2020

PhilRice R&D Highlights

Agronomy, Soils, and Plant Physiology Division

Contents

Agronomy, Soils and Plant Physiology Division

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EXECUTIVE SUMMARY

The Agronomy, Soils, and Plant Physiology Division (ASPPD) promotes modernizing rice agriculture by developing tools and technologies for fertilizer, soil, and water management for rice production. The division also generates information and production-related advisories. All lead to increasing resource-use efficiency and making informed decisions for sustained and more productive rice production and other research and development activities.

Knowing the soil properties, water resources, and other production-increasing and -reducing factors in determining crop productivity is most important. Similarly, increasing and maintaining land productivity require appropriate management techniques that suit specific conditions and types of crop and variety. Soil fertility can be assessed by soil analysis to determine problems related to nutrient deficiencies or imbalances and crop responses. The same is true when studying crop productivity that embodies correct interpretation of all production elements – soil, water, environmental conditions, and other biotic factors. Hence, field experiments, both short-term and medium-term, are essential in examining the productivity and sustainability of crops or land management systems of rice-based environments in which increasing farm yields and profit is dependent. Issues that contribute to non-attainment of potential gains under field conditions can be addressed by providing the needed information and decision-making tools to determine inputs to apply, how, when, and how much.

The long-term inorganic fertility field experiment at PhilRice Central Experiment (CES), which started in 1968, showed that the indigenous soil nutrient supply capacities varied through time but were managed by supplementation to attain the high target yields. The nutrient supplying capacities averages were 88.7kg N/ha, 15.0kg P/ha, and 93.9kg K/ha during the wet season (WS) while 59.0kg N/ha, 17.1kg P/ha, and 83.1kg K/ha during the dry season (DS).

The long-term trend on yield potential showed an average gap of 20% from that of the potential yield. The current DS results showed a slightly larger gap of 27% because of a lower than the average yield potential of 6.60t/ha obtained by the tested rice varieties. In WS, on the other hand, the yield gap was smaller compared with the previous years. The highest yield potential was 5.91t/ha (80% of the potential yield), which was higher than the previous yield potentials of 65%.

EXECUTIVE SUMMARY

The improved version of the Leaf Color Chart (LCC) App as a real-time N fertilizer management tool was evaluated for field performance. It consistently gained significantly higher yields against the previous version and control, indicating a successful optimization of algorithms. The App was released in Play Store in September 2020 and featured in the virtual *Lakbay Palay*. A Gender and Development (GAD)-tagged project, the LCC App provides an opportunity for sight-challenged farmers since the App assesses the color of rice leaves.

The updated version of the Minus-One Element Technique (MOET) App as a pre-cropping and multi-element soil diagnostic tool was field-evaluated in terms of yield and fertilizer use efficiencies. The App consistently gained comparable and higher grain yields than the original version with significantly better fertilizer use efficiencies, as shown by higher AE_N and partial factor productivities across varieties and cropping seasons. For a more customized fertilizer recommendation, a function for adjusting the target yield or fertilizer budget according to the preferred level was included.

N fertilizer application and plant spacing are critical in attaining higher yields. While the agronomic optimum N rate (AONR) and agronomic N efficiency (AE_N) affected yield potentials of the four varieties tested, hill spacing did not significantly affect the yield potentials of all the varieties in both DS and WS. These results suggest that varieties with both high yield potential and high AE_N should be developed.

The long-term organic fertilizer study at PhilRice CES since 2003 showed that organic-basal fertilizers like rice straw and chicken manure or vermicompost did not last long to provide enough nutrients for the whole growth duration of rice crop. This may be one reason why the yield is low in pure organic compared with inorganic fertilizers with several applications. Hence, an N source around the panicle initiation stage is needed. Green manure, like *Azolla microphylla* that mineralizes upon decomposition or several days after incorporation, was found as a potential supplemental N source during that period.

The application of NPK fertilizer could be reduced to half the recommended rate using the developed Organic-Based Nutrient Management for Organic-based Rice production management. It also sustained soil health and productivity and eliminated much farm waste by recycling, thus, sustaining the soil biology and nutrient use efficiency. Using these techniques, the target of sustainable 4t/ha/season was achieved for both inbred and hybrid rice varieties in continuously flooded soil conditions.

Philippine Rice Information System (PRiSM) regularly served in a nationwide scale timely, reliable, and location-specific and seasonal information on the extent of planted rice area, seasonality, yield, production estimates, and potential rice areas that can be affected by flood and drought. It also showed how the synergistic integration of different state-of-the-art technologies like satellite image

analysis, geographic information system, crop growth simulation modeling, and smartphone-based field data collection work in agriculture modernization. Aside from monthly updates, and special bulletins, seasonal reports were submitted to DA as regular bulletins every 20th of May and October annually.

In 2020, the rice area planted in the 1st semester was 2,015,583ha, while it was 2,375,837ha for the 2nd semester. In the 1st semester, 57% of rice planting occurred from December 2019 to January 2020. Early planting (September to November 2019) was observed in 22% of the area, while 21% were planted late in February-March 2020. Around 48% of the rice area was harvested by the 1st quarter, and the remaining 52% were harvested in the 2nd quarter. Cagayan Valley, Central Luzon, Bicol, Eastern Visayas, and Caraga were the regions with large rice areas harvested in the 1st semester. In the 2nd semester, planting in Luzon, Visayas, and Mindanao peaked in July. Rice planting was delayed in Luzon, and the harvesting period was extended until December. The delay in planting and harvesting could be due to the delay in irrigation water availability and COVID-19 lockdowns.

For the 1st semester, the average yield at the national level was 4.16t/ha, 12% higher than the same semester in 2019. Central Luzon had the highest yield of 5.78t/ha at the regional level, about 39% higher than the national average, while Central Visayas recorded the lowest yield (2.85t/ha). At the provincial level, rice yields ranged from 1.80t/ha (Basilan) to 6.92t/ha (Nueva Ecija). Compared with 2019 yield estimates, a significant increase was observed in 28 provinces, with Camarines Sur having the highest increase (66%) and Lanao del Sur with the lowest (10%). On the other hand, a significant decrease in yields was observed in 12 provinces ranging from 10% (Romblon) to 18% (Basilan). During the 2020 1st semester, rice yields in some provinces were lower than the normal average due to drought associated with the 2018-2019 El Niño events. In the 2nd semester, the estimated national average yield was 4.20t/ha, which was 7% higher than the previous estimate. At the regional level, seven out of 16 rice-producing regions had rice yields higher than the national average. Northern Mindanao had the highest average yield of 4.97t/ha, which was 18% higher than the national average, while Caraga had the lowest (3.13t/ha). Compared with 2019 data, all the regions except Caraga showed better yield performance, particularly in BARMM, CAR, Bicol, CALABARZON, Zamboanga Peninsula, Northern Mindanao, and MIMAROPA. At the provincial level, 32 provinces had higher yields than the national average, wherein Bukidnon (5.22t/ha) and Basilan (2.19t/ha) had the highest and lowest, respectively. Better yield performances were observed in all provinces except Samar (-16%), Marinduque (-7%), Davao Oriental (-5%), Aklan (-4%), Agusan del Sur (-4%), Guimaras (-3%), Eastern Samar (-3%), Iloilo (-1%), Lanao del Sur (-1%), Northern Samar (-1%), Davao de Oro (-1%), Davao del Norte (-1%), Catanduanes (-0.5%), and Ifugao (-0.4%).

