2018 NATIONAL RICE R&D HIGHLIGHTS

AGRONOMY, SOILS & PLANT PHYSIOLOGY DIVISION

PHILRICE

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DIVISION

AGRONOMY, SOILS AND PLANT PHYSIOLOGY

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EXECUTIVE SUMMARY

The Agronomy, Soils and Plant Physiology Division (ASPPD) develops technologies that are integrated into crop management system to increase yield of rice and reduce cost of production. These are prerequisites to help rice farmers become globally competitive and help the country become rice-secure.

In 2018, the Division aimed to package technologies that will increase yield by 15% in less productive environments and sustain and improve good harvest in favorable environments. ASPPD implemented five projects: (1) Assessment and management of soil fertility and soil health; (2) Development, evaluation, and enhancement of diagnostic and decision-support tools for rice-based precision farming; (3) Integrated crop management for attaining yield potential of recently-released irrigated lowland rice varieties; (4) Response of rice genotypes to abiotic stresses and crop management: Drought and flood; and(5) Development of organic-based production technology and management for paddy rice and sustainable productive paddy soils. It also maintained the ASPPD Research and Analytical Laboratory Systems.

The Division also managed an Integrated Rice-Based Biosystems Research or *PalaYamanan* Plus Research for Development Complex in partnership with the CREATE-Rice Program. Philippine Rice Information System (PRiSM) was also housed in the Division.

Soil sample collection to assess soil fertility status of PhilRice paddy field.

PROJECT 1:

ASSESSMENT AND MANAGEMENT OF SOIL FERTILITY AND SOIL HEALTH

WB Collado

Maintaining soil fertility is of great importance, and this requires appropriate management approaches to sustain crop production at an acceptable level (Johnston, 2005). Managing soil nutrients efficiently to maintain soil fertility is vital to achieve maximum yields. However, best soil and crop management practices could only succeed if one understands the current nutrient status of the soil and the amount needed for achieving target yield. Under this project, long-term experiments vital for the sustainability and improvement of the cropping system were conducted. Soil fertility was also evaluated to help identify production problems related to nutrient deficiencies or imbalances. Soil and crop management recommendations were also developed for maintaining soil fertility, sustaining and improving crop productivity in an environmentally-safe manner.

Long-term soil fertility experiment

WB Collado, YB Mercado, and CDR Alonzo

This experiment aimed to assess the long-term trends in rice productivity and rice-rice cropping system sustainability. NSIC Rc 222, Rc 158, and Rc 160 were used to determine responses to N, P, and K fertilizer applications. Highest average grain yields and agronomic efficiency of applied N (AE_N) in the dry season were obtained in the site-specific nutrient (SSNM)-based N and the fixed-N management with P and K applications. Yields of 6-8t/ha showed that the full application of NPK through the nutrient input-output balance and the SSNM approaches can be sustained. This represented about 80% of the potential yield of the rice varieties used in the study. Application of only two of the most limiting nutrients in any combination showed relatively lower yield levels (4-6t/ha), while 2.5-3.5t/ha can be achieved without fertilizer application.

In the wet season, N application contributed to the lodging of the test rice varieties during the flowering. Thus, grain yields with N fertilizer applications were low.

Durability of rice-corn and rice-legume cropping systems

SD Cañete and WB Collado

An on-farm field experiment was conducted in 2018 to evaluate the durability of two major cropping systems in the villages of San Joaquin and Balungao in Pangasinan and Palo and Cuyapo in Nueva Ecija. Three farmers' fields from each province were selected as study sites. Two cropping systems were identified for each site: corn-rice-rice cropping system in Pangasinan and rice-mungbean cropping system in Nueva Ecija. Land units are classified as rainfed supplemented with irrigation. New crop management recommendations were developed and tested in the study sites.

In the mungbean-rice cropping pattern, the new rice crop management (NCM) recommendations provided higher grain yield and return on investment (ROI) than farmer's practice (FP). In the corn-rice-rice cropping pattern, NCM provided higher corn grain yield, net benefit, and ROI.

