Quality Rice. Quality Life.

2017
National Rice R&D
Highlights

AGRONOMY, SOILS & PLANT PHYSIOLOGY DIVISION

DEPARTMENT OF AGRICULTURE
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Agronomy Soils and Plant Physiology Division

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Executive Summary

The Agronomy, Soils and Plant Physiology Division (ASPPD) advances research on improved plant, water, soil and nutrient management practices with focus on resource-use efficiency and environmental protection. It's goal is to develop technologies for the rice farmers to increase crop yield and quality of produce through cost-effective, resource-use efficient, climate-resilient, and environmentally-sound farming. The functional objectives were identified based on the specific tasks assigned to the division: (1) identify and propagate approaches for nutrient and crop management with the integration of management of principal insect pests and diseases; (2) develop technologies that will improve soil and water conservation practices; (3) develop practices to manage crop residues for healthy soils in rice ecosystems; (4) strengthen the scientific basis for rice-based cropping system technologies; and (5) assess the impact of developed technologies on environmental quality. Finally, the division started the development of crop management protocols for specific rice ecosystems, and diagnostic tools and processes toward sufficiency and sustainability.

Seven research projects and a project on laboratory management were implemented to partially approach the main objective of the division. These projects were (1) Assessment of soil fertility, plant, water and nutrient management including plant responses, (2) Development and assessment of soils, water and nutrient diagnostic tools, (3) Assessment and evaluation of crop intensification and resource-use efficiency in rice production, (4) Assessment and evaluation of variety, water, nutrient and pest interactions, (5) Development of crop management practice for stress environments, (6) Soils health, water quality and availability, (7) Nutrient and pest interactions, and to support (8) the ASPPD Research and analytical laboratory systems and maintenance.

In the long-term fertilizer experiments conducted on-station, yields of rice varieties applied with pure inorganic fertilizers were low in the 2017 dry and wet seasons due to pest damages (whitehead and hopper burn). In another study, the use of pure organic fertilizers did not further increase the grain yield of PSB Rc82 in the dry season, but with similar yields applied with inorganic fertilizers in the wet season. Agronomic efficiency of applied N (AEN) was found to be higher with inorganic fertilizer than with organic fertilizer use. In the on-farm trials, inherent productivities of rice farms in Laguna, Nueva, and Pangasinan were found to be high due to the suitability of their soil characteristics to lowland rice. Rice yields can be further increased with improved nutrient management using the Rice Crop

Manager and applying the deficient nutrients at the proper amount and time complemented with good cultural management practices. In the rice-other crops cropping system, the two on-farm sites were generally highly suitable for crop diversification. The introduced improved crop management strategy increased the productivity and profitability of the farmer's current cropping patterns and practices with an average advantage return on investment of 8.56% for the corn-rice-rice and 55.8% in the onion-rice cropping systems.

In the production of vermicompost, rice straw and carabao manure produced good and quality fertilizer materials. For the production of vermiworm, the use of banana trunk produced more worms than the other indigenous materials used in the study.

Mid-season nitrogen requirement of rice was determined based on an algorithm derived from the N-Rich reference plots. Highest yield of PSB Rc82 was obtained from the application of 90 and 120 kg N/ha during the panicle initiation (PI) stage. The result showed that the N-Rich reference plot can be used to adjust N fertilizer rates at PI using the optical NDVI measurements and achieve high yield.

The use of rice varieties with high yield potential is one of the key factors in achieving higher productivity and rice self-sufficiency. Along with variety, N fertilizer application has large contribution in attaining high rice yield potential. Most of the test varieties tested achieved higher yield potential with fixed rate and time (FRFT) of N application of 190 kg/ha than the leaf color chart (LCC)-based N application ranging from 74-112 kg/ha in the DS. Grain yield of the LCC-based and FRFT N management did not significantly differ in the WS. This was due to the small differences in the N rates used during WS. AEN were significantly higher in both DS and WS with these two fertilizer management schemes.

Several rice genotypes evaluated under abiotic stresses (flood and drought) showed significant effects on the growth and yield. Under the flood stress trial in the field, average plant height increased by 4.0% following short-term partial flooding (STPF) with 25 cm floodwater depth, but was reduced by 6.8% following STPF with 50 cm floodwater depth. Aboveground plant biomass increased by 2.8% in STPF with 25 cm floodwater depth and was reduced by 32.3% in STPF with 50 cm floodwater depth. With 44-day old seedlings, plant height was reduced by 4.0%; tiller count, 5.0%; number of green leaves, 1.6%; and aboveground plant biomass, 9.4%. Aboveground plant biomass increased by 1.0% with N application two days after de-flooding. However, aboveground plant biomass was reduced by 4.7% N application seven days after de-flooding. Average grain yield increased by 1.4% following STPF with 25 cm floodwater depth but was reduced by 29.7% following STPF with 50 cm floodwater depth. Grain yields of 44-day old seedlings (PSB Rc82, FR13A, and PR41543-B-14-2-1-2) increased by

an average of 24.4% compared with the 21-day old seedlings. Grain yield of Ciherang Ag+ Sub1 was reduced by 14.0% across STPF and SF. Average grain yields were reduced by 1.2% with N application seven days after de-flooding, and by 4.6% with N application two days after de-flooding across STPF floodwater depths. Thus, the increased degree and duration of flooding stress decreased rice crop growth and yield to a greater extent. The role crop management (e.g., use of older seedlings and post-flood N application) in compensating for the reduction in crop growth due to flooding stress among rice genotypes needs further study.