PROJECT 1

Assessment and Management of Soil Fertility and Soil Health

Wilfredo B. Collado

Maintaining the fertility of our agricultural soils is of great importance, and this requires appropriate management approaches to sustain crop production at an acceptable level (Johnston, 2005). Johnston (2005) emphasized that soil analysis and its interpretation is one of the tools used in assessing the fertility of soils. Soil analysis helps identify production problems related to nutrient deficiencies or imbalances and provides a decision-making tool to determine what nutrients to apply and how much. Another method used is through the conduct of long-term field experiments. Long-term experiments are important for examining the productivity and sustainability of cropping or land management systems. Another challenge is the sustenance of the productivity of rice-based cropping systems in which increasing farm yields and profit has taken its toll.

Three studies were undertaken to assess: (1) soil fertility and soil health and develop management recommendations to improve soil fertility and soil health; (2) the indigenous soil nutrient supplying capacities of the different cropping systems; (3) the long-term trends on the yield gap between the potential and the actual yield; (4) the suitability and durability of different rice-based cropping systems and develop management recommendations to improve durability; and (5) the current soil fertility status at the PhilRice CES.

Soil fertility evaluation of the study sites was conducted only for Study 3. The other two studies had soil samples ready for soil analyses but not yet done due to the COVID-19 pandemic restrictions.

The indigenous nutrient supply-capacities of the long-term study test site showed comparable nitrogen, phosphorus, and potassium levels from previous years, except for the indigenous N supply during the wet season (88.7kg/ha). Average P and K supplying-capacities of the test site per season were 15.0kg/ha and 93.9kg/ha, respectively.

The long-term trend on yield potential showed an average gap of 20% from that of the potential yield. The current dry season (DS) results showed a slightly larger gap of 27% from the average 20% from previous years. In the wet season (WS), the yield gap was smaller than in the previous years (20% vs. 35%). The WS showed a more favorable condition in achieving a higher yield.

In the rice-based cropping systems in Nueva Ecija (Cuyapo) and Pangasinan (Balungao), the identified cropping patterns were highly suitable for the soil type. Average yield differences of 0.4t/ha and 0.8t/ha in 2020WS rice were obtained in the trial sites over the farmers' practice. These accounted for 6% and 11% yield advantages, respectively. Dry season corn yields in Pangasinan were affected by corn armyworm. An average kernel yield of 2.07t/ha across treatments was attained but way lower than the normal average of 9.0t/ha. In Cuyapo, mungbean obtained an average yield of 1.16t/ha in the improved nutrient management treatment, higher by 8% than the farmer's practice. The final result on sustainability and profitability of the 2020 cropping patterns will follow when the remaining activities such as post-cropping farmer's interview, soil analysis, and yield data gathering from the third cropping in the case of Pangasinan have been done.

The assessment of the fertility status of the paddy fields in PhilRice CES continued. The second round of soil sampling in the 16 blocks/clusters was done in the DS following the standard procedure for soil sampling. First, soil test results showed a generally low nitrogen level. Sixty-seven percent (67%) of the area had high available phosphorus content, while 25% and 8% had medium and low P levels, respectively. A low concentration of exchangeable potassium was observed in 83% of the area, while only 17% had medium levels. The whole area had an optimum concentration of copper. Zinc levels were 52% optimum, 30% low, and 18% very low. The iron in 96% of the area had optimum levels, while 4% had a low level of <25ppm. For soil manganese, 39% of the samples had optimum levels while 37% had low concentrations. The remaining 24% had a very low concentration of <60ppm. Thus, the paddy soils of PhilRice CES had medium fertility.

Long-term Soil Fertility Experiment

Sandro D. Cañete and Christian Dave R. Alonzo

Two rice croppings were established every year to determine crop productivity and sustainability trends, indigenous nutrient-supplying capacity, agronomic nitorgen (N)-use efficiency, long-term trends on yield gap, and effect on soil fertility. The experiment followed a Randomized Complete Block Design with six fertilizer treatments, three rice varieties, and three replicates.

Dry season (DS) results showed that the highest grain yield of 6.44t/ha was obtained by the Leaf Color Chart (LCC)-based N management treatment with phosphorus (P) and potassium (K) and was comparable with rice plants applied with NPK (6.23t/ha) and NK (5.85t/ha). The lowest yields were obtained by the plants with no fertilizer (2.71t/ha) and those applied with PK only (3.51t/ha). The application of NP only provided a grain yield of 5.37t/ha. In WS, yields in all the fertilizer treatments were comparable. However, this result is unusual; thus, the data will be checked and recalculated as necessary.

Indigenous nutrient-supplying (INS) capacities of the site in DS were 52.7kg, 15.2kg, and 91.3kg N, P, and K per hectare, respectively. In wet season (WS), INS for N, P, and K were 88.7kg, 14.7kg, and 96.5kg a hectare, respectively. Only the WS indigenous N supplying capacity of the area was higher compared with the previous years. Agronomic efficiency of applied N was higher in the LCC-based N management (16.9kg grain/kg N) with 173kg N/ha application than the fixed time and rate of N application (13.0kg grain/kg N) with 210kg N/ha application rate.

Soil fertility evaluation of the test site was not done given the closure of service providers because of the COVID-19 pandemic.

Durability of Corn-Rice-Rice and Mungbean-Rice Cropping Patterns in Lowland Ecosystem

Sandro D. Cañete and Wilfredo B. Collado

Two on-farm experimental sites in San Joaquin, Balungao, Pangasinan and Pugo, Cuyapo, Nueva Ecija (NE) were selected in January 2018 to assess the durability of corn-rice-rice and mungbean-rice cropping patterns in lowland ecosystem. Specifically, the study aimed to determine the inherent and potential productivity of soils under corn-rice-rice and mungbean-rice cropping patterns and generate soil and crop management recommendations for a durable rice-based cropping system. The durability of the cropping patterns was measured in terms of productivity, sustainability, and profitability based on the researcher's recommended nutrient management (RR) and the farmer's practice (FP). Cropping patterns, cropping calendars, and other conventional practices were secured from the farmer-cooperators through interviews. The usual cropping pattern in Pugo is mungbean in November for DS, followed by rice in June for WS; while in San Joaquin, DS corn is planted in January, followed by two WS rice in June and September. Both land units are dependent on shallow tube wells (STW) during the DS and rainfall but supplemented with STWs during the WS.

