-3-2-3-3R	Mestiso 21	1,138.40	4,062.50	1.43	23	synchronized
	IR73013-95-1-3-2R	Mestiso 31	0.00	647.70	0.08	9	Not well synchronized
58897A	PR34302	Mestiso 29	500,000.00		0.09	0	synchronized
19A	PR34142-5-1-3-2R	PR39342H	6,000.00		0.27	0	synchronized
2A	PR34142-5-1-3-2R	PR39383H	6,500.00		0.30	0	synchronized
58025A	PR36246HY-1-19-2-2R	PR36577H	8,000.00		0.37	0	synchronized

IV. Development of Thermo-Sensitive Genetic Male Sterile (TGMS) Lines and TGMS-Based Two-Line Hybrid Rice

Project Leader: SH Escamos

The discovery of thermo-sensitive genetic male sterility in rice provided new avenues to further exploit heterosis using the two-line system. TGMS are genic male sterile genotypes whose fertility/sterility behavior is conditioned by temperature regimes (Virmani, 1996). This system is useful in the Philippines where temperature differences exist due to elevation, latitude and time of year. The increased chances of finding high-yielding hybrids and the more straightforward seed production of TGMS lines makes this system more economically viable.

With the release by the National Seed Industry Council (NSIC) of 2 TGMS-based hybrid rice varieties, the collaborative project between UPLB and PhilRice has demonstrated that breeding and use of TGMS lines to develop two-line hybrids can be successfully done in the Philippines. The project is aimed at developing stable and improved TGMS lines with added focus on earliness and shorter stature. Likewise, it aims to develop two-line hybrids with at least 15% yield advantage over the best inbred variety, pest resistant and with acceptable grain and eating qualities. Earliness, shorter stature and lodging resistance are emphasized in developing new hybrids.

Development of new and diverse TGMS lines through hybridization and selection

SH Escamos, MAT Talavera, TM Masajo

To keep up with the challenge of developing better two-line hybrids, continuous development of new and more improved TGMS lines is an essential component that needs to be pursued. The objective of the study is to develop new and diverse TGMS lines through hybridization and selection. Earliness and shorter stature, resistance to pests and diseases and good grain quality are some criteria considered in selection. TGMS lines. with low critical fertility point is also considered to ensure safe and successful production of pure F1 seeds at MSE.

Highlights:

- Research activities on the development of new improved and stable TGMS lines through hybridization and selection at both male sterile environment (MSE) and male fertile environment (MFE) were continued during the season.

- At MSE (Los Banos), TGMS lines and pollen parents were assembled and planted for making crosses. Also planted were 40 F1s, 33 F2 populations and 2466 lines in the F3-F7 generation. Thirty (30) F1 populations were selected for advancing to the F2 generation. Forty-nine (49) new crosses were generated and will be evaluated in 2013 wet season. From the 33 F2 populations and pedigree nurseries grown during the season, 1336 plants (725 sterile and 608 fertile) were selected. The sterile plants were lifted and brought to MFE (Tublay, Benguet) for further testing and to produce seeds while fertile selections will be evaluated as F3 lines at MSE during the 2013 wet season. Unfortunately, no selection was done in some of the pedigree plots (mostly F3 and F4 lines). There was a severe irrigation problem in the experimental area during the season due to the breakdown of the main irrigation water facility. Use of water pump was resorted to but it was not sufficient to irrigate the whole area, hence, some areas suffered drought and weed problems. Meanwhile, remnant seeds of lines not evaluated will be planted again during the 2013 wet season.

- At MFE (Carranglan, Nueva Ecija and Majayjay, Laguna), planted during the period were 1657 male sterile selections in the generations from F2-F6 (1,204 in Carranglan, Nueva Ecija and 453 in Majayjay, Laguna). Selected and harvested were 1069 plants for testing in pedigree nurseries at MSE in 2013 wet season

- Ten (10) male sterile lines selected in the F6 and F7 will be included in the TGMS observation nursery at MSE for evaluation of stability of sterility this 2013 wet season. Also, at MFE, during the period, 9 advance TGMS lines were also grown for seed multiplication.