In the greenhouse drought stress trial, eight rice genotypes (Green Super Rice or GSR-21, Raeline-10, NSIC Rc282, CT 9993-5-10-1-M, UPL Ri-5, NSIC Rc160, PSB Rc14, and NSIC Rc416) had slow progression of leaf rolling and leaf tip drying; indicating drought tolerance. These eight varieties also recovered better after re-watering due to growth of new leaves and tillers. Under field condition, growth and yield of three rice genotypes (i.e., NSIC Rc418, NSIC Rc282, and NSIC Rc222) in response to fertilizer management with emphasis on K levels at 20-day vegetative drought stress by withholding irrigation from 15 to 35 DAT then re-watered and 20-day reproductive drought stress by withholding irrigation from 60 to 80 DAT then re-watered were evaluated. The fertilizer treatments were: (a) F1: 0-0-0 kg NPK/ha, (b) F2: 120-40-60 kg NPK/ha, and (c) F3: 120-40-120 kg NPK/ha. All of P2O5 at 40 kg/ha and ZnSO4 at 25 kg/ha were applied at 14 DAT. In each of F2 and F3 treatments, 1/3 N and 1/3 K2O were applied at 14 DAT, and the remaining 2/3 N and 2/3 K2O were applied at 40 DAT. Plant heights across rice genotypes ranged from 83.3 to 95.1 cm following vegetative and reproductive drought stresses with fertilizer treatments. NSIC Rc282 showed higher plant heights than NSIC Rc418 and NSIC Rc222. However, NSIC Rc222 had more tiller count per plant. Compared with NSIC Rc418 and NSIC Rc222, NSIC Rc282 was considered more drought-tolerant due to slower progression of leaf rolling (visible reaction to drought stress due to reduction in cell turgor), higher growth (i.e., taller but with less tillers), and grain yield in response to (a) 20-day vegetative drought stress and re-watering and (b) 20-day reproductive drought stress and re-watering, and higher K fertilizer application (i.e., 120-40-120 kg NPK/ha vs.120-40-60 kg NPK/ha). NSIC Rc418 had the lowest grain yield of 1.7 t/ha following vegetative drought stresses and re-watering. NSIC Rc222 had a grain yield of 2.5 t/ha following reproductive drought stress and re-watering. With 120-40-60 kg NPK/ha, NSIC Rc282 had the highest grain yield of 4.5 t/ha following vegetative drought stress. With fertilizer treatment of 120-40-120 kg NPK/ha, higher yields of 4.8 t/ha and 4.3 t/ha were obtained with NSIC Rc282 following vegetative and reproductive stresses, respectively. With the integration of the genetic (e.g., genotype) and agronomic management (e.g., increased level of K fertilizer application), the drought tolerance of rice genotypes could be improved. Among the 18 rice genotypes/varieties evaluated for growth and dry matter yield, only eight genotypes survived.

From the top eight performing genotypes, UPL Ri-5 and Raeline -10 were recommended for evaluation of drought tolerance (bigger soil volume and hence slower drought stress development) in DS 2018.

Some interactions occurring in rice fields like N management, diseases, and beneficial organisms like plant growth-promoting bacteria (PGPB) were evaluated under field, screenhouse, and laboratory conditions. Nitrogen fertilizer application of 95 kg/ha provided optimum growth and grain yield even if infected with the bacterial leaf bight disease (BLB) under field conditions in Nueva Ecija, and 0.825 kg N/pot in screenhouse condition in Agusan del Norte. Severity of BLB and sheath blight (ShB) diseases were significantly lower by 7.7-10.5 % if PGPB was inoculated to the diseased rice plants. Thus, it is recommended that such fertilizer rate and inoculation of PGPB can be incorporated to site-specific nutrient management to increase productivity and cost-effectiveness of rice farming in the two provinces.

In another study, mortality of the paddy earthworm, Sparganophilus sp., significantly increased with increasing concentrations of copper from 0 mg/kg to 1200 mg/kg after 7, 14, and 21 days of exposure. As such, this worm has the potential to be used as test species for assessing soil pollution or contamination with toxic chemicals to ensure safe and better quality products from the rice environments.

In the ASPPD Research and Analytical Laboratory Systems and Maintenance Project, database on the inventory of incoming and outgoing of chemicals, which prevented the over-supply of chemicals was maintained and updated. Twenty-seven laboratory equipment had undergone annual preventive maintenance service (PMS) and calibration while three equipment were repaired. The 2017 semi-annual report on the requirement of “Permit to Purchase” and “Controlled Precursors and Essential Chemicals” on the procurement and usage of chemical supplies in our research activities controlled by the Philippine Drug Enforcement Agency (PDEA) was submitted. Several centers/divisions/institute also used the ASPPD laboratory facility. Walk-in visitors, guests, students and faculties from universities/sectors were accommodated for technical assistance, laboratory orientation and for laboratory benchmarking. Technical assistance and on-the-job training were provided to students and participation to semi–annual Chemical Spill Drill was attended by laboratory personnel.

I. Assessment of Soil Fertility, Plant, Water, and Nutrient Management

Wilfredo B. Collado

The fertility of wetland rice soils traditionally has been very stable because of fertility-conserving farming practices combined with the fertility-enhancing effect of flooding. However, advances in flooded rice culture for the past several decades threatens sustained soil fertility and productivity. Methods used to assess soil fertility, productivity, and sustainability were conducted through long-term field experiments, development and management of fertilizers, and development of crop, land, and nutrient management approaches addressing sustainability and durability of the cropping and land management systems.

Two studies under this project focused on the long-term effects of inorganic and organic fertilizer use on crop productivity, soil fertility, and sustainability of the rice-rice cropping system. The study on inorganic fertilizer use also addresses closing the yield gap that exists between the potential and actual yield. Over the years, continued use of inorganic fertilizers on a rice-rice cropping system at the Central Experiment Station of PhilRice showed that 80 and 65% of the potential yields of the rice varieties tested can be achieved sustainably during the dry and wet seasons, respectively. Grain yields of 8-9 and 5-6 t/ha were achieved in the dry and wet seasons, respectively. Recently, these yield levels were not achieved due to pest damages that need to be addressed to attain the targeted outputs. On the other hand, continued use of pure naturally-available farm organic amendments on a rice-rice cropping system showed similar productivity with that of the pure inorganically grown rice during the wet season only and was achieved every three years. In the dry season, only moderate productivity can be achieved with the use of pure organic materials. Further results of the two studies showed that soil organic matter increased over time even with or without organic and inorganic fertilizer application. Agronomic efficiency of applied N was highest (22.5 kg grain kg/N) with inorganic fertilizer use applied based on crop need using the LCC. Indigenous N, P, and K supplies of the experimental fields at the Central Experiment Station were still high.