An average yield difference of 0.4t/ha and 0.8t/ha in 2020 WS rice were obtained in the trial sites over the farmer's practice in Cuyapo, NE and Balungao, Pangasinan, respectively. These accounted for a 6% and 11% yield increase. On the other hand, DS corn yield in Pangasinan was affected by corn armyworm and was salvaged by the farmer-cooperator due to travel restrictions. An average kernel yield of 2.07t/ha across treatments was attained, but this was way below the normal average of 9.0t/ha in the site. In Cuyapo, NE, mungbean harvest in the trial sites obtained an average yield of 1.16t/ha, which was 8% higher than the farmer's practice.

Data on sustainability and profitability of the 2020 cropping patterns will depend on the remaining activities such as post-cropping farmer's interview, soil analysis, and yield data gathering from the third cropping in the case of Pangasinan.

Assessment of Soil Fertility Status of PhilRice CES Rice Paddy Field

Annie E. Espiritu and Wilfredo B. Collado

Understanding the current nutrient status of the soil is essential to establish the necessary soil requirements to achieve maximum yields. The PhilRice CES represents a wide array of cultural management practices ranging from the breeding of rice varieties, insect pest control and disease management, soils and water management, farm machinery testing, and rice production. Having this wide spectrum of field research, this study aimed to assess the soil nutrient fertility status of the PhilRice CES paddy field. Random soil sampling was done per block, and composite soil samples (0cm to 20cm depth) were collected from the different plots of 16 blocks following the standard procedure for soil sampling. Generally, nitrogen level was low at PhilRice CES paddy field as expected because it is the most limiting nutrient. Sixty-seven percent (67%) of the total soil samples had high available phosphorus (P) content, while 25% and 8% had medium and low P levels, respectively. A low concentration of exchangeable potassium was observed in 83% of the samples, and only 17% had medium levels. The optimum concentration of copper was observed in all soil samples. Fifty-two percent (52%) of the total soil samples had optimum zinc levels, while 30% and 18% had low and very low concentration levels, respectively. The optimum level of available iron (Fe) was observed in 96% of the soil samples, while only 4% had a low Fe level with less than 25ppm. For soil manganese, 39% of the samples had optimum levels while 37% had low concentrations. The remaining 24% had a very low concentration of less than 60ppm. Generally, results showed that CES experimental station had medium fertility.

PROJECT 2

Development, Evaluation, and Enhancement of Diagnostic (Soil, Water, and Nutrient) and Decision Support Tools for Rice-based Precision Farming

Ailon Oliver V. Capistrano

The project aimed to develop, enhance, and evaluate diagnostic and decision-support tools for rice production. In particular, the project aimed for the development of the Leaf Color Chart (LCC) App, refinement of the Minus-One Element Technique (MOET) App, and evaluation of existing soil nutrient diagnostic tools, which was already completed in WS 2019. This year, the LCC App was further evaluated for actual field performance and efficiency. The MOET App updated version also underwent further field evaluation against the original MOET App in terms of yield and fertilizer use efficiencies. The LCC App consistently gained significantly higher yields against the original LCC and the soil plant analysis developement (SPAD) across varieties and cropping seasons. Agronomic efficiencies of applied nitrogen (A_EN) by the LCC App were also better than SPAD in both seasons in NSIC Rc 222 and slightly lower in Rc 204H, indicating that optimizations done with the algorithm were successful. The LCC App was also released in Play Store in September 2020 and featured in the virtual *Lakbay Palay* of the Institute. Likewise, the updated version of the MOET App consistently gained comparable and higher grain yields than the original version, with significantly better fertilizer use efficiencies as shown by higher AEN and partial factor productivities across varieties and cropping seasons. An updated graphical user interface was also completed; the App now includes a function for adjusting the target yield or fertilizer budget according to the preferred level of the MOET App user for a more customized fertilizer recommendation.

With the LCC App visually assessing the rice leaves for correct N-rate application, it provides an opportunity for sight-challenged farmers to properly manage the N needs of their rice fields.

Development of an Android Application Version of the Leaf Color Chart (LCC) for a More Precise Nitrogen Topdress Application in Rice

Ailon Oliver V. Capistrano, Jose Emmanuel G. Hernandez, Job U. Ramos, and Juvy Jane E. Aungon

The study aimed to develop and evaluate an android application for real-time nitrogen (N) topdress applications in rice through digital leaf image analysis. This year, field validation trials were conducted to test the functionality and effectiveness of the android application as a N topdress recommending tool for rice. In 2020 DS, a field validation trial with five treatments (zero nitrogen [0N], recommended rate [RR], Leaf color chart [LCC], soil plant analysis development for [SPAD], and LCC App) was done using two varieties (NSIC Rc 222 and Rc 204H) with four replicates. Results showed significantly higher yields in both varieties (9.85t/ha in Rc 222 and 9.11t/ha in Rc 204H) under LCC App compared with LCC and SPAD treatments but comparable with the yields under RR (9.58t/ha and 9.49t/ha). Agronomic efficiency of applied N (AEN) using the LCC App was found slightly better (22.81kg/kg N) than the LCC, while the use of SPAD in Rc 222 got the lowest (15.47kg/kg N) in Rc 204H. During the 2020 wet season (WS) field validation trial, only one variety (NSIC Rc 222) was used, and treatments were reduced to ON, SPAD, and LCC App to minimize field activities and risks of exposure to COVID-19. Replication blocks were substituted with crop cut subsamples from a larger treatment plot. Actual yield from each treatment plot area was also collected for a more realistic representation of yield performance. Results of the 2020 WS field trial showed the highest yield from the LCC App (6.74t/ha) followed by SPAD (6.33t/ha) and 0N (4.56t/ha) using the area-based yield data. Agronomic efficiency of applied N also showed the LCC App to be more efficient at 12.3kg/ha N than the SPAD chlorophyll meter at 9.4kg/ha N.

Enhancing the MOET Application via Establishment of Correlation Factors and Update of Database and Algorithms

Ailon Oliver V. Capistrano, Jose Emmanuel G. Hernandez, Job U. Ramos, and Juvy Jane E. Aungon

The study aimed to refine the recommended rates of the Minus-One Element (MOET) App by establishing a linear correlation with the nutrient omission plot technique (NOPT) and encoding it in the updated version (V.2) of the MOET App. This year, the 2nd year trials were conducted to evaluate the performance of MOET V.2 relative to V.1. In 2020 dry season (DS), three treatments were imposed (Zero N, MOET App V.1, and MOET App V.2) on three varieties (NSIC Rc 358, Rc 440, and Rc 204H) that were replicated in four blocks. Results showed that MOET App V.2 across varieties either had comparable or higher grain yields (8.89t/ha, 8.42t/ha, and 9.22t/ha, respectively) than MOET App V.1. Agronomic efficiency of applied N (AEN) was also better or significantly higher under MOET App V.2 than MOET App V.1 across the varieties used. Partial factor productivities for phosphorus (P) and potassium (K) were also compared between MOET App versions and were found to be consistently better in MOET App V.2 across varieties except for Rc 358.

