Department of Agriculture

PHILRICE

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PHILRICE R&D HIGHLIGHTS

AGRONOMY, SOILS, & PLANT PHYSIOLOGY DIVISION

Content

DIVISION

Agronomy, Soils, & Plant Physiology Division

Jovino L. de Dios

EXECUTIVE SUMMARY

The Agronomy, Soils, and Plant Physiology Division (ASPPD) aims to improve soil, water, and fertilizer management practices and technologies focusing on increasing resource-use efficiency, sustainability, and modernizing rice agriculture through digital transformation. ASPPD also advances technological research to develop and improve tools, systems, and processes for rice and rice-based production. It will help the rice farmers increase their crop yield, productivity, and profitability and improve product quality through cost-effective and climate-resilient farming.

ASPPD conducted long-term field experiments for organic and inorganic-based fertilizer management experiments. It examined the productivity and sustainability of rice and rice-based cropping systems. It also addressed issues on production sustainability.

The division developed a package of technologies (POTs) to increase its resource use efficiency. It also maintained a Palayamanan plus model farm to cater to the continuous development of a multi-crop rice-based farming system suitable in a changing environment and can provide additional income. This resulted in digitally transformed crop management processes, which will help modernize rice production. Furthermore, ASPPD developed several agricultural information systems and advisories to monitor and assess crop performance.

The ASPPD research laboratory was lodged under the PhilRice Centralized Laboratory to be more efficient in resource management and quality service. Regular preventive maintenance and periodic calibration were conducted.

Forty-one equipment were calibrated while five were validated to guarantee accurate and reliable laboratory results and to improve equipment life. Seven projects were accommodated in the laboratory. Chemicals and equipment were inventoried in compliance with regulatory rules. Laboratory managers also participated in laboratory networks' meetings.

PROJECT 1

PhilRice Soil Information System: A Tool for Effective Crop Management

Sandro D. Cañete

The project aimed to develop a simple guidebook for easy identification of soils and soil management recommendations in the form of Simplified Keys to Soil Series (KSS) for each province and online PhilRice Soil Information System (PSIS)(dbmp.philrice.gov.ph/soil/).

PSIS is a comprehensive, readily accessible, and user-friendly soil information system tool for effective crop management. It helps decision-makers and planners select suitable crops with appropriate management strategies.

The soil series gallery of PSIS consists of validated soil series profiles with physical and soil fertility descriptions, datasets for soil series taxonomic classification, soil management recommendations on rice and other crops, soil limitations, and soil productivity indicators. PSIS is a guide for crop suitability analysis for lowland rice production and major Philippine crops. It also includes the method of soil series identification by province. Currently, soil information were uploaded from 23 provinces. Aside from the web-based information portal, the project developed simplified soil series identification field guide books with International Standard Book Number (ISBN) registered in the National Library. Figure 1 shows the three field guides for Albay, Palawan, and Leyte that are being finalized and ready for ISBN filing.

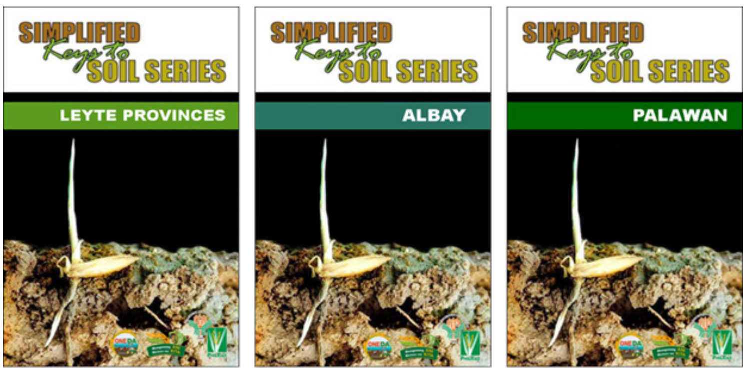

Figure 1. Final prototype of simplified keys to soil series field guidebook for Albay, Palawan, Leyte, and Southern Leyte.

PROJECT 1

Soil survey reports of the eight target provinces were secured, processed, analyzed, and stored at the PSIS working file and database. In addition, 23 climate data for 17 target provinces was sourced from en.climate-data.org and processed while their planting calendar, secured from www.oocities.org, was matched with the consolidated climate data.

Indicators of soil fertility and physical qualities such as relief, water retention, drainage, permeability, workability, stoniness, root depth, erosion, flooding, horizon depth, and other distinguishing characteristics of all soil series under the eight target provinces were encoded in the PSIS.

Crop suitability of 15 annuals and 12 perennials for each soil series within the eight targeted provinces was analyzed. Figure 2 shows the rice suitability maps generated using GIS software for rice and three major non-rice crops in the province.

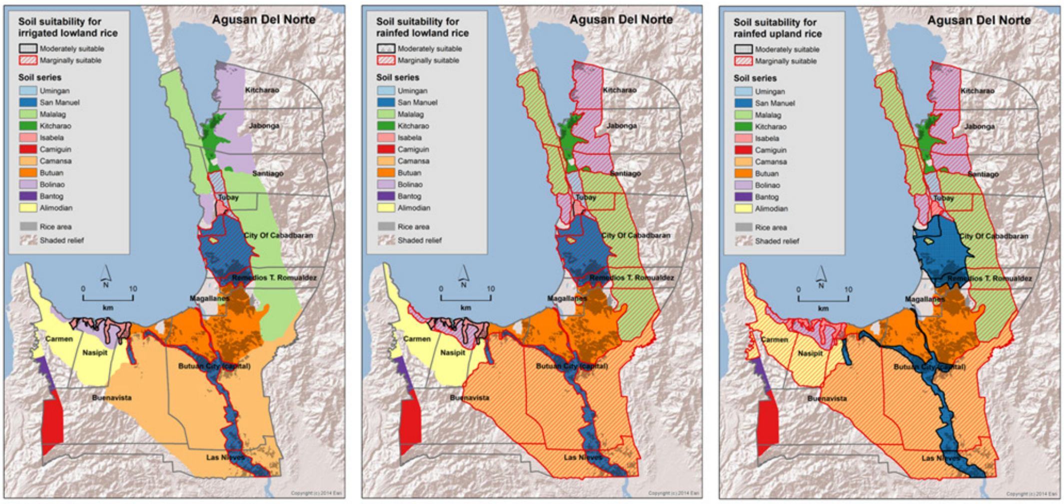

Figure 2. Suitability of maps for rice production under irrigated lowland, rainfed lowland, and rainfed upland in Agusan del Norte.

PROJECT 1

Restructured soil series properties by inserting column/container for soil pH data within 30-50 cm depth; uploaded provincial maps of Occidental Mindoro, Oriental Mindoro, Kalinga, Compostela Valley, Aklan, and Antique and updated references of said provinces. Figure 3 shows that the twenty-seven keys to soil series e-guidebooks were already uploaded to the PSIS database.

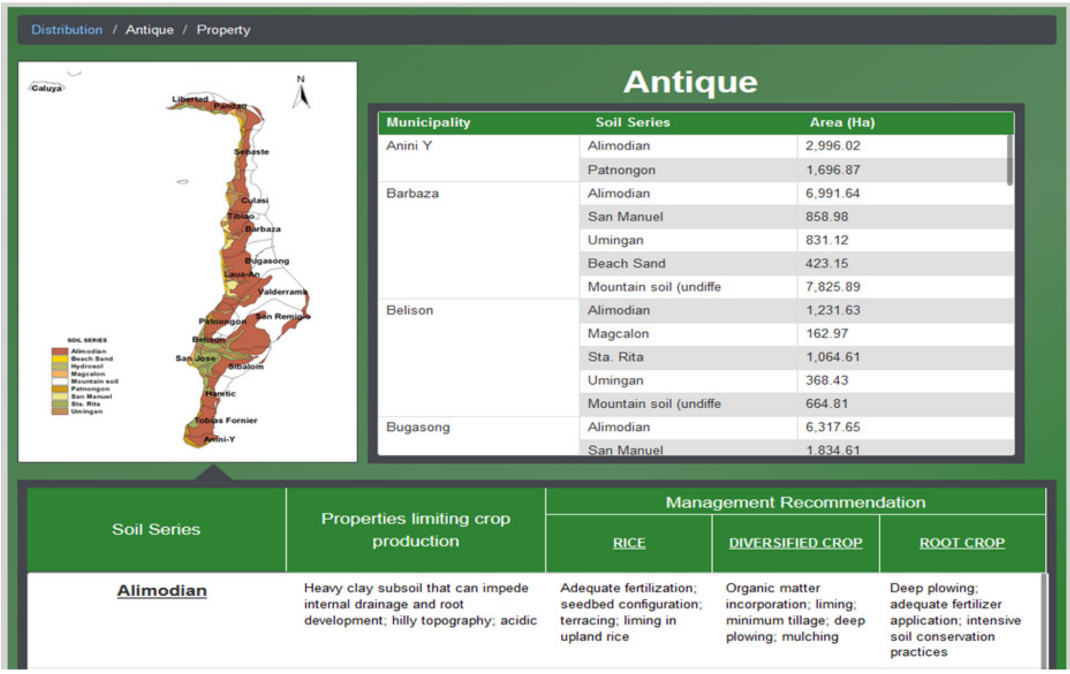

Figure 3. . Sample graphical user interface page with updated maps in online PSIS.

PROJECT 2

Assessment and Management of Soil Fertility and Soil Health

Sandro D. Cañete

Maintaining soil fertility requires appropriate management approaches to sustain crop production at target levels. Managing soil nutrients efficiently to maintain soil fertility is vital in achieving maximum yields. It also requires understanding the current crop-soil nutrient status, indigenous nutrient-supplying capacity, and the crop need for the season.

This project assessed, managed, and provided improved nutrient management recommendations that would increase productivity and cost-effectiveness of the double rice cropping system while sustaining soil health.

The first focus is on the long-term effects of inorganic fertilizer management on changes in soil fertility, sustainability of crop productivity, soil microbial diversity, and closing the yield gap between the potential and the maximum attainable yield of irrigated lowland rice. After decades of double rice cropping, the long-term fertility trial maintained high indigenous nutrient supply capacity while achieving yields close to the maximum attainable yield under good management practices.

Second, the project assessed the soil fertility of the PhilRice Central Experiment Station rice fields. It was affected by previous and current soil and crop management recommendations. As a result, the fertility status of the PhilRice experimental and seed production paddies has remained the same since its first assessment in 2018. Generally, it has medium soil fertility status.

Regarding yield trends, a five-year (2017-2021) average yield from a field experiment for the dry season showed an increase in the first two cropping seasons in fully fertilized plots. It was followed by a consistent decline in the succeeding seasons (2018-2020) and a slight increase in 2021.

Figure 4 shows that the same trend was observed in the other treatments except for the control (unfertilized) and in the PK plots. However, yield levels varied across treatments and years during the WS due to the effect of biotic and abiotic stresses. Thus, the yield trend as affected by the treatments was not observed (Figure 5). The average inherent productivity of the site was 3.24t/ha and 4.58t/ha in the DS and WS, respectively, over the five-year cropping seasons.