Another study focused on the development of a sustainable pure organic-based nutrient management in a rice-rice cropping system as a complementary study for the long-term organic fertilizer study. Green manures were used as topdress fertilizer materials in addition to the organic materials applied initially before crop establishment. Green manures with low C:N ratio like wild sunflower and azolla showed potential in providing additional yield increases when topdressed. Another result of the study on the use of Azolla showed that it had decreased salinity and increased soil pH although the soils used was only slightly acidic. The high iron content in Azolla may indicate its potential as phytoremediation to heavy metal-laden soils. The other green manures apparently cannot grow well in the climatic condition of the Maligaya conditions with too much water and high relative humidity. Hence, Azolla can be the best option as alternative topdress in the rice-rice cropping system. A final organic-based nutrient management protocol will be the output of these two studies.

The other studies focused on the suitability and durability of different cropping systems (rice-based) for the development of a durable, profitable, and sustainable crop and land management systems. The corn-rice-rice cropping system (dry-early wet-late wet) in San Manuel soil series showed high suitability in the area and obtained higher return on investment with the improved nutrient management strategy compared with the farmer's practice. In the onion-rice cropping system (dry-wet) in Quingua soil series, higher yields and profit were obtained through the introduced improved nutrient management strategy than through farmer's practice. In the rice-rice cropping system in Laguna, Nueva Ecija and Pangasinan covering three soil series, namely, Lipa, Maligaya and San Manuel, respectively, the nutrient management recommendations from the Rice Crop Manager have improved the productivity and sustainability of the cropping system. To improve the durability and sustainability of the cropping system, Maligaya soils in Nueva Ecija should be regularly applied with chemical fertilizers containing N, K, and S with rice straw incorporation to increase the supply of K. Lipa soils must be applied with N, K, and S fertilizers instead of NPK or complete fertilizers. San Manuel soils must be applied with NPK or complete fertilizers even without S. Furthermore, nutrient management based on RCM can be employed to the different soil series, especially in dry season, to improve productivity and profitability. Efficiency of the resources used will be measured further to assess sustainability of the different cropping systems.

Long-term Soil Fertility Experiment
Wilfredo B. Collado, MA Ramos

The Long-Term Soil Fertility Experiment at the Central Experiment Station of PhilRice have been conducted since 1968 to assess the sustainability of intensive double rice cropping in a year and to provide indicators of nutrient imbalances with crop intensification and changes in soil properties. The 59th and 60th rice cropping were established in 2017 in an attempt to close the yield gap that exists between the potential and the actual plausible yield under certain environmental conditions.

The dry season grain yield of 7.26 t/ha showed similar yield levels from the previous dry season croppings based on the yield potential of the rice varieties tested. The yield components contributing to the increase in harvest included the number of panicles per unit area and the number of spikelets per panicle. Agronomic efficiency of applied N was highest at 20.45 kg grain kg/N applied with the LCC-based application method. The indigenous nitrogen, phosphorus, and potassium supplying-capacity of the experimental field was 71.9, 20.4, and 102.5 kg/ha, respectively. The indigenous N and P supplies were similar to previous results of field trials but not for K. This is due to the estimation of grain yield from the yield components data.

In the wet season, low grain yields were obtained due to damages caused by bacterial leaf blight and hopper burn from brown planthoppers. Thus, the outputs for the wet season were not achieved. Hence, it is recommended that mechanisms/management to eliminate or minimize these factors must be sought.

Long-term Organic Fertilizer Use in Paddy Rice and Soils
Evelyn F. Javier, AE Espiritu

Most reports on the significant effect of organic fertilizers were on dry crops or agricultural crops that are planted in aerated soils where water is minimally employed. Few had given so much elucidations on their effect on continuously irrigated or submerged soil conditions like rice production. Therefore, this study is set to give data-base and science-based information on the real-time effect of continuous use of organic fertilizer in flooded soils toward development of an organic-based rice production optimized at sustainable level of grain yield and soil health and productivity in a close nutrient cycling system. Several commonly available farm waste were considered as treatments: rice straw, chicken manure, green manure, and vermicompost. These were applied alone, and in combination with half and with full recommended rate for dry season and wet season. Unfertilized plots were used as indicator of the current indigenous nutrient supply. PSB Rc82, an inbred variety, was used as test plants. The treatments were then laid out in factorial RCBD in four replications. In more than 15 years of continuous application of different organic materials mostly available in the farming system, a trend of getting similar yield from the pure organically-grown rice plants and the inorganically-applied plants was observed only in WS 2005, WS 2007, WS 2011, WS 2013, and WS 2016. Nutrient demand is less in the wet season than in the dry season, an apparent reason of comparativeness between organic and inorganic fertilizers. For the rest of the other seasons particular in the dry season, yield was lower from the organically applied plots than those with inorganic fertilizer with or without organic fertilizers in combined. The basic science and/or information will be the basis of packaging component of an organic based rice production technology.

Durability of Rice-rice Cropping in Irrigated Lowland Ecosystem

Jehru C. Magahud, SLP Dalumpines, WB Collado

A durable cropping system is achieved through maintained quality or efficiency of the used resources, so that outputs do not decrease even if inputs are not augmented. As such, the study is conducted to determine the inherent productivity of paddy soils under rice-rice cropping systems, assess the effect of farmers' nutrient management practices vis-à-vis Rice Crop Manager (RCM) on soil productivity, and produce management recommendations for improving productivity of paddy soils. The study was done in 12 sites: Sta. Cruz, Laguna representing Lipa soil series; Muñoz, Nueva Ecija, representing Maligaya series; and San Manuel, Pangasinan representing San Manuel series. Field and screenhouse nutrient omission techniques and field comparison between RCM and farmer's practice were done.

Results showed that all soils have the following characteristics classified as highly suitable (S1) to crop production: slope at 0%, flooding incidence that ranges from no flooding to 3-4 months of flooding, flooding intensity at 0 – 20 cm, volume of coarse fragments at <3%, and soil depth at >80 cm. Drainage is S1 for all Maligaya and San Manuel soils. Meanwhile, drainage ranges from S1 to marginally suitable (S3) in Lipa soils. Surface texture is either S1 or moderately suitable (S2) in Nueva Ecija soils, S2 in most Laguna soils. Suitability in terms of surface texture varies among Pangasinan soils.