During the 2020 wet season (WS) field validation trial, only two varieties (NSIC Rc 222 and Rc 440) were used, and replication blocks were substituted with crop cut subsamples from larger treatment plots to minimize field activities and risks of exposure to COVID-19. Actual yield from each treatment plot area was collected for a more realistic representation of yield performance. Results of the 2020 WS field trial showed the highest grain yield under MOET App V.2 for Rc 222 with a significantly higher AEN than MOET App V.1 based on actual area yield data (crop cut yields are still under process as of this writing). However, the yield of Rc 440 was highest under MOET App V.1, but its AEN was lower than MOET App V.2. Aside from AEN, the partial factor productivities of P and K were also evaluated and found consistently better under MOET App V.2 in both varieties.

Optimization of the Integrated Crop Management Components for Attaining the Yield Potential of Recently Released Irrigated Lowland Rice Varieties

Myrna D. 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 still components that need further improvement, like nutrient management. Other crop management practices like nitrogen (N) fertilizer application and plant spacing are critical in attaining higher yield. Moreover, the presence of pests and diseases, which can have significant effects on yield, is also related to the level of nutrients applied in the field, particularly N and potassium (K). Thus, the project focused on some important components of the integrated crop management that will help boost the yield potential of recently released irrigated lowland rice varieties.

Study 1 determined the agronomic optimum nitrogen rates (AONR) to achieve the yield potential of NSIC Rc 222, Rc 402, Rc 438, and Rc 442 and the agronomic efficiencies of applied N fertilizer (AEN). The AONR ranged from 146kg N/ha to 176kg N/ha and yield potentials were from 7.8t/ha to 9.7t/ha in dry season (DS). On the other hand, AONR ranged from 90kg N/ha to 135kg N/ha and yield potentials were from 5.8t/ha to 7.0t/ha in wet season (WS). Plant spacing did not significantly affect the yield potentials of rice varieties in both seasons. AEN of varieties across N rates during DS ranged from 32kg grain/kg N to 37kg grain/kg N and 19kg grain/kg N to 49kg grain/kg N fertilizer across varieties. The results also suggest the need to breed for varieties with both high yield potential and high AEN. In WS, AEN was affected by the occurrence of heavy rains resulting in inconsistent values.

Study 2 determined the combination of N and K fertilizer levels that will give a high yield with minimum pest damage. Results showed that the best combination of N and K fertilizers with high yield (4.1t/ha) and minimum stem borer (SB) damage of 18% whitehead for Rc 438 was obtained with 45kg N/ha + 80kg K/ha in DS and at 45kg N/ha + 40kg K/ha in WS. Meanwhile, Rc 442 had high yield and minimum SB damage at 45kg N/ha + 40kg K/ha both in DS and WS. The Rc 438 had low brown planthopper damage or hopper burn and a high yield using 135kg N/ha + 40kg K/ha in DS and WS. Moreover, NSIC Rc 438 had a high yield at 40kg N/ha + 40kg K/ha in DS and 45kg N/ha + 120kg K/ha in WS due to low sheath blight infection. In WS, NSIC Rc 438 had a high yield and minimum bacterial leaf blight infection at 90kg N/ha+80kg K/ha, while NSIC Rc 442 got a favorable yield at 135kg N/ha + 80kg K/ha application.

Optimization of Nitrogen Rate to Achieve the Yield Potential of Recently Released Irrigated Lowland Rice Varieties: Effect of Nitrogen Rate and Plant Spacing on Yield Potential of Rice

Myrna D. Malabayabas, Alex J. Espiritu, and Hazel Joy G. Patricio

The study was conducted in 2020 dry season (DS) and wet season (WS) at PhilRice CES to determine the optimum nitrogen (N) fertilizer rate and plant spacing that will enhance the yield potential of recently released irrigated lowland rice varieties under Maligaya clay soil conditions. Twenty-one-day-old seedlings of NSIC Rc 222, Rc 402, Rc 438, and Rc 442 were transplanted with plant spacing of 20cm x 20cm and 15cm x 30cm. The N fertilizer rates were 0, 90, 130, 170, 210, and 250 kilograms a hectare in DS and 0, 50, 90, 130, 170, and 210 kilograms a hectare in WS. Results showed that AONR ranged from 146kg N/ha to 176kg N/ha and yield potentials range from 7.8t/ha to 9.7t/ha in DS. Rc 402 gave the highest yield potential among varieties which was consistent with 2018 and 2019 DS results. In WS, agronomic optimum nitrogen rates (AONR) ranged from 90kg N/ha to 135kg N/ha and yield potentials were from 5.8t/ha to 7.0t/ha. Rc 402, Rc 442, and Rc 222 had comparable yield potentials, while Rc 438 had the lowest yield potential since this variety was prone to lodging and diseases. In DS, AEN of varieties across N rates ranged from 32kg grain/kg to 37kg grain/kg N and 19kg grain/kg to 49kg grain/kg N fertilizer across varieties. Rc 402 had the highest AEN among varieties indicating that it efficiently utilized the applied N fertilizer. The results also suggest the need to breed for varieties with both high yield potential and high AEN. The AEN obtained during WS were inconsistent and even resulted in some negative values. This might be due to overflow in some plots during heavy rains that caused contamination resulting in erratic data.

Relationship of N and K Levels to Incidence of Major Rice Insect Pest and Diseases

Filomena S. Grospe, Evelyn M. Valdez, Salvacion E. Santiago, Juliet P. Rillon, and Gelily DLC. Santiago

The study was conducted at PhilRice CES in 2020 dry season (DS) and wet season (WS) to determine the combination of nitrogen (N) and potassium (K) fertilizer rates that will produce high grain yield with minimum stem borer (SB) and brown planthopper (BPH) damage and sheath blight (ShB) and bacterial leaf blight (BLB) infection. There were five rates of N fertilizer (0kg/ha, 45kg/ha, 90kg/ha, 135kg/ha, and 210kg/ha) and four rates of K fertilizer (0kg/ha, 40kg/ha, 80kg/ha, and 120kg/ha) applied in both field and pot experiments with a fixed rate of 40kg P_2O_5/ha. The stem borer damage was assessed in the asynchronously planted irrigated lowland rice varieties, NSIC Rc 438 and Rc 442, under field condition. On the other hand, the ShB infection was determined in the *Rhizoctonia solani*-inoculated plant samples of NSIC Rc 438, while BLB infection was determined in the *Xanthomonas oryzae*-inoculated plant samples of NSIC Rc 438 and Rc 442. Both disease pot experiments were conducted under greenhouse conditions. The reaction of NSIC Rc 438 to BPH infestation at 65 days after transplanting (DAT) was also determined under net house condition. Results showed that N and K fertilizer combination that produced more grain yield due to lesser SB damage in NSIC Rc 438 was 90kg N/ha + 120kg K/ha (4.6t/ha with 17% WH) in DS and 45kg N/ha + 40kg K/ha (3.8t/ha with 11% WH) in WS. Meanwhile, in NSIC Rc 442, the N and K fertilizer combination that had more yield due to lesser SB damage was with 45kg N/ha + 80kg K/ha (4.1t/ha with 14% WH) in DS and 45kg N/ha + 40kg K/ha (4.5t/ha with 12.1% WH) in WS. NSIC Rc 438 had more grain yield of 38.6g/hill (DS) and 40g/hill (WS) due to lesser hopper burn at 135kg N/ha + 40kg K/ha combination in both DS and WS. Moreover, NSIC Rc 438 had high yield at 38.2g/hill) due to low ShB infection (21.3% RLH) at 45kg N/ha + 40kg K/ha in DS and at 45kg N/ha + 120kg K/ha (29.8g/hill and with 42.2%) in WS. NSIC Rc 438 had more yield (38.2g/hill) and minimum BLB infection (68% RLH) at 90kg N/ha + 80kg K/ha, while NSIC Rc 442 had more yield (24.8g/hill) and lesser BLB infection (68% RLH) at 135kg N/ha + 80kg K/ha application both in WS.