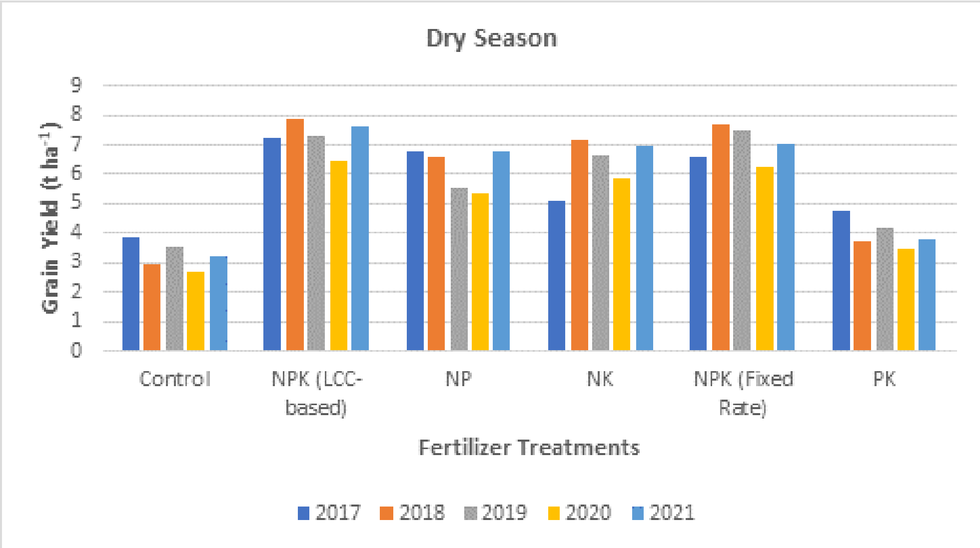

Figure 4. Five-year seasonal dry season grain yields as affected by the different fertilizer treatments. 2017-2021, PhilRice Central Experiment Station, Maligaya, Science City of Muñoz, Nueva Ecija.

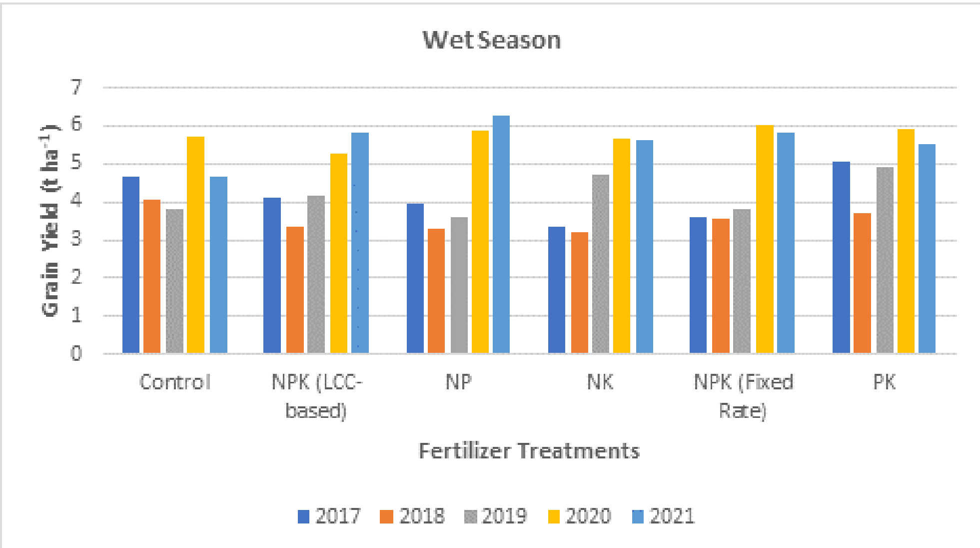

Figure 5. Five-year seasonal wet season grain yields as affected by the different fertilizer treatments. 2017-2021, PhilRice Central Experiment Station, Maligaya, Science City of Muñoz, Nueva Ecija.

In terms of indigenous nutrient supply (INS), on a per hectare basis, 60.81kg nitrogen(N), 16.22kg phosphorus (P), and 97.87kg potassium(K) for the DS, while 78.01kg N, 11.66kg P and 73.29kg K for the WS were observed over the five years (Tables 1 and 2). The abiotic and biotic stresses affected the low indigenous P supply (IPS) and indigenous K supply (IKS) in the WS. Moreover, the INS from the 2021 DS was relatively higher in P and K than the previous average of 69.4kg N, 9.03kg P, and 69.5kg K from 1968 to 2017. Generally, this also suggests no significant decline in the INS of the soil after more than four decades of continuous double rice cropping with inorganic fertilizer under good management practices.practices.

Table 1. The Indigenous nutrient-supplying capacity of the long-term fertility experiment. PhilRice CES, Maligaya, Science City of Muñoz, Nueva Ecija. 2017-2021DS.

NUTRIENT	2017DS	2018DS	2019DS	2020DS	2021DS	DS MEAN
Nitrogen	73.89	57.82	61.07	54.41	56.85	60.81
Phosphorus	12.68	17.90	16.45	14.63	19.43	16.22
Potassium	108.68	104.86	85.12	85.92	104.78	97.87

Data are expressed as a kilogram (kg).

Table 2. The Indigenous nutrient-supplying capacity of the long-term fertility experiment. PhilRice CES, Maligaya, Science City of Muñoz, Nueva Ecija. 2017-2021WS.

NUTRIENT	2017DS	2018DS	2019DS	2020DS	2021DS	WS MEAN
Nitrogen	78.46	61.07	76.42	91.61	82.50	78.01
Phosphorus	8.33	8.00	12.10	14.18	15.68	11.66
Potassium	63.47	52.48	62.88	90.72	96.88	73.29

Data are expressed as a kilogram (kg).

A four-year (2018-2021) average agronomic N-use efficiencies (AEN) of the test varieties were analyzed only in the DS due to yield inconsistencies obtained in the WS that were associated with uncontrollable abiotic and biotic factors. A declining trend was observed through time in the fully fertilized plots except for leaf color chart (LCC)-based fertilization with a slight increase in 2021. LCC-based had relatively higher AEN (22.48kg grains/kg N applied) than the full NPK applied at a fixed rate (3.74kg grains/kg N applied).

Yield gap analysis showed an average difference of 0.82t/ha or 9.44% gap from the simulated potential yield to the measured yield of the highest yielding variety during the DS (Table 3). It denotes that complete NPK application with LCC-based mid-season N application can achieve yield closer to the maximum attainable yield under favorable growing conditions and good management practices.

Table 3. Dry season yield gap analysis based on the highest yielding rice cultivar used in the experiment. PhilRice CES, Maligaya, Science City of Muñoz, Nueva Ecija

YEAR	ACTUAL YIELD	POTENTIAL YIELD	YIELD GAP, %
2018	8.20	8.70	5.75
2019	8.40	8.70	3.45
2020	6.60	8.70	24.14
2021	8.30	8.70	4.40
MEAN	**7.88**	**8.70**	**9.44**

Data expressed as tons/ha (t/ha).

The three-season soil analysis showed an increasing trend of organic carbon in the unfertilized, NPK (LCC-based), and NP plots. At the same time, a slight decrease was observed for the rest of the treatments, and total N, had a declining trend over time.

Conversely, there was a build-up of available P across fertilized plots while exchangeable K declined across the treatments in the last two cropping seasons. An increasing organic carbon through time was observed from 1968 to 2017. Declining available P and exchangeable K but increased with changes in the nutrients applied was also observed.

Soil microbial community-level physiological profiling showed that the average well color development (AWCD) was significantly high in all treatments except for PK fertilized plots. The AWCD value in PK fertilized treatment indicates that microbial communities utilize the carbon substrate present in the EcoPlate. Furthermore, carbon substrate utilization showed that adding the recommended amount of fertilizer required for the crop based on morphological symptoms modified the metabolic profile of microbial communities (Kong et al., 2006).

Functional diversity indices determine the functional diversity of soil microbial communities in terms of carbon source utilization patterns. The corrected optical density for the 24-hr incubation period was used for the computation. Significant differences were observed between the functional diversity index of microbial communities expressed as the Shannon index (Table 4).

Results suggest that species richness and evenness significantly affect soil microbial functional diversity differentiation under long-term inorganic fertilization. Similarly, significant differences between the evenness index of the different treatments were observed, which suggests that differentiation of soil functional diversity occurs at the level of differential carbon utilization and is independent of species diversity.

Table 4. Microbial diversity status of Long-Term Fertility Experiment after 2021 wet season harvest. PhilRice CES, Maligaya, Science City of Muñoz, Nueva Ecija.

TREATMENT	AWCD	SHANNON (H)	EVENNESS (E)
NPK (SSNM)	172.61ab	2.67bc	0.7763bc
NP	292.8a	3.00abc	0.8736ab
NK	256.24ab	2.78abc	0.8087abc
NPK	290.59a	3.01ab	0.8777a
PK	134.58b	2.66c	0.7739c

Means within a column followed by the same letter are insignificant at a 0.10 % significance level

The fertility status of the PhilRice experimental and seed production paddies has remained the same since its first assessment in 2018. Generally, it has medium soil fertility status. The paddy soils have moderately to slightly acidic; very low to low (98.5%) and medium (1.5%) N; low (4%), medium (29%), and high (67%) available P; low (81%) to medium (19%) exchangeable K; and low (45%) to medium (55%) organic matter (Figures 5-9).

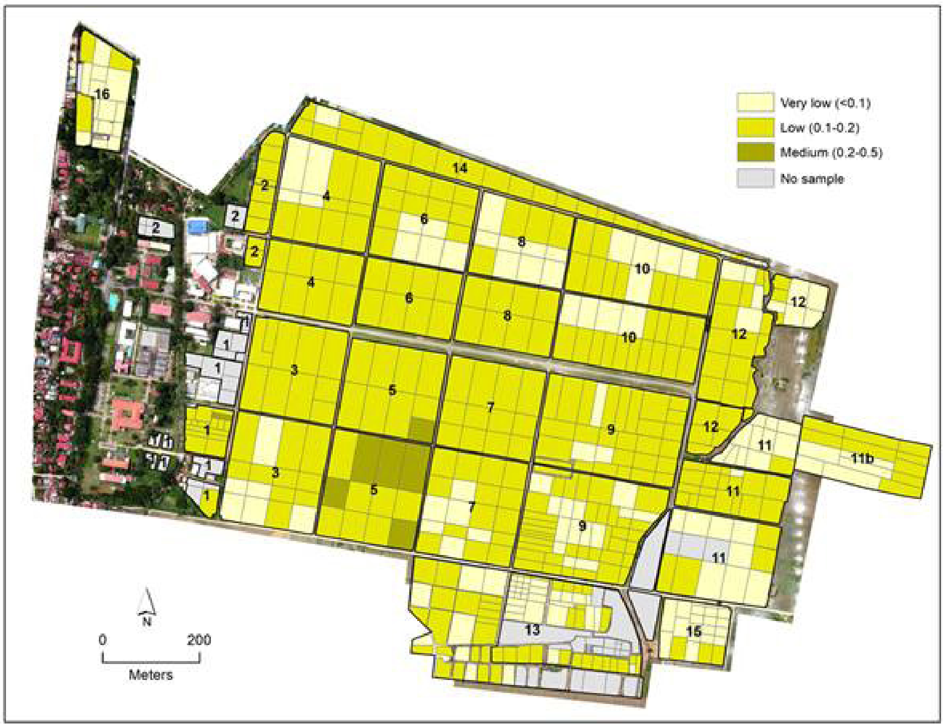

Figure 5. Soil total N map at PhilRice CES Field Blocks, 2020DS.

