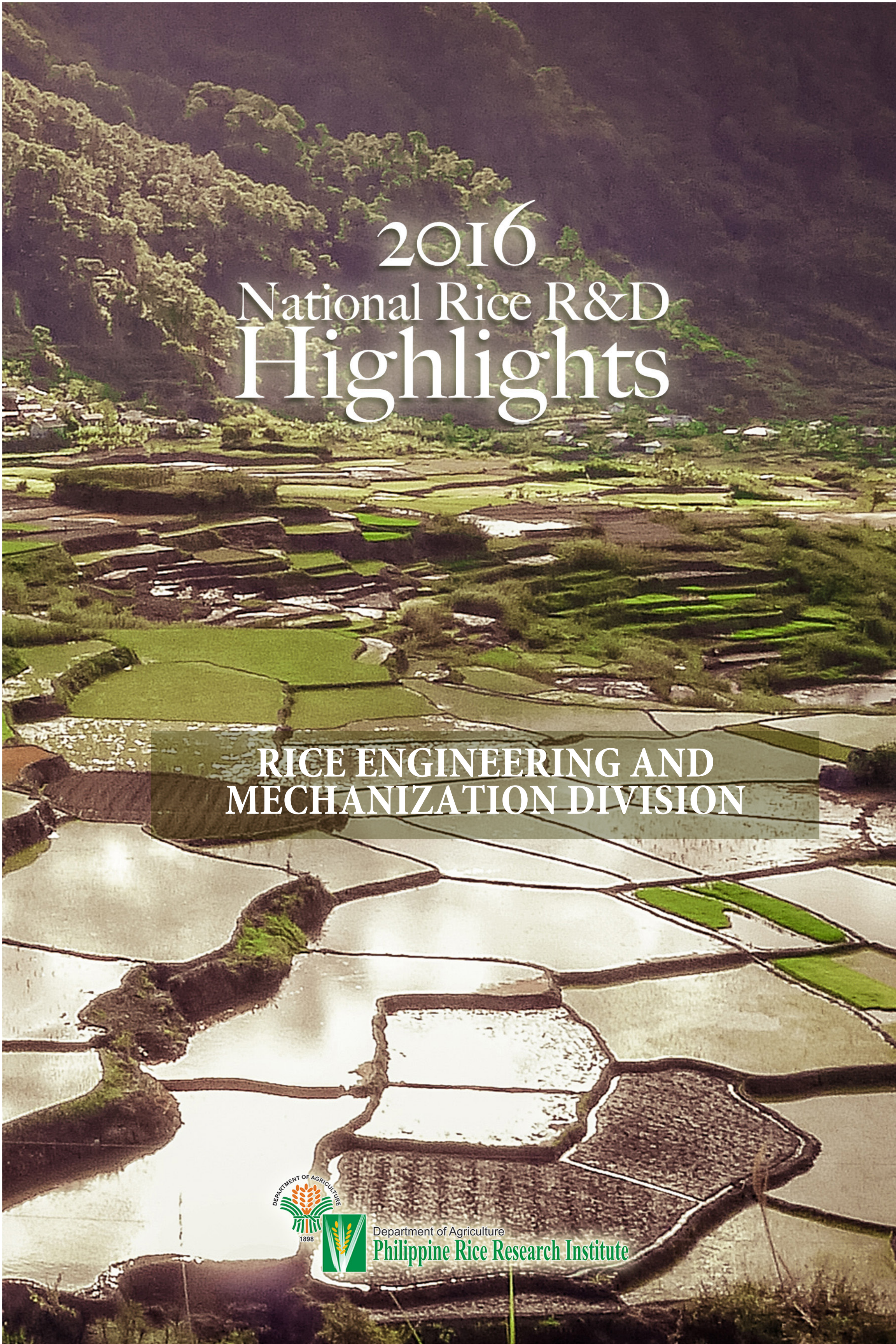

2016 National Rice R&D Highlights

RICE ENGINEERING AND MECHANIZATION DIVISION

DEPARTMENT OF AGRICULTURE 1898
Department of Agriculture
Philippine Rice Research Institute

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Rice Engineering and Mechanization Division

Division Head: Evangeline B. Sibayan

Executive Summary

The division implemented a total of 33 studies for 2016 with a total funding of PhP 29.4M. Of these, 15 were externally funded with PhP 21.6M, 11 studies under the program Farming without Fossil Energy (FFE) with PhP 3.8M funding, and 7 division based studies with a funding of P 4.0M. Summing up, the division received P26.1 M funds from external donors which is 73.46% of its total budget for the year. There is one new study funded by IRRI CCAFS that started in July and there are 4 studies that will be completed within the year.

The four promising technologies completed this year were funded by PCAARRD-DOST i.e. a) improved 1.3 m combine harvester with features that makes the machine work even in deep mud condition which was the major defect of the first prototype, b) the precision riding type multi row seeder that will further increase seed savings and that can also be used for hybrid rice cultivation that only requires 15-20 kg seeds per hectare, c) the riding type multi row transplanter that will be of higher capacity and efficiency compared to the currently popular walk behind transplanter from Japan, and d) the far infra red paddy dryer that provides another option for paddy drying.

The initial data gathered using the CRH lined silo for seed storage showed that the viability of the stored seeds was maintained up to 10 months and conformed to the standard. However, its cost is much higher compared to that of the “saclob”.

For research addressing climate change, the study under the MIRSA project showed that CH_4 emissions in continuously flooded fields are higher in both wet and dry season. High N_2O emission fluxes were measured 1-5 days after the application of urea in both the wet and dry seasons. The study further showed that AWD cannot be implemented during the wet season at PhilRice CES because of the almost uniform and sufficient rainfall received annually. Data gathered for the last 3 years revealed that there is a significant difference in yield during the dry season compared to the wet season but no significant difference among water management treatments.

I. Development of Production and Postproduction Farm Machinery

Project Leader: Caesar Joventino M. Tado

Development of Ride-On Stripper Combine

CJMTado and DPOna

Postharvest losses start during harvesting and threshing operations. Timely harvesting and threshing is essential if we are to keep losses to a minimum. However, harvesting in the Philippines is still mostly done manually, requiring 16 to 25 man-days per hectare. Furthermore, labor shortage at harvest time is now a reality in many of the major rice-producing areas in the country. A combine harvester that can operate well in Philippine rice fields is thus essential in improving timeliness of operation and reduction of postharvest losses, especially in large rice-producing provinces where harvest labor is now becoming scarce.

The stripper harvester, a machine which strips the grains leaving the straw still uncut in the field takes only less than half of the material that is being handled by cutterbar combines. Thus, a lighter machine with lower power requirement is possible with the stripper combine.

Basically, the project aims to further improve the existing ride-on stripper combine harvester design and to pilot test the improved version in selected areas in the country. It aims to promote the machine as an alternative to the existing reaper type of combine harvester in order reduce power requirement by at least 20%, and further increase field capacity by at least 25%.

Activities:

- The prototype design is on-going. Design speeds of components such as fan, oscillating conveyors, and screw conveyors were updated.

- Design and 3D CAD of main clutch assembly, undercarriage rollers, rubber crawler sprocket, and rubber crawler tensioner were accomplished. Prospective fabricators for these parts were identified.

- Started the fabrication of undercarriage frame and chassis (Figure 1).

Figure 1. Undercarriage Frame and Chassis.

- Ordered the fabrication of undercarriage rollers, rubber crawler sprocket, and rubber crawler tensioner to the partner fabricator/manufacturer.

Design and Development of Carbonized Rice Hull (CRH)-Insulated Rice Silo to Reduce Storage Losses

LCTaguda, DPDal-uyen, CJMTado, MUBaradi, BMCatudan, FPBongat, and SRBrena

Maintaining the viability of rice seeds for a longer period is a constant problem in the Philippines due to environmental factors and pest infestation. Existing storage facilities of farmers cannot fully protect the seeds from insect and rodent damages. Unfavorable ambient conditions cause microbial and fungal proliferation. Hence, a 1-ton capacity rice silo insulated with carbonized rice hull (CRH), was developed to reduce storage losses. CRH was used as insulator for its wide availability, low thermal conductivity, high moisture retention and pathogen-free capability.

Activities:

- Interviewed farmers 5 farmers (2 from Ilocos Sur and 3 from Ilocos Norte) using storage silo for seeds and gathered baseline data as basis for designing the silo.

- Prepared design for the one ton CRH-insulated rice silo based on the baseline data gathered.

- The prototype silo (1.9m height and 1.25m diameter) was made with double walls of GI sheets, 4cm apart. The inner wall was perforated with evenly distributed 1.2cm diameter holes. The space between the walls was filled with CRH. The inner wall was lined with a permeable clothe to prevent the CRH from mixing with the stored seeds. The silo had a detachable conical cover to prevent rain water and moisture accumulation. The bottom was slanted at 30” with a square chute opening (20cm x 20cm) at the lowest part, covered with sliding door for easy unloading. The silo was elevated by 40cm with a frame.

- Evaluated the silo in an outdoor situation exposed to various weather conditions for 12 months. It was filled with NSIC Rc216 in July 2015 from an April harvest. Seed samples, from 12 equidistant sampling points 10cm away from the inner cylinder and 3 sampling points at the center, were obtained once a month for analysis on selected variables. Samples were stratified to bottom, middle, and top categories.

- Prepared experimental set-up for further evaluation of the silo. Storage performance of the silo and one ton saclob will be compared in an outdoor condition. Seed sampling openings with airtight removable cover were installed to the silo and saclob to minimize removing the cover/roof of the silo and opening the saclob during collection of seed samples eliminating the exposure of stored seeds to the ambient. Moreover, laboratory equipment were installed outside and inside the saclob and silo to measure the ambient temperature and stored seeds temperature; and in the middle of the CRH insulation of the silo to measure the temperature to determine the efficiency of CRH as heat insulator.

Results:

- The silo maintained the viability of the stored NSIC Rc216 seeds for 10 months based from the result of the 12 months evaluation. Although all other variables were still within the acceptable range after 12 months of storage, germination rate dropped below 85% after 10 months. For 10 months, the germination rate ranged from 89.7 to 97.3% and moisture content stayed within 10.6 to 12.5%. Over 100 weevils and 1.2% damaged seeds were recorded from each of the three

750g samples. In the seed vigor test, above the 85% cut off level germination rate was maintained for 7 months in the 3-day accelerated aging test and 2 months in the 5-day accelerated aging test.

Performance Evaluation of a Hydraulic Ram Pump (HRP) for Irrigating Rice and Rice-based Crops in Ilocos

NDGanotisi, HPAbando Jr, and CJMTado, and EBSibayan

A hydraulic ram pump (HRP) is a pump that pushes water uphill using energy from falling water. It is simple and applies a mechanism by which the weight of falling water is used to raise a portion of itself to a considerable height. The study aims to a) identify areas suitable for hydraulic ramp pump operation in Ilocos; b) to evaluate the performance of a hydraulic ramp pump in the locality; and c) to validate the use of HRP in irrigating rice and rice-based crops.

Results:

- Three sites suitable for hydraulic ram pump operation were identified i.e. Brgy. Estancia, Piddig, Brgy. Abaca, Bangui, and Brgy. Magnuang, Batac, all in Ilocos Norte. The three Barangays had creeks where a ram pump can operate and can serve an estimated area of 15 to 20 ha each site planted with rice during the wet season and corn and vegetables during the dry season.

- A downdraft HRP was assembled from materials available at the station (Figure 2).

- Conducted initial testing and evaluation using a simulated water drop through plastic tanks elevated 2.0m above the pump. The tank was filled and the water was allowed to drop at the installed ram pump through an irrigation hose. Discharge rates was gathered (Figures 3a and 3b).

- Results showed that the HRP produced an average output of 6,246li/day or 6.25 m3/day at a discharge height of 3.5 to 7.5m above the pump (Table 1) .

- Conducted testing of a 3” HRP (Figure 4) from Tayum, Abra (Figure 5) . The HRP used in Abra, was installed in the embankment of Abra river (Figure 6) taking advantage from the overflow of the lined irrigation canal to fill water tanks approximately 15 to 20m above the river. The water stored is distributed to households. However, the HRPs are retrieved during rainy season to avoid being carried away by flood during typhoons.

Figure 2. Operation of the assembled downdraft hydraulic ram pump explained during the visit of the Acting Executive Director at the station (October 26, 2016).

Figure 3a. Gathering discharge rate of the HRP at 2m elevation.

Figure 3b. Gathering discharge rate of the hydraulic ram pump at 7.5 m above the pump.

Table 1. Discharge of a 2" downdraft hydraulic ram pump at diferent heights and a constant water drop of 2m above the pump.

Height (m)	Volume (ml)	Time (sec)	Discharge	
			li/day	m³/day
3.5	750	7	9,257	9.26
3.5	750	8	8,100	8.10
3.5	750	8	8,100	8.10
5.5	750	12	5,400	5.40
5.5	750	11	5,891	5.89
5.5	750	11	5,891	5.89
7.5	750	14	4,629	4.63
7.5	750	15	4,320	4.32
7.5	750	14	4,629	4.63
Average			6,246	6.25

Figure 4. A 3" hydraulic ram pump from Tayum, Abra.

Figure 5. Riverbanks in Tayum, Abra where hydraulic ram pump are installed during the dry season. However, pumps are retrieved during rainy season to avoid being carried away by flood.

Figure 6. Interacting with the manufacturer of hydraulic ram pump while visiting the site, Hon. Bienvenido Dion, Jr. (SB member and former Vice-Mayor).

Adaptability Test and Improvement of the Manually-Operated Rice Transplanter

LCTaguda, DPDal-uyen, MUBaradi, and MGGalera

Production remains as labor and cost-intensive operation such that rice farming remains generally as a subsistence activity. Moreover, hired labor in the farm is decreasing owing to preference of labor to employment opportunities in the urban centers and abroad and high level of education and literacy in the labor force (Bautista, 2013).