PROJECT 4

ASPPD Research and Analytical Laboratory System and Maintenance

Project Leader: Annie E. Espiritu

The Research and Analytical Laboratory Systems and Maintenance Project was established to support the division's R&D activities. Hence, there is a need to capacitate the laboratory system for quality data and analyses. This project aimed to sustain and improve the existing laboratory facilities and ensure their availability for use at all times for better quality research outputs. To meet this objective, it is necessary to ensure that the analytical laboratory system is maintained through periodic calibration, preventive maintenance and service, and other services that could further enhance and warrant its sustainability. In 2020, 39 pieces of equipment had been calibrated by an external calibrator, while seven pieces of equipment had undergone internal validation to guarantee accurate and reliable laboratory results and at the same time improve equipment life. The ASPPD laboratory had accommodated 10 studies of core and externally-funded projects in the conduct of several laboratory activities, including the use of laboratory facilities. Aside from this activity, the management of chemicals and equipment through database inventory was updated for laboratory reference purposes. Compliance with a regulatory requirement such as inventory of controlled and regulated chemicals used in the laboratory was also reported. Likewise, to get abreast of the current local and global scenarios in soils laboratory, participation in national and global soil laboratory networks' meetings and online activities were done. Given its importance, the project needs to be continuously capacitated for quality research outputs not only for the ASPPD R&D activities but the Institute, as well.

Development of Organic-Based Nutrient Management for Paddy Rice and Management of Productive and Environment-Friendly Paddy Soils

Evelyn F. Javier

The organic-based nutrient management (OBNM) for rice was built up from the basic information on the nutrient dynamics and other physico-chemical properties of the paddy soils, which are different in aerated soils. Several studies have been conducted since 1998 that led to the development of the different component upscaling to the proper application of organic fertilizers alone or in combination with inorganic nitrogen, phosphorus, and potassium (NPK) fertilizers. Mineralization study showed that rice straw with a high C:N ratio should be incorporated not later than 30 days before transplanting, or it could be incorporated together with effective microorganism (EM1) or chicken manure (CM) at 14 days after transplanting, while those with lower C:N ratio could be incorporated not later than ten days before transplanting. These application techniques also had something to do with reducing methane emission. However, organic-basal fertilizers lasted only in the middle tillering stage. This is the reason why the yield is still low as compared with the yield of those applied with inorganic-based nutrient management (IBNM). Hence, there is a need to supply the needed N in the panicle initiation stage of the rice plant (Study 1). There had been no observed residual N every after the season. As it mineralized in 2-3 days after incorporation, green manure showed potential as an alternative organic source of topdress N (Study 2). *Azolla microphylla,* among all 30 species of *Azolla* studied, had exhibited good growth and sporulation in a hot and humid lowland rice ecosystem, especially when paddy soils were applied with chicken manure or carabao dung in lieu of the inorganic P fertilizer (Study 2). Optimization on the use of *A. microphylla* for OBNM revealed that application was needed at 10, 30, and 45 days after transplanting (DAT) in wet season (WS) and at 10, 30, 45, and 60 DAT in dry season (DS) (Study 2). This was in addition to the basally applied organic fertilizers like the rice straw inoculated with either chicken manure, vermicast, or EMBI. The target of sustainable 4t/ha per season was achieved for both inbred and hybrid rice varieties in continuously flooded soil conditions (Study 3). Comparing the packaged OBNM, the IBNM showed an additional yield increase if given organic-based nutrient management. Eventually, the application of NPK fertilizer can be reduced to half the recommended rate. The developed OBNM for Organic-based Rice (OBRice) production management sustained soil health and productivity and eliminated much farm waste through recycling, thus sustaining the soil biology and increasing nutrient use efficiency.

Long-Term Organic Fertilizer Use in Paddy Soils and in Paddy Rice

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This study, conducted since 2003, is set to (1) give database and science-based information on the real-time effect of continuous use of organic fertilizer in flooded soils toward the development of an organic-based nutrient management for rice production, and (2) optimize at a sustainable level the grain yield and soil health and productivity in a close nutrient cycling system. The organic source as treatments: rice straw (RS), RS with Effective Microorganism (RSEM), chicken manure (CM), green manure (*Azolla*), and vermicompost (Vc), were applied alone and in combination with half and full recommended inorganic nitrogen, phosphorus, potassium (NPK) rates for dry (DS) and wet seasons (WS). Unfertilized plots were used as an indicator of the current indigenous nutrient supply. PSB Rc 82 was used as the test plant. After 16 years of continuous application of different organic materials, results showed a consistently similar yield trend between the organic-based nourished rice plants and the inorganically fertilized plants in 2005 WS, 2007 WS, 2011 WS, 2013 WS, 2016 WS, 2018 WS, 2019 WS, and 2020 WS. Regardless of the applied nutrient sources, there was no significant increase in the soil N level. Soil P in plots applied with chicken manure (CM) was consistently highest among the organic sources. For available soil K, RS and RSEM showed a higher contribution to the soils than the other organic sources, but a gradually decreasing trend was observed. No increase in soil organic matter content was observed despite the long-term application of different organic sources. A significant decrease in available zinc and copper was observed seven years after continuous application of either inorganic or organic fertilizers, although there was sustained availability after that. In contrast, an increasing soil iron content until the 10^{th} year and a gradually decreasing trend was observed to date. No significant changes were observed in the soil available manganese.