PROJECT 2

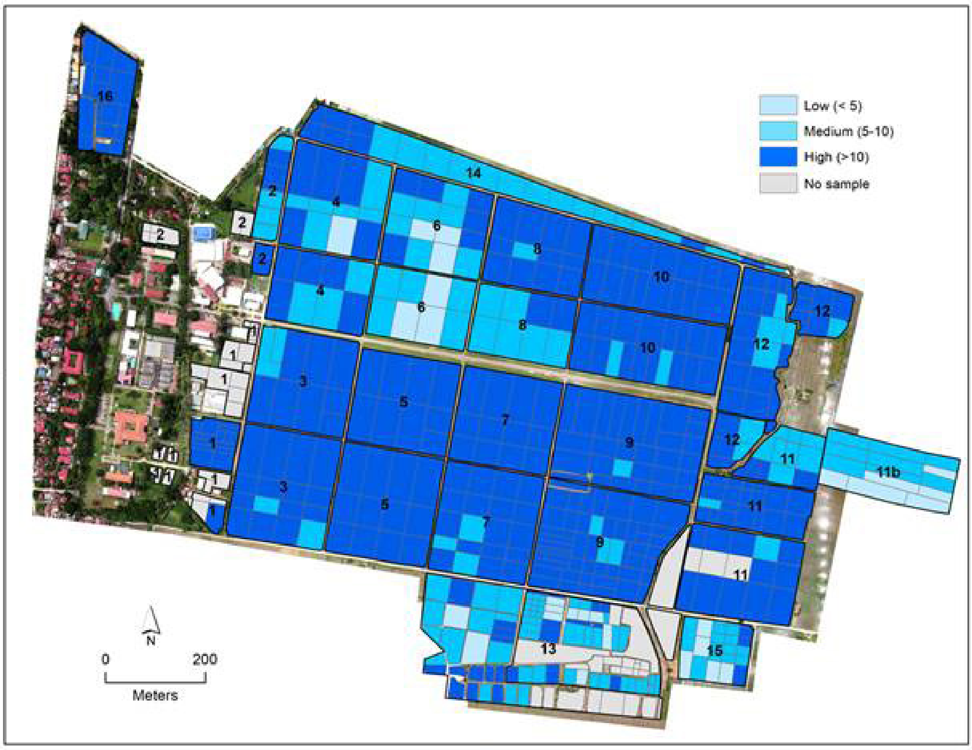

Figure 6. Soil available P map at PhilRice CES Field Blocks, 2020DS.

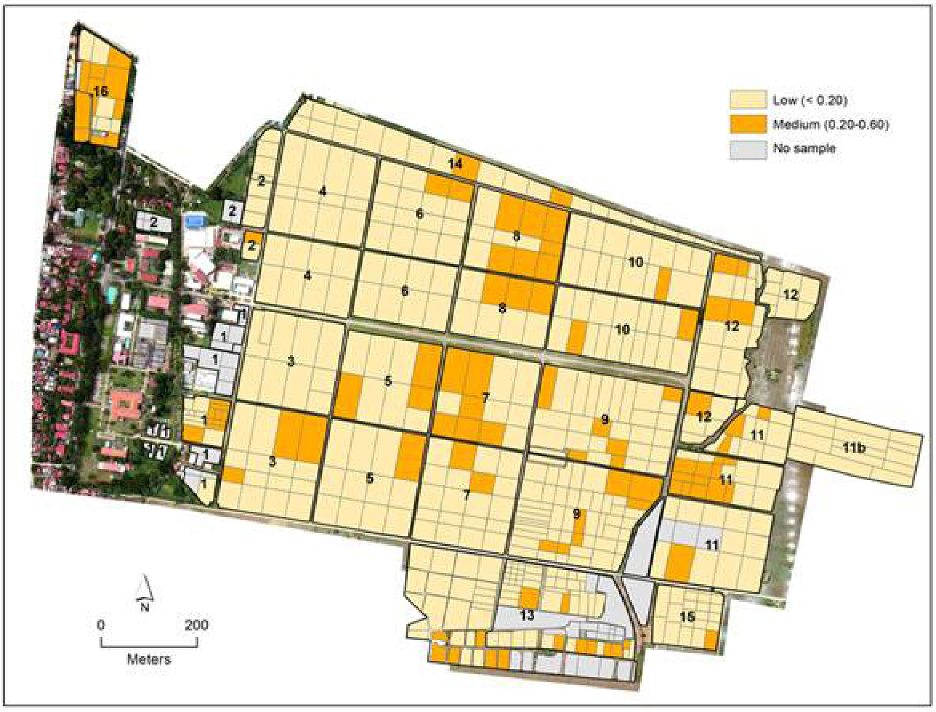

Figure 7. Soil exchangeable K map at PhilRice CES Field Blocks, 2020DS.

PROJECT 2

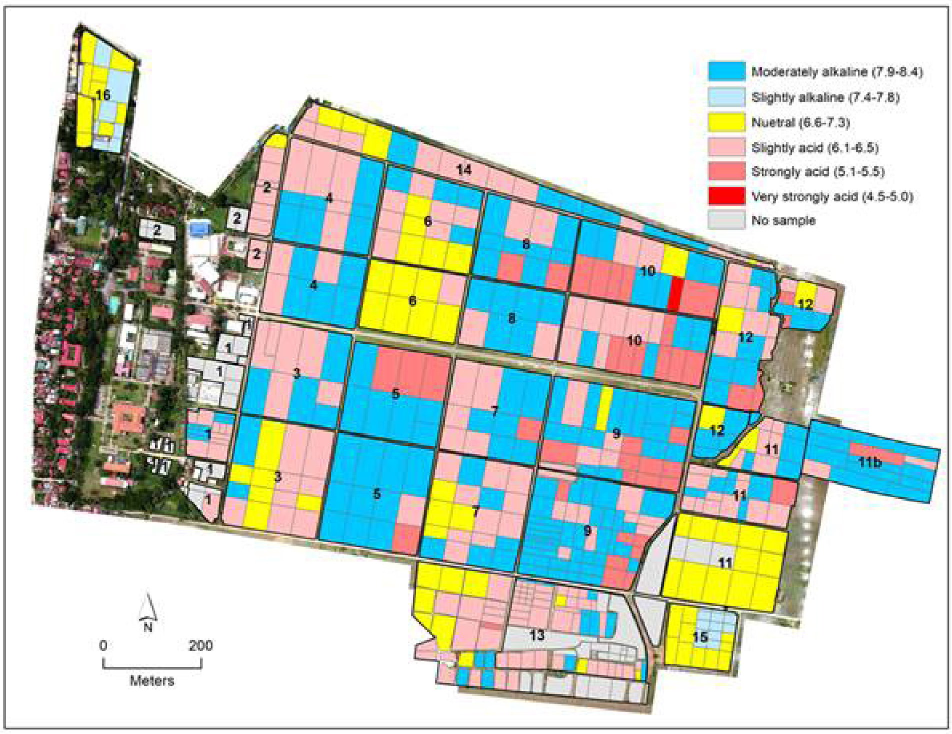

Figure 8. Soil pH map at PhilRice CES, 2020DS.

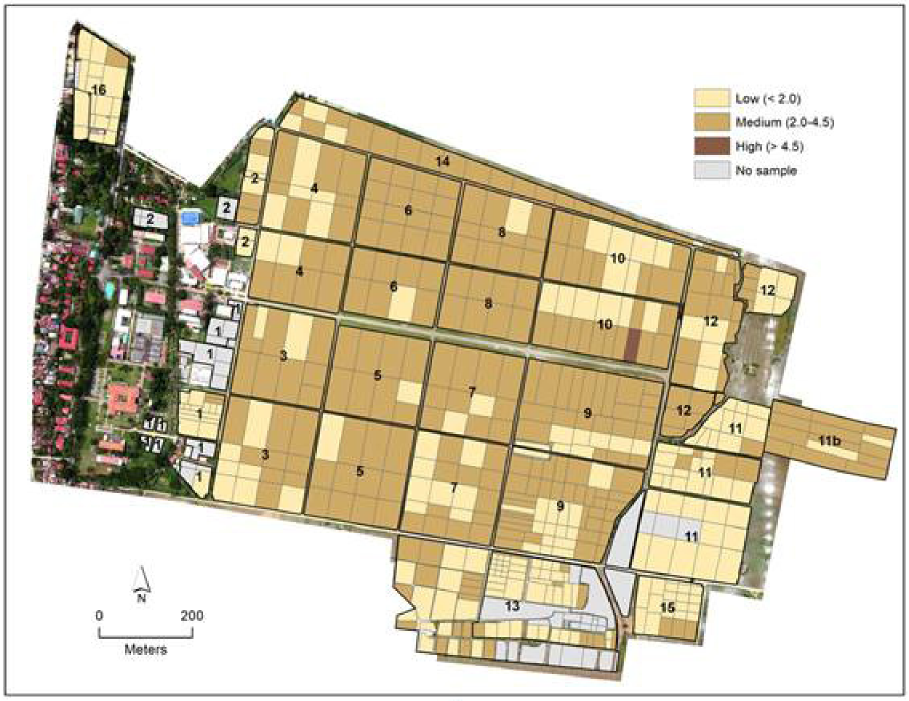

Figure 9. Soil pH map at PhilRice CES, 2020DS.

PROJECT 3

Philippine Rice Information System (PRiSM)

Jovino L. de Dios and Eduardo Jimmy P. Quilang

The Philippine Rice Information System (PRiSM) is a nationwide remote sensing-based and digitally transformed rice crop monitoring system operated by PhilRice in collaboration with DA Regional Field Offices, PhilRice Branch Stations, and Agricultural offices at LGUs nationwide. PRiSM continuously provides reliable, near-real time, and location-specific rice production situations like area , seasonality, yield, production estimates, and areas affected by flood and drought since 2018.

PRiSM revolutionized rice monitoring in the Philippines, especially in how data and information were collected, processed, and shared using digital technologies like, remote sensing, geographic information system, crop growth simulation modeling, and smartphone-based field data collection. PRiSM products are readily accessible at www.prism.philrice.gov.ph and through bulletin releases. Furthermore, data/reports in the map and tabular formats were submitted to DA through PRiSM regular bulletins on May 20 and November 20 for the first and second semesters, respectively.

The continuous support of several partners ensured sustained PRiSM operation. With this, more quantitative time-series assessments and more system improvements became possible. PRiSM also focuses on developing ICT-based processing systems, knowledge management, and analytical infrastructures, transforming PRiSM into a vital link among data providers, analysts, and information users.

The smartphone-based surveys collected field characteristics, , crop management practices, field status, crop stages, and other relevant information. It monitored 2,011 farmer's fields (869 DS and 1,142 WS). All collected data were checked for completeness, quality, and reliability with PRiSM Analytics online. In addition, in collaboration with DA-AMAD, a weekly survey of palay farm-gate prices was collected using digital-based surveys. Generally, farm-gate prices were affected by grain quality, variety, and typhoon occurrence in the area.

Twelve tropical cyclones were monitored by PRiSM for their possible effects on standing rice crops in affected areas. Damage assessments were conducted from 445 validation points from

Cagayan Valley, Ilocos, Central Luzon, CALABARZON, MIMAROPA, Bicol, Western Visayas, Eastern Visayas, and SOCKSARGEN.

The rice area planted in the 2021 first season was 2,064,881ha and 2,446,743ha for the second season with 96% accuracy based on 1,876 validation points with a total annual rice area planted of 4,551,624ha. The percentage contribution of harvest in Luzon, Visayas and Mindanao for the first quarter were 49% (561,848ha), 25% (285,543ha), and 26% (297,711 ha), respectively and 66% (598,836 ha), 15% (136,674 ha), and 19% (174,043 ha), respectively for the second quarter.

During the second semester, 25% (610,971ha) of the total rice areas were planted in June, 34% (831,136ha) in July, and 24% (585,079ha) in August. The remaining 17% were planted in March (6,186ha), April (72,841ha), May (242,881ha) and September (97,650ha). The percentage contribution of harvest in Luzon, Visayas, and Mindanao for the third quarter was 51% (422,108ha), 18% (150,806ha), and 31% (261,213ha), respectively. For the fourth quarter of 2021, the percentage contribution of harvest in Luzon, Visayas, and Mindanao was 67% (1,073,945ha), 18% (288,426ha), and 15% (244,861ha), respectively.