Development of new and diverse TGMS lines through recurrent selection
JC Descalsota and TM Masajo

To reinforce TGMS breeding work at PhilRice Los Baños, an initiative to develop TGMS lines through recurrent selection was added. Recurrent selection as a breeding method is generally used in cross-pollinated crops but could also be employed in self-pollinated crops like rice using genetic male sterility system to facilitate natural cross pollination. The main purpose of the method is to concentrate on fewer individuals in the population desirable traits through recurrent cycles of intercrossing and selection. Compared to the generally used hybridization and pedigree selection, intercrossing among individuals in recurrent selection keeps plants in heterozygous conditions allowing for more chances of genetic recombination.

Highlights:

- At MSE (Los Baños), two TGMS composite populations, namely: TPP1 and TPP2, were established during the dry season of 2013 for recurrent selections. The two populations were in the sixth cycle of recombination cycle last dry season.

- From each population, 300 sterile plants were selected during the season and were brought to MFE site (Tublay, Benguet) for seed increase.

- Seeds from selected sterile and fertile plants were collected and processed separately from each population and will be used in another cycle of recombination. Plant type, lodging resistance, growth duration, panicle and grain characteristics, and freedom from disease and pest damage were the main selection criteria.

- A total of 600 F2 plant selections were established in 2013 dry season pedigree nursery at MSE site for evaluation and selection. From these populations, 485 plants were selected. Selections were brought to MFE site (Tublay, Benguet) for evaluation and multiplication of seeds.

- At MFE (Carranglan, Nueva Ecija), eighty-nine (89) and 140 selections from the TPP composite populations were selected and harvested while 708 selections from the pedigree nursery of 2012 wet season were also selected and harvested and will be evaluated at MSE during the 2013 wet season.

Identification and development of pollen parents for two-line hybrids
JC Descalsota and TM Masajo

Essential to hybrid development programs for both two-line and three-line system is the availability and identification of potentially good-performing pollen parents. Characters, such as yield, plant height, lodging resistance, maturity, resistance to pest and diseases, grain acceptability, tolerance to abiotic stresses, and pollen–shedding ability, are traits considered in the selection of pollen parents. Drawing pollen parents from existing inbred variety development programs has been the common practice in hybrid breeding. But lately, with growing interest on hybrids and increased demand for pollen parents, finding suitable and diverse inbreds as male parents of hybrids has become increasingly difficult. Furthermore, access and use of improved germplasm developed and introduced from elsewhere are covered by PVP and MTA and provisions therein could be rather restrictive. While the TGMS project at Los Baños will continue to identify and source pollen parents from available materials, it is doing breeding work purposely to develop better pollen parents for TGMS hybrids.

Highlights:

- Three composite populations, namely: PPI1, PPI2 and PPI3, were established last dry season 2013 for identification and selection of potential pollen parents. From each population, 150 fertile plants were selected and processed separately. Some of the seeds from these selections were collected for evaluation in pedigree nursery and the remaining seeds were bulked for each population and will be used in the maintenance of the composite populations.

- Also, seeds from selected sterile and fertile plants from each population were collected and will be used in next recombination cycle in the incoming season.

- For evaluation and identification of superior pollen parents in pedigree nurseries, a total of 300 F2 selections were established during the 2013 dry season. These populations were selected during the wet season of 2012. Evaluated in the pedigree nursery during the season were 2979 F4 lines. Selections include potential breeding materials, pollen parents and entries for national trials. Out of these entries, 116 were selected and will be advanced for further evaluation in the coming season.

- Two highly selected TGMS hybrid pollen parents (TG101M and TG102M) are being morphologically tagged with purple coloration at the leaf sheath base through backcrossing. The two BC5 populations were established during the dry season of 2013. BC5 plants with very similar characteristics as their recurrent parents and with distinct purple base coloration were selected and used to generate the BC6.

- Four (4) BC6 crosses using TG101M as recurrent parent were made while 6 were done for TG102M as recurrent parent. F1s were raised for evaluation and selection. Also, test crosses with PRUP TG101 and PRUP TG102 were made from each of the selected BC5s to evaluate these selected backcross progenies.

Development of two-line experimental hybrids
SH Escamos, MAT Talavera, TM Masajo

In order to find good performing hybrids, test cross of the TGMS lines with as many and as diverse pollen parents available is necessary. Not all hybrids exhibit positive heterosis for economic traits, hence, there is a need to produce a large number of experimental hybrids for testing and evaluation. The objective of the study is to generate as many experimental hybrids as possible to increase the chances of finding heterotic hybrids.