Optimized Utilization of Azolla spp as Alternative and Potential Organic-based Nitrogen Nutrition for Irrigated Rice Crops

Evelyn F. Javier, Xarin Xara G. Sto. Domingo, Jerome M. Mercado, and Ma. Leah M. Sevilla

In the advent of supplementing the insufficiency of the organic basal nutrient supplement to rice during the middle tillering stage to panicle initiation stage as resulted in Study 1 and to achieve a sustainable 4t/ha, several green manures like *Azolla, Sesbania, Aeschynomene,* and *Indigo* were tested for paddy rice. *Azolla microphylla* was consistently found to be tolerant of hot and humid environments and could still grow and sporulate normally in the rice paddies. In the field trial, *Azolla microphylla* was tested and optimized as an organic-based topdress nitrogen (N) source for inbred rice variety, Peñaranda (PSB Rc 82), and hybrid rice variety NSIC Rc 204H or Mestiso 20 (M20). In 2020 DS, two organic-based basal fertilizers, rice straw plus chicken manure and rice straw plus vermicompost, were used. Topdressing *A. microphylla* was also done two to three times at different growth stages. Hybrid rice variety, M20, showed a positive response to the application of organic fertilizers at basal and the conventional inorganic nitrogen, phosphorus, potassium (NPK) fertilizer application, which is even higher than the pure inorganic fertilizer. It also gave good yield in DS when nutrient demand is higher and good response to the pure organic-based nutrient management using rice straw with chicken manure as basal and *Azolla* as topdress applied three times. Generally, the target of 4t/ha yield was achieved by the organic-based nutrient management.

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

Evelyn F. Javier, Xarin Xara G. Sto. Domingo, Jerome M. Mercado, Alex J. Espiritu, Ma. Leah M. Sevilla, and Mirasol del Rosario

The study was conducted to evaluate and assess different nutrient management under saturated soils and continuously flooded soil conditions but with emphasis on the packaged organic-based nutrient management (OBNM) compared with the inorganic-based nutrient management (IBNM) of the PalayCheck System. The PalayCheck System showed an additional yield increase if given OBNM. This again showed that the two packaged nutrient management were complementary and not necessarily contradicting. OBNM plus only half of the inorganic nitrogen, phosphorus, and potassium (NPK) rates also showed potential for a sustainable yield of 4 tons or higher per hectare in both dry and wet seasons, regardless of the applied organic-based basal fertilizer, rice straw vermicompost, or rice straw with chicken manure. Likewise, a higher yield was also observed in the continuously flooded soils. The result was similar to the OBNM, as demonstrated in the FutureRice Farm. To support the alternative organic-based topdress N source, *Azolla* production was maintained as part of the system *(Study 3.3)*. To create a cooler microenvironment, vegetables were planted along and above the *Azolla* pond, where vegetables were also applied with vermicompost and topdressed with composted *Azolla*. Growing vegetables above the *Azolla* production pond can also be an additional income source if the farmers will sell them for profit and also provide family food security. Since the vegetables are organically grown, it would give an added value to the vegetables produced in the *Azolla* production.

PROJECT 6

Philippine Rice Information System (PRISM)

Eduardo Jimmy P. Quilang

Rice is crucial to food security as it is a staple food to the great majority of Filipinos and a source of livelihood for more than 2 million farming households in the Philippines. Due to rice's cultural and economic importance, a remote sensing-based monitoring system is essential in identifying the scale and magnitude of production gaps to enable decision-makers and planners to make informed decisions in responding to emergencies based on transparent and accurate information. PRiSM, a remote sensing-based rice monitoring system, in collaboration with DA Regional Field Offices (DA-RFOs) and PRiSM Unit, continuously provided reliable, timely, and location-specific seasonal information on the extent of cultivated rice area, its seasonality, yield and production estimates, and rice areas affected in the event of flood and drought. PRiSM revolutionized rice monitoring in the Philippines and how rice-related information was generated and shared through a synergistic integration of different state-of-the-art digital technologies such as satellite-based remote sensing, geographic information system, global positioning system, crop growth simulation modeling, smartphone-based field data collection, and Information and Communication Technologies (ICTs). PRiSM data products were accessible to project partners and interested users through bulletins and online sharing platforms such as the PRiSM website and Infolib.

The success of PRiSM, which led to its operationalization, was anchored to the project's long-term strategic and sustainability plans such as capacity building, forging partnerships, engagement of emerging partners and potential users, and effective communication system. Since the outset of the project, key stakeholders were identified, and opportunities were created to keep them engaged and involved in project development. Stakeholders' expectations were clarified and addressed, and their feedback were considered in fine-tuning the system. Building capacities in the development and use of PRiSM products and services and sustaining the whole system were deemed important and critical. Continuous trainings on rice mapping, crop modeling, use of GIS tools, and latest ICT technologies significantly enhanced the technical capacity of PRiSM staff. Also, annual updating and retooling on data collection protocols resulted in more reliable data and information gathered from the fields. The PRiSM Operations Manual is continuously being improved to ensure that operational concepts of PRiSM can easily adapt to current conditions.

As PRiSM operation continued, strengthening partnership and regional coordination became one of its priorities. The regional partners helped in the evolution of PRiSM, and continuous technical support was needed to ensure sustained regional participation, such as strengthening regional capacities to analyze and utilize PRiSM data products. PRiSM is on the lookout for opportunities provided by the increasing availability of free satellite data and the transformational power of evolving ICT technologies. For instance, more quantitative time-series assessments could be produced using big data approaches and new information technologies that integrate crowd-sourced and multi-thematic data with satellite-based observations. PRiSM will also focus on developing ICT-based processing systems, knowledge management, and analytical infrastructure transforming PRiSM into a vital link between data providers, data analysts, and information users.

To steer the project successfully and ensure unhampered delivery of PRiSM data products and services, specific and tangible deliverables are set annually. More specifically, these include:

(1) reports/documentation of land profiles and monitoring of crop growth parameters in selected areas as input for rice mapping, yield estimation, and damage assessments;

(2) maps and estimates of lowland rice planted area, and the start of rice cropping generated using synthetic aperture radar (SAR) satellite images throughout the year;

(3) enhanced rice yield monitoring system for continuous and timely generation of high-quality data and information on rice yields and productivity;

(4) maps and estimates of rice area at risk and/or affected by drought and flood;

(5) strengthened and continuous technical support to RFOs, local government units, inter-agency, and collaborators;

(6) maintained and improved ICT infrastructure to help capture, transmit, process, store and share data and information to target clients;

(7) improved processes, systems, and applications through R&D activities; and

(8) established effective communication and coordination to enhance project management and product delivery.

For 2020, all of these expected outputs were delivered by PRiSM despite some project disruption caused by the COVID-19 pandemic. One of the key activities largely affected by community lockdowns and travel restrictions imposed by the government was the regular field monitoring at PRiSM project sites.

PRISM-Field Monitoring of Rice Areas in the Philippines

Darlynne Kaye Matias, Meriam Conado, Eve Daphne Radam, Harvey Gonzaga, Gerald Bello, Chennille Kaye Galvan, Ederlina Carino, Nonilon Martin, Gina de Mesa, Don Banares, Gabriel Flancia, Brian Gepiga, Jecribert Peligro, Mitzi Philline Tejada, and Jaybee Calapit

PRISM estimates data on rice area, seasonality/planting dates, seasonal yield, and flood- or drought-affected areas by using satellite data, remote sensing, geographical information system (GIS), and crop modeling. These generated sets of information are validated through field monitoring using standardized field protocols and smartphone-based data collection forms and applications. A set of field protocols and forms was developed for seasonal field data collection in monitoring field locations, farm profile, photos, field status, crop growth stages, crop management practices, production, and crop damages due to flood or drought.