The average rice yield at the national level for the first semester was 4.24t/ha, which is 2% higher than the 2020 estimate (4.16t/ha). Central Luzon (5.81t/ha), Ilocos Region (4.78t/ha), Cagayan Valley (4.72t/ha), Davao Region (4.57t/ha), CAR (4.56t/ha) and Northern Mindanao (4.38t/ha) surpassed the national average yield and majority of the regions had an increase in average yield ranging from 0.1t/ha to 0.32t/ha. The highest yield gain was in Davao (0.32t/ha) and MIMAROPA (0.2t/ha). The estimated palay production during the first semester was 8,748,070 tons. The production grew by 370,502t or 4%, from 8,377,568t in 2020. Central Luzon remained the largest rice-producing region contributing 24% of the total rice production, followed by Cagayan Valley (17%), Western Visayas (9%), and SOCCSKSARGEN (6%). Nueva Ecija was the largest rice-producing province in the country, with a 14% share of the total production, followed by Isabela (8.2%), Cagayan (6.6%), and Pangasinan (4%).

During the second semester, the estimated national average rice yield was 4.33t/ha, or around 3.0% higher than the 2020 estimate. The top three high-yielding regions since 2018 were Northern Mindanao (5.11t/ha), Central Luzon (5.01t/ha), and Davao (4.77t/ha). On the other hand, the regions with yields below the national average of 4.33t/ha were Caraga (3.37t/ha), Central Visayas (3.59t/ha), Western Visayas (3.76t/ha), CAR (3.77 t/ha), CALABARZON (3.78t/ha), BARMM (3.93t/ha), Eastern Visayas (3.96t/ha), Bicol (4.04t/ha), SOCCSKSARGEN (4.19t/ha), Zamboanga Peninsula (4.2t/ha), and MIMAROPA (4.32t/ha). As a result, the estimated total production volume in the second semester was 10,585,021t, or about 6.04% higher than in 2020 (9,982,513t).

The estimated annual production was 19,333,091t or 5.3% higher than in 2020 (18,360,081t). The total production in Luzon was 6,760,435t, 1,664,420t in Visayas, and 2,160,166t in Mindanao. Among the regions, Central Luzon contributed the highest production (19.5%), followed by Ilocos (13.1%), Cagayan Valley (13%), Western Visayas (10.1%), and MIMAROPA (7.5%). These five regions have a combined production of 6,690,384t or almost 63.2% of the country's total rice production. The factors that possibly contributed to the general increase in yield performance are water availability, farmers' use of high-quality seeds, efficient use of fertilizer, fewer pests and diseases, favorable weather conditions, and a boost in the government's support services to the farmers.

Production slightly declined in some areas particularly Rizal, Bataan, Ifugao, Zamboanga Sibugay, and Cavite. It was most likely due to the effects of crop moisture stress, particularly on rainfall-dependent rice production areas in the regions. The improvement in overall yield performance and increase in total rice areas planted were the significant drivers in the growth of palay production for the first semester of 2021. Therefore, the country's total rice production trend this year can be attributed to the increase in rice-planted areas. In addition, better yields brought about by favorable weather conditions intensified government support programs for farmers such as subsidies of good quality seeds, fertilizers, and agricultural extension activities.

The project developed a practical method for estimating production losses due to extreme weather events. The Department of Agriculture (DA)'s flood damage matrix for rice was tested for estimating production losses due to tropical cyclones using the PRiSM data. As a result, the estimated production losses due to tropical cyclones in the second semester were around 126,167t, covering only the flooding of standing rice crops detected by PRiSM from April to October 2021.

The project also developed tools and strategies to transform yield data into value-added information relevant to rice stakeholders. PRiSM data products on yield were reprocessed into GIS-ready formats for easy overlaying with other geographically referenced information and further analyses. An excel-based tool was also developed to analyze yield trends and variability across time and locations. Provincial-level estimates of average rice yield by harvest month for the first and second semesters of 2021, as requested by DA, were also generated. The project also generated mid-season rice yield forecasts for RCM sites that were used in the study on N fertilization adjustment. A customized rice yield data/information was made for RCEP use. A prototype of a web-based crop planting calendar based on PRiSM yield data, climate type, and ENSO category (El Niño, La Niña, neutral) was developed.

Reports on rice areas at risk of flooding, mainly the rice planted areas and estimated growth phases of rice that are most likely to be affected along the forecasted track of the tropical cyclone, were regularly submitted to DA in support of their assessment of flood damage to agriculture. As a result, from October 2020 to December 2021, PRiSM generated 21 reports on rice areas at risk of flood damage for 3 LPA, 1 TEFS, and 17 tropical cyclones.

PRiSM generated flood maps for the 19 tropical cyclones from October 2020 – December 2021. However, there were no SAR images for detecting floods brought by tropical cyclones "Crising" and "Lannie". It also generated a flood occurrence map - in rice and non-rice areas- combining all flood maps from 2018 to 2020—the project submitted 19 Special Bulletins - on assessing rice areas affected by floods. The special bulletins contain information on the estimates of rice areas at risk, flood-affected rice areas; and maps of standing rice crops and flooded rice areas.

The project maintained and improved the PRiSM infrastructure as the backbone for data collection, management, and sharing. It also acquired and installed additional storage; integrated the SAN as remote storage; set up and deployed an additional database; developed dashboards for yield analytics, weather data, and cropping calendar; developed a prototype IS of API for data request and sharing, and established a system and data redundancy. In addition, the project maintained and optimized the website's performance, functionalities, and GUI; improved the generation of downloadable PRiSM data reports; improved Data Analytics functionalities; and developed additional features.

One-hundred nineteen requests on data products through PRiSM Infolib (prism.philrice.gov.ph/infolib) were served. The requested data products were satisfactorily delivered on time. The PRiSM website also reached over 4,000 user engagements and peaked around May-June.

PROJECT 4

Development of Organic-based Nutrient Management (OBNM) for Organic Paddy Rice Production (OBRice) Technology and Sustainable and Productive Paddy Soils: The Residual Effects on Grain Yield

Evelyn F. Javier

Different studies on indigenous organic-based fertilizers, including the long-term organic fertilizer application in paddy soils, were conducted to determine the components for organic-based nutrient management (OBNM) optimized for an average grain yield of 4t/ha for the wet and dry season. Three OBNM options had been packaged. Proper timing of rice straw application and other farm wastes was considered in the package to the timing of nutrient releases and reduction of methane emissions. Another objective was to rejuvenate paddy soil using organic fertilizers and repopulate it with beneficial microorganisms needed to mineralize fertilizer materials in lowland soil conditions.

Information on the dynamics of available soil nutrients and their residuals after 16 years of continuous application of organic fertilizers was generated. An organic-based nutrient management technology was optimized to attain an average grain yield of at least 4t/ha for inbred and hybrid rice. OBNM alone and organic-based integrated nutrient management were evaluated to attain an average yield of at least 4t/ha under flooded and saturated soil conditions. Three packaged organic-based nutrient management for rice production were developed and summarized in layman's terms, which were presented to the National Rice Program (Figure 10).

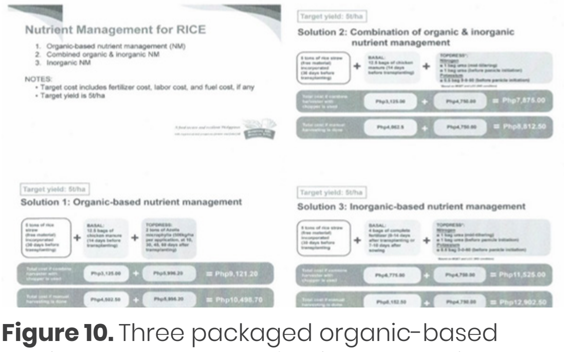

Figure 10. Three packaged organic-based nutrient management for rice production were developed and summarized into layman's terms.

Farmers should be guided on maximizing the use of all organic materials available on their farms to be used as fertilizer. It should also be emphasized that burning any crop and animal residues is not healthy for the environment and not much beneficial to crop production. However, incorporating them into the soil to turn them into compost, as shown in Table 5, is a better option for sustainable soil health and productivity. In addition, the increased microbial community due to the application of organic materials into the soil hastens the mineralization of the nutrient elements in organic forms, making them available to the plants.

Table 5. Different nutrient management options for rice production and soil health.

Nutrient Management Packages	Application Method
Organic-based PalayCheck™ system **5 t/ha or more at 14% grain moisture content**	**Basal Application:** Rice Straw should be incorporated until 30 days before transplanting, preferable by dry land preparation to avoid high GHG emissions. During the second harrowing, around 14 days before transplanting, apply 500 kg/ha of air-dried chicken manure or carabao manure, or depending on the straw yield, use the ratio of 10 rice straw:1 manure. As an option, one bag/ha urea can be applied for faster decomposition, and the field water should be around field capacity. **Inorganic NPK fertilizer application:** •Apply 40-40-40 kg/ha NPK per hectare at 10 DAT as the first application. •Apply one bag of urea during the WS or 1.5 bags during the DS at 20 DAT, 35-38 DAT, and 45 DAT or EPI or use LCC. •At 45 DAT or early panicle initiation, one bag of muriate of potash per hectare is applied during the DS and 0.5 bags of MOP/ha during the WS. *Note:* *K application can be reduced after three years of continuous rice straw. Likewise, P application can be reduced after three years of continuous chicken manure. However, it should be based on MOET or soil analysis results.*

PROJECT 4

Organic-based PalayCheck™ System with half inorganic NPK fertilizer rate **Average 4-5 t/ha at 14% grain moisture content**	**Basal Application:** Rice Straw should be incorporated at least 30 days before transplanting, preferable by dry land preparation, to avoid high GHG emissions. At the second harrowing or around 14 DAT, apply 500 kg/ha of air-dried chicken manure or carabao manure. As an option, one bag/ha urea can be applied for faster decomposition, and the field water should be around field capacity. **Inorganic NPK fertilizer application:** •Apply only one-half of the NPK fertilizer recommended rate per season: •NPK fertilizer is applied at 10 DAT (for example, 45-15-15 NPK rate/ha in the WS; 60-20-30 NPK in the DS. •Apply 15 kg/ha urea at 20 DAT and 45 DAT or EPI for the WS; use an N rate of 20 kg/ha plus a K rate of 10kg/ha in the DS, or you may use an LCC-based N application. *Note:* *K application can be reduced or eliminated after three years of continuous rice straw application. Likewise, P application can be reduced or eliminated after 3 years of continuous chicken manure. However, it should be based on MOET or soil analysis results.*
Pure Organic-based Nutrient Management (OBNM) **Average 2 to 4 tons per hectare yield**	**Basal Application:** Chopped fresh or on-site rice straw should be incorporated at least 30 days before transplanting, preferable by dry land preparation to avoid high GHG emissions. •At the second harrowing or around 14 DAT, apply 500 kg/ha of air-dried chicken manure or carabao manure. **Top dress of alternative organic N sources:** •Application of 500 kg Azolla microphyla/ha at 7 DAT, 10, 30, and 45 DAT for the wet season •Application of 500 kg Azolla microphyla/ha at 7 DAT, 10, 30, 45 DAT, and 60 DAT for dry season *Notes:* *•Lower the water depth in the paddy field to 2cm for easier incorporation of Azolla into the soil to start mineralization using either the mechanical paddy weeder or trampling. By this, N is released on the second day after incorporation. Not fully incorporated, Azolla may not supply the needed N for rice plants.* *•any green manure available on the farm can be an alternative, though Azolla is the cheapest and has a higher Partial Budget Analysis among other green manures* *•Suggested for those going into certified organic rice production; for those with the limited financial capability to buy commercial fertilizers and willing to compost and recycle their own farm wastes as nutrients for the plants and increase microbial activities.*

based on the results of different studies under the Organic Based Nutrient Management Project conducted from 1996-2020. Agronomy, Soils, and Plant Physiology Division, at PhilRice Central Experiment Station, Maligaya Science City of Munoz, Nueva Ecija.

