2019

PHILRICE R&D HIGHLIGHTS

AGRONOMY, SOILS, AND PLANT PHYSIOLOGY DIVISION

Contents

DIVISION

Agronomy, Soils, And Plant Physiology

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Executive Summary

The Agronomy, Soils, and Plant Physiology Division contributes in modernizing rice agriculture by developing tools and technologies for fertilizer, soil, water management, and agricultural information systems to increase resource-use efficiency. Tools, technologies, and knowledge that help make informed decisions are the division's concern especially on what, when, how, and how much resources to apply. Similarly, understanding the current soil, nutrient, and water status of the field helps us in rice production, technology demonstration, and in making improvements both on-farm and on-station activities.

Six (6) projects are currently conducted by the division as division-based and in collaboration with other agencies and divisions. Three (3) are focused on developing fertilizer recommendation; one (1) on giving timely information on rice area planted, start of season and yield estimates; one (1) for water management advisory; and one (1) for rice seed information system. These exploit the use of satellite technology, smartphones, mobile communications, internet, field sensors, computer applications, and information technology in agriculture.

Computer-based fertilizer apps and systems were developed: the LCC App and MOET App. Validation of the LCC App under field conditions showed that grain yields were consistently higher than those obtained using other diagnostic tools across cropping seasons, while the MOET App was updated with better grain yield and resource–use efficiency with nutrient omission plot field trials. The LCC App is for real-time N management, while MOET App is for most nutrients and as pre-cropping recommendation like the Rice Crop Manager (RCM). MOET, however, is based on specific plant response, while RCM is based on a long-term and wider area records and simulations that consider interactions of different production factors.

Satellite-based Philippine Rice Information System (PRiSM) implements a nationwide near-real-time and location-specific information on rice area planted, planting dates, yield estimates, areas at risks of flood and drought, and affected rice areas. It uses radar remote sensing, crop growth simulation modeling, smartphone-based field surveys, and information and communication technologies. Field datasets from 1,140 rice fields calibrate the classification

parameters while 1,934 observation points are used to assess accuracy. The total area planted during the first semester of 2019 was 1,811,096ha and 2,241,287ha for the second semester. The overall accuracy of the rice area maps was 92%.

While modernizing agriculture, rice production sustainability issues are addressed in two long-term field experiments on organic- and inorganic-based fertilizer managements. Generally, the use of organic- and inorganic-based fertilizers is complementary and more nitrogen (N) from tillering to flowering is needed. Azolla spp. as organic-based topdress was found best and most practical. Rice straw increased K after three years of continuous application with chicken manure. NSIC Rc 204H had higher yield under the organic-based fertilizer management than PSB Rc 82. Further, PSB Rc 82 yielded more under well-drained to saturated soil condition than when continuously flooded area, regardless of the organic-based basal fertilizer used. Use of inorganic fertilizer in a continuous double rice cropping at 51st year remained sustainable and productive. Yield of LCC-based N with phosphorus (P) and potassium (K) application in the dry season was 7.01t/ha, while yields of 6.92t/ha with fixed NPK and 6.58t/ha with fixed NK were obtained. Yields of no fertilizer was 3.15t/ha, while those with PK and with NP were 3.94t/ha and 5.32t/ha, respectively. With these results, the indigenous nutrient-supplying capacity of the site was 59.0, 17.1, and 83.1 kg N, P, and K per ha, respectively, with no significant difference from previous years. These experiments examined the productivity and sustainability of rice in terms of yield, sustenance, and productivity.

On-farm trials were also being conducted in a continuous corn-rice-rice and mungbean-rice cropping patterns in lowland rice-based areas. These were done to assess productivity, sustainability, and profitability, and generate soil and crop management recommendations toward durable rice-based cropping systems. Most trials showed increased yields in both dry and wet seasons. In some sites, both study and farmer's practice exceeded the yield target of 5.2t/ha for rice. The same was observed for other crops.