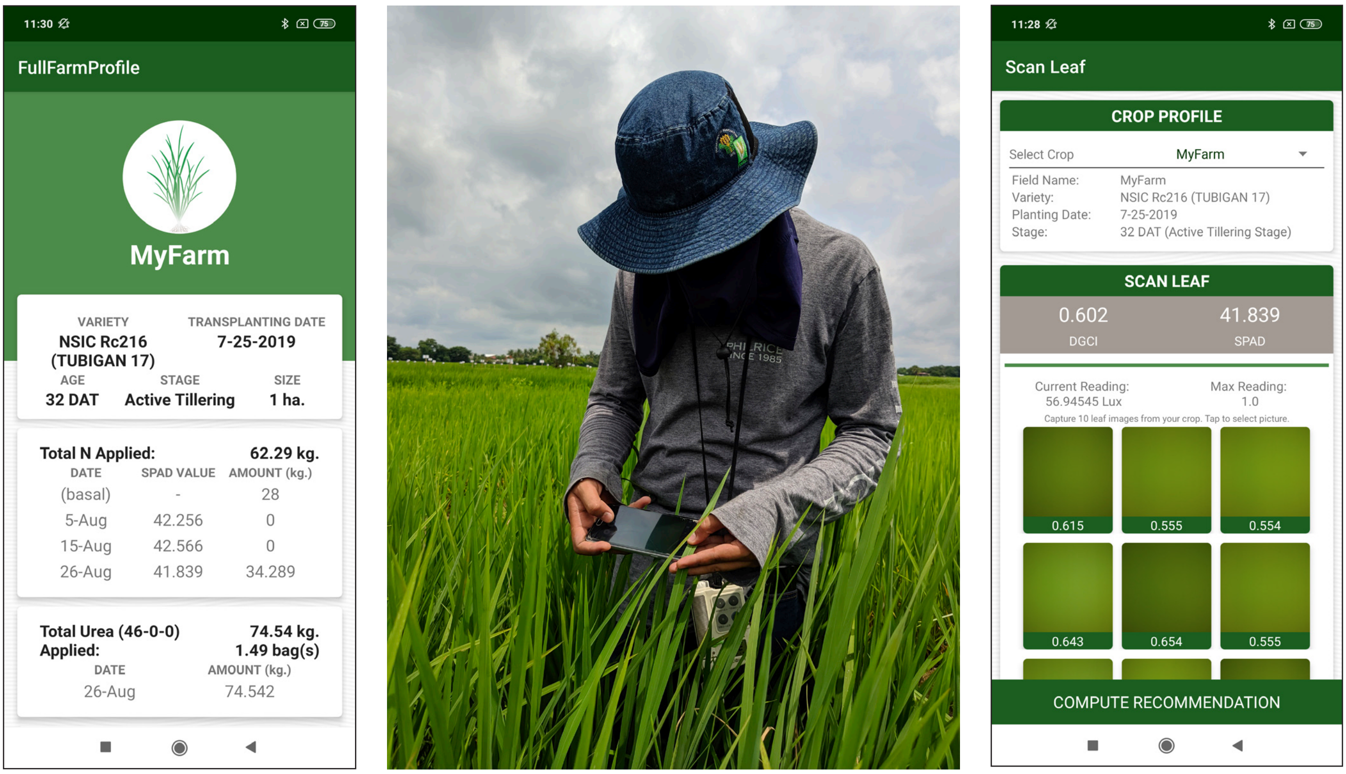
Applying NCM recommendations in the wet season resulted in an average yield advantage of 1.16 and 0.66t/ha over FP in Cuyapo and Pangasinan, respectively. Grain yields in the dry season were also higher by an average of 0.29t/ha than corn produce in Pangasinan.

NCM recommendations resulted in an average income advantage of P18,479.70/ha and P11,786.12/ha during the wet season in Cuyapo and Pangasinan, respectively. This translated to 18.79% and 9.42% increase in the ROI. An increase of 6.0% and 4.58% in the net income and ROI was also gained from trying out NCM recommendations for corn in the dry season. The durability of both cropping systems in terms of productivity and profitability can be partially realized after the completion of the ongoing third (rice) and second (mungbean) in Pangasinan and Cuyapo.

Assessment of Soil Fertility Status of PhilRice CES Rice Paddy Field

AE Espiritu and WB Collado

Understanding the current nutrient status of the soil is essential to establish the soil requirements needed for maximum yield. In DS 2018 fallow period, soil samples were collected from the 16 blocks of PhilRice CES experimental field. Collected soil samples were air-dried while 30% of the samples were processed for nutrient analysis. In WS 2018, the remaining 70% were processed for laboratory analysis. Seventy-five percent (12 blocks) of the 16 clusters were weighed and measured for ph. Forty-three percent of the samples were analyzed for organic matter.



1st and 3rd photo: LCC interface; Middle photo: Field testing the LCC App

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PROJECT 2:

DEVELOPMENT, EVALUATION, AND ENHANCEMENT OF DIAGNOSTIC (SOIL, WATER, AND NUTRIENT) AND DECISION SUPPORT TOOLS FOR RICE-BASED PRECISION FARMING

AOV Capistrano

Maintaining soil fertility is of great importance, and this requires appropriate management approaches to sustain crop production at an acceptable level (Johnston, 2005). Managing soil nutrients efficiently to maintain soil fertility is vital to achieve maximum yields. However, best soil and crop management practices could only succeed if one understands the current nutrient status of the soil and the amount needed for achieving target yield. Under this project, long-term experiments vital for the sustainability of the cropping system were conducted. Soil fertility was also evaluated to help identify production problems related to nutrient deficiencies or imbalances. Soil and crop management recommendations were also developed for maintaining soil fertility and sustaining crop productivity in an environmentally-safe manner.

This project aimed to make soil, weather, and crop information/data useful in farm-level decision-making through the development or enhancement of automated tools and devices that collect and/or analyze data for appropriate action to improve crop health, farm productivity and resource use efficiency. Studies under this project include: 1) Development of an Android Version of the Leaf Color Chart (LCC); 2) Enhancement of the Minus-One Element Technique (MOET) App through Nutrient Omission Plot Technique (NOPT) correlations; and 3) Evaluation of the Best Diagnostic Tools for N Application.

A prototype of the LCC android version, which can capture digital leaf images of rice plants, extract dark green color index (DGCI) values, and compute precise amount of N-based fertilizers for topdress application was developed. Once optimized, the app could be integrated with the MOET App, which will result in a more efficient N-fertilizer management. The current MOET App was also enhanced to improve its fertilizer recommending feature as it was earlier observed that it recommends high N rates, which significantly reduces the agronomic efficiency. The current MOET App was evaluated in the third study.