Regarding the residual effect of long-term organic fertilizer application to the paddy soils on yield and other soil properties, the grain yield from previously applied with only organic fertilizer plots gave a significant yield reduction during the DS. However, a slightly higher yield was observed in the WS if previously applied with decomposed rice straw in situ and with effective microorganisms (EM1).

There were no observed soil N residues despite the continuous application of organic and inorganic fertilizer into the paddy soils. Neither of the applied organic fertilizers had given residual soil N. Soil N was very low to compensate for the needs of the rice plants. Phosphorus was just within the level the rice plants needed. Chicken manure contributed the highest P while rice straw contributed the highest K.

Soil organic matter content was sustained at more than 2% with higher values with the continuous application of rice straw with or without inoculant. Adding inorganic NPK to the basally applied rice straw also enhanced the increase of soil organic matter.

PROJECT 5

Enhancements of Palayamanan Components

Myrna D. Malabayabas

Palayamanan started with crop diversification and intensification and later integrated livestock, fish, mushroom production, and vermicomposting, which elevated its name to Palayamanan Plus. The system has evolved as a development and training platform to help address food security, poverty, and climate change risks in unfavorable environments. Thus, components like rice production, rice-duck-vegetable integration, and continuous vegetable production were maintained and improved to showcase the system's benefits to farmers and other stakeholders.

Planting multi-crop with animal integration maximized resource use and increased productivity and income. The production model showed that maximizing the rice-duck area by planting vegetables and other cash crops along bunds and canals is an excellent strategy to improve crop productivity and increase income. They were planting vegetables in available spaces like bunds and, after harvest, generated an annual gross margin of P62,842.15 with P16.59income/m2.

PROJECT 5

The rice-duck-vegetable integration was intensified by planting papaya and doing some value-adding on duck eggs. As a result, this production system generated a total annual gross margin of P66,175.05 and an income of P38.01/m2, which exceeded the target of P30/m2.

To utilize more substrate for vermicomposting, locally available materials were evaluated, aside from the mixture of spent mushroom substrate and carabao manure. Initial activities include the construction of six vermibeds and the use of pistia or water lettuce as a potential substrate. In addition, banana culm and other available biomass were used to maintain their population. During the multiplication process, 884kg of vermicompost were produced.

Some nutraceutical crops included as an additional production component have started. Thai and sweet basil, oregano, herba buena, damong maria or mugwort, and aloe vera were collected and grown in plastic pots. These nutraceutical crops can be used for future value-adding activities and will provide an additional source of income for farming families. Ginger was also planted in a 7.5m2 area, and the team harvested 32kg of rhizomes.

The project maximized land and water resources in rice production areas. NSIC Rc 160 and six traditional and special rice varieties were planted in 0.5ha. The front bund was planted with bush sitao, mungbean, and pole sitao using zero tillage. Squash was grown after the WS rice. The grain yield of NSIC Rc 160 in DS was 6.58t/ha, while harvest from the special rice ranged from 6.07t/ha to 8.95t/ha. In the WS, NSIC Rc160 yielded 5.82t/ha, while the special rice had only 0.93-2.66t/ha due to severe bird damage and crop lodging. Rice with a yield of 2,657.96kg generated a gross margin of P52,905.16. The vegetables planted in the front bund generated a gross margin of P9,936.99. The total gross margin was P62,842.15 and an income/m2 of P16.59. It could have been higher and possibly reached the target P30 income/m2 if rice was not severely damaged by birds and did not lodge in the wet season.

PROJECT 6

Development of Appropriate Nutrient Management for Newly Released Irrigated Lowland Rice Varieties

Myrna D. Malabayabas

Nutrient management plays a significant role in attaining the varieties' yield potential under ideal conditions. One way to determine the appropriate nutrient management is through nutrient uptake analysis during the critical growth stages in a fertilizer field trial, followed by field verification for the desired yield level. Furthermore, considering water availability also affects nutrient uptake, it is essential to factor in water management to achieve maximum rice productivity. Therefore, the project developed appropriate nutrient management that will help achieve the maximum yield potential of newly released irrigated lowland varieties through a package of technologies.

The experiment was designed as a split-plot with water management as the main plot and the combination of variety and NPK rates as a subplot in four replications. Rates of nitrogen (N), phosphorus (P), and potassium (K) fertilizers were based on the NPK uptake of the specific test variety formulated from their uptake. The treatments were (F1) maximum rate, variety specific NPK uptake x target yield, (F2) full rate, maximum rate minus soil indigenous nutrient supply of the soil, (F3), half of the full NPK rate, (F4) grow out rate or the NPK rate used by plant breeders in the grow-out test, and (5) no fertilizer application. The N fertilizer was applied 30% at 10-14 days after transplanting (DAT), 30% at mid-tillering, and 40% at panicle initiation, while all the P and K fertilizers were applied at 10-14 DAT.

Results showed that NSIC Rc 506, Rc 508, Rc 510, Rc 512, and Rc 514 performed well with half NPK rates of the plant's nutrient requirement. Grain yields did not differ significantly between alternate wetting and drying (AWD) and continuous flooding (CF).

The unfertilized plots showed comparable yields with the fertilized plots. In most varieties, those applied with maximum NPK rates gave lower yields than the rest of the treatments. Heavy rains occurred during August and September, resulting in crop lodging, especially those applied with maximum NPK rates. Since those in the unfertilized plots and lower N rates were harvested earlier, they were not affected by heavy rains. Water management (AWD and CF) did not significantly affect the yields of the varieties during this season, and the frequent rain can also account for this during the growing period. The yield components were not significantly affected by the different NPK rates.

PROJECT 7

Solubility of heavy and light metals in paddy soils continuously applied with organic and inorganic fertilizers

Evelyn F. Javier (CES)

An initial observation of arsenic, lead, cadmium, and chromium in the paddy soils being continuously applied with different organic fertilizers and rice grain led this research to verify further. The concentrations, however, were still lower than the set maximum level by the world health organization. A deeper understanding of the possible higher solubility of metalloids in paddy fields due to fertilizers was challenged. Results may guide the farmers in deciding what nutrient management options they should adopt, considering the potential increase in these contaminants in their field.

Soils from the long-term organic-inorganic fertilizer trials in 2003 (initial trial), 2005, 2007, 2011, 2013, 2015, 2017, 2019, and 2020 (last application of fertilizers) were taken and analyzed for some heavy metals (Pb, As, Cd, Cr, Ni) and light metals (Fe, Mn, Cu, Zn) elements. In addition, secondary data on organic carbon from the same trial was taken as a variable subject to the correlation coefficient index against the analyzed metalloids. Grain samples of 2019 were likewise analyzed of the same metalloids to observe any translocation from the soils into the grain.

On the relationship of some metallic elements with soil organic-C, arsenic, lead, and zinc had a weak correlation with organic-C. In contrast, cadmium, copper, iron, manganese, and nickel have a medium relationship with organic-C. Therefore, it may indicate that the solubility of these elements is being affected by high organic-C in the soil. However, there were some indications of a negative correlation with Mn (2003) and Zn (2019, 2011, 2013, and 2017) while Pb (2011, 2013). On the other hand, almost all the elements had positive correlation coefficients. However, the increase has also been gradual through the years.

There were no significant differences in all the elements analyzed due to the application of organic fertilizers, with or without inorganic NPK, except for iron and zinc. However, those applied with organic fertilizers with and without inorganic fertilizers had slowly increased yet higher iron and zinc than the other fertilizers applied from 2003 to 2020.

Translocation of the heavy and light metals was observed to have accumulated more in the rice straw and unpolished rice than in the rice hull.

Externally-funded Project 1:

Evaluation of the BioPrime 5-5-5 on the Growth and Yield of Irrigated Lowland Rice

Sandro D. Cañete

The manufacturer claims that BioPrime 5-5-5 can be used as an addition to conventional fertilizer or as a supplement. BioPrime contains ingredients that work to create balance in the soil. It provides the ingredients for the naturally occurring soil microorganisms to thrive and grow exponentially. It is an organic formulation of micronutrients, enzymes, and micro-minerals. It contains vitamin precursors of plant origin in a highly concentrated mass of autotrophic, aerobic, and facultative enzymes, coenzymes, and exoenzymes. It is a complete system of microorganism stimulation containing inducer molecules to accelerate the activity and rate of replication of microorganisms such as bacteria, fungi, algae, and actinomycetes. In addition, it contains glycosides, which provide the energy required to sustain accelerated microbial activity. Moreover, BioPrime 5-5-5 brings life back to the soil by promoting the soil's natural micro and macro-organism activity, resulting in the production of enzymes, building organic matter, converting chemicals/waste into readily-available plant nutrients, balancing pH, and scavenging heavy metals to create habitat for soil biota – especially earthworms. It has also been proven to accelerate the composting process of waste rapidly.

A review of nanotechnology and its application in agriculture by Manjunatha et al. (2016) showed that the use of Nano fertilizers caused an increase in nutrient-use efficiency, reduced soil toxicity, and minimized the potential adverse effects associated with overdosage and reduced the frequency of application. Therefore, the potential of reducing the use of inorganic fertilizer in combination with BioPrime 5-5-5 in sustaining the optimum yield of irrigated lowland rice is significant. Therefore, site-specific nutrient management strategies such as the Rice Crop Manager combined with the BioPrime technology across growing seasons should be explored.

Externally-funded Project 1:

The field trial was established in the 2021 wet season at PhilRice CES. The soil is Maligaya Series, which has an excellent texture that shrinks and swells during drying and wetting cycles. Therefore, this area is highly suitable for rice production. Type I climate is characterized by two distinct dry (December to May) and wet (June to November) seasons. The test variety is NSIC Rc 222, high-yielding inbred rice, with an average yield of 6.1t/ha and a maximum yield of 10t/ha that matures in 114 days. It was laid out in a Randomized Complete Block Design (RCBD) with four blocks and five treatments.

The data were analyzed using the Statistical Tool for Agricultural Research and treatment means were compared using Tukey's Honest Significant Difference test at a 5% probability level.

The recommended fertilizer rate (RFR) was based on the recommendation of the Rice Crop Manager App with a target yield specific to the experimental site. The target yield setting is based on the extracted information on the location of the field, type of variety to be planted (type and duration), the typical yield from the past seasons in the site, sowing month, type of seeds, and the status of water supply during the cropping season.

The recommended fertilizer rate (RFR) was 113-25-25kg N, P2O5, and K2O per hectare with a corresponding wet season target yield of 6.35t/ha and was assigned as Treatment 1 (control). Treatments 2 to 4 are the BioPrime 5-5-5 combined with inorganic fertilizer, while Treatment 5 is 50% of the RFR. The BioPrime treatments differed in the time and amount of application combined with full-dose or half-dose of the RFR. Treatment 2 has the RFR combined with 15g/ha BioPrime 5-5-5 applied during the seed soaking, at the seedling stage, and at 30 days after transplanting. The same BioPrime treatment was used in Treatment 3, but the RFR was reduced to 50%. Likewise, Treatment 4 is similar to Treatment 3 except for adding 10g ha-1 BioPrime 5-5-5 as soil treatment applied a day before the first irrigation at post-planting. For seed treatment, 5g of BioPrime 5-5-5 powder was activated in 1L of non-chlorinated water for 48 hours and diluted to 15L of non-chlorinated water before seed soaking. The seeds were soaked in the solution for 24 hours at a rate of 15L solution per 20kg seeds. After seed soaking, the seeds were incubated for 24 hours before seed sowing. The same procedure was followed for activation and dilution for foliar and soil treatments. However, the volume of non-chlorinated water was proportioned to the amount of powder used.