Highlights:

- Two-line experimental hybrids were generated through handcrossing using 15 promising TGMS lines and 86 pollen parents. Promising lines from the NCT, the UPLB breeding nurseries, NSIC released varieties and wide hybridization-derived lines were used as male parents.

- One hundred sixty (160) new experimental hybrids with sufficient seeds were produced during the season. Performance of these new hybrids will be evaluated in the 2013 wet season hybrid observation nursery. The targeted 200 experimental hybrids were not met due to irrigation problem encountered during the season as mentioned earlier.

Evaluation and field performance testing of promising hybrids
DJ Lalican, MAT Talavera, SH Escamos, TM Masajo

Before a hybrid can be nominated to the NCT, it has to pass a series of evaluation and testing to determine its overall performance. The experimental hybrids have to undergo testing in the Hybrid Observational Nursery (HON) to initially eliminate inferior performing hybrids. Selected hybrids are elevated to the preliminary yield trial and advance yield trial for a more thorough evaluation for yield, insect and disease reaction and grain and milling qualities. Promising hybrids are channeled to multi-location and yield potential trials.

The objective is to evaluate the performance of experimental hybrids and identify and select the best performing hybrids that can be channeled to the National Cooperative Tests..

Highlights:

- Two hundred forty-six (246) experimental hybrids were evaluated in the Hybrid Observational Nursery (HON) during the season using Mestiso 19 and Mestiso 20 as hybrid checks, and PSB Rc 82 and PSB Rc 18 as inbred check varieties. Seventy-three (73) hybrids were identified better than the higher yielding inbred check PSB Rc 82. Sixty-four (64) hybrids yielded more than one ton higher than the higher yielding inbred check while 18 hybrids performed better than the higher yielding hybrid check Mestiso 20. F1 seeds of these hybrids will be produced this wet season for further testing in the hybrid preliminary yield trial (HPYT). The performance of some good performing hybrids is shown in Table 30. HON 1626 gave the highest yield (9609 kg/ha) followed by HON 1721 (8931kg/ha). Preliminary evaluation of grain quality in terms of amylose and gel temperature was also conducted.

- In the hybrid preliminary yield trial (HPYT), 32 two-line hybrids were evaluated during the season. Two hybrids were identified as being more superior than the best inbred check (PSB Rc 18), yielding more than one ton higher Table 31. Highest yield obtained was 7407kg/ha with a yield advantage of 20% over PSB Rc 18 and 26% over PSB Rc 82. Three (3) hybrids yielded higher than the other inbred check PSB Rc 82 with yield advantage of 16% to 26%.

- Ten (10) promising hybrids comprised the advance yield trial conducted during the season. The yield of test hybrids ranged from 5561 to 7328kg/ha (Table 32). HAYT 88, which had the highest yield, gave a yield advantage of 26% over PSB Rc 82.

Two promising hybrids were identified and selected during the dry season. F1 seeds of these hybrids will be produced this wet season in preparation for entry to multi-location trials and eventually to the National Cooperative Test (NCT).

Promising hybrids entered in NCT and multi-location trials

- One (1) promising hybrid designated as PRUP 10 was entered in the 2013 dry season trial of the NCT. This hybrid had a yield advantage of 29.5% over PSB Rc 82, medium maturing and grows to a height of around 108 cms.

- Three (3) good performing hybrids were entered in the multi-location trials being conducted by PhilRice. These hybrids are early-maturing and have a yield advantage of 29.9 to 68.3% over PSB Rc 18 and 13.8 to 29.5% YA over PSB Rc82.

Table 30. Yield and agronomic traits of good performing hybrids in the hybrid observation nursery, 2013 dry season.

Index No.	Grain Yield (kg/ha)	% YA over PSB Rc 82	% YA over PSB Rc 18	Maturity (days)	Tiller/hill (no)	Plant height (cm)
HON 1626	9609	56	74	119	10	100
HON 1721	8931	45	62	119	12	104
HON 1570	8800	43	60	119	9	95
HON 1572	8660	40	57	119	12	100
HON 1626	8659	40	57	117	10	98
PSB Rc 18	5528	-	-	131	14	94
PSB Rc 82	6172	-	-	124	13	96
M19	6696	-	-	123	14	97
M20	7331	-	-	128	11	106

Table 31. Yield and agronomic traits of some good hybrids in the preliminary yield trial, 2013 dry season.