Development of an android application version of the Leaf Color Chart (LCC) for a more precise Nitrogen topdress application in rice

AOV Capistrano, JEG Hernandez, JJE Auñgon, and JU Ramos

The study aimed to develop an android application version of the LCC that can accurately assess leaf color and recommend precise N-fertilizer. A prototype application was developed with the methods for leaf image capture, RGB extraction, conversion into dark green color index (DGCI) and SPAD equivalent values, and computation of N-based fertilizers for direct field application. Comparative assessment between the SPAD equivalent values of the prototype and actual readings via SPAD 502 chlorophyll meter were done and showed an acceptable linear fit between the two values using two test varieties, NSIC Rc 216 and Rc 204H. This indicates that the prototype can already simulate the function of a standard chlorophyll meter through its programmed algorithm and use it in computing the required amount of N. In WS 2018, an initial field trial was conducted to compare the performance of the prototype with the original LCC, recommended rate, and SPAD 502. Results of the yield trial showed no significant difference among the control, RR, LCC App, and SPAD under the inbred test variety. However, these results are not totally conclusive as the other test varieties suffered from pest, disease, and abiotic stress, which severely affected yield and analysis.

Enhancing the MOET App via establishment of NOPT correlation factors and update of databases and algorithms

AOV Capistrano, JEG Hernandez, JJE Auñgon, and JU Ramos

The study aimed to enhance the MOET App in providing a more realistic fertilizer recommendation through establishing a correlation between MOET biomass and NOPT biomass. It also updated the app's rice varietal database to increase the varietal choices of its users. As the NOPT is conducted in actual field plot conditions, fertilizer recommendations generated via this method was deemed more realistic than the MOET, which only small field soil samples were used to diagnose soil nutrient deficiencies.

MOET pots/pails were placed within NOPT plots. Test plants receive the same environmental condition throughout the evaluation. Test plants were collected from NOPT and MOET setups relative to the collection time for MOET biomass assessment.

Results showed variabilities in the biomass outputs grown in the DS and WS; hence, were segregated prior analysis. Regression analysis showed a strong linear correlation between the MOET and NOPT biomass with R^2 values ranging 0.7 - 0.85 for NPK and 0.65 for S. These results are sufficient for MOET App recommendations to be closely simulated with a NOPT setup. Incorporating the respective linear equations in the MOET App can now simulate the NOPT biomass using a MOET biomass as input and computes its field fertilizer recommendation based on the simulated NOPT biomass. The new recommendations generated by the enhanced MOET App were compared with the original MOET App using two test rice varieties, which showed significant reductions in N rates per hectare. However, grain yield advantage from using the enhanced MOET App is not totally conclusive as the other test variety suffered from pest, disease, and abiotic stress, which severely affected yield and analysis.

Assessment of existing diagnostic and recommendatory tools for increasing nitrogen-use efficiency

FS Grospe and JRA Vera Cruz

Farmers apply N fertilizer based on visual estimates, which could be higher or lesser than the requirement considering higher grain yield and lower input cost. With several decision-support tools available and accessible for nitrogen management such as MOET App, LCC, soil test kit (STK), and chlorophyll meter (soil plant analysis development/SPAD-502), farmers options for better N-use efficiency. This study evaluated existing nutrient diagnostic and recommendation tools in terms of AE_N fertilizer. Decision-support tools were used as treatments and evaluated under field condition laid out in Randomized Complete Block Design with four replications. In DS 2018, different tool-based N recommendation rates from MOET App (158kg), LCC (101kg), STK (120kg), and SPAD 502 (101kg) N /ha were applied in each plot transplanted with Rc 216. Test applied with 110kg (MOET App), 88kg (LCC), 88kg (SPAD-502), and 90kg (STK) N/ha in WS 2018. Applications of N for LCC- and SPAD-based management were done whenever LCC readings fell below the critical value of 4 during weekly measurements and when SPAD-502 readings were below the threshold value of 35. The MOET App- and STK-based N scheduled applications were followed. Use of LCC and SPAD-502 resulted in high average AE_N of 31.88 and 31.33kg grain/kg N, respectively, followed by STK (23.41kg grain/kg N) and MOET (21.30kg grain/kg N) during DS. In WS, AEN of LCC, SPAD-502, and STK were similar ranging 3.91-8.82kg grain/kg N. MOET-based N management had the lowest AE_N. This could be attributed to the low grain yield obtained from the crop cuts during WS. However, this low AE_N from the MOET-based N management will be further verified using the yield components collected.

Experimental set of the study on optimization of N rate and plant spacing to achieve the yield potential of recently-released irrigated lowland rice varieties at PhilRice CES

PROJECT 3:

OPTIMIZATION OF THE INTEGRATED CROP MANAGEMENT COMPONENTS FOR ATTAINING YIELD POTENTIAL OF IRRIGATED LOWLAND RICE VARIETIES

MD Malabayabas

Optimum crop management is needed to enhance the yield potential of modern rice varieties. PhilRice developed the PalayCheck System for irrigated lowland rice as a guide for proper crop management. However, there are components needing further improvement like nutrient management. Other crop management practices such as plant spacing and its interaction with nutrients particularly N is also critical in attaining higher yield. The occurrence of pests and diseases is also related to the level of N fertilizers applied in the field, which may have significant effect on yield. Thus, the project focused on optimizing important components of the integrated crop management that will help boost the yield potential of recently released irrigated lowland rice varieties.