In 2020, PRISM monitored over 2,045 farmers' fields across the Philippines. Data on field profile (1,646), cultural management (1,615), crop status (10,180), production data (1,017), fertilizer applied (782), crop cut (561), and validation points (4,677) were collected. A total of 21 typhoons and several low pressure areas were monitored; field damage assessment in Cagayan Valley, Central Luzon, CALABARZON, and Bicol Region (149 validation points) was conducted. These validated field data were used to analyze and interpret satellite imagery, calibration of the thresholds used for rice classification, and accuracy assessment of rice area, yield, and flooded/drought-affected rice maps. Due to the pandemic, data collection and implementation in some regions were affected. PRISM also collected weekly data on prevailing *palay* prices from several key informants per region from September to November (1,584 data from 9 surveys). All data and reports were submitted to the PhilRice Management and Department of Agriculture.

Mapping of Rice Areas in the Philippines using Remote Sensing Technology

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PRiSM uses microwave remote-sensing for rice monitoring because it offers near-real-time estimates of rice area, seasonality, and an all-weather monitoring capability. Remote sensing has been used effectively for rice mapping (Mosleh et al., 2015; Xiao et al., 2005; Xiao et al., 2006; Gumma et al., 2011a; Gumma et al., 2011b; Nuarsa et al., 2011; Nuarsa et al., 2012; Nguyen et al., 2012; and Yang et al., 2008) because of its periodicity, objectivity, and capability to obtain information at different temporal and spatial resolutions (Chen and McNairn, 2006). It provides scalable and unbiased estimates of rice area at low cost to support, supplement, and improve survey and statistical methods (Nelson et al., 2014; Gumma et al., 2014). Therefore, the remote sensing derived-planted rice area should complement the survey-derived-harvested area from the Philippine Statistics Authority (Ozdogan et al. 2010) to help DA in planning and policy formulation.

The availability of free satellite images from Sentinel-1A and 1B of the European Commission's Copernicus Program (Aschbacher and Milagro-Pérez, 2012) and semi-automatic rice mapping software (MAPscape 5.5.2) allowed PRiSM to have an operational remote sensing-based rice crop monitoring system at a national scale since 2018. Sentinel-1 is a C-band SAR sensor suitable for rice monitoring even in small paddy fields (Aschbacher and Milagro-Pérez, 2012). Using Sentinel-1A and 1B, PRiSM provides rapid, detailed, and accurate information on the rice crop, such as planted area and seasonality in the Philippines using remote sensing. Continuous research is necessary to accommodate changes in sensor, resolution, and use of open-source software to sustain this operation.

PROJECT 6

Enhancement of PRISM Rice Yield Monitoring System Using Remote Sensing and Crop Simulation Modelling

Elmer D. Alosnos, Eve Daphne Radam, and Michael Barroga

This study aimed to enhance the PRiSM rice yield monitoring system to ensure the continuous and timely generation of high-quality data and information on rice yields and productivity in the Philippines. This was achieved through the synergistic integration of state-of-the-art technologies such as crop growth simulation modeling, remote sensing, geographic information system (GIS), smartphone-based field data collection, and dynamic database management system. Data products on rice yield were shared with end-users through regular bulletins and the PRISM online portal. For 2020, PRiSM generated rice yield estimates for the first and second semesters. Results showed that the national average rice yields for the first and second semesters were 4.16t/ha and 4.20t/ha, respectively. At the regional level, the highest average yields were recorded in Central Luzon (5.78t/ha) and Northern Mindanao (4.97t/ha) for the first and second semesters, respectively. The highest average yields at the provincial level were obtained in Nueva Ecija (6.92t/ha) for the first semester and Bukidnon (5.22t/ha) for the second semester. Compared with last year's yield performance, the national average yields this year were relatively higher by 12% for the first semester and 7% for the second semester. Total annual rice production for 2020 was estimated at around 18,360,081 metric tons. The factors that possibly contributed to better yield performances this year were farmers' use of high-quality seeds, efficient use of fertilizer and water resources, improved management of crop pests and diseases, favorable weather conditions, and increased government support services. To manage the enormous amount of input data used for crop modeling and output data such as simulated yield and production estimates, the Crop Modelling - Database Management System was developed for data warehousing with capabilities for online data integration, data reformatting, data analytics, and generating dynamic and customized reports.

Philippine Rice Information System – Detection of Flooded or Drought-affected rice areas

Sonia L. Asilo, Pristine Mabalot, Johnny Maloom, Darlyn Kaye B. Matias, Eve Daphne O. Radam, Meriam Conado, Mary Rose O. Mabalay, Jean Mirandilla, Elmer Alosnos, Harvey Gonzaga, Gerald Bello, Chennille Galvan, Ederlina Carino,Nonilon Martin, Gina de Mesa, Gabriel Flancia, Mitzi Philline Tejada, Jaybee Calapit, Don Bañares, Brian Gepiga, Jecribert Peligro, Michael Barroga, and Maria Angelique Dela

The country experiences an average of 20 tropical cyclones annually, some of which cause major damage to infrastructure and livelihood. Excessive rainfall, especially during typhoons, can result in continuous inundation and a decrease in plant photosynthesis and respiration (Masutomi et al., 2012). The extent and severity of the damage to rice crops depend on the timing of the typhoon relative to the growth stage of the crop (Blanc and Strobl, 2016).

Drought is another recurring climatic event that affects the country, with major drought events associated with El Niño Southern Oscillation. El Niño from 1997 to 1998 severely affected about 70% of the country, resulting in an estimated P3 billion in damage to rice and corn crops (De Guzman, 2009). Rice yields are adversely affected by lack of water, particularly during the reproductive stage, when the rice crop is most sensitive to water stress (Matsushima 1970).

The Department of Agriculture (DA) requires timely and accurate estimates of rice production loss as a result of natural calamities (e.g., typhoon, flood, and drought) to make informed decisions on emergency aid, seed distribution, other required interventions, and also for estimating potential rice production shortfalls. In particular, during the monsoon season, severe flooding damages rice fields. Such extreme weather conditions are likely to occur in the future more frequently. This makes a rice information system necessary in providing rapid and accurate assessments.

PRISM estimates the extent of rice areas affected by extreme weather events using Synthetic Aperture Radar images for flood and optical images for drought detection. A protocol for assessing the extent of flood and drought-affected rice areas using remote sensing and field surveys was developed and implemented to deliver to DA estimates of rice areas at risk and rice areas affected by flood or drought. PRISM aims to help DA make informed decisions, planning interventions, and emergency response to affected areas through the delivery of remote sensing-derived information.