Results of minus-one element technique from WS 2015 until DS 2017 showed the following: the three soil series deficient in N; Maligaya and Lipa series deficient in K and S; Lipa series sufficient in P; and San Manuel series sufficient in S. Indigenous P (25.1 kg/ha) and K supply (181.8 kg/ha) were significantly higher in Lipa series.

RCM improved rice yield by 0.74 t/hectare in six sites in DS 2017. The six sites recorded an average of 7.55 t/ha for RCM and 6.81 t/ha for farmer's practice.

Maligaya soils should be regularly applied with chemical fertilizers containing N, K, and S, and rice straw should also be incorporated in these soils. N, K, and S fertilizers instead of NPK or complete fertilizers can be applied on Lipa soils should such combination is cheaper. NPK or complete fertilizers without S can be applied on San Manuel soils should this combination is cheaper. Furthermore, nutrient management based on RCM can be employed to the soil series during dry season.

Improving Agricultural Productivity Using Soil-based Agro-technology Transfer

Sandro D. Cañete, WB Collado

The study validated the performance of rice and non-rice cropping system associated with the requirements to enhance production on the on-farm level and provide common medium of communication for series-based technology transfer. Technology demonstration-cum research trials were established in the two land units known for their high suitability to multiple types of crop: San Manuel series in Brgy. San Joaquin, Balungao, Pangasinan and Quingua series in Brgy.Burnay, Talavera, Nueva Ecija.

Suitability analysis using the FAO framework showed that corn-rice-rice and onion-rice in Pangasinan and Talavera, respectively, have high inherent suitability ratings with respect to the properties of the land units. Interventions associated with land limitations such as drainage (rice) and nutrient management (all crops) were employed to optimize the performance and increase the profitability of the cropping systems.

In San Manuel series, the performance of the cropping system showed that rice consistently out-yielded the farmer's practice by an average of 0.30 t/ha and 0.29 t/ha in 2016 third cropping and 2017 second cropping, respectively. These were associated with the efficient use of nutrient particularly nitrogen. Higher return on investment (ROI) was also generated in the two rice cropping systems across sites averaging an increase of 20.60% and 7.67% over the farmer's practice. The second year of yellow corn production had an average yield difference of 0.58 t/ha compared with the farmer's practice. Relatively, almost similar ROI was generated from the trial and farmer's practice sites.

In Quingua series, higher yields and profit were obtained in the study sites than from the usual farmer's practice. Bigger and heavier onion bulbs were produced in the trial sites with an average yield difference of 3 t/ha over the farmer's practice. This implies an efficient nutrient use relative to crop yield. Similar results were observed in rice production.

Results showed that the site specific nutrient management using RCM for rice and the adjusted recommendations based on the inherent fertility of the soil for non-rice crops consistently improve the performance of the crops, increase nutrient use efficiency, and economic benefits across sites and seasons relative to the farmer's practice.

Optimized Utilization of Azolla spp as Alternative and Potential Organic-Based Nitrogen Nutrition for Irrigated Rice Crops
Evelyn F. Javier, XXG Sto Domingo, JM Mercado

Supplement the insufficiency of the organic basal nutrient supplement to rice, a study with different activities were conducted to (1) optimize the use of A. microphylla as a topdress N fertilizer to supplement two best organic-based basal fertilizer, and (2) screen different Azolla accessions as potential organic topdress N fertilizers to problem soils and environment.

A hybrid and inbred rice varieties were used as test plants. Significant effect on yield was observed only during the wet season, apparently due to lower nutrient demand during wet season when lower solar radiation is limited. It is interesting to note that a hybrid rice variety was responsive to pure organic fertilizer in the WS 2017 but yielded a comparative harvest with the inbred variety during DS 2017. Application of KeyCheck No 5 of the Palaycheck System showed significant grain yield among the subplot treatments regardless of varieties used in the dry season. This signify that there are still improvement in the technology component to get a comparative yield from the OBNM particularly on the right amount and right time of application of organic N alternative sources.

The screening of different Azolla accessions was conducted to find its potential as alternate N sources in hot and humid irrigated lowland rice ecosystems and as ameliorating aquatic plants for problem paddy soils (e.g., acidic and saline). Four Azolla spp had survived the hot and humid rice areas with A. microphylla as the most tolerant variety. Introduction of Azolla had decreased the salinity status of the soils, and also increases soil pH. Likewise, the high iron content observed in Azolla may indicate its potential as phytoremediation to iron toxicity problems in rice soils.

II. Development and Assessment of Soils, Water, and Nutrient Diagnostic Tools
Ailon Oliver V. Capistrano

This project aimed to develop and evaluate tools that would aid farmers in their decision-making particularly on the area of fertilizer management. Although it is one of the most significantly yield-affecting activities in rice production, it also receives the least attention from most farmers often resulting to improper or poorly fertilized rice fields hence, their low productivity. This reality can be traced from the fact that most farmers have minimal appreciation and financial investment for rice nutrient management. They often rely on information handed-down from their fathers gained through years of experience but are oftentimes loosely congruent with the principles of crop nutrition. As such, this project helped farmers manage their fertilizer applications through the assessment of a recently developed light quality sensor-based diagnostic prototype for nitrogen and basic studies about dark green color index (DGCI) extraction from digital leaf images and its correlative values of actual leaf nitrogen (N) contents under the LCC App development study.

Estimating mid-season N requirement from N-rich plots is a continuing study from last year, which successfully produced a sensor-based prototype device that can assess the nitrogen needs of the crop at the panicle initiation (PI) stage and compute precise amounts of N-containing fertilizers for application through its embedded algorithm.

In 2017, the LCC App development study has successfully completed its 3rd cropping season of digital leaf image capture from three cultivars under 27 different N-fertilizer managements and DGCI extractions. DGCI across three different camera resolutions (5MP, 8MP, and 13MP) showed high correlation with R2 values of 0.997 and 0.991 while partial analysis of N appeared to decline below optimum at 20 days after the 3rd N-split. Upon project completion, both tools will optimize the use of electronic devices to diagnose crop nutrient status just by a click of or a tap of a finger and immediately recommend precise fertilizer applications for corrective purposes.