In DS 2018, studies were implemented with the following objectives: determine the optimum N fertilizer rate that will help achieve the yield potential of NSIC Rc 222, Rc 402, Rc 438, and Rc 442; determine the optimum planting distance/ spacing; determine the optimum levels of N and potassium fertilizers to prevent or minimize the occurrence of diseases such as sheath blight and bacterial leaf blight and insect pests such as brown planthopper and stemborer; and, generate physiological information of selected irrigated lowland rice varieties which can help in developing crop management practices for higher yield potential. In WS 2018, the studies on optimum N fertilizer rate and plant spacing were combined into one study as suggested during the project logframe review.

Optimization of Nitrogen Rate to Achieve the Yield Potential of Recently-Released Irrigated Lowland Rice Varieties

MD Malabayabas, AJ Espiritu, and HJG Patricio

Among nutrients, N is the most important determinants of yield potential, which can also be enhanced with proper plant spacing. Hence, a study was conducted in WS and DS 2018 to determine the yield potential of newly-released irrigated lowland rice varieties at different N fertilizer rates and plant spacing. In DS 2018, the yield potentials of NSIC Rc 222 and Rc 442 were achieved with 90 and 130kg N/ha for Rc 402 and Rc 438. The N rates of 210 and 250 kg N/ha significantly reduced AE_N of the test varieties.

The effect of plant spacing on the yields of Rc 160, Rc 222, Rc 240, Rc 400, Rc 438, and Rc 440 was also determined in DS 2018. Higher yield was achieved with 15cm x 30cm spacing for low tillering variety like Rc 240. The rest had comparable yields with 15cmx 20cm, 20cm x 20cm, and 15cm x 30cm spacing. This suggests that these plant spacings can be used for the five varieties tested. However, it is recommended to use 15cm x 30cm as it will save more seedlings without sacrificing the yield.

In WS 2018, the effect of combining different N fertilizer rates and plant spacing indicated higher yield of Rc 222 and Rc 402 at 15cm x 30cm. The yields of Rc 438 and Rc 442 were comparable in both plant spacings. Grain yields across variety and planting distance were optimum at 90 kg N/ha.

Relationship of N and K level to incidence of major rice insect pest and diseases

FS Grospe, JRA Vera Cruz, JP Rillon, and EM Valdez

The study was conducted at PhilRice CES to determine the relationship of N and K fertilizer levels on the incidence of ShB, BLB, and SB damage. In DS 2018, only ShB and BLB damage were assessed under greenhouse condition. In WS, effect of N and K levels on SB damage and yield was conducted under field conditions. Results showed that 135kg N/ha was the optimum level for yield of Rc 238 and Rc 442. However, the optimum N level with reduced ShB and BLB damage cannot be deduced from the results because the level of infection was below the critical levels to cause significant effect on yield. For SB damage, the different N and K level combinations had no significant effect on severity and incidence of whiteheads. However, it was very clear that N level of 90kg/ha and above increase whiteheads or SB damage.

Physiological Profiling of New and Popular Rice Varieties in the Philippines

AOV Capistrano, JJE Auñgon, and JU Ramos

The study aimed to generate physiologic information per rice variety in the Philippines that are popular and recently released by the National Seed Industry Council (NSIC). These information are important for the development of management practices or package of technologies appropriate per variety for rice crop production to be more economical and ultimately profitable for farmers. Initially, heat units and stomatal conductance were collected in DS 2018 from two inbred rice varieties while only heat units were collected during WS 2018. Stomatal conductance collection in WS 2018 was postponed due to difficulty of diurnal monitoring caused by the rainy weather conditions of the season.

PROJECT 4:

RESPONSE OF RICE GENOTYPES TO ABIOTIC STRESSES AND CROP MANAGEMENT: DROUGHT AND FLOOD

RT Cruz

Drought and flood are two of the major abiotic stresses in rainfed lowland rice ecosystem. Grain yields can be reduced to 1.5t/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 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. 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. Of the 18 rice genotypes tested for drought tolerance, the top 8 genotypes, namely, Green Super Rice or GSR-21, Raeline-10, Rc 282, CT 9993-5-10-1-M, UPL Ri-5, Rc 160, PSB Rc 14, and Rc 416 had slower progression of leaf rolling and leaf tip drying and had higher plant biomass. These visible plant reactions to drought stress resulting aboveground plant biomass were considered important components of the overall drought tolerance of the rice crop. Field studies in DS 2017 and 2018 assessed leaf morphological, growth, and yield responses of three rice varieties to different K levels: 0-0-0, 120-40-60, and 120-40-120kg NPK/ha applied before imposing the 20-day drought stress at vegetative stage (15 to 35 days after transplanting or DAT) and reproductive or flowering stage (60-80 DAT). N and K (1/3 each) and P fertilizers were applied 14 DAT while remaining 2/3 N and K at 40 DAT. In response to drought stress, average soil moisture content decreased to 9% and soil strength increased to 2 MPa. Rc 282 had the slowest progression of leaf rolling with 120-40-120kg NPK/ha. Varieties exposed to vegetative drought treatment were less affected in terms of yield reduction based on the well-watered control ranging from 7.6 to 30.0% with Rc 282 having the lowest yield reduction. With reproductive drought treatment, Rc 282 had higher panicle exsertion rate and lower spikelet sterility. Based on the well-watered control and without fertilizer, yield reductions due to reproductive drought stress were highest across varieties and ranged from 33.3 to 46.2%. With 120-40-60kg NPK/ha, yield reductions ranged from 19.6 to 33.1%. With 120-40-120kg NPK/ha, Rc 282 had the lowest yield reduction of 6.5% suggesting the role of increased 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 92.8cm to 108.0cm. There was no significant difference between the Control (2-