The targeted grain yield (6.35t/ha) based on the RCM recommendation for the cropping season was surpassed by all treatments. However, the grain yield did not differ significantly relative to the effect of the treatments (Table 6). It was noted that the excellent weather conditions had contributed to higher yield levels compared to the usual wet season yields. Likewise, the 20-40% lodging evident in the full-fertilized treatments (T1 and T2) may be associated with the production of yields lower than the 50% reduced inorganic fertilizer combined with BioPrime 5-5-5 in which lodging was not observed. The percentage of filled grains produced can partially explain it.

Moreover, high grain yields were observed in the treatments with a 50% reduction of inorganic fertilizer combined with BioPrime 5-5-5. A yield increase of 6.86% and 5.26% over the full dose of inorganic fertilizer were achieved using the 50% inorganic fertilizer combined with 15g/ha and 25g/ha BioPrime 5-5-5, respectively. It showed that using BioPrime 5-5-5 with 50% of the recommended fertilizer rate could produce a higher yield than the recommended inorganic fertilizer in an irrigated rice-growing condition. At some point, this can be explained by the heavier grains, higher percentage of filled grains, and higher number of panicles produced in the inorganic fertilizer and BioPrime 5-5-5 combination treatments.

Table 6. Effect of fertilizer management on the yield and yield components of rice. 2020 Wet Season, PhilRice Central Experiment Station, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

TREATMENTS	Grain Yield (t ha-1)	Panicle m-2	1,000-Grain Weight, g	Filled Grains per Panicle %	Spikelets per Panicle
T1. RCM	7.29	315.10	24.74	75.20	117.70
T2. RCM + 15g BioPrime (applied 3x)	7.04	302.08	24.99	76.89	130.16
T3. 50% RCM + 15g BioPrime (applied 3x)	7.79	306.77	25.60	81.14	120.85
T4. 50% RCM1 + 25g BioPrime (applied 4x)	7.66	329.16	24.69	77.33	121.14
T5. 50% RCM	6.98	288.54	25.00	81.14	117.80
CV (%)	8.23	11.30	2.73	4.85	5.44

Regarding economic benefit, 25g BioPrime 5-5-5 applied four (4) times in combination with 50% of the recommended inorganic fertilizer rate showed an added net benefit of Php. 2,823.87 per hectare.

Extra Core Project 1:

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

After some new findings of a similar project in 2014-2017 in response to the mine tailings pond leakage in 2012, it was recommended that this work be continued for another two years to include other mining activities like copper and nickel mining. Hence, this project was continued in Pangasinan and Zambales from 2018 to 2020. Likewise, small field trials were also established to assess some ameliorating techniques in the contaminated soils to contain the soil contaminants and remove them from the rice paddies. Data on heavy metals like mercury (by outsourced service laboratory), arsenic, lead, chromium, cadmium, nickel, copper, iron, manganese, and zinc (by ICP-OES at PhilRice ASPPD laboratory) were analyzed from the soils. Plant samples were taken from the different sampling sites and the amelioration trial sites. However, due to the unexpected pandemic concerns, the laboratory analyses of samples were intermittently done due to community quarantine ordinances and institute lockdowns and disinfection due to several Covid-19 cases.

On the possible deposition of heavy and light metals in the paddy rice areas near mining activities, the distances of mining activities to the rice areas determined the extent of deposition. The nearer the activities, the higher the deposition of metalloids. From 2014 to 2017, mercury, arsenic, and cadmium have had more deposition, as indicated by the computed Enrichment Factor (or contamination index) in irrigated rice areas relatively far from the mining activities. In 2018-2019, higher deposition was observed as indicated by the enrichment factor (EF) of lead, zinc, copper, and iron. On the other hand, other heavy and light metals were observed to have slowed down.

On the aspect of potential bioaccumulation of heavy and light metals through the rice plants, as a part of the food chain, in controlled mining (with mine tailing ponds), the results are the following. As a general trend, higher deposition of metalloids was observed in the soils nearest to the mine tailing pond and the Agno River Irrigation system. The lesser amount was translocated into the rice plants, the higher of which was confined in the rice straw and rice hull. Only zinc showed a high concentration in the unpolished rice, commonly known as brown rice, followed by iron content. Heavy metals are also present in the unpolished rice within the standard limit set by the WHO. In open-pit mining with gold and copper mining and nickel and copper mining, observations were: that the inclusion of close mining concerns was only in the 2019 seasons. Hence, the data presented here are the samples taken in 2019 and analyzed by the ICP-OES procedure. Most of the metalloids are translocated and lodged. The Fe is highest in rice straw and hull of unpolished rice. The same trend for manganese, though lower concentrations had been translocated relative to its concentration in the soils. Generally, most of the metalloids had been taken up and stored primarily on the rice straw and hull. The most observed ones accumulated in the unpolished grain are copper, iron, manganese, and zinc.

In assessing and identifying the best and most practical phytoremediation measures in the contaminated soils and possible reduction of translocation to the rice plants from contaminated soils, results were: Ipomea aquatica (kangkong), Sphenoclea zeylanica (burat aso), Azolla microphylla, and Monocharia vaginalis (gabi gabihan) were excellent in mining Arsenic (As) and mercury (Hg) in a contaminated soil as evident by the low concentration of arsenic found in rice grains (polished and unpolished), rice hull, and rice bran, particularly in the dry season. Furthermore, Ipomea aquatica (kangkong) showed the best among the used phytoremediation-abled plants in contaminated paddy soils.

Assessing the application of carbonized rice hull (CRH) and aluminum silicates in the immobilization of heavy/light metals in the contaminated soils and possible reduction of translocation to the rice plants from contaminated soils: CRH shows to be a better potential chelating material for arsenic (As) and mercury (Hg) than Zeolite as evident by the lower absorption in rice hull and unpolished and polished rice grain. However, the partial data analysis showed that the soil mercury and arsenic were still higher than the critical limit (0.01, by EMB, Japan).

Extra Core Project 2:

Field Evaluation of FPA-Approved Fertilizers for Irrigated Lowland Rice Ecosystem for the Packaging of Best Nutrient Management Technology

Wilfredo B. Collado

The project evaluated different FPA-approved fertilizers and related products from companies in six PhilRice stations. In the DS, 48 participating entries comprised 15 companies plus PhilRice (from 35 participants and 11 in its initial season in 2020 WS). In the WS, 51 entries were implemented in all the project sites, including PhilRice, with the addition of common farmers' practices in each site for comparison. As a result, the target yield and production cost during the dry season is 8t/ha at P7/kg input cost and 5t/ha at P8/kg input cost for the wet season.

The companies including PhilRice, implemented different nutrient management technologies, i.e., fertilizer rates and application time, depending on the location. Except for 1-2 companies, PhilRice, and the farmers' practice, which used soil-based inorganic fertilizers, the entries used a combination of soil-applied fertilizers single elements or combination (nitrogen, P2O5, K2O, S2O4, zinc) and foliar-applied fertilizers single or combination elements (calcium, copper, magnesium, manganese, zinc, sulfur, boron, iron, molybdenum, zinc). Other products include growth promoters such as microorganisms, bio-stimulants, fulvic acid, humic acid, organic matter, and vitamin B complex. The application rate and times were also variable depending on the location. The field performance of each participant, including those participating in all the field trial sites, was variable indicating the location-specificity of the package of technologies implemented. The application of fertilizer products has become diverse, including the combination of elements. In-depth analysis of the application rate and time vis-à-vis the application of rice crop growth stage provides information on crop uptake at critical growth stages.

In the 2021 dry season in PhilRice CES (Table 7), yield and production cost per unit ranged from 7.31t/ha (P8.14/kg) to 8.44t/ha (P6.23/kg), with Yara obtaining the highest yield (8.44t/ha at P6.23/kg) followed closely by PhilAsia (8.3t/ha at P6.81/kg) and Allied Botanical (8.26t/ha at (P6.71/kg). In Isabela, the yield range was from 4.98t/ha to 6.62t/ha (P7.44-P10.81 per kg input cost), with Atlas obtaining the highest yield at 6.62t/ha (P7.87/kg). In the two setups in Batac, the on-farm in Banna recorded yields ranging from 3.38t/ha to 4.28t/ha (P12.77-P14.21/kg input cost), with Allied Botanical obtaining the highest at 4.28t/ha (P12.81 per kg cost) while the on-station field performance was 3.64-5.91t/ha (P13.07-P20.55 per kg) with PhilRice obtaining 5.89t/ha (P13.07). In Negros, the yield obtained in all the entries ranged from P5.46t/ha to P6.81t/ha (P7.28-P10.42 per kg), with Atlas obtaining the highest yield at 6.81t/ha (P7.28/kg input cost). In Agusan, the yield range was from 3.81 to 5.23t/ha (P8.3-P10.29 per kg), with EnviroScope getting the highest yield at 5.23t/ha at P9.42/kg. In Midsayap, the yield range was from 2.89t/ha to 3.6t/ha (P10.28-17.74 per kg input cost), with PhilRice getting the highest yield (3.6t/ha at P11.25/kg) followed closely by ThailPhil at 3.34t/ha (P10.28/kg).

Table 7. Highest yielders in each station are based on crop cut and actual grain yield samples. January-June 2021.

PhilRice Station	Company	Grain Yield, t/ha		Fertilizer rate (kg/ha NPK)
		Crop-cut	Actual	
CES	Allied Botanical Corp.	9.08	8.26	117-60-60 + Neb-88 Ultra + Foliar Products
CES	Yara Fertilizer Phil. Inc.	8.48	8.44	129.9-33.5-64.5-4.5S-0.55B-5.7Mg-0.3Zn + Yara Vita Crop Boost
Isabela	BioPrime Agri Industries Inc.	8.66	5.65	78-46.5-76.5 + Nano Ag
Isabela	Atlas Fertilizer Corp.	6.67	6.62	144.5-27-76.5
Batac	PhilRice	6.88	5.89	166.1-35-53
Banna	Enviro Scope Synergy Inc.	3.81	4.10	134-42-57 + Neb-88 Plus
Banna	Allied Botanical Corp.	3.34	4.28	121.6-60-60
Agusan	Allied Botanical Corp.	5.51	4.78	117-60-60 + Neb-88 Ultra + Foliar Products
Agusan	Enviro Scope Synergy Inc.	5.18	5.23	136-21-36 + Neb-88 Plus
Negros	Enviro Scope Synergy Inc.	8.45	5.64	104-35-50 + Neb-88 Plus
Negros	Atlas Fertilizer Corp.	7.63	6.81	143.25-18.75-43.25-2.63Zn
Midsayap	PhilRice	6.27	3.60	123.5-49.5-31.5

In the 2021 wet season (Table 8), a yield from 4t/ha to 5t/ha was easily achieved by most participants across locations. In CES, the field performance was from 3.83t/ha to 6.31t/ha (P5.6-P11.04 per kg), with

Extra Core Project 2:

Xanadu Agri obtaining the highest yield at 6.31t/ha with P5.60 per kg cost. In Isabela, the yield ranged from 4.94 to 6.47t/ha (P6.68-P8.92/ kg), with PhilVin Trading obtaining the highest yield at 6.47t/ha (P7.33/ kg) followed closely by EnviroScope at 6.43t/ha (P6.84/kg cost). In Batac, the yield ranged from 4.49t/ha to 6.58t/ha (P8.89-P12.98/ kg), with PhilRice obtaining 6.58t/ha (P8.89/kg). EnviroScope yield the highest at 5.81t/ha (P9.82/kg). In Negros, the yield ranged from 4.15 to 4.9t/ha (P8.64-P10.91/kg), with BioPrime obtaining the highest yield at 4.9t/ha (P9.61/kg), followed closely by PhilAsia (4.89t/ha at P9.76/kg), PhilRice (4.82t/ha at P8.64/kg), and EnviroScope (4.81t/ha at P10.36/ kg). In Agusan, six participants recorded yields of more than 5t/ha, with Atlas obtaining the highest yield at 5.93t/ha (P7.64/kg) while AgriGrowth harvested 4.58t/ha. In Midsayap, participants gained 5.82-6.81t/ha (P5.26-P8.24/kg), with the farmers' practice obtaining the highest yield of 6.81t/ha (P6.49/kg) followed by PhilAsia at 6.49t/ ha (P6.06/kg).