Estimating Mid-season Nitrogen Requirements of Rice Based on Nitrogen-rich Reference Plots
Jasper G. Tallada and MA Ramos

Yield of the rice crop is invariably affected by weather conditions for the same cultural management. The use of reference plots on which optical measurements are made can provide systematic basis for adjusting mid-season fertilizer rates. The study generally aimed to develop an algorithm for nitrogen fertilizer recommendation based on electronic optical measurements of a nitrogen-rich plot as a reference guide at mid-season growth stage of the rice plant. Field experiments were conducted with varied nitrogen fertilizer rate application. Optical measurements for normalized difference vegetation index (NDVI) were taken. Fertilizer adjustments were made for low initial N applied plots using an algorithm at panicle initiation stage. The yields of the N-adjusted plots matched the plots that receive high levels of nitrogen.

Development of an Android Application Version of LCC for Precise Nitrogen Topdress Application
Ailon Oliver V. Capistrano, JJE Aunon, JEG Hernandez, JU Ramos

Precise nitrogen (N) topdress application for rice can only be achieved if the actual N-content within the plant can be quantified. Fortunately, this can be achieved through technology. SPAD 502 meter developed by Minolta was used to be the easiest means to quantify the N-content of a plant and provide recommendations. It was proven to be effective and capable but it was also very expensive and economically unadvisable for farmers' use. PhilRice developed the LCC as an inexpensive alternative but it also lacks the high-tech appeal of a device for such use. In this new age of information and communication technology, smartphones are powerful enough to emulate the SPAD 502 functions and can potentially upgrade the LCC to an android application. The only requirement would be is to decipher how the attached features of a smartphone can be used and serve such purpose. Therefore, this study explored how the built-in cameras of smartphones and the android platform/operating systems can be manipulated and developed to become a digital device for quantifying the leaf N-content of a rice plant and generate recommendations for topdress application. Digital leaf images at different crop stages and N-fertilizer treatments were captured, processed, and analyzed to extract the leaf's DGCI. DGCI across 3 different camera resolutions were compared and found that the 5MP was highly correlated to both 8MP and 13MP as shown by the respective R2 values of 0.997 and 0.991. This high correlation verifies that a 5MP resolution camera is already suitable for the target app. While partial analysis of leaf N showed that across N-fertilizer treatments, leaf N-content decline below optimum levels 20 days after the 3rd N-split.

III. Assessment and Evaluation of Crop Intensification and Resource Use Efficiency in Rice Production
Myrna D. Malabayabas

PhilRice continuously develop and improve rice production technologies that can help address the country's goal for rice security. Some of these technologies include controlled irrigation (CI), which is an alternative water management practice that can be adapted in areas with limited water resource and those that are located in the tail end of an irrigation system. On nutrient management, the use of LCC is being promoted to increase the efficiency of the N fertilizers applied in the field. These technologies were tested in selected varieties with high yield potential during the 2017 dry and wet season. Another cross-listed study from PhilRice-Los Baños in 2015-2017 also researched on the effect of rice-based crop rotation on soil physiochemical properties and pest incidence in upland ecosystem.

The first study evaluated the water and agronomic efficiency of applied nitrogen of rice varieties NSIC Rc160, NSC Rc222, NSIC Rc228, NSIC Rc240, NSIC Rc360, and PSB Rc18 under CI and LCC-based N fertilizer application. Minimum tillage was employed in the land preparation. Pre-germinated seeds were broadcast-seeded at the rate of 20 kg seeds/ha. Results showed that the use of CI in combination with LCC-based N fertilizer application improved water use efficiency of test rice varieties. Moreover, NSIC Rc160, Rc222, Rc238, Rc240, Rc360, and PSB Rc18 were adapted to CI because grain yields were comparable with continuous flooding, which is the conventional method of water management. Farmers especially those with fields near the tail end of the irrigation system can adopt CI as this method did not result in significant yield loss. To further reduce the cost of production, minimum tillage, and direct seeding method of crop establishment can also be combined with LCC use and CI.

Another study investigated the effect of three rice-based crop rotations on soil physicochemical properties and pest incidence under upland environment. Crop rotation is a form of crop management that utilized the diversity of different crops that is grown after one cropping season at a given area. Effective cropping pattern maximizes the use of farm resources both on biological and physical components. Success, however, differs on the choice of crop to be grown and management that the farmers will employ. Based on field experiments, the different cropping patterns promoted the normal life cycle and processes of a prey-predator relationship of farm insects. No detrimental ¬¬¬¬damage was observed in the field due to natural predation and breakage of the pest cycle. Disease infestation was also found to be minimal. Early vegetative stage of the crops suffered weed infestation, which was observed across the cropping system. The abundance and ability of the numerous weeds competed with available resources for the crops which later resulted in poor growth and delayed maturity. Broad-leaved weed species were abundant, however, sedge species were more prevalent. The diversity of weeds hindered effective single control measure due to its different nature. Weeds must be managed in the early vegetative stage to gain crop advantage over the weeds for nutrient, light, and water requirement. The abundance of weeds was lowest during late reproductive stage due to shading intolerance. Severe infestation due to insect pest was observed even without pesticide application. The ratio of beneficial and destructive phase was at equilibrium. Crop diversification increased the population of the beneficial insects.

The two studies provide information to farmers and other stakeholders who may opt to adapt the technologies used in the studies. The use of controlled irrigation increased water productivity and reduced fuel and irrigation input energy of high yielding varieties. LCC-based N application also increase nitrogen use efficiency of rice; thereby, reducing N fertilizer input. In addition, crop rotation reduces pest damage and eventually increases yield in the upland ecosystem.

Evaluation of Water and Nitrogen Use Efficiencies of Varieties with High Yield Potential
Myrna D. Malabayabas, AJ Espiritu, HD Villanueva

The study was conducted in DS and WS 2017 to evaluate the water and nitrogen use efficiencies of high-yielding rice varieties: NSIC Rc160, NSC Rc222, NSIC Rc238, NSIC Rc240, NSIC Rc360, and PSB Rc18 under controlled irrigation (CI) and Leaf Color Chart (LCC)-based nitrogen (N) fertilizer application. Minimum tillage was employed in the land preparation. Pre-germinated seeds were broadcast-seeded at the rate of 20 kg seeds t/ha. Water management employed was controlled irrigation with continuous flooding as control. N fertilizer application was based on LCC reading with N omission plot or no N fertilizer application (NOP) as control and basis for determination of agronomic efficiency of the applied N fertilizer (AEN). Results showed that the use of CI in combination with LCC-based N fertilizer application improved water use efficiency of selected high yielding rice varieties. Moreover, most of the modern rice varieties tested such as NSIC Rc160, NSIC Rc222, NSIC Rc238, NSIC Rc240, NSIC Rc360, and PSB Rc18 were adapted to CI method of water management. Farmers need not worry to adopt CI as this method did not result in significant yield loss. To further reduce the cost of production, minimum tillage and direct seeding method of crop establishment can also be combined with the use of LCC and CI.