Rice transplanting is one of the most tedious labor in rice production. Mechanization would be the best solution. How-ever, it has always been associated with big or engine-powered machinery. A feasibility study conducted at IRRI in 1977 indicated that it may be too costly for small rice farmers to use powered transplanters. As a result, IRRI Engineering Department began a low-cost manual transplanter project until the TR5 eight-row transplanter was developed. However, it did not popularize because it require seedlings grown on special mat type nursery which is not a common practice of farmers and it requires well puddled soil with the help of power tiller or animal drawn puddler to ensure proper fixing of the seedlings and reduced missing hills (Rice Knowledge Management Portal, 2011).

However, China had developed a manually-operated transplanter that transplant seedlings grown on traditional seedbed. The machine transplants seedlings at the recommended age, therefore, do not require well puddled soil. It is commercially available and the technical performance is promising.

Results:

- Dialogue with Super Trade in Quezon City and Amianan Hardware in Laoag City for the procurement of the machine in China. Unfortunately, Super Trade contacts in China couldn't find a supplier of the machine near its location while Amianan Hardware's contacts in China declined to negotiate on unit of transplanter only.

- One manually-operated two-row rice transplanter was procured in China via online purchase.

- Evaluated the performance of the transplanter at the station using seedlings established on modified dapog and on seedbed using the PalayCheck recommendations. The following parameters were gathered; number of missing hills, number of seedlings per hill and seeding rate per hectare. Number of missing hills using seedlings established on modified dapog is

25% to 35% average, while seedlings established on ordinary seedbed is 30% to 40% average. Number of seedlings per hill for optimum performance of the machine needs to be 4 to 7 seedlings for the seedlings established on modified dapog and on seedbed. Seeding rate of the machine both for the seedlings established by dapog and ordinary seedbed are 50kg to 60kg per hectare.

- Ongoing modification of the seedling picking mechanism of the machine to reduce moving parts to minimize missing hills and to reduce number of seedlings per hill.

II. Development of an Integrated Postharvest Management System for the Rice Postproduction Industry

Project Leader: Manuel Jose C. Regalado

Every unit operation in the production-postproduction-handling chain is critical in terms of producing good quality milled rice with minimum losses. Good quality milled rice is rice with whole grains and is called head rice in the trade. The grain is well polished, free of contaminants, and possesses the preferred cooking and eating qualities. The latter is mainly a varietal characteristic, and the cooking and eating quality of rice is associated by consumers with varieties or brand names, and not with grades set up by the Philippine Trade Standards (PTS).

A 2002 nationwide survey conducted by the National Food Authority (NFA) and the International Rice Research Institute (IRRI) indicates that 68% of milled rice sold in the retail markets qualifies only as PTS Grade No.2. This is due to non-uniformity in polish, high percentages of broken grains, and the presence of discoloured kernels and other contaminants. These are considered failures in the post-production and marketing system.

The production of good quality milled rice starts with good quality palay. Similarly, the production of uniform-sized palay, of a single variety that matures uniformly, starts with certified seeds that are planted and cultivated with the proper agronomic care. Timely harvesting minimizes field losses and the presence of unfilled or immature kernels.

The purity of rice harvest is anywhere from 90 to 95% sound kernels. The desired moisture content of 14% or lower is critical. Wet harvests contain a moisture content of about 21% for the dry season crop and 24% for the wet season crop. When it is raining, moisture goes up as high as 28%. The wet harvest is unstable, and the metabolic heat of grain respiration causes discoloration. Wet grains not immediately dried due to the lack of mechanical dryers results in heavily discoloured grain.

Milled rice is retailed in rice stalls in public markets and is displayed in open boxes. Filipinos prefer the softer textured varieties that are well polished, but will settle for the lower priced PTS Grade No. 2 rather than the premium grade No.1. On the other hand, restaurants look for the fluffier varieties. Supermarkets sell graded rice that is packaged using their own brands, or use parodies of well-known brands. The grades and standards do not reflect the cooking and eating properties of rice, and consumers have to depend on variety or brand names. There is a lot of misrepresentation and quality inconsistency in the brands sold.

Postharvest losses can be as high as 30% of production depending on processing and handling circumstances. Physical losses are mainly due to spillage or pest infestation. The more critical losses are the loss in quality due to bio-deterioration, and damage to the grain during drying, storage, and milling. Qualitative losses are also due to discoloration, presence of contaminants, varietal mixing, and grain fissures that wind up as broken kernels during milling. Severe grain fissuring causes a reduction in milling recovery, and broken grains sell for only half the price of head rice. All of these losses can be minimized through technology, information dissemination, and training of technicians. A focus on producing good quality rice automatically reduces postharvest losses.

The project aims to: (1) develop and test a PalayCheck® system for integrated rice postproduction management, covering harvesting, threshing, hauling, cleaning, drying, storing, and milling operation; (2) develop clusters or groups of rice varieties categorized according to their similarities in physical, chemical, cooking and eating, and nutritional attributes; and (3) develop and come up with improved trade standards for paddy (palay), and milled rice.

Originally the project consisted of three studies, namely: (1) Development of postharvest management keychecks and best practices for improving the rice post-production system; (2) Improvement, validation and application of field test methods for market quality identification and milled rice clustering in the market; and (3) Development and testing of improved paddy and milled rice standards. Study 1 is ongoing, but will be completed this 2016, while Study 2 has been completed in 2014. Study 3 is still to be implemented in collaboration with the National Food Authority. Meanwhile, a fourth study on "Evaluation of soil productivity, agronomic, performance and greenhouse gas emissions of combined effects of biochar and AWD (alternate wetting and drying) on rice production" has been incorporated in this project in 2016.

Development of postharvest management keychecks and best practices for improving the rice post-production system

MJCRegalado and PSRamos

While substantive strides have been made in the Philippine rice production sector, developments in the postproduction industry apparently have not kept pace with increased production. To address the inefficiencies, a sound integrated crop management (ICM) system should incorporate not only the production aspects, but the postharvest process as well, to cover palay harvesting, threshing, cleaning, drying, milling and storage operations. If the ICM for irrigated rice, which is now known as the PalayCheck® system, would be enhanced with key checks and best practices in the postproduction process, then farmers will not only learn to preserve the quality of the palay that they will sell, but also produce a better quality product that will command a better price. An integrated rice postharvest management protocol anchored on the PalayCheck® system must also be developed and packaged for the rice postproduction industry. This can serve as a training and educational tool to equip farmers, traders, millers, and operators on how to achieve better quality palay and milled rice that would meet international standards. This study aims to: (1) develop a system of key checks and recommended best practices for an integrated rice postharvest management, covering harvesting, threshing, hauling, cleaning, drying, storing, and milling operations; and (2) incorporate postharvest key checks and best practices in the PalayCheck® system, then validate and refine the system.

Through multi-sectoral workshops conducted from 2012–2013 at PhilRice Los Baños, Laguna and PhilRice CES, the following rice post-harvest management key checks were identified and selected for critical operations, namely:

1. Harvesting and threshing: Cut, piled and threshed palay at the right time.
2. Pre-Drying Storage: Palay sorted according to variety type, moisture content, discoloration and damage.
3. Drying: Dried palay with good quality.
4. Cleaning: Palay with premium purity.
5. Storage: Market quality preserved and losses to pests prevented during storage.
6. Milling: Maximized milling and head rice recovery.
7. Packaging: Milled rice protected from spillage, pest, contamination, and humidity.

The corresponding best practices identified and recommended for each key checks were as follows:

1. Reap and thresh within the day or the following day. Use a thresher or combine with the correct machine settings. Pile the harvest for not more than a day as these results in heat buildup. This leads to grain discoloration and lowers the quality of milled rice. Use underlay (canvass, laminated sack, or net) to catch shattered grains and to protect the pile from ground moisture. Adjust blower air inlet to provide good initial cleaning of the harvest. Too high air flow rate results in higher grain loss while a low air flow rate increases the amount of impurities in the grain.

2. Classify and sort according to variety type, moisture content, discoloration and damage. Stack bags with sufficient space for natural aeration. Wet grains should be the priority in drying.

3. Dry the palay immediately after threshing. If it is not possible, aerate fresh palay by spreading thinly under shade on concrete pavement, tarpaulin, plastic net, or canvas. Make sure that the drying area is free from impurities such as pebbles, sand, and other debris. Spread the grain 2 to 4cm. thick and stir every 30 minutes. If using a mechanical dryer, dry the palay according to the recommended drying temperature (43°C for flatbed dryer and 60°C for recirculating dryer). Avoid drying palay on roads to reduce loss, grain breakage, and contamination.

4. Clean palay using a blower, fan, or seed cleaner. Use appropriate air flow adjustment and grain feeding rate.

5. Storage area should be clean, orderly, free from leaks and holes, and not prone to flooding. Use pallets and sacks that are free from residual infestation. To prevent pests, spray insecticides on the walls, floors, and beams of storage area before storing palay. Provide adequate space from walls and in-between piles for ventilation, cleaning, and pest control purposes. Windows and exhaust fans should be screened to prevent entry of birds and rodents. Conduct regular monitoring for pest infestation. Tag and label piles correctly (i.e. date of piling, weight, variety, grain classification, pest control measures applied).

6. Milling machines should be operated by a trained and skilled operator. Use machines that can produce at least 65% milling recovery and 80% head rice on milled rice basis.

7. Use a durable packaging material. Follow the recommended color-coded packaging to indicate quality: blue (special or fancy rice), yellow (premium), white (grade 1 to 5 with 1 being 90% head rice and 5 being 55%).

Experiments to validate and test the key checks were conducted at the PhilRice CES irrigated rice paddy field and at REMD for four seasons from 2014 dry season to 2015 wet season. Three rice cultivars, namely: hybrid variety PSB Rc72H (Mestizo 1 or M1) and inbred varieties NSIC Rc160 and Maligaya Special or MS 16, were planted in a 2.2ha paddy field according to a strip-plot in RCBD design lay-out with 4 replications.

The crops were harvested at three different harvest dates: optimum harvest date, five days before optimum harvest, and 5 days after optimum harvest. Harvest methods included the following: (1) manual reaping on the first day, collection and piling on second day, and mechanical threshing on third day; (2) manual reaping and collection and piling on the first day, and mechanical threshing on the second day; (3) manual reaping, collection and piling, and mechanical threshing on the first day; and (4) combine harvesting on the first day. During harvest, each of the 12 plots in the 2.2ha field was divided into four strips corresponding to the four harvest methods. Grain losses incurred during each harvest operation were determined using standard assessment methods.

Drying methods used were sun drying on concrete pavement and mechanical drying in a heated air flatbed dryer. Storage methods included: (1) pile of 50kg capacity plastic sacks of dried paddy at ambient air condition directly on concrete floor without plastic pallet; (2) pile of 50kg capacity plastic sacks of dried paddy at ambient air condition on plastic pallet; and (3) 50kg capacity plastic sacks of dried paddy inside a PhilRice SACLOB or cocoon (plastic hermetic storage system). Germination rate for MS-16 and NSIC Rc160 and storage losses for the three varieties were also evaluated at the end of the six-month storage period. Laboratory test milling of samples from the dried paddy harvest lots were done one month and six months after storage to determine total milling and head rice recoveries.

Results:

- Total losses for cutting, piling, and threshing operations across seasons were less than the national average of 5.2% when the three operations were done on the same day or when combine harvester was used, both at five days early and optimum harvest times (Tables 2a and 2b).

- Combine harvesting even of a 5-day late crop still met PNS/PAES performance criterion for maximum total machine loss of 3.5%.

- After six months of storage, higher germination rates, less storage losses, higher milling and head rice recoveries were attained with samples that were flatbed-dried and stored in a hermetic cocoon (Tables 3a and 3b).

- The improved PalayCheck postharvest protocol is now ready for pilot testing in farmers' fields and commercial rice mills.

Table 2a. Mean grain loss across rice varieties MS-16, Mestizo 1, and NSIC Rc160 harvested at three different harvest times using four different methods (2014 DS and WS, PhilRice CES, Muñoz, Nueva Ecija).

Harvest Method	Mean Grain Loss (% of Field Yield) Across 3 Varieties					
	5 Days Early Harvest		*Optimum Harvest Time*		*5 Days Late Harvest*	
	2014 DS	2014 WS	2014 DS	2014 WS	2014 DS	2014 WS
Cut on 1st day, pile on 2nd day, and thresh on	6.79	7.92	5.82	6.94	17.99	18.56
Cut and pile on 1st day, and thresh on 2nd day	4.25	5.41	4.21	5.02	10.99	12.42
Cut, pile, and thresh on 1st day	2.19	3.21	1.04	1.85	6.96	7.97
Combine Harvesting	1.40	2.03	1.16	1.56	2.76	3.50

Table 2b. Mean grain loss across rice varieties MS-16, Mestizo 1, and NSIC Rc160 harvested at three different harvest times using four different methods (2015 DS and WS, PhilRice CES).

Harvest Method	Mean Grain Loss (% of Field Yield) Across 3 Varieties					
	5 Days Early Harvest		*Optimum Harvest Time*		*5 Days Late Harvest*	
	2015 DS	2015WS	2015 DS	2015WS	2015 DS	2015WS
Cut on 1st day, pile on 2nd day, and thresh on 3rd day	6.87	8.23	6.14	7.12	18.52	18.96
Cut and pile on 1st day, and thresh on 2nd day	5.22	5.69	4.43	5.19	11.50	12.70
Cut, pile, and thresh on 1st day	2.42	3.28	1.16	2.00	7.32	8.21
Combine Harvesting	1.54	2.09	1.19	1.61	2.90	3.54

Table 3a. Evaluation of drying and storage methods for rice varieties MS-16, Mestizo 1, and NSIC Rc160 in terms of germination rate, storage loss, milling recovery and head rice recovery (2014 DS and WS, PhilRice CES).