Table 8. The highest yielders in each station are based on crop cut and actual grain yield samples. 2021 July-December.

PhilRice Station	Company	Grain Yield, t/ha		Fertilizer rate (kg/ha NPK)
		Crop-cut	Actual	
CES	Xanadu Agri Products Inc.	7.56	6.31	0-0-0 + Xanadu Maxpower F1, Xanadu Maxpower F2, Xanadu Maxpower F3
Isabela	Enviro Scope Synergy Inc.	8.43	6.43	129-14-29 + Neb-88 Plus
Isabela	PhilVin Trading	7.93	6.47	104-40-60 + Liquid O + AMR + Better Yield
Batac	Enviro Scope Synergy Inc.	7.30	5.81	136-21-36+ NEB-88 PLUS
Batac	PhilRice	7.13	6.58	146-35-50
Agusan	Allied Botanical Corp.	6.14	5.79	117-60-0 + NEB-88 Ultra, Nordox, Nutrivant
Agusan	Atlas Fertilizer Corp.	5.75	5.93	121.5-10-64-3Zn
Negros	Bioprime Agri Industries Inc.	6.72	4.90	35.35-11.2-11.2 + Nano Ag
Negros	PhilRice	7.06	4.82	70.7-22.4-22.4
Midsayap	Farmer's Practice	6.88	6.81	82.71-32.69-30
Midsayap	Phil-Asia Fertilizer Corp.	7.15	6.49	118.8-30.8-30.8 + Vitazyme

Extra Core Project 3:

Rice Crop Manager Philippines Phase III: Transition to Operational Sustainability for Research and Dissemination from IRRI to DA (DA-PhilRice Component)

Wilfredo B. Collado

Phase 3 of RCM from 2019 to 2021 supported the sustainable operation and dissemination of Rice Crop Manager Advisory Service (RCMAS), the research, and the transition of RCM Advisory Service from its developer to DA. This three-year project enhanced uptake and practice of improved RCMAS by extension workers and farmers to support the Philippines Rice Industry Roadmap. It aimed to achieve a successful, efficient, and timely transition of RCM Advisory Service and associated applications, databases, processes, training, and management to help farmers attain higher yields and incomes.

This project prepared the operation, management, and dissemination of the RCM system to be institutionalized in the Department of Agriculture's regular operation that requires capacity building for the appropriate DA agencies and counterparts to ensure the system's smooth operation and sustained use. Some of the critical characteristics of this project included scalability and replicability, relevance for Filipino farmers, partnerships, impact on yields and income, and governance.

RCMAS continued to build field-level data that helped provide DA with validated field conditions through interoperable maps and optimized databases. It is also integrated with other DA information systems, contributing to updating DA databases. IRRI and PhilRice identified critical opportunities for interoperability across DA-funded programs that leverage digital tools or applications for impact. IRRI and PhilRice co-led the assessment, identification, and recommendations on best integrating these tools to ensure that these are interoperable.

PhilRice handled the research leadership for RCM in nine regions. Meanwhile, 14 DA-RFOs led their research activities with technical assistance from PhilRice and IRRI with logistical support from LGUs.

Extra Core Project 3:

Farmer-cooperators were selected with assistance from the LGU. Field staff members recruited by PhilRice and researchers from DA-RFO implemented field research and data collection. PhilRice researchers periodically visited the DA-RFO field research when allowed to travel to monitor and advise DA-RFO research staff in adequately implementing the research and the information to capture and record. However, due to the continuing Covid-19 pandemic, field monitoring was limited. The meetings and interactions with IRRI were online. The research trials included: (1) Nutrient Omission Plot Technique (NOPT) field trials, (2) field-specific RCM evaluation/ enhancement field trials, and (3) cluster-based RCM evaluation field trials. The RCM evaluation for the cluster of fields was pilot-tested in 2021 2nd semester to address the need for one recommendation per cluster of fields for scaling. It was based on the recommendation of project reviewers to see whether one recommendation could be applied to a group of farmers. The field trials were primarily conducted in farmer's fields, while some were conducted in an on-station environment.

In 1st semester, 206 RCM trials were conducted, PhilRice established 34% of which, while DA-RFOs established the rest. Consequently, 158 (77%) of the total established trials were completed. The rest were dropped due to contamination, harvesting without prior notice on the farmer's side, the effect of pests and diseases, and Covid-related reasons. Seven RCM research themes were strategically established based on the needs of each growing environment within the region. The RCM evaluation in locations with high fertility has the most significant number of trials established with 29.75% completed trials, followed by RCM evaluation in locations with abiotic stresses (25.32%) and RCM with mid-season target yield adjustment using the PRiSM yield estimates (19.62%). Finally, the RCM Enhancement trial (11.39%), RCM with weed management interventions (7.59%), RCM evaluation in suspected Zn deficient areas (3.16%), and RCM evaluation using quality seeds (3.16%) completed the trials. Field implementation and data collection were handled by the researchers assigned in their respective areas. Research updating were conducted bi-monthly to PhilRice through the RCM research focal persons from DA-RFOs.

Furthermore, technical and input support was promptly delivered by PhilRice and IRRI representatives upon request from DA-RFOs.

Unfortunately, field monitoring was generally limited due to travel restrictions brought about by the Covid-19 pandemic. In 2021 Semester 2, PhilRice and DA-RFOs conducted 163 RCM evaluation trials. Among the established trials, PhilRice has started working on Domain-Specific Recommendation RCM trials in seven provinces. This trial provides similar nutrient and crop recommendations per farm cluster in a season.

Extra Core Project 4:

Optimizing Yield Potential of F1 Hybrids and Parents: Component B

Ailon Oliver V. Capistrano

Rice F1 hybrids are known to surpass the genotypic and phenotypic potentials of their parent lines due to heterosis. However, such potential may not be fully realized in a growth-limiting environment. Hence, proper crop care and management should also be established for these F1 hybrids. Nutrient management is one of the most important aspects of crop production. The lack of nutrients may prevent plants from functioning optimally to achieve economically productive yields. As most hybrids have greater potential yield than other varieties, evaluating their internal nutrient efficiencies and maximum potentials at optimum nutrient rates can provide much basis of the nutrient uptake rates of hybrids, which will later facilitate the calculation of specific fertilizer recommendations.

From the evaluation experiments of 2018-2020 for optimum N and K applicable to the entries, the optimum N rate of 120kg N/ha and 90-120kg K/ha K rates for the DS identified through statistical significance (SS) were validated in 2021 dry season. At the same time, wet season optimal rates of 80kg N/ha and 30-90kg K/ha were also validated in 2021 WS. Validations were done by comparing the NK optimum rates identified via SS against regression analysis (RA) derived NK rates from the previous experiments under variable N (0N, 80N, 120N, 160N, and 200N) and K (0K, 30K, 60K, 90K, and 120K) per hectare as treatments. The same cultivar entries were used in the validation trials.

In the DS, the N and K rates derived through statistical significance (SS) or regression analysis (RA) were compared via a field trial at PhilRice CES Experimental Field Block 3. Although grain yields between SS and RA were not statistically different, the field trial showed that more varieties performed better under NK rates derived through SS, with 8 out of 14 entries gaining better grain yields (Figure 11). Furthermore, both N and K rates derived under SS were significantly lower than those derived through RA (Figures 12 and 13). These results show that the best approach in identifying the optimum N and K rates for a genotype is still through an actual field trial under different nutrient levels and then statistically analyzing the yield data for significant differences across nutrient levels. In this case, it was proven that the N rate of 80-120kg N/ha under SS was the optimum for most entries. Similarly, K rates under SS were also significantly lower at 30-90kg K/ha than with the K rates applied at RA at 34-350kg K/ha.

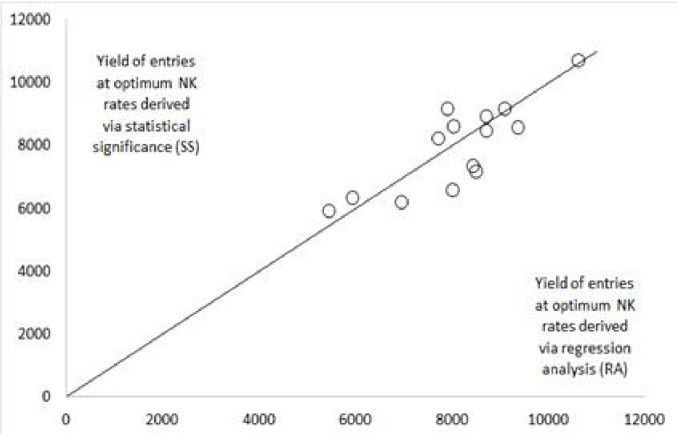

Figure 11. Comparison of yields between two NK rates (RA vs. SS) applied per entry, 2021 DS.

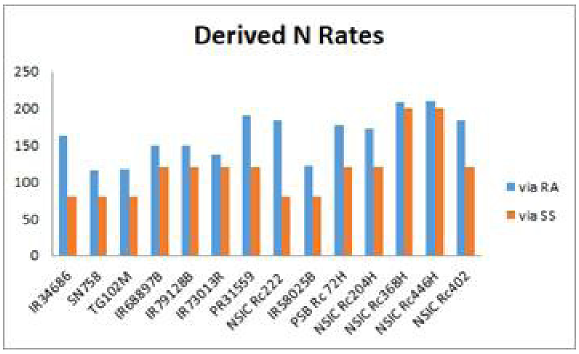

Figure 12. Derived N rates via RA and SS, DS2021.

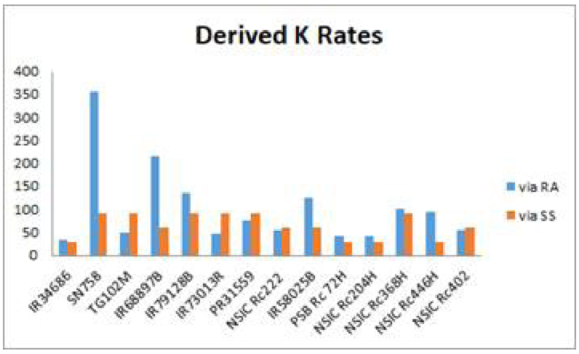

Figure 13. Derived K rates via RA and SS, DS2021.

Extra Core Project 4:

In the WS, the N and K rates derived through SS and RA were analyzed via a field trial in the same site as the DS trial. Grain yields from both fertilizer treatments were again not statistically different. However, more varieties performed better under SS-derived NK rates than RA-derived NK (Figure 14). Similar to DS results, N and K rates derived through SS were significantly lower than via the RA approach (Figures 15 and 16). These results validate DS findings that the best approach to identifying N and K rates is through field trials at varying nutrient levels and statistically analyzing.