Investigating the Effect on Soil Physicochemical Properties and Pests Incidence in Three Rice-based Crop Rotations under Upland Environment
Mark Joseph T. Mercado and Victoria C. Lapitan

Cropping pattern is a form of crop management entailing the cultivation of different crops after each season. Effective cropping pattern maximizes the use of farm resources both on biological and physical components. Success, however, differs on the choice of crop to be grown and farmers' practices.

Based on the field experiment, the different cropping patterns promote the normal life cycle and processes of a prey-predator relationship of farm insects. No ¬damage was observed in the field due to natural predation and breakage of the pest cycle in the field. Disease infestation was also found to be minimal.

Across the cropping system, weed infestation occurences were observed during the early vegetative stage. The abundance and ability of the numerous weeds compete with the available resources for the crops, which later results in poor growth and delayed maturity. Broadleaved weed species have the highest abundance, however, dominance was found in the sedge species. The diversity of weeds hinders effective single control measure due to its different nature. Weed management must be performed as early as the early vegetative stage to gain advantage over the weeds for nutrient, light, and water requirement. The abundance of weeds is lowest during late reproductive stage due to shading intolerance.
Infestation due to insect pest was not severely observed even without application of preventive pesticide. Ratio of beneficial and destructive phase was at dynamic equilibrium. The diversification increases the population of beneficial insects; controlling the number destructive insects.

IV. ASPPD Research and Analytical Laboratory Systems and Maintenance

Annie E. Espiritu and Evangeline F. Javier

The ASPPD Research and Analytical Laboratory Systems and Maintenance Project of ASPPD was proposed and funded in DS 2012 to support the ASPPD R&D activities and capacitate the laboratory system for quality data and analyses. To continuosly improve and maintain the current and newly acquired laboratory facilities, preventive maintenance services and calibration is necessary to ensure quality data output. Normally, laboratory management and maintenance to complement and implement the IMS policy of the Institute had been sourcing out funds from external sources. The external sources though of higher fund support are not stable. Hence, this project was established to (1) provide assistance in the improvement/upgrade of the laboratory facilities for better quality research output; (2) constantly optimize laboratory/ chemical procedures for soils and plant samples; and (3) build-up database and inventory of information on the chemical and laboratory supplies and usages.

V. Assessment and Evaluation of Variety, Water, Nutrient, and Pest Interactions

Leylani M. Juliano

Yield Potential of Irrigated Lowland Rice Varieties in Response to Nitrogen Management

Myrna D. Malabayabas, HD Villanueva, RT Cruz

The use of rice varieties with high yield potential is one of the key factors in achieving higher productivity and rice self-sufficiency. Along with variety, crop management practices particularly nitrogen (N) fertilizer application has large contribution in attaining high rice yield potential. Thus, a study was conducted in 2017 DS and WS to determine the yield of selected recently-released rice varieties under Leaf Color Chart (LCC)-based and fixed-rate, fixed-time (FRFT) nitrogen (N) management. The agronomic efficiency for applied N (AEN) was also determined based on the N omission plot (NOP). Results showed that most test varieties achieved higher yield potential with FRFT N application of 190 kg/ha than the LCC-based N application that ranged from 74 to 112 kg/ha in DS. On the other hand, grain yield between LCC-based and FRFT N management did not significantly differ in WS. This was due to the small differences in the N rates used during WS. AEN were significantly higher in both DS and WS. The results also indicate that there is a need to adjust the recommended rate of LCC-based N application to achieve the maximum yield potential of the recently-released rice varieties.

VI. Response of Rice Genotypes to Abiotic Stresses and Crop Management: Drought and Flood

Rolando T. Cruz

Drought and flood are two of the major abiotic stresses in rainfed lowland rice ecosystem. Grain yields can be reduced to 1-2 t/ha in drought-prone and flood-prone rainfed lowland rice ecosystems but may vary depending on the timing, duration, and intensity of the abiotic stress. Climate change, which can be triggered by El Niño and La Niña phenomena, can intensity drought and flood occurrences, respectively. Success in improving crop productivity under abiotic stress has been limited due to lack of integrated crop management approach. Use of tolerant rice varieties/ genotypes and appropriate crop management in a well-defined environment can improve crop productivity in drought-prone and flood-prone rice ecosystems.

The two-week screening for drought tolerance at vegetative stage in the screenhouse showed that drought was exemplified by the decrease in soil moisture content and increase in soil strength. Out of the 18 rice genotypes tested for drought tolerance, the top 8 genotypes, namely: Green Super Rice or GSR-21, Raeline-10, NSIC Rc282, CT 9993-5-10-1-M, UPL Ri-5, NSIC Rc160, PSB Rc14, and NSIC Rc416 had slower progression of leaf rolling and leaf tip drying, and higher plant biomass. These visible plant reactions to drought stress and resulting aboveground plant biomass were considered important components of the overall drought tolerance of the rice crop. In the field, following 20-day reproductive/flowering stage drought stress, NSIC Rc282 had a grain yield of 3.7 t/ ha with fertilizer treatment of 120-40-60 kg NPK/ha. With 120-40-120 kg NPK/ ha, yield of NSIC Rc282 was increased to 4.3 t/ha suggesting the role of increased potassium (K) level in enhancing enzyme activity and minimizing yield loss due to drought stress.