Evaluation Parameter	Drying & Storage Method, Variety and Cropping Season																	
	Sun drying and ambient pile storage without pallet						Sun drying and ambient pile storage with pallet						Flatbed drying and hermetic cocoon (saclob) storage					
	MS-16		*Mestizo 1*		*NSIC Rc160*		*MS-16*		*Mestizo 1*		*NSIC Rc160*		*MS-16*		*Mestizo 1*		*NSIC Rc160*	
	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS
Germination Rate (%), before storage	100	98	N.D.	N.D.	100	99	100	98	N.D.	N.D.	100	99	100	98	N.D.	N.D.	100	99
Germination Rate (%), after storage	87.5	85			85.5	86	87.5	82			89	85	97.0	98			98.0	98
Storage Loss (%), after 6 months*	9.99 (DS)						8.89 (DS)						0.0 (DS)					
Milling Recovery (%), after 6 months	59.87	61.87	57.87	53.53	56.87	49.54	61.55	62.77	58.73	57.73	60.50	50.67	66.34	64.42	62.31	60.13	67.55	56.27
Head Rice Recovery (%), after	58.99	58.03	55.64	47.53	54.98	41.54	58.00	59.00	52.73	51.73	58.90	47.37	62.00	60.26	59.90	57.26	63.90	51.27

*N.D. - Not determined because Mestizo 1 harvest is not F1 seed; * Aggregate for the three varieties*

Table 3b. Evaluation of drying and storage methods for rice varieties MS-16, Mestizo 1, and NSIC Rc160 in terms of germination rate, storage loss, milling recovery and head rice recovery (2015 DS and WS, PhilRice CES).

Evaluation Parameter	Drying & Storage Method, Variety and Cropping Season																	
	Sun drying and ambient pile storage without pallet						Sun drying and ambient pile storage with pallet						Flatbed drying and hermetic cocoon (saclob) storage					
	MS-16		*Mestizo 1*		*NSIC Rc160*		*MS-16*		*Mestizo 1*		*NSIC Rc160*		*MS-16*		*Mestizo 1*		*NSIC Rc160*	
	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS
Germination Rate (%), before storage	100	99	N.D.	N.D.	99	99	100	99	N.D.	N.D.	99	99	100	99	N.D.	N.D.	99	99
Germination Rate (%), after storage	87	83			89	85	88.0	85			89	87	98	98			98	99
Storage Loss (%), after 6 months*	9.6 (DS) / 10.2 (WS)						8.5 (DS) / 8.9 (WS)						2.5 (DS) / 1.2 (WS)					
Milling Recovery (%), after 6 months	59.97	60.87	57.97	52.53	56.97	51.34	62.55	62.57	59.73	58.13	61.50	53.40	67.44	64.02	63.41	59.85	67.58	56.57
Head Rice Recovery (%), after	58.23	58.52	55.12	48.45	43.98	47.50	58.50	59.50	53.60	52.73	58.80	50.30	59.12	61.26	56.55	58.96	60.12	54.27

*N.D. - Not determined because Mestizo 1 harvest is not F1 seed; * Aggregate for the three varieties*

Improvement, validation and application of field test methods for market quality identification and milled rice clustering in the market APPTuaño, *MJCRegalado and BOJuliano*

Market price of milled rice is primarily determined by its physical attributes (e.g. size, shape, translucency broken and head rice) easily observed by the consumers. High percentage of broken lowers the value of milled rice. Aside from its physical attributes, cooked rice texture is also considered by consumers when purchasing milled rice in the market, however physical attributes do not always equate to excellent cooking and eating quality. In addition, labeling of market milled rice are not based on true PSB/NSIC Rc names but on popular rice variety names attractive to consumers but not indicative of the true cooking and eating quality of the sample. The National Food Authority has already established a grading system for rice classification in terms of physical attributes but up to date, there has not been any classification regime adopted for clustering/identifying the cooking and eating quality type of milled rice in the market for consumers to rely on and use as basis for purchasing.

In 2006, Roferos et al. proposed the clustering of Philippine released modern varieties into four clusters based on apparent amylose content (AC) and gelatinization temperature (GT) combination. Data from cooked rice texture indicator methods such as Instron cooked rice hardness and Rapid Visco-Analyser (RVA) pasting viscosity were used to supplement the AC-GT combination (Roferos et al. 2006). The same classification maybe used to group market milled rice samples even though they have various variety names in the retail markets so that the consumers may know the quality type of a certain sample when cooked.

Field tests have been adopted, modified and/developed to suit Philippine setting and requirements. In 2002, Kongseree et al. developed an AC field test to determine percentage of mixture of high-AC grains in Jasmine or Khao Dawk Mali 105 (low-AC rice). The method was adopted and slightly modified in 2009 by Tuaño et al. to be used for AC type identification of milled rice samples in the market. These as well as other tests that can still be improved, will be very useful in completing a set of tools for predicting quality type of market samples to be used by rice quality inspectors, millers, traders, retailers and consumers. Classifying them into quality clusters that can easily be identified and adopted will also help minimize the effect of mislabeling of market samples to consumers' decisions and other purposes (e.g. rice-based food products manufacture).

This study aims to: 1) enhance the efficacy, sensitivity and repeatability or reproducibility of improved rapid field methods for milled rice quality type identification; 2) determine the current trends in AC and GT of milled rice samples in the market and subject to grain quality clustering;

and 3) validate the improved field tests using different sets of milled rice samples to establish good correlation with actual laboratory analysis and other cooked rice texture indicators.

Results:

- A scientific article titled "Grain quality of rice in selected retail stores and supermarkets in the Philippines," based on the results of the study's Objective 2 activities, has been published in the International Journal of Philippine Science and Technology (PhilSciTech), 9(1):15–22.

- This article reported, among others, that:
  1. Out of 388 nonwaxy milled rice samples collected, 217 were intermediate apparent amylose content (AC, mean of 20.9%), followed by 141 high AC, and 30 low AC, while 36 glutinous (waxy) rice samples were also collected. In general, nonwaxy milled rices in the market were long-grained and had slender shape.

  2. Field test for apparent amylose type classification required 40% more iodine for staining the grains due to the oxidized state of the sample surface, which reacted with the iodine and tended to underestimate AC type. This iodine-staining method estimated AC type adequately (81.4 %) with most of the errors being borderline AC values of 17±1% and 22±1%.

  3. Brown rice was mainly intermediate AC with mean AC value lower than that of milled rice (19.1% vs 20.9%), and had varying gelatinization temperature (GT).

  4. Majority of the imported rices were Thai and Japanese, with low AC and low GT.

  5. The existing grain quality profile and trends in the Philippine retail market may have significant implications on rice varietal improvement and rice commercialization programs in the country, particularly on future breeding objectives for grain quality and in selecting good quality inbreds and hybrids for varietal promotion, respectively.

Evaluation of soil productivity, agronomic performance and greenhouse gas emissions of combined effects of biochar and AWD on rice production

KSPascual, NCRamos, FSGrospe, MEDCasil, and EBSibayan

The increasing use of rice biomass as renewable source of energy produces substantial amount of biochar as by-product that can be used as a potential source of organic fertilizer, reduces greenhouse gas (GHG) emissions, and sequesters carbon in an intensive rice production system. On the other hand, the alternate wetting and drying (AWD) water saving technique which provides multiple aerations in irrigated rice soil, improves grain yields, saves water, and reduces GHG emissions. Combining the effects of biochar application and AWD in rice production are therefore, expected to significantly reduce the GHG emissions from irrigated ecosystem while having good yield. Hence, there is a need to assess the effects of these two crop managements to fully understand their potential agronomic and environmental benefits to rice production system. This study evaluated the soil productivity, agronomic performance of rice, and GHG emissions of combined effects of biochar and AWD in rice production. Field experiment was established during 2016 dry and wet seasons at PhilRice-CES, with 2 water management (CF, AWD) and 5 biochar rate (0, 10, 20, 30 t ha-1) application as treatments. The experiment was laid out in strip plot RCBD design with 3 replications. Weekly gas samplings, soil, plant height, number of productive tillers, grain yields and yield components were gathered and evaluated.

Results:

2016 DS

- No significant differences were observed on the grain yields of rice between the control and amount of biochar applied regardless of water management. However, a yield advantage of 147 to 369kg/ha was observed with the incorporation of biochar relative to the control (without) in both CF and AWD. The highest grain yield was obtained under 10 t/ha biochar (6,668 to 6,828 kg/ha) regardless of water management (Figure 7);

- The AWD significantly reduces the cumulative CH_4 emissions by 50 to 69% relative to CF regardless of the amount of biochar rate. The lowest (20.3 CH_4 kg/ha) and highest (29.1 CH_4 kg/ha) cumulative CH_4 emissions, were observed under 20 and 30t/ha biochar, respectively. Cumulative CH_4 emissions were reduced by 17 to 42% (AWD) and -10 to 9% (CF) relative to the control (without biochar) (Figure 8);

- The AWD significantly increases the cumulative N2O emissions by 59 to 342% relative to CF with or without biochar. The increase was more pronounced at 30t/ha biochar with 3.2kg N2O/ha. While addition of 20t/ha biochar under CF did not vary the N20 emission relative to the control (Figure 9).

- The CO2- equivalent global warming potential (GWP) in AWD decreased by 7 to 47% relative to CF regardless of biochar rate. Lowest GWP with 851 and 1,772kg ha-1 CO2-equivalent were obtained under 20 t/ha biochar in AWD and CF, respectively relative to the control (without). The global warming potentials (GWP) were estimated using the IPCC radiative properties of CH4 and N2O emissions relative to CO2 over a 100-yr time horizon.

- Average irrigation interval using AWD was observed at 12 days compared to 3 days in CF regardless of the biochar rate. The highest was observed under 10 t/ha biochar with 14 days irrigation interval;

- In general, there was a trade-off between CH4 and N2O cumulative emissions under AWD regardless of biochar rate. A negative correlation (r = -0.60) between the two parameters suggests that reductions of CH4 emission, increases the N20 emissions or vice versa under AWD. Moreover, the optimum rate of biochar that reduces GHG emissions while having good yield was best shown under 20t/ha biochar in AWD. Further validation of the results is recommended.

2016 WS

- No significant differences were observed on the grain yields of rice between the control and biochar rate applied regardless of water management. However, in AWD, grain yields increased with increasing rate of biochar rate; while in CF the control (no amendment) obtained the highest grain yields, followed by biochar rate of 10t/ha (Figure 10).

- Bulk density of soil decreased with increasing rate of applied biochar at 0 to 10 cm soil depth in both CF and AWD, while there was no clear trend observed for other soil depths. The decreasing trend implies that at this depth, applied biochar up to 30 t/ha is effective to improve soil aggregate (soil compaction) which could lead to increased total porosity in soil (Figure 11).

- Gas analyses are still on going and to be completed by the end of December 2016. A total of 9600 gas samples are currently on-analysis using gas chromatograph equipped with FID/ECD.

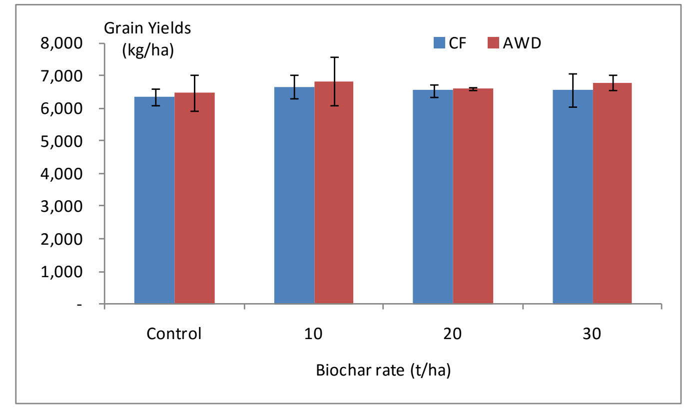


Figure 7. Grain yields of rice under different water management and biochar rate application, 2016 DS. Error bars are standard error of mean.

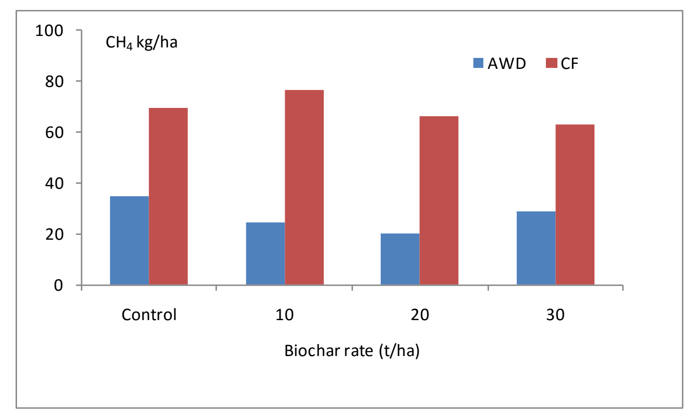


Figure 8. Cumulative CH4 emissions under different water management and biochar rate application, 2016 DS.

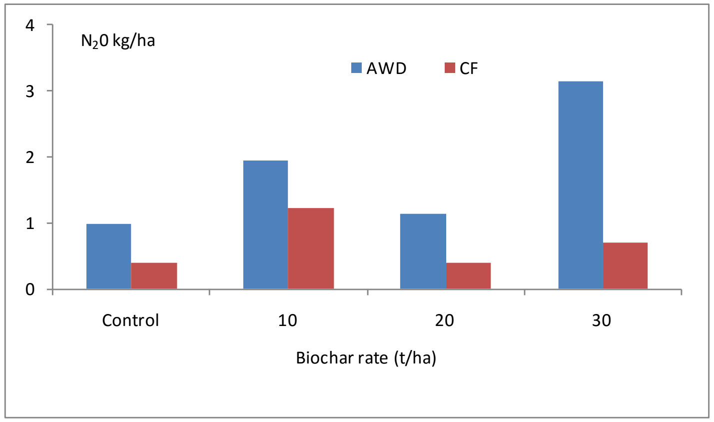


Figure 9. Cumulative N20 emissions under different water management and biochar rate application, 2016 DS.

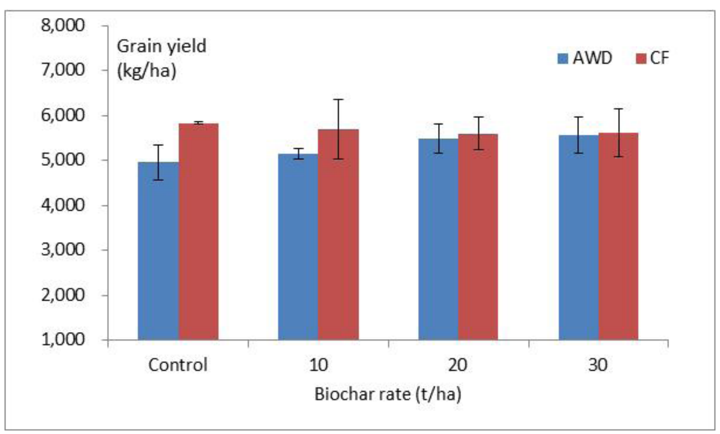


Figure 10. Grain yields of rice under different water management and biochar rate application, 2016 WS. Error bars are standard error of mean.