Index No	Grain Yield (kg/ha)	% YA over PSB Rc 82	% YA over PSB Rc 18	Maturity (days)	Plant height (cm)	Tiller/hill (no)
HPYT 367	7407	26	20	111	102	17
HPYT 351	7186	22	17	112	100	14
HPYT 340	6826	16	11	110	95	15
HPYT 369	6798	14	10	110	99	12
PSB Rc 18	6164	-	-			
PSB Rc 82	5870	-	-	115	96	14
M19	7274	-	-	112	94	17
M20	7331	-	-	115	105	14

Table 32. Yield and other agronomic traits of promising hybrids in the advance yield trial, 2013 dry season.

Entry	Grain Yield (kg/ha)	% YA over PSB Rc 82	% YA over PSB Rc 18	Maturity	Tiller No	Height (cm)
HAYT 88	7328	26	12	126	26	100
HAYT 89	7222	24	10	119	24	104
HAYT 90	6903	18	5	123	18	102
HAYT 87	6798	17	3	116	17	100
HAYT 86	6683	15	2	121	15	107
PSB Rc 18	6571	-	-	133	15	102
PSB Rc 82	5834	-	-	126	13	98
Mestiso 19	7261	-	-	123	11	96
Mestiso 20	7434	-	-	126	11	11

TGMS Hybrid Seed Research

SH Escamos, MAT Talavera, TM Masajo

To maximize the use of the TGMS phenomenon, different areas of research with regard to its utilization are essential. One of the aspects that needs to be looked into is the flowering behavior of TGMS lines currently being utilized in the generation of experimental hybrids to maximize their usefulness as parents in the production of hybrids.

Based on the past 5-year temperature record in Los Baños, mean temperature is lower during the months of November to February (25.9 to 27.1 OC) and higher during the months of April to September (27.8 to 29.1OC). Sensitive phase of TGMS for F1 seed production should coincide with the months with higher temperature.

This study is being conducted to determine the flowering behavior of some selected TGMS lines and pollen parents. Monthly planting of the lines and observation-taking were continued during the period. Results indicated that reversion to fertility was observed for some TGMS lines planted in October, all TGMS planted in November and some in December of 2012. Temperature-sensitive phase of the lines coincided with the beginning of the cold period in December. Data gathered during the two-year period are currently being processed and analyzed.

Another problem looked into by the project is the effect of mixture of selfed-seeds of the TGMS parent on the yield performance of the two hybrids Mestiso 19 and Mestiso 20. Purity of the hybrid seed may be affected by temperature fluctuation during F1 seed production due to reversion to fertile phase of the TGMS parent. Selfed-seeds of S-lines are considered impurities if mixed in the F1. The study aims to determine the level of mixtures of selfed-seeds that could significantly reduce the yield performance of hybrids. This study was also conducted to validate the 4% seed certification standard set by NSQCS for mixtures in the F1.

Highlights:

- The experiment was laid out in a split-plot design with variety (Mestiso 19 and Mestiso 20) as the main plot and the amount of S-line (%) added in the F1 as the subplots (0, 1, 3, 5, 7, and 9%).

- It was observed that grain yield of both Mestiso 19 and Mestiso 20 tends to decrease as amount of S-line mixture in the F1 is increased. As expected, all TGMS lines present in the F1 were male sterile, producing none or few seeds due to outcrossing. Significant reduction in yield was observed in the treatment with 4.8% S-line (based on actual count of S-line in the plots) in the F1 of Mestiso 20. In the case of Mestiso 19, significant yield reduction in yield was observed at 5% amount of S-line. The results are not yet conclusive and the study will be conducted again in 2013 wet season to confirm the results.

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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Department of Agriculture

PHILRICE

PHILIPPINE RICE RESEARCH INSTITUTE

We are a chartered government corporate entity under the Department of Agriculture. We were created through Executive Order 1061 on 5 November 1985 (as amended) to help develop high-yielding, cost-reducing, and environment-friendly technologoies so farmers can produce enough rice for all Filipinos.

We accomplish this mission through research and development work in our central and seven branch stations, coordinating with a network that comprises 57 agencies and 70 seed centers strategically located nationwide.

To help farmers achieve holistic development, we will pursue the following goals in 2010-2020: attaining and sustaining rice self-suffiency; reducing poverty and malnutrition; and achieving competitiveness through agricultural science and technology.

We have the following certifications: ISO 9001:2008 (Quality Management), ISO 14001:2004 (Environment Management), and OHSAS 18001:2007 (Occupational Health and Safety Assessment Series).

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