In the screenhouse with short-term partial flooding (STPF) for two weeks and stagnant flooding (SF) for one month, plant heights of most rice genotypes ranged from 92.8 cm to 108.0 cm, and there was no significant difference between the Control (2-3 cm floodwater depth) and flooding treatment with 25 cm floodwater depth. Based on the Control, the aboveground plant biomass was reduced by an average of 44.8% for 25 cm and 50 cm floodwater depth treatments. STPF and SF reduced aboveground plant biomasses by 21.5% and 23.5%, respectively. In the field, there was significant difference in grain yield between the Control and STPF with 25 cm floodwater depth treatments across varieties (i.e., FR13A, Ciherang Ag+ Sub1, PSB Rc82, and PR41543-B-14-2-1-2). Based on the Control, grain yield was reduced by 29.7% following STPF with 50 cm floodwater depth across varieties. When compared with 21-day old seedlings, grain yields of 44-day old seedlings of PSB Rc82, FR13A, and PR41543-B-14-2-1-2 were increased by an average of 24.4% across STPF and SF treatments. Based on the Control, average grain yield was reduced by 1.2% with N application 7 days after de-flooding, and by 4.6% with N application 2 days after de-flooding across STPF floodwater depth treatments. The increased degree and duration of flooding stress decreased rice crop growth and yield to a greater extent.

Flood Tolerance of Rice Genotypes in Relation to Crop Management
Rolando T. Cruz, JRA Vera Cruz, NV Desamero

The screenhouse study assessed the growth and biomass of PSB Rc18, PSB Rc82, NSIC Rc222, PR41543-B-14-2-1-2, PR41561-B-2-Sal-2-1-1-1, and tolerant checks Ciherang Ag+ Sub1 and FR13A in response to short-term partial flooding (STPF) (i.e., 25 and 50 cm floodwater depths for 2 weeks from 21-35 days after transplanting or DAT) and stagnant flooding (SF) (i.e., 25 and 50 cm floodwater depths for 1 month from 21-51 DAT).

The field study assessed the growth and grain yield of PSB Rc82, Ciherang Ag+ Sub1, and PR41543-B-14-2-1-2 in response to STPF, seedling age, and N management. In the screenhouse, results showed that for most rice genotypes, plant heights were reduced by 4.8-16.5% with 50 cm floodwater depth based on the Control with 2-3 cm floodwater depth. Aboveground plant biomasses on the average were reduced by 44.8% across floodwater depths. STPF and SF reduced aboveground plant biomasses by 21.5% and 23.5%, respectively. In the field and based on the Control, plant height was reduced by 6.8% following STPF with 50 cm floodwater depth but not with 25 cm floodwater depth. Grain yield was reduced by 29.7% following STPF with 50 cm floodwater depth across genotypes but not with 25 cm floodwater depth. Compared with 21-day old seedlings, grain yields of 44-day old seedlings of PSB Rc82, FR13A, and PR41543-B-14-2-1-2 were increased by an average of 34.4%, whereas grain yield of Ciherang Ag+ Sub1 was reduced by 14.0% across STPF and SF. Based on the Control (no post-flood N application), grain yield was not improved by post-flood N application.

Response of Rice Genotypes to Drought Stress and its Management in Rainfed Lowland System
Rolando T. Cruz, GP Faustino, NV Desamero (PhilRice), JE Hernandez (UPLB)

The screenhouse study assessed the drought tolerance of 18 rice genotypes in response to 20-day vegetative drought stress by withholding irrigation from pots 15 – 35 days after transplanting (DAT). The field study assessed the growth and yields of NSIC Rc222, NSIC Rc418, and NSIC Rc282 in response to vegetative drought stress and reproductive drought stress. Each stress treatment received 120-40-60 and 120-40-120 kg NPK/ha, in which 1/3 N and 1/3 K, all P and Zn were applied at 14 DAT and remaining N and K at 40 DAT. Results of the screenhouse study showed that among the 18 genotypes tested, GSR-21, Raeline-10, NSIC Rc282, CT 9993-5-10-1-M, UPL Ri-5, NSIC Rc160, PSB Rc14, and NSIC Rc416 were considered drought tolerant based on slower progression of leaf rolling and leaf tip drying, and better recovery after rewatering. Results of the field study showed that during the stress period, NSIC Rc282 had the slowest progression of leaf rolling. Overall, grain yields were higher with 120-40-120 kg NPK/ha than with 120-40-60 kg NPK/ha. With 120-40-120 kg NPK/ha, grain yields of NSIC Rc282, NSIC Rc222, and NSIC Rc418 were 4.8, 4.1, and 4.2 t/ha, respectively, following vegetative drought stress. Likewise, yield of NSIC Rc282 was higher following reproductive drought stress. Based on the fertilized and well-watered Control, percent yield reductions were lower with 120-40-120 kg NPK/ha. With increased level of K fertilizer, leaves of NSIC Rc282 were less rolled and this could have contributed to increased efficiency of photosynthesis and reduction in transpiration; thereby, minimizing yield loss.

VII. Soil Health, Water Quality and Availability
Evelyn F. Javier

Optimization of Efficient Production and Quality of Vermicompost using Different Substrates
Evelyn F. Javier, VIG Mapa, PS Ramos Jr.

Vermicomposting have been found to be an effective solution in addressing some environmental problems posed by the heavy use of chemicals and pesticides on agricultural lands and crops. It can serve as a farm waste disposal strategy, a source of fertilizer for crops, and can increase economic value of the farming system. However, nutrient content and the quality of vermicompost varied with materials and substrates. Thus, this study was conducted to standardize and establish a guide for the process of vermicomposting by identifying suitable materials/substrates with the optimum ratio of mixture in order to consistently produce high quality products that does not vary across lots or batches. Rice straw as the main substrate were used with azolla, sesbania, banana trunks, and carabao manure as materials for the fast decomposition of the compost.

After series of trials for the best combination of substrate and decomposition materials, the animal and green manure combination produced the highest N, P, and K concentrations of the vermicompost. Sesbania and carabao manure produced the highest N and P contents of the vermicast, respectively. Nitrogen content of the vermicompost ranged from 1.50 to 3.77%, P at 0.018 to 0.35%, and K at 0.223 to 0.603%. The total

NPK percentage of the end product was relatively higher (average 3.26%) than some commercial organic fertilizers. The organic matter produced of the different formulations ranges from 33.66 to 45.66%, that provided a very good C:N mean ratio of 14.25%. In another trial where banana trunks were used, the micronutrient contents of the vermicompost increased: Zn at 226.98 ppm; Cu at 8.53 ppm; Mn at 400.33 ppm; and Fe at 232.62 ppm.