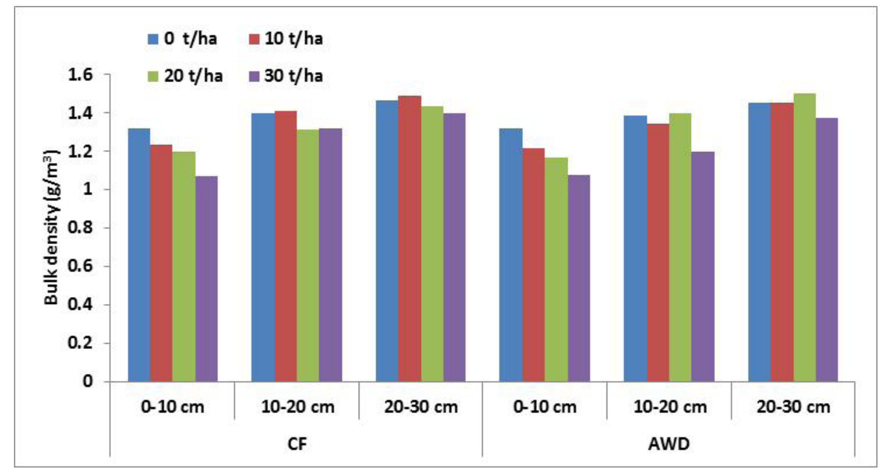


Figure 11. Bulk density at varying biochar rate under CF and AWD.

III. Promotion of Matured Engineering Technologies

Project Leader: Eden C. Gagelonia

Promotion of Matured Engineering Technologies

ECGagelonia, JARamos, ASJuliano, EGBautista, and EBSibayan

The task of improving productivity in rice cultivation through the use of yield-enhancing and cost-reducing mechanization technologies falls on the shoulders of PhilRice, as one of the lead rice R&D institution in the country. In fact, PhilRice, through its Rice Engineering and Mechanization Division, has been at the forefront in the development of production machinery and postharvest equipment for rice production. At present, more of these technologies have already been successfully developed by PhilRice engineers. A vigorous technology transfer strategy is therefore needed in order for these equipment be adopted by farmers in the countryside. A strong partnership with agri-machinery manufacturers is also necessary in the promotion and commercialization of these technologies.

The following were the tasks and objectives of the project:

- Promote matured engineering technologies for adoption by farmers/stakeholders.
- Transfer matured engineering technologies to manufacturers for mass production and commercialization.
- Promotion of matured engineering technologies
- Accreditation of manufacturers
- Monitoring of accredited manufacturers for quality validation of the equipment
- Mass production of matured technologies

Results:

- Two manufacturers were issued a renewal of license to manufacture PhilRice machineries upon submission of report of sales and payment of license fee. Val Agri-Machineries and Machine Shop of Guimba, Nueva Ecija and GCG Welding Shop of Sto. Domingo, Nueva Ecija will another 3 years to manufacture and sell laboy tiller and rice hull gasifier engine pump system, respectively. Two new manufacturers from Iloilo City were being accredited upon submission of letter of intent and other documentary requirements. Both manufacturers were initially validated (Table 4). This is an offshoot of a manufacturer's forum that was held last June 2016 and was attended by 15 representatives from different agri-machinery manufacturers nationwide.

- A number of equipment consist of rice flour mill, micromill, and rototiller were manufactured for provision to branch stations being the partners for the promotion of the technologies. All units allotted for the stations were completed while some have already been delivered to the station.
- Agricultural machinery technologies were showcased during the regular Lakbay Palay of PhilRice in the past two seasons. During the event, farmers have witnessed the operation and demonstration of rototiller, transplanter, rice hull gasifier, and microtiller. Posters of other equipment were also featured in the event. Matured engineering technologies were also advertised during the convention of the association of engineering profession in the Philippines. And in partnership with PhilRice museum, promotion of engineering technologies through participation in exhibits has been done.

- REMD, through the project, has also manufactured set of blower and furnace for a 4-ton and 8-ton reversible airflow dryer upon the request of private clients. Three 4-ton models were installed at Isabela (1u) and Nueva Ecija (2u). Five 8-ton models were installed at Oriental Mindoro (2u), Bulacan (1u), and Surigao City (2u). Testing of these dryers and training of operators were conducted being part of the technology transfer to the beneficiaries. Additionally, one set of blower and furnace for an 8-ton reversible dryer was fabricated and installation at PhilRice station in Sta Cruz, Oriental Mindoro. Moreover, various equipment were acquired by private individuals through the project which include rototiller, carbonizer, gasifier stove, and rotary weeder (Table 5).

Table 4. New accredited manufacturer, CY 2016.

Manufacturer	Address	Equipment	License validity
Val Agri-Machineries and Machine Shop	23B A. Salvador St., Sta. Veronica, Guimba, Nueva Ecija	Laboy and Micro tiller	October 31, 2019
G.C.G Welding Shop	Sto Rosario, Sto. Domingo, Guimba, Nueva Ecija	Mobile gasifier	November 30, 2019
Yul Metal Craft	Quezon Avenue, New Lucena, Iloilo City	Seed cleaner and Dryer	For processing
Iloilo Metalcraft and Builders MPC	#29 Huervana St., La Paz, Iloilo City	Riding attachment	For processing

Table 5. Equipment acquired by private clients, CY 2016.

Payor	Date paid	OR	Particulars	Quantity
Theody Barroga	1/20/2016	7794060	Carbonizer	1
Junifer Dizon	2/2/2016	7794074	Carbonizer	1
Mylene Culling	2/2/2016	7794075	Gasifier stove with fan	1
Marvelin Rafael	2/5/2016	7794078	Gasifier stove w/o fan	1
Research Outreach Station	3/1/2016	7794096	Carbonizer	1
OPHI	3/2/2016	7794097	Weeder	1
Alvin Tondoc	3/21/2016	7794181	Weeder	1
DA-CAR	3/21/2016	99160	Microtiller	1
Joselito dela Cruz	5/11/2016	7794300	Rotary weeder	1
Dann Jomari C. Cara	5/11/2016	7794298	Gasifier stove w/o fan	1
Rolando Villacorta	5/12/2016	7794307	Rotary weeder & Gasifier stove w/o fan	1
Lorenzo Aquino	5/13/2016	7794311	Rotary weeder	1
Munoz High School	5/25/2016	7794332	Gasifier stove w/o fan	1
Ferdinand dela Cruz	5/31/2016	7794337	Rotary weeder	1
Melisa Posadas	5/31/2016	7794341	Rotary weeder	2
Eladio Gales	6/6/2016	7794348	Blower & furnace	2
Cleverick Pajarillo	6/6/2016	7794376	Gasifier stove w/ fan	1
Jesus Dumaual	6/17/2016	7794378	Rotary weeder	1
Neil Alvin Cruz Tandoc	6/21/2016	7794380	Rotary weeder	2
Level and Detail Construction	6/22/2016	7794386	DP blower & furnace	2
Edgardo Bernardo	6/24/2016	7794393	Rototiller	1
Patricio Baltazar	7/4/2016	7794402	DP blower & furnace	1
Patricio Baltazar	7/11/2016	7794410	DP blower & furnace	1
Daniel dela Cruz	7/25/2016	7794437	carbonizer	1
Donna Salonga	8/3/2016	7794447	Blower & furnace	1
Donna Salonga	8/3/2016	7794446	DP blower & furnace	1
Julius Sesuca	8/10/2016	7794449	Rotary weeder	1
Rico Pagkalinawan	8/23/2016	7794464	Blower & furnace	1
PhilRice Mindoro			Blower & furnace	1
Jovelyn Montesines			Carbonizer	1
Richard Bautista			DP blower & furnace	1
PhilRice Los Banos			Carbonizer	3
DA-CAR	9/29/2016	7794505	Additional payment for microtiller	1
Raymundo M. Lucero	9/28/2016	7794506	carbonizer	1
Level and Detail Construction	10/21/2016	7794554	Full payment for blower and furnace	1
TOTAL				**41**

Externally Funded Projects

IV. Enhancing Rice Production and Postproduction Efficiencies Through Improvement and Use of Appropriate Mechanization and Postharvest Technologies

Project Leader: Manuel Jose C. Regalado

Rice farms in the country have low productivity not only as result of poor crop management but also because of low mechanization level. Three major activities have to be mechanized in order to improve productivity as well as reduce costs: 1) crop establishment, 2) harvesting and threshing, and 3) drying. The direct effects of mechanization on crop yield include timeliness, precision in the conduct of operations, especially hill seeding in rows or in seedling preparation and mechanical transplanting, and reduction of field losses for activities associated with harvesting up to drying. It is estimated that yield productivity through precision seeding or machine transplanting can be enhanced by roughly 10% while loss prevention during harvesting and drying can contribute to another 10%, contributing to about 20% increase/recovery in crop yield.

Results of a postproduction loss assessment study conducted jointly by then BPRE (now PHilMech) and the Philippine Rice Research Institute (PhilRice) from 2007–2009 showed that average paddy losses incurred from harvesting, piling, threshing, drying and milling operations averaged 14.4% during January to December, with less losses incurred in the first semester (dry season) (14.0%) than in the second (wet season) (14.8%) (Francisco 2010).

The results imply that: (1) high milling loss points to the need to improve milling facilities; (2) high drying loss indicates that drying facilities are still inadequate or farmers or processors are not using more efficient ones, if there are any. There is a need to design drying systems which are acceptable and affordable to end-users; and (3) high harvesting, threshing and piling losses indicate that the present varieties used by farmers are shattering. The level of mechanization of paddy reaping and threshing should also be upgraded with the improvement and use of the combine harvester technology to avoid delays in harvesting and eliminate cut crop handling and piling in the field, which invariably lead to physical and quality losses.

In an earlier study conducted by the International Rice Research Institute in collaboration with PhilRice, results showed that, in 1999, it cost US$96 to produce a ton of paddy in Central Luzon compared with only $59 in the Central Plain of Thailand and $74 in the Mekong Delta of Vietnam (Moya and Dawe 2006). Machinery and labor costs accounted for most of the difference, with material input costs constituting only a small percentage of the difference.

The goal of the program is to contribute to the increase of rice supply in the country, thus helping to achieve and sustain national rice self-sufficiency. This can be realized by improving productivity while simultaneously reducing production costs and postharvest losses. The program's objectives therefore are to enhance the efficiency of crop establishment methods, such as transplanting and direct-seeding by developing appropriate mechanical transplanting and direct seeding machines. It also aims to increase the efficiency of rice harvesting, drying and milling operations by improving the quality of the harvested, dried and processed rice, and reducing postharvest losses through the development and use of efficient machines. The program has four component projects that are implemented by PhilRice, namely:

1. Development of a locally adapted and manufactured riding-type precision seeder;
2. Development and pilot testing of a local riding-type transplanter;
3. Development and pilot testing of improved 1.3-meter rice combine harvester; and
4. Development and pilot testing of a combined conduction and far-infrared radiation paddy dryer.

Development of a Combined Conduction and Far-Infrared Paddy Dryer

MJCRegalado, ATBelonio, BYLived, and JADelaCruz

Drying paddy during harvest season is one of the major problems in the Philippine rice postproduction value chain. This is more critical during wet season when paddy harvested has very high moisture content owing to rainy or humid conditions. After harvesting and threshing, grains left undried will easily spoil, consequently deteriorating paddy quality and reducing profit of farmers.

The technology of drying high moisture paddy by employing high temperature short time drying has been proven in the past. Conduction drying in a rotary drum dryer has been made possible to reduce the moisture of paddy with combined heating and cooling process. Also, several studies had been done on far-infrared drying of paddy which can reduce the moisture of the grain even at lower initial moisture content without significant loss in the milling quality of the grain. The combined principles of conduction and far-infrared radiation can be a major breakthrough in the field of paddy drying. The use of rice husk gasification technology for providing heat energy requirements would entirely eliminate the high cost of and dependence on imported fossil fuel. With this innovative method, a breakthrough in paddy drying science and technology can be generated.

This project aims to develop and pilot test a rapid paddy dryer employing combined conduction and far-infrared radiation principles and using rice husk as heat source. Specific objectives are to: 1) design and construct a combined conduction and far-infrared radiation dryer for paddy using rice husk as heat source and evaluate its performance at PhilRice CES; 2) compare the grain quality parameters of the dried paddy using prototype with those dried using conventional sun drying; 4) evaluate the economics of using the dryer; and 5) conduct pilot-testing of the new rapid-drying technology.

Results:

- A combined conduction heating and far-infrared radiation paddy dryer prototype has been designed and developed (Figure 12). To optimize far infrared radiation drying, three direct burners (Figure 13) using producer gas from the rice husk gasifier as fuel were installed to heat the pumice (cement-ash mixture) surface emitter to generate far-infrared radiation. The chimney was also improved to provide uniform heat distribution.

- Re-wet paddy with initial moisture content (MC) of 21.1% could be dried to 17.2% after passing through the rotary drum dryer, and to 15.5% after going through the oscillating cooler with a capacity of 0.7 t/ha. The drying curve is shown in Figure 14.

- Figure 15 shows that paddy with initial MC of 19.6%, paddy could be dried to 15% in the FIR dryer in five passes with average temperature of the emitters at 121°C. In another test, paddy with 16.5% MC could be dried to 13.2% in the infrared dryer after three passes with a capacity of 0.7t/ha, with average emitter temperature at 138°C (Figure 16).