3cm floodwater depth) and flooding treatment with 25cm floodwater depth. Based on the Control, the aboveground plant biomass was reduced by an average of 44.8% for 25cm and 50cm floodwater depth treatments. STPF and SF reduced aboveground plant biomass by 21.5% and 23.5%, respectively. Under 100cm floodwater depth, FR13A had the highest plant height of 79.3cm and was reduced by 2.8% (based on the control with 2-3cm floodwater depth) in response to STPF. Rc 222 and PR41543-B-14-2-1-2 did not survive. FR13A had aboveground biomass of 7.2g/plant and had the lowest biomass reduction of 57.7% in response to STPF with 100cm floodwater depth. Aboveground biomass of Ciherang Ag+ Sub1, Rc 282, PSB Rc 82, and UPL Ri-5 ranged from 0.4-6.8g/plant and were reduced by 65.7-100% in response to STPF with 100cm floodwater depth. In the field, grain yield of rice genotypes in response to STPF ranged from 1.0 to 5.6t/ha across floodwater depth treatments. With 25cm and 50cm floodwater depths, grain yield of rice genotypes was significant at 11.8-16.3%, based on the Control with 2-3cm floodwater depth. Under 100cm floodwater depth, only FR13A survived after the STPF treatment and was reduced to 41.2%, based on the Control. In terms of seedling ages, grain yield of Ciherang Ag+ Sub1 and PR41543-B-14-2-1-2 was higher by 5.7 to 15.0% with the use of 21-day old seedlings, based on the Control with 2-3cm floodwater depth. This is in contrast with FR13A and Rc 82 that showed higher grain yield of 3.7 to 41.7% with the use of older seedlings (44-days), based on the Control with 2-3cm floodwater depth. In addition, grain yield of rice genotypes in response to post-flood N applications increased by 5.6 to 21.1% with N application at 7 days after de-flooding (DAD) based on the Control with 2-3cm floodwater depth. Reports suggest that N can be easily absorbed when applied at 7 DAD, which possibly matched the crop's demand after flooding stress and could be used for faster growth recovery (Bhowmick et al 2014). Time of post-flood N application is important in determining the recovery growth especially when stand establishment was completely damaged by floodwater stress (Ella and Ismail, 2006).

Flood Tolerance of Rice Genotypes in Relation to Crop Management

RT Cruz, LC Peralta, JRA Vera Cruz, LL Espiritu, JH Ajos, and NV Desamero

Flooding or submergence severely affects rice crop growth and yield in rainfed lowland areas. Yields ranged from 1.0 to 2.0t/ha in flood-prone and submergence-prone rainfed lowlands (Bhowmick et al., 2014). Short-term partial flooding or STPF can be 25 to 50cm deep and lasts for about two weeks. Stagnant flooding or SF is frequently 25 to 50cm deep and partially submerges the shoot for a few weeks or months (Kato et al., 2014). Rice crop productivity can be improved by using flood-tolerant rice genotypes and appropriate crop management, e.g., seedling age and post-flood nitrogen (N) application (Bhowmick et al., 2014; Gautam et al., 2014). In the screenhouse, results showed that FR13A, Ciherang Ag+ Sub1, PR41543-B-14-2-1-2, and Rc 82 were the top performing rice genotypes in terms of plant height and aboveground/shoot biomass in response to STPF and SF with 25cm and 50cm floodwater depths. Based on the Control with 2-3cm floodwater depth, plant heights of most rice genotypes increased by 1.7 to 16.7% in response to STPF with 25cm floodwater depth and by 11.3 to 30.5% in response to SF with 25cm floodwater depth. This could be associated with an escape mechanism wherein the stem elongates keeping a portion of the shoot above water as floodwater rises. FR13A and the other genotypes did not survive the SF treatment with 100cm floodwater depth. With STPF (a) 25cm and (b) 50cm floodwater depths, FR13A had the highest shoot elongation rates of 1.59-2.26cm/day and 0.99-2.18 cm/day, respectively. Ciherang Ag+ Sub1, PR41543-B-14-2-1-2, Rc 18, and Rc 82 had shoot elongation rates ranging from 0.6 to 1.97 cm/day. Plants that had slow shoot elongation could have utilized the quiescence mechanism to conserve substrates until water recedes. Compared with other genotypes, the survival of FR13A could be due to its better adaptive mechanism during flooding stress resulting to higher plant height and aboveground/shoot biomass. Based on the Control with 2-3cm floodwater depth, shoot biomass of FR13A was reduced by 22.1% and 30.0% in response to STPF with 25cm and 50cm floodwater depths, respectively. Shoot biomass of Rc 222, PSB Rc82, Rc18, and Ciherang Ag+ Sub1 were reduced by 8.8-84.1%. In response to SF with 25cm and 50cm floodwater depths, aboveground/shoot biomass of FR13A were reduced by 15.2% and by 24.8%, respectively, based on the Control.