In the efficiency of waste conversion to vermicompost, the use of carabao manure or banana trunk as additive to rice straw gave comparative quantity of vermicompost and vermicast. However, higher vermi or worms had been produced in the formulation with banana trunks. It was observed that the worms used the banana trunks for their cooling system when their environment became hot and that they multiplied better without the banana.

The best materials for the production of good and quality fertilizer from vermicomposting were rice straw and carabao manure. For the production of vermiworm, the use of banana trunk can be worth studying further.

VIII. Interactions among Nutrients, Pests, Beneficial Organisms, and Toxicants

Jehru C. Magahud

Some interactions occurring in rice fields need to be studied to improve rice farming and products from rice farming. For instance, application of very high rates of nitrogen (N) fertilizer promotes rice growth and yield, but it can also result in greater yield reduction from diseases. Recent reports indicated that plant growth-promoting bacteria (PGBP) can antagonize certain diseases. Furthermore, earthworms are known to have linear responses with concentrations of toxic chemicals. As such, several field, screenhouse and laboratory experiments were conducted to understand such interactions for their potential applications.

The study on relationship of N occurrence of rice diseases and the role of N2-fixing microorganims conducted in Nueva Ecija and Agusan del Norte showed that applying 95 kg N/hectare for field conditions in Nueva Ecija and 0.825 kg N/pot in screenhouse condition in Agusan del Norte resulted in optimum growth and grain yield even if infected with the bacterial leaf bight disease (BLB). Severity of BLB and sheath blight (ShB) diseases were significantly lower by 7.7 – 10.5 % if PGPB if inoculated to the diseased rice plants. If such fertilizer rates be incorporated to site-specific nutrient management, and if such PGPB would have the same negative effect to diseases in the field, these findings can result in increased productivity and cost-effectiveness of rice farming in the two provinces.

Moreover, the study on "Abundance of Mega and Microdriles as Indicator for Degradation of Paddy Soils" showed that mortality of the paddy earthworm, Sparganophilus sp., significantly increased with increasing concentrations of copper. As such, this worm has the potential to be used as test species for assessing soil pollution or contamination with toxic chemicals to ensure safe and better quality of products from the rice environments.

Relationship of N to the occurrence of rice diseases and the role of N2-fixing microorganims

Jehru C. Magahud, SLP Dalumpines, JA Cruz, JP Rillon, ND Santiago, FS Grospe, NBB Paz, VF Israel, AJC Santos

While application of very high rates of nitrogen (N) fertilizer promotes rice growth and yield, it can also result in greater yield reduction to diseases. As such, the study was conducted in Nueva Ecija and Agusan del Norte to determine the level of N that can produce the highest yield or least loss from bacterial leaf blight (BLB) and sheath blight (ShB) diseases, and determine a soil-applied microorganism that can reduce severity of the two diseases. NSIC Rc226, a susceptible rice variety, was grown in the screenhouse or on the field. Diseases were inoculated on the leaves or sheath, while plant growth-promoting bacteria (PGPB) was inoculated in the soil. For the January-April 2017 field experiment at PhilRice CES, results showed that the growth and grain yield of rice plants, BLB inoculated or not, were optimum at 95 kg N/hectare. BLB severity of rice inoculated with PGPB was significantly lower at 221 kg N/hectare: 7.6% for those inoculated with PGPB, and 15.5% for those not inoculated with PGPB at 21 days after BLB inoculation. For the July-October screenhouse experiment at PhilRice CES, ShB severity of rice inoculated with PGPB was significantly lower at 1.650 g N/pot: 20.3% for those inoculated with PGPB, and 30.8% for those not inoculated with PGPB at 22 days after ShB inoculation; and 25.8% for those inoculated with PGPB, and 33.5% for those not inoculated with PGPB at 29 days after ShB inoculation. For the March-June and July-October screenhouse experiments in PhilRice Agusan, results showed that the growth and yield parameter of rice plants, BLB inoculated or not, were optimum at 0.825 kg N/pot. For the March-June screenhouse experiment in PhilRice Agusan, BLB severity of rice inoculated with PGPB was significantly lower at 0.825 kg N/pot: 12.9% for those inoculated with PGPB, and 22.0% for those not inoculated with PGPB at 25-26 days after BLB inoculation. The study implies that fertilizer application rates that give optimum growth and grain yield even under BLB infection is 95 kg N/hectare for field conditions in Nueva Ecija, and 0.825 kg N/pot in screenhouse condition in Agusan del Norte.

Abundance of Mega and Microdriles as Indicator for Degradation of Paddy Soils

Jehru C. Magahud, SLP Dalumpines, NM Aspe, CC Cabusora

Irrigated rice areas are habitats of earthworms that can be used as additional test species for assessing risks from contamination or pollution from toxic chemicals. Basic studies about responses of the potential test species to a toxic chemical can serve as basis for future research that will develop suitable test procedure for such species. Sparganophilus and Drawida are semi-aquatic fresh-water earthworms that commonly inhabits stream banks and rice paddies. Meanwhile, copper pollution in Philippine rice areas was also reported.

This study compared the methods in determining the abundance of macro and microdile and assess its relationship with the rates and frequency of pesticide/fertilizer application. Earthworms were sampled from rice fields and brought to the laboratory for morphological examination. The responses of earthworms in soils mixed with increasing concentrations of copper was also tested. The earthworms from 10 sites in Nueva Ecija and Pangasinan resemble Sparganophilus tamesis (Benham, 1892) in terms of body length (80-175mm), body segmentations (189-253), clitellum (saddle-shaped from XV-XVI to XXII-XXV), and absence of body pigmentation and secondary annulations. The earthworms from a site in Agusan del Norte was identified as Drawida sp. based on its body length (90-110 mm), body segementations (121-128), clitellum (saddle shaped from IX-XII to XX-XIV), reddish brown body wall, and presence of secondary annulations. Results showed that mortality of immature Sparganophilus significantly increased with increasing concentrations of copper from 0mg/kg to 1200mg/kg after 7, 14, and 21 days of exposure. The study implies that the mortality response of Sparganophilus sp. is potential indicator for assessing contamination or pollution in soils.

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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