- Results of another drying test this 2016 WS showed that 637kg of paddy (mixed varieties) could be dried from 24% MC to16% MC in 4 passes thru the FIR, with throughput at 780kg/h, drying capacity at 300kg/h, grain residence time in the dryer of about 8 minutes, and moisture reduction rate at 3.6 percentage points per hour. In another test, results showed that partially dried paddy at 16% MC could be dried to 12% MC in two passes, with average throughput at about 700kg/h, drying capacity of 350kg/h, grain residence time of about 10 minutes, and moisture reduction rate of 1.8 percentage points per hour. Average rice husk fuel consumption for each test was about 60kg/h for a duration of eight hours. Heating the pumice emitter surface to the desired temperatures of more than 100°C took more than five hours.

Figure 12. The combined rotary conduction and far infrared radiation paddy dryer.

Figure 13. Three direct burners using producer gas from the rice husk gasifier heated the pumice (cement-ash mixture) surface emitter to generate far-infrared radiation.

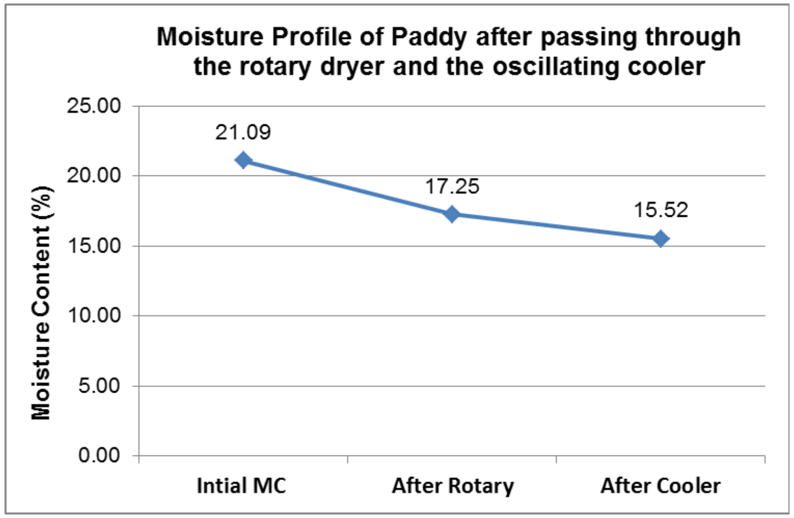


Figure 14. Paddy moisture reduction after passing through the rotary dryer and oscillating cooler.

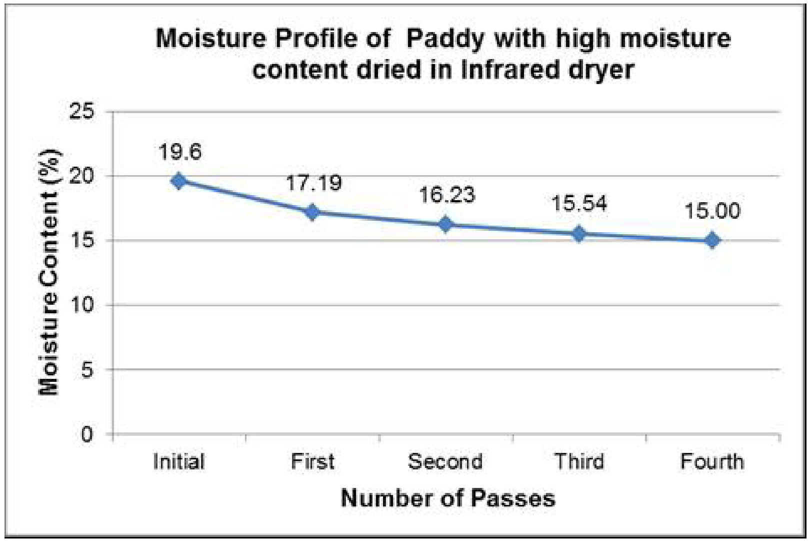


Figure 15. Moisture reduction curve of re-wetted paddy dried in the far infrared radiation dryer.

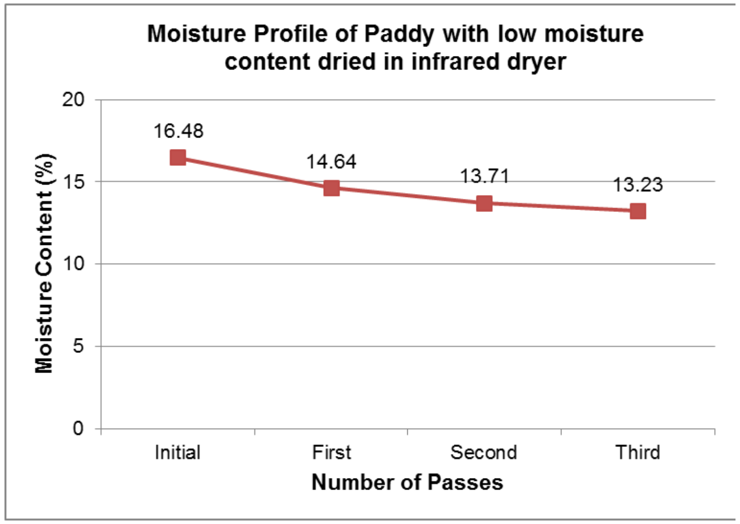


Figure 16. Moisture reduction curve of partially dried paddy completely dried in the FIR dryer.

Development and Pilot Testing of Improved 1.3 meter Rice Combine Harvester

CJMTado and DPOna

The current design of PhilRice 1.3 mini combine rice harvester has been proven for its efficient performance on dry field condition. This machine has been introduced throughout the country in previous years. However, the level of adaptation is still very low owing to various reasons. One of these is the rapid change in weather or atmospheric conditions. Continuous rains before and during harvest, especially in the wet season, tremendously affects the soil condition of the field thereby limiting machine utilization. Also, some users of the mini-combine complain about difficulty of adjusting the header, and noticeable cracked grains in the harvest. Thus, a new study was proposed to further improve the 1.3m mini-combine harvester.

Activities:

- Fabrication of the first prototype was completed (Figure 17 and 18).

Figure 17. Combine harvester first prototype

Figure 18. Combine harvester prototype climbing on dike.

- Conducted preliminary testing of ground drive on muddy field and initial field testing with standing crop.

- Designed and fabricated a tractor trailer that is fitted on the design and size of the combine harvester, to be used as transport on pilot test sites (Figure 19).

Figure 19. Tractor Trailer for 1.3 meter Rice Combine Harvester

- Started the fabrication of commercial prototype main frame and thresher top cover (Figure 20).

Figure 20. Commercial Prototype Main Frame.

Results:

- Conducted modification of main clutch from idler type to conical clutch.

- The combine harvester was able to propel on a muddy field with an approximate hardpan depth of 200mm. The combine harvester was also able to climb at a dike with an approximate 30° incline.

- Threshing system exhibited minimal grain losses.

- Modification of system drive from PTO driven to engine driven is needed. This to minimize clogging on system conveyors during turns and maneuvers.

Development and Pilot Testing of a Local Riding-Type Rice Transplanter
ASJuliano and JPMiano

With labor intensive operation requiring 20-25 man-days/ha and lack of manpower during the peak period of crop establishment, it is more beneficial to use mechanized transplanting system as it reduces labor costs and seed requirement (from minimum of 80 to 40 kg/ha for inbred variety), but also allows shortening the period of raising the seedlings (from 25–30 days to 15 to 18 days). This project is being conducted to develop a locally made riding type rice transplanter that is suitable for transplanting rice crop.

Results:

- The commercial prototype of the local riding-type transplanter is being assembled at Rice Engineering and Mechanization Division (REMD) shop of PhilRice Central Experiment Station (Figure 21).

- The main transmission gearbox, spindle transmission, rear drive transmission, eccentric gearboxes, pickers, and hydraulic components were fabricated locally by MIAP members (Metal working Industries Association of the Philippines) using CNC milling/cutting machines.

- Plastic component parts were being fabricated by the manufacturer (INCA Philippines Inc.) using rotational molding for light weight and quality materials.

- Pilot testing of the local riding-type rice transplanter commercial prototype will be conducted from November 2016 to October 2018 in Region III (Nueva Ecija), Region VI

(Iloilo), and Region XII (North Cotabato). Pilot testing project was funded by DOST-PCAARRD with a total budget of PhP 4.5M.

Figure 21. Local riding-type transplanter commercial prototype being assembled.

Development of Locally Adapted and Manufactured Riding Type Precision Seeder

ECGagelonia, HVValdez, and JEOAbon

The study focused on the design and development of Ride-On Precision Seeder (RPS) that can drop precise number of seeds per hill with comparable efficiency to imported units and that can also be used for hybrid cultivation. It also aims to reduce the seed requirement per hectare and the unit cost.

The design was based on a mechanical riding-type seeder from Korea and manual push-type seeder from China. The prototype was fabricated at the shop of Rice Engineering and Mechanization Division (REMD) with Rollmaster Machinery and Industrial Services Corp. of Metal Industries Association of Philippines (MIAP) as the collaborating manufacturer. The seeder has 8-rows spaced at 25cm, and 35cm between the 4th and 5th rows. It has built-in leveler cum furrow opener and creates canalet every 4-rows. A hydraulic system was used to raise and lower the seeding assembly. The seeder is 4-wheel driven powered by 13hp reduction-type gasoline engine.

Results:

- The machine (Figure 22) was used to established direct seeded inbred rice variety (NSIC RC240) in 880 m^2 field for DS2016. During the test, power steering mechanism was used and the engine was replaced by 13hp (1800rpm reduction type) from the first engine which is 18hp (3600rpm). Headland pattern at boundaries was followed.

- The machine accomplished 10-trips and has 2.20m swath. During the test, the forward speed was reduced from 1.18kph to 0.77kph and difficulty of shifting to 2nd gear was observed. Since the forward speed was reduced the theoretical field capacity was also reduced to 1.36ha/d (8hr operation per day).

- The machine accomplished seeding the field with area of 880m2 in 23min 21.9sec (including unproductive time during turning and adjustments) with a field efficiency of 69.10% and effective field capacity of 0.94ha/d. The increase in field efficiency was attributed to the field dimension and ease of turning at headland as an effect of the power steering mechanism.

- The machine has a seeding rate of 23.80kg/ha (adjusted to 14% MC) and is within the target seeding rate of 15kg/ha to 30kg/ha and the PhilRice recommended seeding rate of 40kg/ha.

- Seedling emergence was counted at 13DAS. Five quadrant of 1mx1m was the sampling area and the average seedling emergence was 79 plants per/m^2.

- A single seed metering mounted on a platform in the laboratory was again tested at two different seed metering opening and two seed variety (Inbred and hybrid). The belt speed was 1.20kph which is identical to the forward speed of the machine gathered during the DS2015 field testing. Based on the results presented in Table 6, at opening 1 using NSIC Rc296 (inbred), an average of 1.8 seeds per hill (1 to 5 seeds/hill) at average distance per hill of 10.9cm (7 to 14cm), and missing hill of 22.22%. While for Mestizo-19 (hybrid) an average of 2.4 seeds per hill (1 to 6 seeds/hill) at average distance of 11.8cm (8 to 15cm), and missing hill of 9.93%. At opening 2, an average of 6.2 seeds per hill (1 to 12 seeds/hill) for NSIC Rc296 (inbred) and 7.3 seeds per hill for Mestizo-19 (hybrid) was observed. Average distance per hill was 11.2cm (7 to 15cm) and 11.0cm (7 to 15cm) for inbred and hybrid, respectively. Percent missing hill was almost negligible with 4.04% for inbred (with 1-missing hill for every 17hills).

- The assembly of the second unit (improved prototype) is on-going at the REMD shop (Figure 23). Major components such as main transmission gearbox, rear transmission gearbox, engine, hydraulic components, seeding assembly, and seed metering were already fabricated/ contracted. Plastic component parts were being fabricated by the collaborating manufacturer (INCA Philippines Inc.). The improved prototype is targeted to be completed by the end of December 2016, though the project ends last October 2016. This unit will be subjected to field testing for verification before making the final report of the project. A continuation project is being proposed for 2017 to 2018 implementation.

Figure 22. Improved riding-type precision seeder with 13hp gasoline engine 1800rpm-reduction type and power steering mechanism (January 27, 2016).

Figure 23. Assembly of improved prototype riding-type precision seeder.

Table 6. Laboratory test results using NSIC Rc296 and Mestizo 19 at two seed metering opening, PhilRice CES.

Seed Metering Opening	Variety	Seeds per hill (Range)	Distance per hill, cm (Range)	Number of missing hill	Percent missing hill
1	NSIC Rc296	2.1 (1-4)	10.9 (9-14)	4	22.22
		1.6 (1-5)	10.6 (7-13)	5	27.78
		1.6 (1-4)	11.1 (7-14)	3	16.67
	AVERAGE	**1.8**	**10.9**	**4.0**	**22.22**
	MESTIZO 19 (HYBRID)	2.2 (1-5)	11.5 (8-15)	2	11.76
		2.7 (1-6)	12.5 (9-15)	1	6.25
		2.4 (1-6)	11.4 (9-14)	2	11.76
	AVERAGE	**2.4**	**11.8**	**1.7**	**9.93**
2	NSIC Rc296	7.0 (1-12)	10.1 (7-13)	0	0.00
		5.6 (2-10)	11.9 (9-15)	1	6.25
		6.0 (2-10)	11.6 (10-15)	1	5.88
	AVERAGE	**6.2**	**11.2**	**0.7**	**4.04**
	MESTIZO 19 (HYBRID)	7.5 (3-11)	10.9 (7-13)	0	0.00
		7.4 (2-14)	11.4 (9-15)	0	0.00
		6.9 (4-10)	10.8 (9-14)	0	0.00
	AVERAGE	**7.3**	**11.0**	**0.0**	**0.00**

V. Improving Crop Productivity in Drought Prone Rainfed Lowlands in the Philippines with Mechanized Direct Seeding Technology

ECGagelonia, EGBautista, and HVValdez

Dry seeding is practiced in rainfed rice growing areas in the Philippines due to scarcity of irrigation water. Farmer usually doing it by manual broadcasting palay seeds in previously leveled or furrowed field. Farmers usually complain on uneven seed distribution, high seed rate, and laborious method due to unavailability of machine to replace the existing method.