In the field, results showed that grain yield of FR13A was reduced by 11.8% in response to STPF with 25cm floodwater depth and by 29.4% in response to STPF with 50cm floodwater depth. In response to STPF with 100cm floodwater depth, only FR13A survived but grain yield was significantly reduced by 41.2%. PSB Rc 82, Ciherang Ag+ Sub1, and PR41543-B-14-2-1-2 were reduced by 12.5 to 16.3% in response to STPF with 25cm floodwater depth and by 14.3 to 42.9% in response to STPF with 50 cm floodwater depth. With the use of 21-day old seedlings, FR13A and PR41543-B-14-2-1-2 had higher yield increase of 29.3% and 26.2%, respectively. N application was at 7 DAD based on the Control with 2-3cm floodwater depth and no post-flood N application. With the use of 44-day old seedlings, PR41543-B-14-2-1-2 had the highest yield increase of 2.8%, based on the Control with 2-3cm floodwater depth and no post-flood N application. Reports suggest that N can be easily absorbed when applied at 7 DAD and could have matched with the crop's demand for N after flooding stress, and recover faster (Bhowmick et al 2014). Determining the growth recovery of rice genotypes is very important especially when crop stand establishment was completely damaged by floodwater stress (Ella and Ismail, 2006); hence, post-flood N application would be beneficial.

Response of Rice Genotypes to Drought Stress and Its Management in Rainfed Lowland System

RT Cruz, GP Faustino, NV Desamero, and JE Hernandez

Success has been limited in increasing rice grain yield in drought-prone rainfed lowlands. Hence, it is important that both agronomic and genetic management strategies focus on use of available soil moisture for growth and yield. The screenhouse study assessed the drought tolerance of 18 rice genotypes in response to 20-day vegetative drought stress by withholding irrigation in 8l pots with 8kg clay soil from 15 to 35 DAT with 120-40-60kg NPK/ha applied in 2 splits: all P and 1/3 N and K at 14 DAT; and 2/3 N and K at 40 DAT. Soil moisture depletion was faster in the screenhouse, resulting in lower soil moisture content, higher degree of leaf rolling reaching the highest score of 5 and leaf tip drying reaching the highest score of 5. GSR-21, Raeline-10, Rc 282, CT 9993-5-10-1-M, UPL Ri-5, Rc 160, Rc14, and Rc 416 (top eight) were considered drought tolerant based on slower progression of leaf rolling and leaf tip drying and better recovery after rewatering. The aboveground dry matter yield reductions of the top eight varieties at the end of drought treatment (35 DAT) was 57.8% and 68.1% reduction for other varieties. At 46 DAT, the top eight varieties had 71.1% reduction based in the Control and 80.2% reduction for other varieties.

Field studies in DS 2017 and 2018 assessed leaf morphological, growth, and yield responses of three rice varieties to different potassium levels: 0-0-0, 120-40-60, and 120-40-120 kg NPK/ha applied before imposing the 20-day drought stress at vegetative stage (15-35 DAT) and reproductive or flowering stage (60-80 DAT). N and K (1/3 each) and P fertilizers were applied 14 DAT and remaining 2/3 N and K at 40 DAT.

In response to vegetative drought stress, average soil water content decreased to 8.5 % and soil strength increased to 2.4 MPa. Rc 282 had the slowest progression of leaf rolling with 120-40-120 kg NPK/ha. Rc 282 had higher panicle exsertion rate and lower spikelet sterility. Based on the well-watered control and without fertilizer, yield reductions due to drought stress ranged from 13.6-25.4%. With 120-40-60 kg NPK/ha, yield reductions ranged 18.3-22.8%. With 120-40-120kg NPK/ha, Rc 282 had the lowest yield reductions of 3%.

In response to reproductive drought stress, average soil water content decreased to 9.4% and soil strength increased to 2.3 MPa. Rc 282 had the slowest progression of leaf rolling with 120-40-120kg NPK/ha. Rc 282 had higher panicle exsertion rate and lower spikelet sterility. Based on the well-watered control and without fertilizer, yield reductions due to drought stress ranged 33.3-46.2%. With 120-40-60kg NPK/ha, yield reductions ranged 19.6-33.1%. With 120-40-120kg NPK/ha, Rc 282 had the lowest yield reductions of 6.5-8.5%.

PROJECT 5:

DEVELOPMENT OF ORGANIC-BASED PRODUCTION TECHNOLOGY AND MANAGEMENT FOR PADDY RICE AND SUSTAINABLE PRODUCTIVE PADDY SOILS (OBRICE)

EF Javier

Most of the reviews on organic nutrient supplements had proven very effective but not specifically on rice plants. The big challenge is posted: How does organic rice farming work and be sustained in continuously flooded or irrigated ecosystem where chemical reactions differ from the aerated ecosystem? To optimize an organic-based nutrient management for rice is the ultimate output of this project.

Mineralization of different organic materials was conducted in the previous 10- year trial of this same research project, which served as the basis of the proper time of basal organic fertilizer application. With three studies under this project, a package of an organic based nutrient management (OBNM) for organic rice production technology in irrigated rice ecosystem that would yield 4t/ha in the rice cropping year is seen to be developed.