PRISM IT Systems Development and ICT Infrastructure

Michael Barroga, Jovino L. De Dios, Arturo C. Arocena Jr., Henry DC. Cayaban, and Ma. Angelique N. Dela Cruz

This study ensured the data and information of PRISM were available and secured using the available infrastructure and technology. Moreover, this study also developed a web geographic information system prototype to integrate PRISM resources for decision-makers and other stakeholders. The full management of PRISM information and communication technology (ICT) was conducted using hosting and domain providers, development of website and analytics, improvement of PRISM Collect, and partnership with DOST-ASTI and DA-ICTS to sustain the project. Servers and workstations replaced cloud processing and web service. Likewise, domain hosting was housed under the PhilRice domain and premise. Collaborations with other government agencies were continued to ensure PRISM data and information security. The data and information produced by PRISM were classified, stored, organized, and processed in a secured server with a remote mirror and can be accessed, processed, and downloaded through the PRISM official website/ portal with identified levels of access. Remote servers were established in ASTI and DA-ICTS using a high-performance computer for redundancy. For data backup and infra improvement, additional storage and scheme were developed. Additional storage was also procured for the new data processed with upgrades and modification with workstations and servers. The design and functionality of the website were enhanced by optimizing the existing IS like InfoLib, data products interactive maps, and the analytics and data management module. Moreover, data product requests were catered using the InfoLib IS, which facilitated the request, file and information management, and monitoring.

Assessment of the Build-up and Bioaccumulation of Heavy Metals, and Mitigation Measures against their Effects on Paddy Soils and Rice Plants

Evelyn F. Javier, Corazon A. Santin, Mariella Grace Galang, Perfecto S. Ramos Jr., Jerome M. Mercado, Philip Tanay, Don Miguel, and Bryan Lasquite

This project was conducted mainly to assess the impact of siltation and heavy metals deposition due to mine tailings or mining activities in the rice paddies and the rice plants and their grains. Two main studies were conducted to assess: (1) the impact of siltation and heavy metals deposition in paddy soils due to gold, nickel, and copper mining activities; and (2) the translocation and bioaccumulation of light and heavy metals in the different parts of the rice plants including milled rice. The water wastes coming from active mining activities might have merged into the irrigation systems catering to rice production areas. Study 1 was conducted by soil and plant sampling in Pangasinan and Zambales, where gold, nickel, and copper mining were active. In contrast, Study 2 was conducted in the area nearest to the gold mining activities and where prior studies had shown higher contaminants. Different light metals (zinc, copper, iron, and manganese) and heavy metals (mercury, arsenic, nickel, cadmium, chromium, and lead) were analyzed. Some partial information had already been noted from the results. Particularly, some sampling sites had soil containing heavy metals higher than the threshold levels as well as higher levels of contaminants in the rice hull, rice straw, and unpolished and polished grains. In contrast, some were lower than the threshold levels. The weeds used as phytoremediation also showed their potentials to absorb particular heavy metals while carbonized rice hull could be as good as the synthetic clay zeolite in adsorbing the heavy metals in the soils, conversely reducing their uptake in the rice hull, rice straw, and unpolished and polished grain. However, all results, for now, were not yet conclusive as chemical analyses of the samples taken from both studies are still ongoing.

Assessment of Impact of Siltation and Heavy Metals Deposition in Major Rice Producing Areas and Accumulation in Rice Plants Due to Mining Activities in Pangasinan and Zambales

Evelyn F. Javier, Corazon A. Santin, Mariella Grace Galang, Perfecto S. Ramos Jr., Jerome M. Mercado, Philip Tanay, Don Miguel, and Bryan Lasquite

This study was conducted to evaluate any bioaccumulation of contaminants due to nearby mining sites in some irrigated rice areas of Pangasinan and Zambales. The amount and concentration of major heavy metals such as mercury (Hg), arsenic (As), lead (Pb), cadmium (Cd), chromium (Cr), and nickel (Ni), as well as the light metals: iron (Fe), zinc (Zn), copper (Cu), and manganese (Mn) in soil and various part of the rice plant were determined from 2018 dry season to 2019 wet season for Pangasinan and 2019 for Zambales. Areas in Pangasinan were stratified into four clusters relative to their accessibility to Agno River Irrigation System (ARIS): Upper ARIS (UARIS), Middle ARIS (MARIS), Lower ARIS (LARIS), and Non-ARIS (NARIS). For Zambales, Sta. Cruz (14 sites) and San Marcelino (8 sites) were selected as sample sites. In 2018, analyzed soils in Pangasinan showed that Hg, Cd, Cr, and Ni were highest in NARIS, Pb in UARIS, and As in MARIS. Hg, Cd, and Ni levels were found to be above the threshold value for paddy soil, while levels of As, Pb, and Cr were below the threshold value. Rice plant also had high Hg and As in all parts with unpolished rice having the highest, followed by rice straw, then the rice hull. In contrast, only Ni, Cd, and Cr were found in the rice hull, while Pb was not detected in any part of the plant. In Zambales province, Ni, Cd, and Cr content were very high in all sites of Sta. Cruz, particularly in Lomboy; while Hg, As, and Pb were below the threshold value. In San Marcelino, only Ni was very high in the soil, while As was detected in Buhawen. Lastly, Hg was consistently high in the polished rice while Cr and Ni in rice straw were higher than the threshold value in all sampling sites of Sta. Cruz and San Marcelino.

Assessment of Potential Phytoremediation in Paddy Soils Contaminated with Heavy Metals in Pangasinan

Evelyn F. Javier, Corazon A Santin, Mariella Grace Galang, Perfecto S Ramos, Jr., Jerome M. Mercado, Philip Tanay, Don Miguel, and Bryan Lasquite

This study was conducted primarily to evaluate the possible mitigating measures for the accumulated heavy metals both in the soil and the rice plants. The two assessed identified mitigating measures were: (1) phytoremediation using different weeds/plants such as *Azolla microphylla, Sphenoclea zeylanica* (burat-aso), *Monochoria vaginalis* (gabi-gabihan), *Ipomoea aquatica* (kangkong), *Arachis pintoi* (mani-manian), and *Vigna radiata* (mungbean); and (2) chelation using potential ameliorating materials such as carbonized rice hull (CRH) and zeolite. Partial results for phytoremediation showed that burat-aso is most effective in absorbing As, followed by kangkong, then the gabi-gabihan. Meanwhile, the mani-manian is more effective than the mungbean in absorbing Hg. *Azolla* was shown to have more absorbed Ni but could still accumulate As and Hg in smaller amounts. Other heavy metals like Pb, Cr, and Cd were not detected in all phytoremediating plants. At 45 DAT, the rice hull had the highest Hg (*ave. 12.62ppm*) compared with other plant parts, regardless of remediating weeds used. The high Hg in the unpolished rice showed that the *Azolla*, mani-manian, and mungbean were not effective in mitigating translocation of Hg, but other weeds like burat-aso, gabi-gabihan, and kangkong had in the unpolished rice. Polished rice had comparative Hg content regardless of the remediating plants used. Likewise, the use of chelating materials like CRH and synthetic zeolite had successfully deterred absorption of Hg in the plant parts compared with the use of phytoremediation only, as shown by the lower absorbed Hg. When compared with the control or untreated soils, there was lesser Hg in the polished and unpolished rice, but the Hg levels in the rice hull and rice straw are comparable. All other heavy metals were not detected in the different parts of the harvested rice plants.