The study focused on the design and development of multi-purpose seeder (MPS) to help local farmers in addressing such problems in the rainfed. The machine is attached to customarily used hand tractor with ride-on operator for mechanical direct seeding of palay, mungbean, and corn in dry field condition. Seeds are evenly distributed using a metering device that controls the amount of seed then drop it in the created furrow and later close it to protect from birds and rodents. The seeder has 4-rows and row spacing can be adjusted depending on the needs of the farmer and the crop to be planted.

Results:

- The prototype machine was preliminarily field tested. Results showed that the machine can accomplished seeding 2.4 ha/d for rice, 1.6 ha/d for corn and 2.7ha/d for mungbean (Table 7). The row spacing for rice is 20cm, and for corn and mungbean is 60cm.

- The prototype seeder was demonstrated in Paniqui, Tarlac (Figure 24); Umingan, Pangasinan and Paoay, Ilocos, Norte where farmers are practicing dry direct seeding. The machine was also showcase during 2016WS Lakbay Palay at PhilRice CES and FFS field day in Paniqui, Tarlac.

- Three field experiments was established in WS2016 using the machine (1 in Baloc, Sto. Domingo, N.E; 1 in PSU, Sta. Maria, Pangasinan; and 1 in MMSU, Batac Ilocos, Norte) with seeding rates of 58kg/ha, 48kg/ha and 30kg/ha, respectively, using NSIC Rc348 (Sahod Ulan 12) as the test variety. The furrow opener was adjusted and seeding depth was 31.5mm, 21.1mm, and 15.8mm during the tests. Results showed that seedling emergence (at 20DAS) was highest at PhilRice CES with deeper seeding depth of 31.5mm with 169 plants/m^2 (Figure 25).

- Comparative study was also done to evaluate the performance of MPS (58kg/ha) dry direct seeded rice in comparison to conventional sowing methods [furrow seeding 60kg/ha (FS60), broadcast seeding 60kg/ha (BS60 and broadcast seeding 150kg/ha (BS150)]. Results showed that MPS seeded plots has the highest yield of 2673kg/ha compared to 2663kg/ha, 2187kg/ha and 2343kg/ha of FS60, BS60 and BS150 plots respectively.

Figure 24. Prototype MPS attached to hand tractor during the field demonstration at Ventinilla, Paniqui, Tarlac (June 8, 2016).

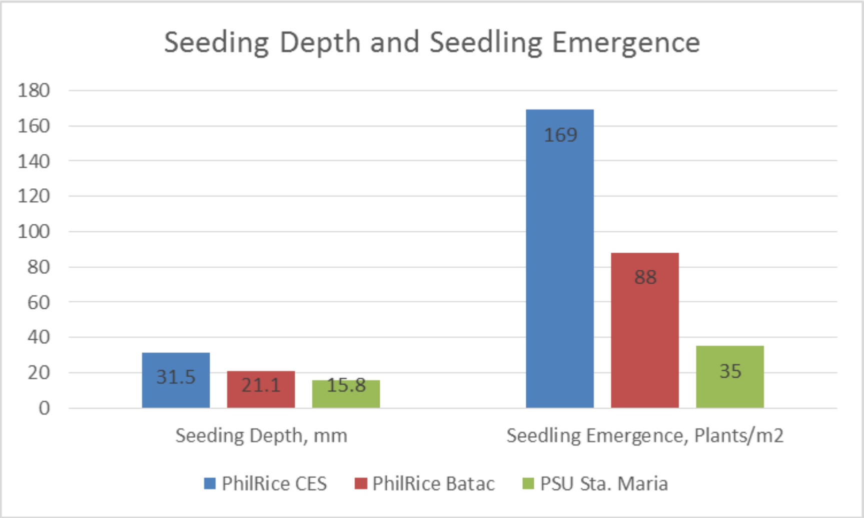


Figure 25. Seeding depth and seedling emergence in three sites WS2016.

Table 7. Field performance results of hand tractor attached MPS using three different crops, PhilRice CES, March 2016.

Attributes	Crops		
	Rice	Corn	Mungbean
Forward Speed, kph	2.8	2.8	2.8
Row Spacing, cm	20	60	60
Hill Spacing, cm	3	25	4
Capacity, ha/d	2.4	1.6	2.7

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

KSPascual, NCRamos, FSGrospe, MEDCasil and EBSibayan (PhilRice); OBSander, RRRomasanta, and RWassman (IRRI)

Irrigated rice ecosystem consumes abundant water where ponded water in the rice fields is widely practiced among farmers. In the Philippines, where rice remains the most important food crop, 70% of the area harvested to paddy rice comes from irrigated environment. With the daunting challenges due to climate change, rice scientists are looking for ways to reduce the impact of wetland agriculture, as one the major contributory sources of methane (CH4) gas to the atmosphere. The alternate wetting and drying (AWD) technique, which has been a banner technology for water savings in the national, communal and pump irrigation system in the country, is expected to reduce CH4 emissions from the rice fields. It has the potential to mitigate greenhouse gas emissions (GHG) owing the multiple aerations into the soil unfavorable for methane formation. Hence, there is a need to assess and account CH4 emissions at the farmers' fields, as GHG also varies significantly with soil type, and crop management practices. This study aims to evaluate the GHG emissions (i.e. CH4 and N20) in selected rice farms in Central Luzon, covering gravity (Site 1) and pump (Site 2) irrigation systems.

Activities:

- Selected farms in Nueva Ecija and Tarlac for the GHG measurement at the farmers' fields covering gravity (Site 1) and pump (Site 2) irrigation systems during the 2016 dry season.
- Designated three field plots of at least 500 square meters at the farmers' fields for the GHG flux measurements;
- Installed observation wells in all AWD plots to guide farmers when to irrigate;
- Conducted weekly gas sampling using a closed chamber method following an established protocol;
- Analyzed gas samples using gas chromatograph equipped with a flame ionization detector (FID) and electron capture detector (ECD).
- Gathered and recorded data on crop management practices, daily field water level, and evaluated yield and yield components.

Findings:

- Table 8 shows some of the details of the crop establishment and location of the two sites. Sites 1 and 2 had different planting method, manual transplanting and broadcast, respectively. Both sites practiced CF and AWD, and additional MSD in site 2. The source of irrigation in site 1 was from a communal canal with water released by NIA, and in site 2 was from a pump irrigation system, and additional owned shallow tube well for supplemental irrigation. In both sites, straw was incorporated during wet land preparation, and 3 splits fertilizer application were performed.
- Cumulative seasonal CH4 emission was lower in AWD (118.3kg CH4 ha-1 season-1) than CF (207.2kg CH4 ha-1 season-1) in site 1. The CH4 reduction in AWD was 43% relative to CF (Figure 26). In site 2, highest emission was obtained by CF (5.8 kg CH4 ha-1 season-1), followed by MSD (3.0 kg CH4 ha-1 season-1), and AWD (1.2 kg CH4 ha-1 season-1). The CH4 reduction in MSD and AWD was 48 and 79%, respectively, relative to CF (Figure 27).
- Cumulative seasonal N2O emissions in both sites were almost marginal (0.002 to 0.003 kg N2O ha-1 season-1) regardless of water management.
- The total CO2- equivalent global warming potential (GWP) in CF was 43% higher than AWD in site 1. The GWPs were 5,181.2 and 2,959.3 kg CO2 equivalent ha-1 season-1 in CF and AWD, respectively. In site 2, the GWP in CF was 48 and 79% higher than MSD and AWD, respectively. The GWPs were 145.1 and 75.5, and 31.0kg CO2 eq ha-1 season-1 in CF, MSD, and AWD, respectively. The global warming potentials (GWP) were estimated using the IPCC radiative properties of CH4 and N2O emissions relative to CO2 over a 100-yr time horizon.
- In general, both sites showed that AWD significantly reduces the CH4 emissions in AWD relative to CF. Higher emission was noted those farms under a gravity type of irrigation (canal) than a pump irrigation system. This could be due to more controlled delivery of water irrigation in the pump system.

Table 8. Details of crop establishment and location of the two sites for GHG measurements, 2016 DS.

Details	Site 1	Site 2
Location	Malayantoc, Baloc Nueva Ecija	Carmen, Anao Tarlac
TSAG Location	Lat.G-3-B	TG59 Irrigators 58
Variety	NSIC Rc 216	NSIC Rc 222, NSIC Rc 216,NSIC Rc 160
Planting method	Manual transplanting (waray)	Manual broadcast
Straw incorporation (stubbles)	Yes	Yes
Fertilizer application (bags/ha)	3 (14-14-14), 3 (46-0-0), 2 (17-0-17)	3 (14-14-14), 3 (46-0-0), 1 (17-0-17)
Water Management	CF, AWD	CF, MSD, AWD
Source of irrigation	Canal (NIA)	Pump (NIA) and with owned shallow tube well for supplemental irrigation
Date of planting	15-Dec-15	22-Nov-15

TSAG- turn out service area- the smallest group of water users in an irrigated system; CF- continuous flooding, MSD- mid season drainage, AWD- alternate wetting and drying; NIA - National Irrigation Administration

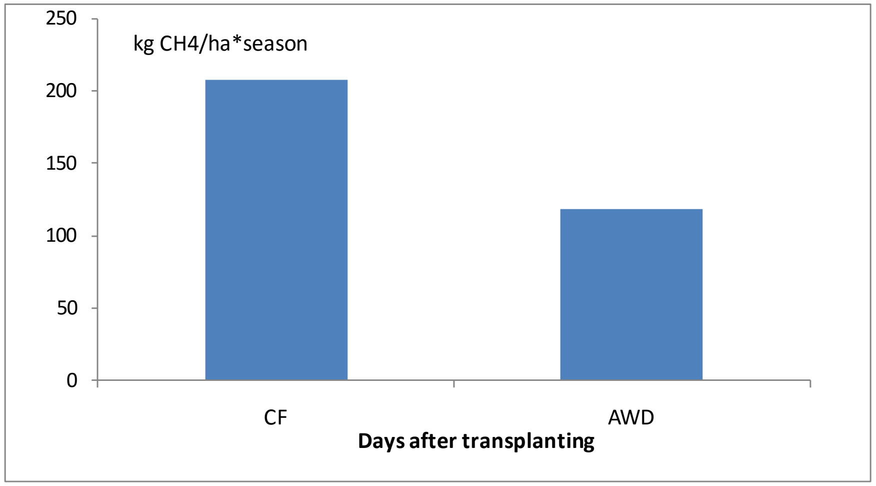


Figure 26. Cumulative CH4 emissions under different water management in site 1 using a communal irrigation system, 2016 DS.

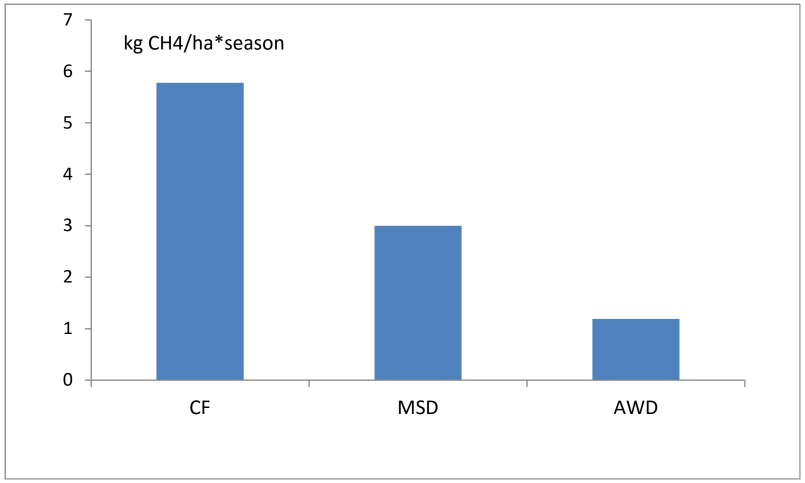


Figure 27. Cumulative CH4 emissions under different water management in site 2 using a pump irrigation system, 2016 DS.

VII. Technology development for circulatory food production systems responsive to climate change: Development of mitigation option for greenhouse gases emissions from agricultural lands in Asia (MIRSA 2)

KSPascual, NCRamos, FSGrospe, MEDCasil, and EBSibayan

Irrigated rice fields are identified as one of the major sources of atmospheric methane (CH4) owing to anaerobic decomposition of organic matter. Hence, it is important to develop ways to mitigate greenhouse gas (GHG) emissions from rice production to the global atmosphere.

In 2013, a research project, MIRSA (Greenhouse Gas Mitigation in Irrigated Rice Paddies in Southeast Asia), was established to assess AWD water management as mitigation option for GHG emissions from rice production in Southeast Asian countries. Concurrent experiments were established in Indonesia, Thailand, Vietnam and the Philippines for 6 cropping seasons. It aims to develop guidelines on the effective implementation of AWD in the Southeast Asia to achieve the emission reduction target of 30% relative to the conventional technique. This project is funded by the Secretariat of the Agriculture, Forestry and Fisheries Research Council of the Ministry of Agriculture, Forestry and Fisheries of Japan.

Activities:

- Established field experiment (now in its 5th season) during 2016 dry season at the experimental farm of PhilRice. The experiment was laid out in a randomized complete block design in four replications. Three water management techniques were established: (1) Continuous flooding (CF) wherein water was maintained at 2 to 5cm depth during crop growth period; (2) Alternate-wetting and drying (AWD) wherein the field was irrigated when the water depth reached 15cm below soil surface and (3) AWD at -25cm threshold level for irrigation (AWDS).

- Conducted weekly gas sampling, following the established protocol of closed chamber method and additional sampling during first, third and fifth day after fertilizer application. The analysis of methane and nitrous oxide were analyzed using gas chromatograph equipped with a flame ionization detector (FID) and electron capture detector (ECD).

- Gathered and measured daily field water level, grain yields and yield components.

Results:

- Grain yields were not significantly different ($p < 0.05$) among treatments. Grain yields of CF, MSD and AWD were 6.3, 6.0, and 6.5 ton ha-1;

- Analysis of gas samples collected for GHG content is on-going at IRRI.

VIII. Smart Farming-based Nutrient and Water Management of Rice and Corn Production (PCARRD) (626A-RTF-004) - Application of Nuclear Analytical Technique for Efficient Nutrient and Water Management in Rice Production.