From the same organic fertilizer trial (Study 1), it was shown that organic material with lower C/N ratio (wild sunflower) releases nitrogen faster than those with higher C/N ratio (rice straw) (Javier and Tabien 2003). From this result, another study was conducted to determine and optimize the best possible organic topdress N nutrition for the organically-basal fertilized plots (Study 2). Initial study using any of the green manure with low C/N ratio and being the best or fastest materials to release nutrients was done comparing urea fertilizer. Green manure showed to be a potential topdress N source for yield increase similarly to urea top dress. Different *Azolla spp* and other biofertilizers (*Sesbania*, *Aeschynomene*, *Indigo*, and *Vigna sp*) are also potential organic basal and topdress fertilizer, and worth looking into (Study 3B, 3C). The optimization of the packaged organic-based rice management was also conducted in 2018 (Study 3A) to determine its sustainability under irrigated rice ecosystem and at the Future Rice and Agro Ecotourism Farm.

Long-term organic fertilizer use in paddy soils

EF and AE Espiritu

The effect of continuous application of organic fertilizers/waste in a continuously irrigated or submerged soil conditions such as in rice production is different from the aerated or dry soils. Therefore, this study will give science-based information on the real-time effect of continuous use of organic fertilizer in flooded soils to produce an organic-based rice production optimized to sustain grain yield, soil health, and productivity in a close nutrient cycling system. These farm wastes were used as treatments: rice straw, chicken manure, green manure, and vermicompost. These were applied alone, and in combination with half and full recommended rate for dry season and wet season. Unfertilized plots were used as indicators of current indigenous nutrient supply. Rc 82 was used as test plants. More than 14 years of continuous application of different organic materials showed that organic and inorganically-applied rice plants have similar yields in wet seasons 2005, 2007, 2011, 2013, 2016, and 2018. This is because rice plants have lower nutrient demand in the wet than in the dry seasons. Meanwhile, organically-grown rice plants recorded lower yields than rice plants applied with combined organic and inorganic fertilizers in the dry seasons.

Optimized utilization of *Azolla spp* as alternative and potential organic-based nitrogen nutrition for irrigated rice crops

EF Javier, JM Mercado, and XX Sto. Domingo

The study was conducted to assess different green manures like the *Azolla spp* as alternative nitrogen sources for topdress fertilizer not only on normal paddy soils but also in acidic and saline soils. The sub-studies were conducted in greenhouse and on field.

In the greenhouse, *Azolla microphylla* was consistently found to be tolerant in hot and humid environment and can still grow and sporulate normally. *Azolla spp* was also found to slightly decrease salinity and increase soil pH. Meanwhile, field experiments in 2018 wet and dry seasons showed that combination of organic and inorganic produced better yield than pure inorganic fertilizer. Applying chicken manure and reincorporating rice straw into the soil gave higher yield than using vermicast and rice straw. Slight increase of grain yield with the addition of Azolla compost in the basal nutrition and as top dress was observed but it was comparable with the Key check #5 of the PalayCheck™ System and the organic-basally applied PalayCheck™ System. Thus, there is a need to verify and modify the treatments to come up with yield higher than the inorganic-based PalayCheck™ System such as combinations of the organic-basal nutrient sources, frequency, and quantity of the alternative organic-based N sources as top dress.

Technology Verification and Assessment of the Packaged Organic-based Nutrient Management for Rice Production (OBRice)

EF Javier, JM Mercado, AJ Espiritu, and MD del Rosario

This study aimed to produce an organic-based nutrient management for paddy rice production (OBRice) that can sustain 4t/ha throughout seasons. It specifically aimed to assess and compare (1) packaged organic-based nutrient management (OBNM) (based on the results of study 1 and 2), (2) purely inorganic based nutrient management (IBNM) of the PalayCheck system, (3) inorganic based NM of the Palaycheck System but with organic-basal nutrient management, and (4) half of the inorganic NPK rate of the nutrient management of the Palaycheck System with organic-basal nutrient management at basal.

Results showed potential grain yield of the OBNM over the standard IBNM of the PalayCheck System. The IBNM of the Palaycheck system showed additional yield increase under organic based nutrient management. This implies that the two packaged nutrient management are complementary. As organic fertilizers improve the soil texture, they also improve the soil biological factor for holistic productivity and health; thus, higher fertilizer use efficiency is expected.

Experiments at the Future Rice Farm showed that continuously submerged soil condition has higher yield than well-drained soil condition. The submerged plots may have nutrient sources from the irrigation water coming from the upper plots, which were applied with inorganic fertilizers. Plot orientations will be done for better optimization of the OBNM for OBRice Production.

Growing vegetables above the Azolla production pond can also be an additional income and can contribute to household food security.