This season proved that 80kg N/ha and 30kg K/ha are optimum for most entries, with the exemption of some entries that were applied with higher K rates due to the results of the previous experiments in 2019-2020. Overall, the SS approach to identifying optimum NK rates is the most site-applicable and resource-efficient, as validated by these 2021 field trials.

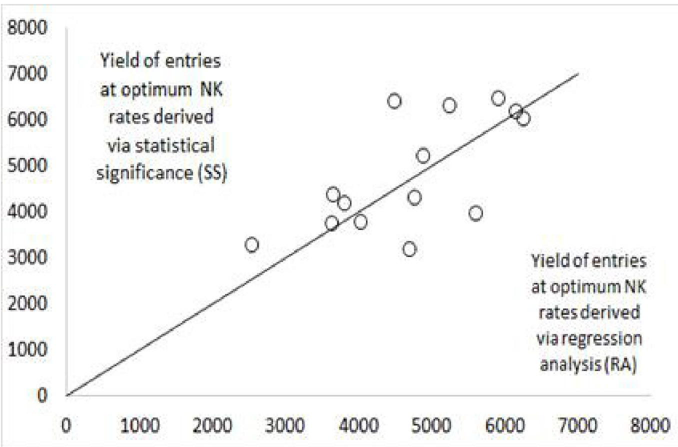

Figure 14. Comparison of yield between 2 different NK rates (RA vs. SS) applied per entry, WS2021.

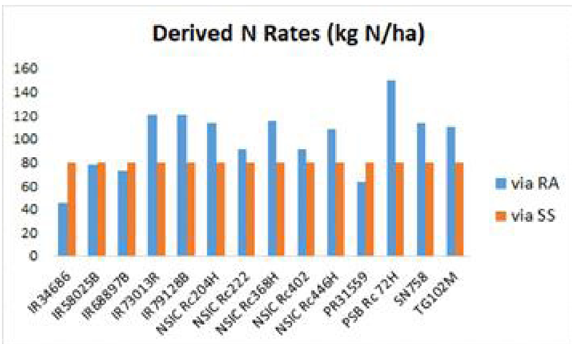

Figure 15. N rates via RA and SS, WS2021.

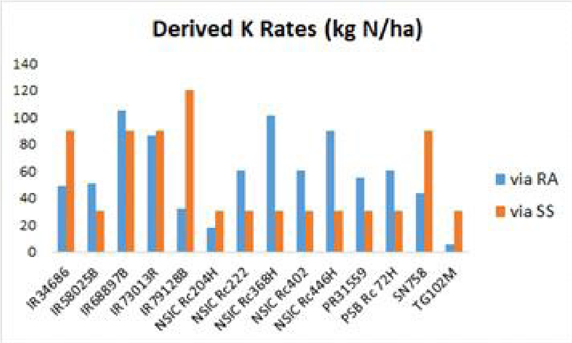

Figure 16. K rates via RA and SS, WS2021.

In the actual NPK, uptake rates (AUR) in the DS was used to derive the NPK rate for application per entry. In addition, these rates were tested via a yield trial with the published uptake rates (PUR) of Witt et al. (1999) as a comparator at PhilRice CES Experimental Field Block 3. Results of the field trial showed that more entries (8/14) responded better to the NPK rates derived via PUR, as shown by the resulting grain yields. However, between treatments across entries, grain yields were statistically insignificant (Figure 17). However, if the NPK rates were to be compared per entry, most of the NPK rates derived via AUR were higher than the PUR, indicating that NPK rates derived using the published uptakes of Witt et al. (1999) were more economical to use, as shown in Figures 18-20.

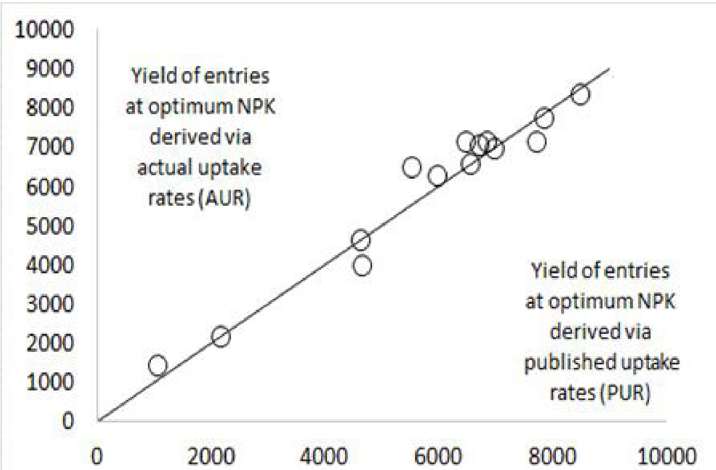

Figure 17. Comparison of yield between 2 different NPK rates applied per entry, DS 2021.

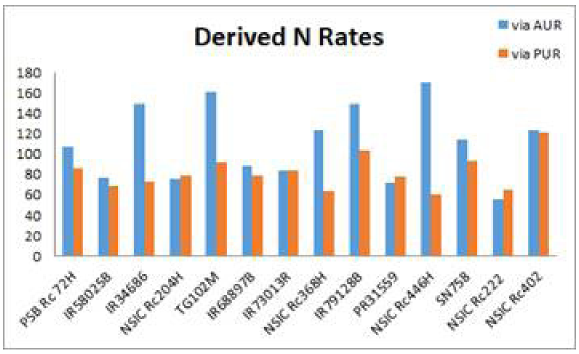

Figure 18. N rates via AUR and PUR, DS 2021.

Extra Core Project 4:

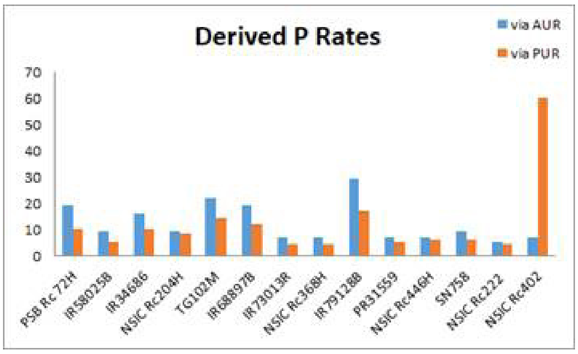

FIGURE 19. P rates via AUR and PUR, DS2021.

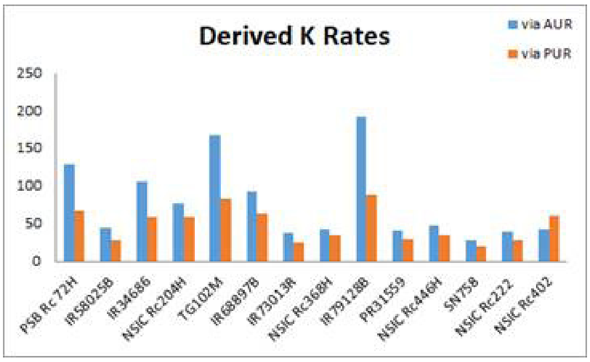

FIGURE 20. K rates via AUR and PUR, DS2021.

The NPK rates derived via actual uptake (AUR) were again tested per entry against NPK rates derived via Witt et al. (1999) published uptakes during the WS. Results of grain yield again showed that more entries performed (10/14) better under PUR-derived NPK rates than with AUR-derived NPK rates. Similar to DS NPK rates results, AUR-derived NPK rates were again higher than PUR-derived NPK rates verifying that the published uptake rates of Witt et al. (1999) are valid to this date, as shown in Figures 21-24.

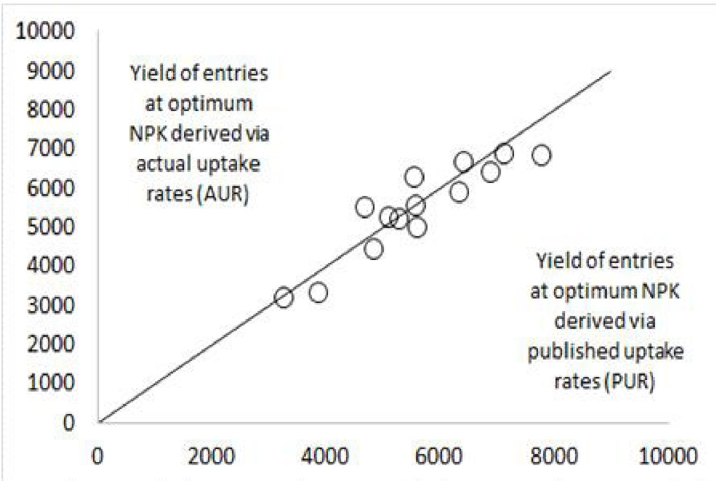

FIGURE 21. Comparison of yield between 2 different NPK rates applied per entry, WS2021.

Extra Core Project 4:

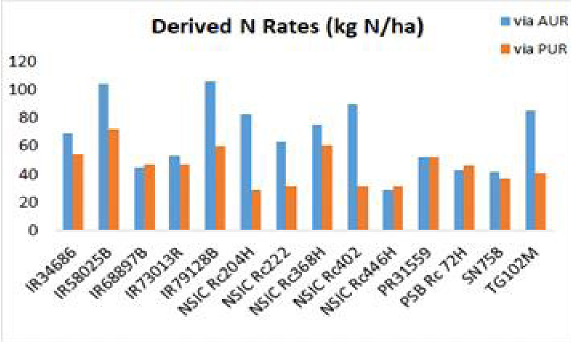

FIGURE 22. N rates via AUR and PUR, WS2021

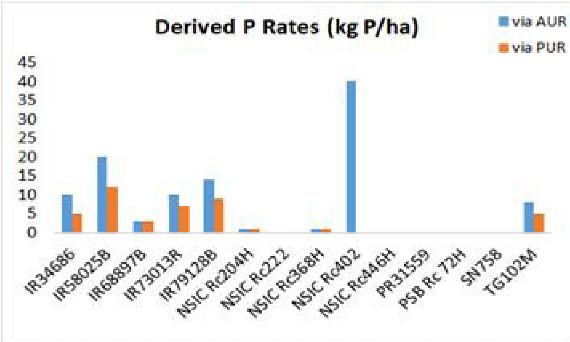

FIGURE 23. P rates via AUR and PUR, WS2021.

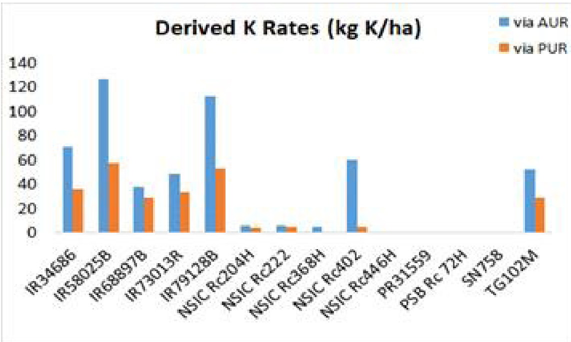

FIGURE 24. K rates via AUR and PUR, WS2021.

The optimum N and K rate/ha derived using Statistical Significance is more applicable than those derived using Regression Analysis in both dry and wet seasons; N and K rates were much more economical under Statistical Significance than under Regression Analysis in both dry and wet seasons; Most entries yielded better using the published uptake rates as a basis for fertilizer application verifying that the published rates are still valid to this date; NPK rates derived using the Actual Uptake rate were mostly higher than the Published Uptake rate hence, would be less economical to use.