Project Leader: Evangeline B. Sibayan

Evaluation of nitrogen-use efficiency (NUE) of rice cultivars under aerobic rice (AR) production system

KSPascual, FSGrospe, APSabasaje, MAParugrug, and EBSibayan

Aerobic rice is a production system especially developed for 'aerobic rice' varieties grown under well-drained, non-puddled, and non-saturated soils. This system uses input-responsive variety and complementary management practices to achieve optimum yield. Hence, in terms of nutrient management, it is necessary that site-specific requirement must be determined in order to achieve optimum yield. This study aims to evaluate the nitrogen use efficiency of five recommended 'aerobic rice' cultivars in varying levels of nitrogen (60, 90, 120kg N/ha) using isotope dilution technique in order to come up with an optimal N recommendation to improve yields.

Activities:

- Installed isotope plots ($0.22m^2$) on the main plot wherein 10 atom % 15N labeled ammonium sulfate was applied upon transplanting. Ordinary ammonium sulfate was also applied outside the isotope plots.

- Collected soil, water, and plant samples at different growth stages (mid-tillering, panicle initiation, and flowering) to determine the natural abundance of deuterium (2H), oxygen (18O), and carbon (13C) using the isotope ratio mass spectrometer and liquid scintillation counter.

- Gathered grain yield in a $5m^2$ at the center of the main plot; sun-dried yields for 2 to 3 days, and corrected at 14%

moisture content. Yield component were also obtained from 5 pre-selected hills per plot.

Results:

- Grain yields were not significantly affected by all treatments. Among varieties, V1 (NSIC Rc9130) had higher yield by 21-24% compared with V2 (NSIC Rc9) and V3 (PSB Rc72H). Mean grain yields ranged from 2.6 to 3.4 ton ha-1 (Figure 28).

- Among fertilizer rate, grain yields of N1 (0-40-40 kg N, P2O5, K2O/ha) was significantly lower by 40-60% relative to other treatments. Highest yield was obtained by N4 (120-40-40 kg N, P2O5, K2O/ha) among treatments. Mean grain yields ranged from 2.05 to 3.29 ton ha-1. (Figure 29).

- Plant height at maturity was significantly affected by fertilizer rate and variety. Among fertilizer rate, N3 and N4 obtained the highest with 80 and 82cm, respectively. Lowest plant height was obtained by N1 with 70 cm, but not significantly different with N2. Among varieties, plant height of V2 was significantly highest at 88cm, while V1 and V3 were not significantly different with 70 and 72cm, respectively (Table 9).

- The V2 (NSIC Rc9) was significantly highest in productive tiller, number of spikelets per panicle and number of filled spikelets per panicle among variety. No significant differences were observed among fertilizer rate.

- For the isotopic results, crop and water samples were collected based on established protocol and were sent to the Philippine Nuclear Research Institute (PNRI) for the analyses.

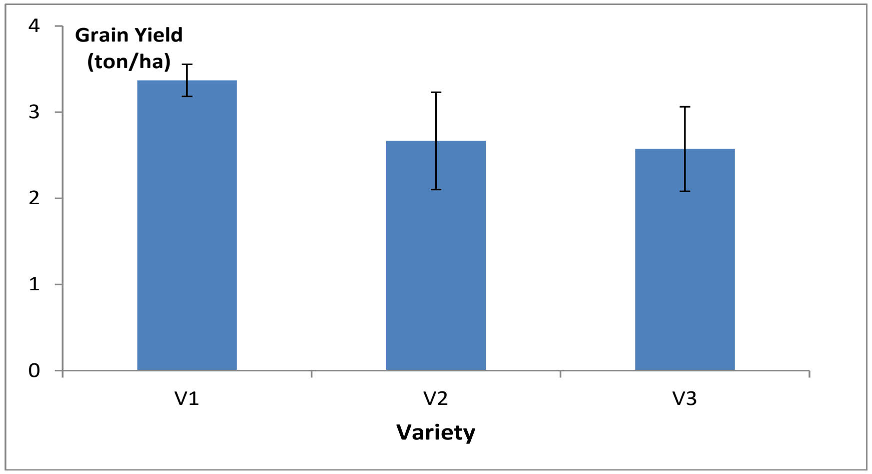


Figure 28. Grain yields of rice under different varieties, 2016 DS, PhilRice-CES V1 = NSIC Rc130; V2 = NSIC Rc9; V3 = PSB Rc72H.

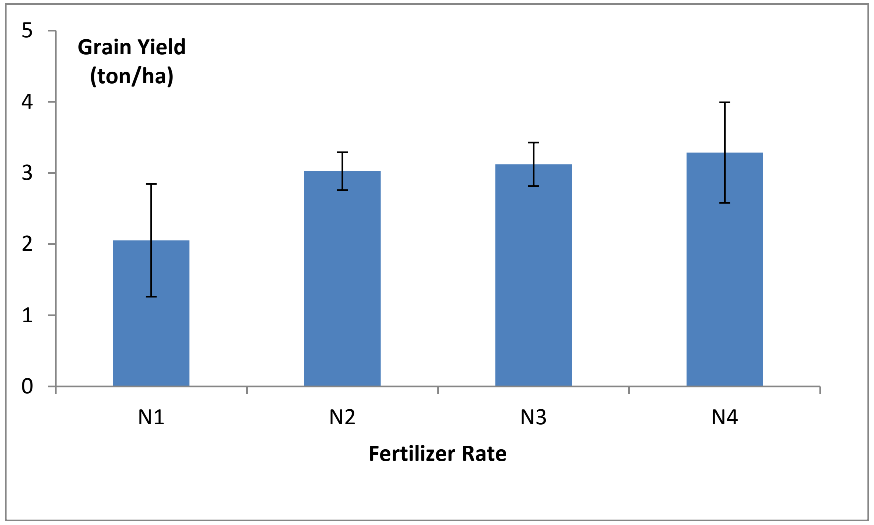


Figure 29. Grain yields of rice under different fertilizer rate, 2016 DS, PhilRice-CES N1= 0-40-40; N2 = 60-40-40; N3 = 90-40-40; N4 = 120-40-40 kg N-P-K per ha.

Table 9. Plant height, productive tiller and yield components of rice under different varieties and fertilizer rate, 2016 DS, PhilRice-CES.

Treatments	Plant height cm	Productive tiller m^2	No. of Spikelets per panicle	No. of Filled Spikelets per panicle	Filled Spikelet %	UnFilled Spikelet %	1000 grain wt g	Harvest Index
Fertilizer								
N1	70 b	338 a	62 a	45 a	73 a	27 b	20.30 a	0.27 a
N2	74 ab	363 a	74 a	53 a	72 a	28 b	20.70 a	0.26 a
N3	80 a	407 a	72 a	52 a	74 a	26 b	20.68 a	0.27 a
N4	82 a	373 a	81 a	48 a	59 b	41 a	21.02 a	0.20 a
Variety								
V1	70 b	318 b	65 b	46 b	73 a	27 a	20.66 a	0.20 b
V2	88 a	354 b	85 a	55 a	66 a	34 a	20.31 a	0.26 a
V3	72 b	439 a	66 b	47 b	71 a	29 a	21.06 a	0.29 a
Analysis of variance								
Replication	0.0413 *	0.2628 ns	0.1117 ns	0.0204 *	0.0334 *	0.0334 *	0.6640 ns	0.0093 **
Fertilizer (F)	0.0417 *	0.1212 ns	0.1038 ns	0.4331 ns	0.0064 **	0.0064 **	0.2339 ns	0.3150 ns
Variety (V)	0.0006 ***	0.0189 *	0.0034 **	0.0273 *	0.0992 ns	0.0992 ns	0.1868 ns	0.0238 *
F x V	0.5658 ns	0.4055 ns	0.5811 ns	0.4201 ns	0.7756 ns	0.7756 ns	0.5737 ns	0.3729 ns

N1= 0-40-40; N2 = 60-40-40; N3 = 90-40-40; N4 = 120-40-40 kg N-P-K per ha; V1 = NSIC Rc130; V2 = NSIC Rc9 ; V3 = PSB Rc72H

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

In a column, means followed by the same letter are not significantly different at 0.05 level of probability by Least Significant Difference (LSD).

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

Project Leader: MJC Regalado

This project is in support to the Philippine Food Staple Sufficiency Program of the Department of Agriculture which include prioritizing investment that can increase and sustain production growth especially interventions that have long term effects on rice productivity. It aims to increase production and reduce inputs through development, dissemination, and adoption of appropriate crop management technologies in both irrigated and rainfed ecosystems. Specifically it is geared to increase yield and area harvested to rice in irrigated and including other crops in rainfed lowland ecosystems; increase water productivity and reduce rice yield variability between irrigated and rainfed ecosystems with or without supplemental irrigation; promote and improve awareness on proven technologies that are resource use efficient; investigate related scenarios on changes brought by adoption of direct seeding and AWD such as shift on weed species and population, pest and diseases, and mechanization options; and refine existing technologies adaptable to ecological conditions especially on direct seeded rice in rainfed areas.

Component 1: Accelerating the dissemination of associated technologies for increasing yield and profitability in irrigated and rainfed ecosystems.
EBSibayan, KSPascual, LMJuliano, PSRamos, OHAbdulkadil, GFEstoy, MACdePeralta, HRPasicolan, ACSuñer, VCLapitan, JBTapec, RAMSanchez, MDParugrug, RSSalazar, JSGabisay, RRNarisma, GABFlancia, ARSRivera (PhilRice); SYadav, RCabangon, MBurac (IRRI)

Activities:

- Implementers meetings and project briefings conducted for the additional sites in Regions III, IX, and new sites in Region IVA. The implementers' meeting aims to brief key partners (NIA staff, DA-RFOs, and LGU officers) about the project, and how to implement based on established protocol.

- Series of appreciations seminar on S and T updates on rice production technologies that are resource use efficient. The two-day seminar cum workshop aims to enhance knowledge of the participants on crop management based on the PalayCheck System with emphasis on water management, specifically, the alternate-wetting-and drying (AWD) water saving technology. The workshop also includes planning for the establishment of technology demo farms (TDFs) in selected irrigators associations (IAs) or farmers organizations (FOs);

- On-site briefings on the implementation of TDFs for the selected IAs and FOs, and trained them on associated technologies and implementation protocols;
- Established TDFs in selected irrigated and rainfed areas;
- Provisions of seeds, drum seeders, and observation wells to some farmer cooperators for the TDFs of varietal trial, row seeding and AWD;
- Field monitoring and field visits to the different TDFs for documentation;
- Farmers' field day at selected TDF sites in different regions in the Philippines to share and discuss the results of technologies demonstrated;
- Participation to the annual FSSP project meetings organized by DA-BAR and project coordination meetings organized by the FSSP coordination group at IRRI;
- Attendance to a project-partnership launching with Right Agricultural Development Incorporated Korean Saemul Rice, Isabela State University, and Agri-component Corporation on January 21, 2016 at Echague, Isabela. The partnership jointly showcased technologies on seeds, machinery and recommended practices in rice farming;
- Regional Assessment and Planning Workshop of the project in Region 2 in DA-CVRC, Ilagan City on February 23, 2016;
- Project assessment and process documentation workshop in Cebu on May 25 to 26, 2016, participated in by 57 project staffers from PhilRice, IRRI and DA-RFOs.

Results:

- Table 10 shows progress of activities by region as of June 30, 2016. In total, there were 56 implementers meetings, 52 appreciation seminars, 466 on-site briefings, 1,812 TDFs' established, and 135 field days conducted nationwide. Photo documentation was shown in Figures 30, 31, and 32.
- From January to June 2016, 13 appreciation seminars with 514 participants and 58 onsite briefings with 1,496 attendees were conducted. There were also 214 TDFs, 22 field days,

535 observation wells, 662 packs of seeds at 2kg per pack and 16 drum seeders distributed to farmer cooperators (data not shown);

- In Mallig Isabela, there was a reduction in the frequency of water pumping for irrigation using shallow tube wells from 2 to 3 times a week to once a week. Farmer cooperators (Mr. Igmeo Ventura and Mrs. Leonida Baniqued) reported that a reduction of diesel consumption from 2.5 to 1.5 drum per cropping season using AWD was achieved;
- Irrigated area increased by 27 to 33% in Balufia and Liwanag IAs in Tumauini, Isabela using AWD; From the average of 75.1 ha area harvested during wet season, it increased to 95.1 ha during the dry season in Balufia IA using AWD; Similarly, from 125.0 area harvested during wet season, it increased to 166.5 ha in Liwanag IA using AWD;
- In Ilocos Norte, new varieties such as NSIC Rc360, NSIC Rc392, and NSIC Rc230 achieved higher grain yields which ranged from 6.2 to 6.5 ton ha-1 relative to the common variety used by farmers- PSB Rc82 with 5.3 ton ha-1.
- Using observation wells for AWD, farmers in 4 IAs (Bonga Pump 1, SANDMIA IA, Western IA and Cabuquiran IA) in Ilocos Norte were able to observe and record 7 days irrigation interval for their fields;
- In San Rafael Bulacan, NIA- AMRIS reported that power consumption of a low-lift pump for irrigation was reduced from 118,1 78 to 113, 680kWh when farmers in Kapatiran IA used AWD; This resulted in a 3.8% reduction in power cost;
- In Bagong Silang IA in Apalit, Pampanga, there was no observed change in the irrigation interval using AWD, however farmers relayed that they are no longer worried if there is no visible water on their fields provided that there is water inside the observation well;
- In Masinloc, Zambales, farmer cooperators of Sta. Rita Tinaptapi IA, reduced their seeding rate from 60 to 40kgs ha-1 using drum seeder for row seeding relative to manual broadcast method;
- In Region V, increased resource use efficiency through the use of associated technologies was observed in ten TDFs. Seeding

rate was reduced by 63% using plastic drum seeder for row seeding (from 100-150 to 37-60 kg ha-1) relative to manual broadcast; reduced fuel cost by 57% using AWD in pump-irrigated areas (from 112 to 48 li) ; and increased quantity of fertilizer rate using RCM from 91-21-14 to 101-32-32 NPK kg ha-1 as per recommended but improved yield by 33.3% (7.3 to 9.7 ton ha-1);

- In ten TDFs in Zamboanga del Norte and Zamboanga del Sur, frequency of water delivery for irrigation reduced from 12 to 8 times using AWD; mean grain yields also increased by 5.8% in farms practicing AWD relative to previous yield using conventional method (*e.g.* continuous flooding);

- In Region IX, farmer cooperators in six IAs increased their yields by an average of 5.7% and reduced frequency of water delivery for irrigation by 33.3% using AWD (from 12 to 8 times) (Table 10); In addition, seeding rate was reduced from 120kg ha-1 (PhP 3,840) to 60kg ha-1 (PhP 1,280); thus saved PhP 2,560 by using plastic drum seeder for row seeding.