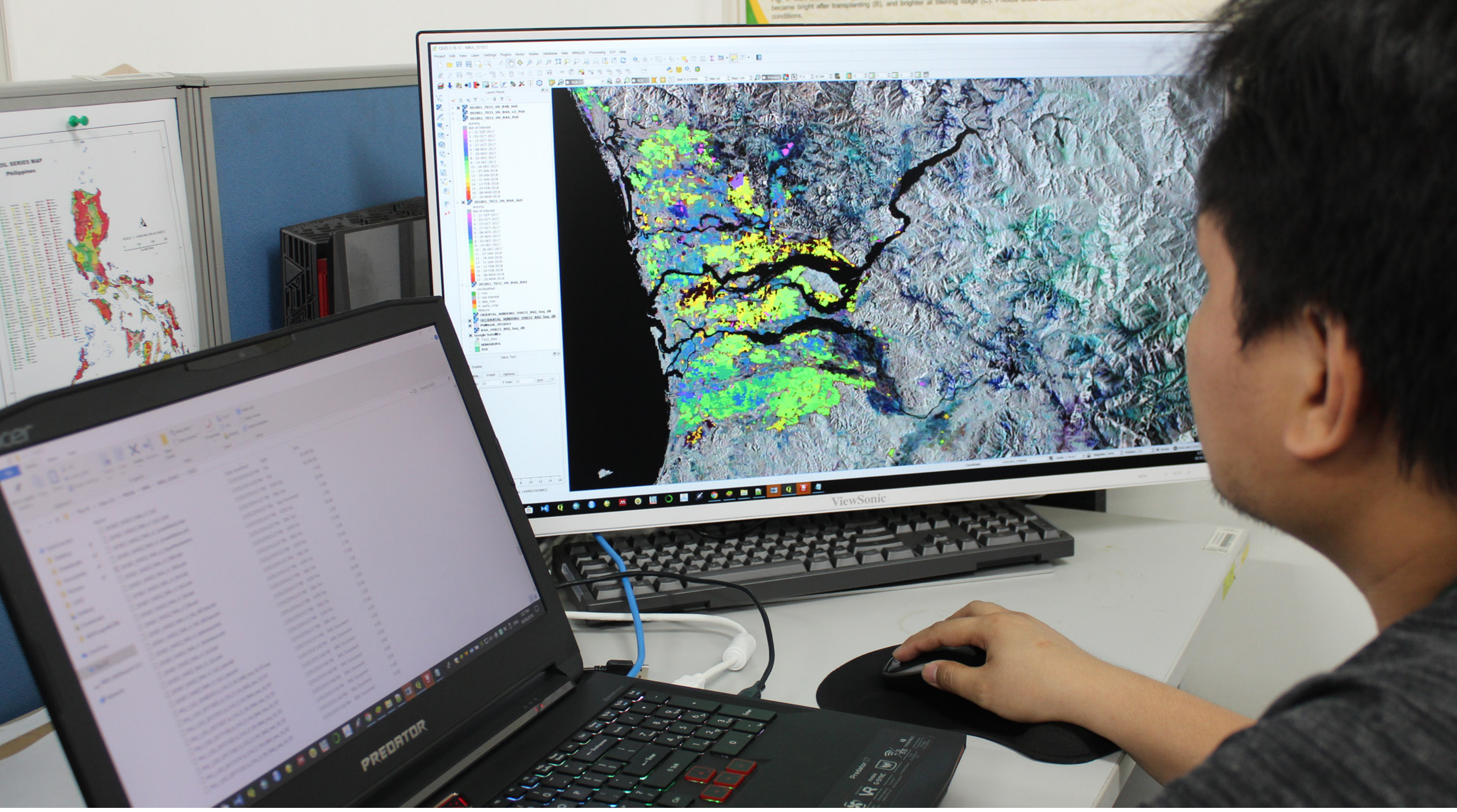
PROJECT 6:

ASPPD RESEARCH AND ANALYTICAL LABORATORY SYSTEMS AND MAINTENANCE

AR Espiritu and EF Javier

This study ensured that analytical laboratory system is maintained through periodic calibration. New equipment were acquired in 2018. Existing equipment in good condition underwent calibration and preventive maintenance service. Series of hands- on- training on proper handling, use of newly acquired equipment, and proper preventive maintenance were conducted. Database on chemicals and equipment were updated and improved to ensure safe storage of laboratory information that could be retrieved for publication or reference. ASPPD laboratory had also served as an avenue for laboratory benchmarking of other universities. Networking/technical/laboratory assistance and consultations were also provided to students.

Compliance to regulatory requirements such as inventory of controlled and regulated chemicals used in the laboratory were reported. ASPPD laboratory underwent annual work environment monitoring to ensure that working condition is within the acceptable range for specific chemical.



PROJECT 7:

PHILIPPINE RICE INFORMATION SYSTEM (PRiSM) OPERATION

EJP Quilang

The Philippine Rice Information System (PRiSM) provides timely information on rice crop seasonality, area, yield, and extent of flood or drought estimates using remote sensing, crop growth simulation, and information technologies. The information system provides regular updates on tabulated and map forms at high spatial resolution using synthetic aperture radar satellite images, crop information model, atmospheric data and other ground observation. PRiSM data and information are up to municipal level averages and ranges that are available at a web-based portal, https:/prism.philrice.gov.ph that facilitates PRiSM operation and information sharing.

The PRiSM is fully operational starting second semester of 2018 after its development from 2013 to 1st semester 2018. The strategic and operational plans and final external review were crafted before its final deployment. Operational requirements, plans, needed experts and regional facilitators in each PhilRice branch station were identified and finally briefed for operation. Standard sustainability plan for every region was produced to guide the Department of Agriculture-Regional Field Offices (DA-RFOs) in sustaining PRiSM operations.

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

With a "Rice-Secure Philippines" vision, we want the Filipino rice farmers and the Philippine rice industry to be competitive through research for development in our central and seven branch stations, coordinating with a network that comprises 59 agencies strategically located nationwide.

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

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