Table 10. Progress of activities with associated technologies by region (as of June 30, 2016).

Region	Activity					
	Implementers' meeting	S&T update/ training	On-site briefings	TDF establishment	Activity monitoring/data collection	Field day
1	*	*	√*	*√	*	*
2	*√	*√	√*	*√	*√	*
3	*√	√	√*	*√	*√	*
4A	√					
4B	√	*√	√*	√	√	
5	*	*	*	*√	*√	*√
6	*√	*√	√*	*√	*√	*√
7	*	*	*	*	*√	*
8	*	*	√	*	√	
9	√*	*	√*	*√	*√	*
10	*	*	√	√	√	
11	*	*	√*	*√	*√	*
12	*	*	*	*	*√	*
13	*	*	*	*√	*√	*√
18	√*	√*	√*	*√	*√	*√
CAR	*	*	√*	*√	*√	*
ARMM	*	*	*	√	*√	
PhilRice	30	43	231	508	-	34
DA-RFOs	28	9	235	1304	-	101
TOTAL	**58**	**52**	**466**	**1812**	**-**	**135**

Note: The symbol √ means the activity was conducted between 1 January and 30 June 2016; the asterisk (*) means this activity was conducted in the previous year of the project.

Component 2.1 A shift in weed species and populations, pests and diseases, changes in micro-climate, and options for mechanization in fields adopting AWD water management technique
ECMartin, RMSMartin and KSPascual

Weed populations are usually mixed and composed of a number of different species in any given field. Weed management practices (any practice, not just herbicides) will have a slightly different effect on the individual species in the population mixture. Over time, continued use of one practice can lead to the population being dominated by one species or group of species. Any cultural, physiological, biological, or chemical practice that modifies the growing environment without controlling all species equally can result in a weed shift. This study aims to identify potential weed problems in water-saving technology for rice; document temporal and spatial shifts in weed species in fields that practice alternate wetting and drying (AWD) and determine the effect of water-saving technology and weed management on the yield of rice.

Activities:

- Evaluated possible weed shift in farmers' rice fields adopting AWD and continuous flooding during dry season 2016 in three farmers' field in Brgy. Calantipe, San Simon, Pampanga.

- Two water management plots with an area of 500m2 each served as sampling area. One plot for alternate wetting and drying (AWD) and another plot for continuously flooded (CF). The varieties used were NSIC Rc 222, 342 and 298. Transplanting dates range from December 18 to 27, 2015.

- Weed count by species was measured in three 1m2 quadrat at 28 to 39 DAT, 64 to 66 DAT and at 75 DAT.

Results:

- Seven weed species were observed during 2016 dry season in continuously flooded plot. This includes; 4 grasses (Leptochloa chinensis, Ischaemum rugosum, Echinochloa glabrescence and Echinochloa crus-galli), 2 sedges (Cyperus iria and Fimbristylis milliacea) and 1 broadleaf (Ludwigia octovalvis).

- For alternate wetting and drying plot (AWD), eight weed species were observed. This includes 5 grasses (Leptochloa chinensis, Ischaemum rugosum, Echinochloa glabrescence, Echinochloa colona and Echinochloa crus-galli), 2 sedges (Cyperus iria and Fimbristylis milliacea) and 1 broadleaf (Ludwigia octovalvis).

- Cyperus iria dominated the AWD plot while Ischaemum rugosum and Echinocloa crusgalli dominates CF plot. (Table 11).

- Herbicides used by farmers were Londax (Bensulfuron Methyl) and Nominee (Bispyribac-sodium).

- Higher yield was recorded in CF plot (5.19 t/ha) than with AWD plot (4.63t/ha).

Table 11. Top three weed species observed throughout the season in both plots, 2016 DS.

Treatment	28-39 DAT	64-66 DAT	75 DAT
Continuous Flooded	*-Cyperus iria* *- Ischaemum rugosum* *- Fimbristylis miliacea*	*- Leptochloa chinensis* *- Cyperus iria* *-Echinocloa crusgalli*	*- Echinocloa crusgalli* *- Ischaemum rugosum* *- Cyperus Iria*
AWD	*-Cyperus iria* *- Ischaemum rugosum* *- Leptochloa chinensis*	*- Cyperus iria* *-Leptochloa chinensis* *- Fimbristylis miliacea*	*- Cyperus iria* *-Ischaemum rugosum* *- Echinocloa crusgalli*

Evaluation of agronomic and energy efficiencies of mechanical direct-seeded rice crop establishment in combination with reduced tillage
MJCRegalado, CPMAriola, and KSPascual

With the increasing cost of rice production, there is a need to apply combination of rice production technologies that could lessen the production costs while increasing the income of farmers. This study generally aims to evaluate the performance of hybrid and inbred rice varieties under reduced tillage with fertilizer recommendation of Rice Crop Manager (with and without vermicast) and direct-seeding methods under rainfed condition. Specifically it aims, to evaluate yield response of mechanical direct seeded rice; and determine the advantages of application of organic fertilizer under reduced tillage and alternative seeding methods, if there are any, in terms of energy efficiency and cost-effectiveness.

Activities:

- Conducted field experiment during 2016 dry season (December 2015 to April 2016) at PhilRice-CES, Nueva Ecija. Plots size at 3.3 x10.0 m (for blocks 1 to 12) and 2.6 x 8.4 m (for blocks 13-24) were laid out in split- split plot design in RCBD with nutrient management technique (level= 2) as the main plot, mechanical direct seeding (level= 4) as the sub-plot and variety (level = 3) as the sub-subplot in four replications;

- The main plot consisted of rice crop manager recommendation with and without vermicast (RCM and VRCM); The sub-plot consisted of row seeding using manual plastic drum seeder (DS), push-type Korean seeder (KS), manual dibbling (L), and a drill type seeder using the Indian zero till planter (IZ); The sub-sub plot treatments consisted of varieties M20 (V1), NSIC Rc9 (V2); and NSIC Rc298(V3) (Figure 33);

- The experimental field was dry plowed once using a 4-wheel tractor with rotary tiller (rotavator). Pre-emergence and post-emergence herbicides were applied at 3 and 18 days after sowing, respectively. Occasional rouging and manual weeding were also employed to keep the plot weed free at 0-45 DAS. Sown seeds were protected from birds, rats (using baits) and other pests that feed on the seedling or the seeds. One day after seeding, flush irrigation was done to promote seedling emergence. Subsequent flush irrigation was employed once a week. The crops were harvested when 80 to 85% of the grains in the panicle have matured.

- Gathered data on plant height, weed counts, grain yield and yield components. Other parameters such as energy efficiency, labor productivity and cost-effectiveness will be computed.

Results:

- Figure 31 shows the grain yields of the different treatments under rainfed condition for 2016 DS. NSIC Rc298 was significantly higher ($P < 0.05$) by 11 to 20% relative to M20, but both varieties were not significantly different with NSIC Rc9. Mean grain yields ranged from 3.1 to 3.9 ton ha-1 across nutrient management and seeding methods.

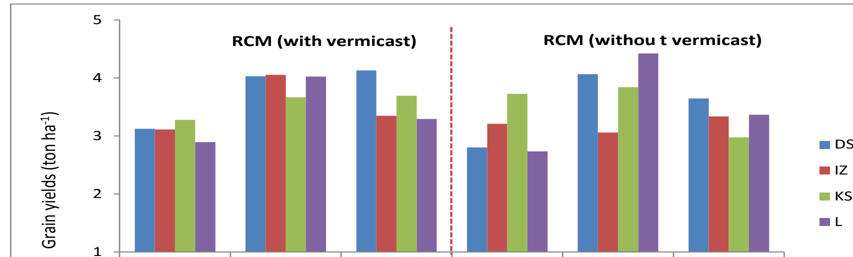
- There were no significant effects of RCM with or without vermicast application and seeding methods on the grain yield of rice;

- Mean grain yields in RCM without vermicast application showed that DS had higher yields by 6 to10% relative to other treatments. Grain yields ranged from 3.4 to 3.8 ton ha-1;

- Plant height of NSIC Rc9 was significantly higher ($P < 0.05$) with 97.2cm relative to other treatments;

- Energy efficiencies, labor productivities and cost-effectiveness of the different treatments will be computed (on-progress).

Figure 30. Crop stand of NSIC Rc298 at 51 DAS grown under reduced tillage and aerobic soil condition using mechanical (push-type seeder) and conventional method (dibbling), PhilRice-CES, 2016 DS.



	M20	NSIC Rc298	NSIC Rc9	M20	NSIC Rc298	NSIC Rc9
DS	3.12	4.03	4.13	2.80	4.07	3.65
IZ	3.11	4.05	3.35	3.21	3.06	3.34
KS	3.28	3.67	3.69	3.73	3.84	2.98
L	2.89	4.02	3.29	2.74	4.42	3.37

Figure 31. Mean grain yields of the different treatments under rainfed condition for 2016 DS.

Development and dissemination of zero-till planter with fertilizer applicator for direct seeding
MJCRegalado, CPMAriola, MLRafael, and KSPascual

Rice production systems in the Philippines are changing and farmers are moving from manual intensive activities to various labor saving technologies. Reduced tillage and direct seeding for example offer such advantages because of faster and easier planting, reduction of labor and drudgery, increased water-use efficiency, and often higher profit in areas with assured water supply. With the advent of mechanical row seeding, establishing direct-seeded rice considerably reduced labor requirements and further improve seedling emergence by placing seeds at a more uniform depth in the seedbed. In unfavourable rainfed environment, mechanical seeding may be important in reducing drought stress of seedlings by providing better seed covering after seeding (Pandey et al., 2002). Combining these principles, a zero-till planter, initially developed in India, had been improved by Philippine Rice Research Institute to suit the Philippine condition.

Activities:

- Established field experiment for the performance evaluation of the PhilRice-developed reduced till planter during 2016 DS at PhilRice CES. The experiment was laid out in split plot RCBD design in three replications. The main plot consisted of seeding method: Broadcast (B); Push type Seeder and PhilRice-developed Reduced Till Planter (RTP); the sub plot consisted of varieties: PSB Rc10 (V1) and NSIC Rc222 (V2) (Figure 32).

- Gathered data on seedling emergence, actual seed rate, plant height, grain yields and yield components.

- Energy efficiencies, labor productivities and cost-effectiveness of the different treatments will be computed (on-progress).

Figure 32. Dry seeding using different seeding methods (a) reduced till planter (b) push type seeder (c) broadcast method.

Results:

- Table 12 shows the design specifications of the PhilRice-developed reduce till planter. The till-planter has a field capacity of 2 to 3 ha/day and a seeding rate of 20 to 60 kg rice/ha. It has 9 rows with an effective working width of 2 meters. The prime mover is a compact four-wheel tractor with a labor requirement of one person;

- Performance evaluation of the planter during 2016 DS, showed that actual seeding rate of RTP was within the range of recommended seed rate of 20 to 60 kg seed/ha for seeding. The seeding rate were 58 and 35kg seeds/ha for PSB Rc10 and NSIC Rc222, respectively. These were higher than the push type seeder which had and seeding rate of 41 and 29 kg seeds/ha for PSB Rc10 and NSIC Rc222, respectively. Necessary adjustment on the angle of tilt of the seed metering plate will be done to obtain 40kg/ha seeding rate.

- No significant differences were observed on the grain yields among seeding methods (Figure 33). However, grain yields of RTP were higher by 6 to 11% relative to PS and B, regardless of varieties; the same results were also noted in the yield components wherein the productive tiller per m2, percent filled and unfilled grain, and the 1000 grain weight did not differ among seeding methods (data not shown).

- Plant height at maturity of NSIC Rc222 was significantly higher by 16% ($P< 0.05$) relative to PSB Rc10 across seeding methods.

- Grain yields were significantly different among varieties. Grain yields of NSIC Rc222 were higher by 25 to 28% relative to PSB Rc10 regardless of seeding methods (Figure 33).

Table 12. Design specification of the PhilRice developed till planter.

Details	Specifications
Prime mover	Compact four wheel tractor
Field Capacity (ha/day)	2-3
Labor requirement (no. of person)	1
Number of rows	9
Effective working width (m)	2
Seeding rate kg/ha	20-60 (for rice)

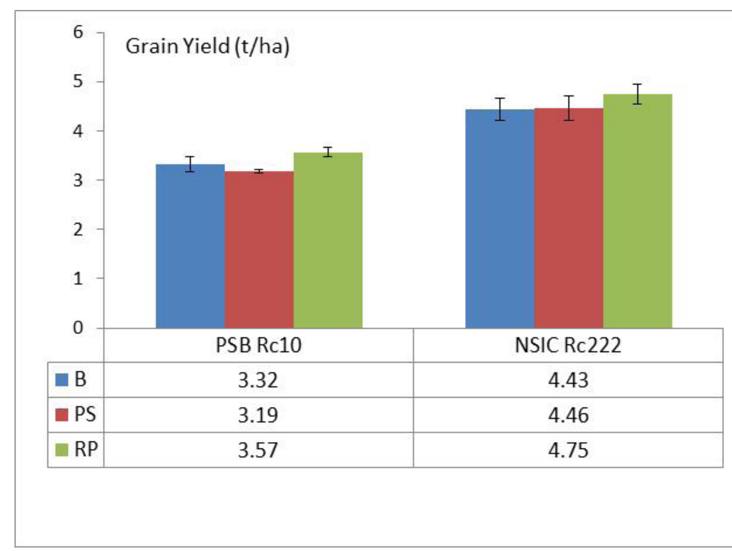


Figure 33. Mean grain yields of two rice varieties under different seeding methods, 2016 DS.

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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