Background information on specific crop and nutrient management like plant spacing, N, K, and pest and diseases of modern rice varieties was generated. The agronomic optimum N rates (AONR) of NSIC Rc 222, Rc 402, Rc 438, and Rc 442 ranged from 131 to 161kg N/ha, with yield potential of 8.14 to 9.74t/ha in the 2019 DS. In the 2019 WS, it was 154 to 192kg N/ha with a yield potential of 6.51-8.15t/ha. Their AONR in the DS was not far from the general N fertilizer recommendation of 120kg N/ha. The best combination of N and K fertilizer with yield of 5.9t/ha and minimal (10.7%) whiteheads for PSB Rc 438 was 210kg N/ha + 40kg K/ha in the DS and 135kg N + 80kg K/ha in the WS. NSIC Rc 442 had high grain yield and minimal whiteheads at rates of 135kg N/ha, 135kg N/ha + 120kg K/ha in the DS, and 90kg N/ha + 120kg K/ha in the WS. PSB Rc 438 had low hopperburn damage and had a high yield of 135kg N/ha + 40kg K/ha in the DS. Moreover, NSIC Rc 438 had higher yield at 210kg N/ha + 120kg K/ha in the

DS and 210kg N/ha + 120kg K/ha in the WS due to low sheath blight infection compared with other treatment rates.

The division activities need a good support from a properly maintained research laboratory. Thirty-nine equipment were calibrated as part of preventive maintenance to guarantee results and lengthen equipment life. Several trainings were done on proper use and maintenance of new equipment. Management of chemicals and equipment through database inventory was updated. Soil fertility assessment was also done in PhilRice CES field to have better interpretation on the results from various researches conducted in the area like pest, nutrient, soil, and water management; farm machinery studies; seed production; and rice breeding activities. Generally, N is low and the most limiting nutrient. For available P, 67% of soil samples had high P content and the rest had medium to low. Low exchangeable K (0.06 to 0.19 meq/100g soil) was observed in 83% of the samples and 17% had medium levels (0.20 to 0.31 meq/100g soil). Initial results show that soil has medium fertility.

PROJECT 1

Assessment and Management of Soil Fertility and Soil Health

WB Collado

This project generally aimed to assess temporal effects of nutrient management on soil fertility and soil health and provide management recommendations for productive, sustainable, and durable rice and rice-based cropping systems.

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

Long-term Soil Fertility Experiment

WB Collado and YB Mercado

Two rice crops were established in the 2019 DS and WS to determine the effect of continuous double rice cropping on trends in crop productivity and sustainability in rice production; assess the effect of continuous double rice cropping on soil fertility, trends in indigenous nutrient supplying capacity, and agronomic N-use efficiency; assess the long-term trends on yield gap between the potential and the actual attained yields; and evaluate whether the yield gap can be closed with site-specific N management. The experiment was laid in RCBD with 6 fertilizer treatments and 3 rice varieties. These were replicated three times.

DS results showed that the highest grain yield of 7.01t/ha was obtained by the LCC-based nitrogen (N) management treatment with phosphorus (P) and potassium (K) and was comparable with the rice plants applied with NPK (6.92t/ha) and NK (6.58t/ha), with N applied at fixed time and rate. Lowest yields were obtained by the plants with no fertilizer (3.15t/ha) and those applied with PK only (3.94t/ha). The application of NP only provided a grain yield of 5.32t/ha. Indigenous nutrient-supplying capacities of the site were 59.0, 17.1, and 83.1kg N, P, and K/ha, respectively. Agronomic efficiency of applied N was higher in the LCC-based N management (17.8kg grain/kg N), with 173kg N/ha application, than the fixed time and rate of N application (14.2kg grain/kg N), with 210kg N/

ha application rate. The yield components that contributed to the increase in yield were panicle and spikelet number.

The WS cropping was affected by heavy rains during the flowering and ripening stages that caused severe lodging. Grain yields of plants applied with N regardless if P and K were applied, were generally low.

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

SD Cañete and WB Collado

Two on-farm experimental sites in San Joaquin, Balungao, Pangasinan and Pugo, Cuyapo, Nueva Ecija 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 towards durable rice-based cropping systems. The durability of the cropping patterns were measured in terms of productivity, sustainability, and profitability. Cropping pattern, cropping calendar, and other conventional practices were secured from farmer cooperators through interview. The usual cropping pattern in Pugo is mungbean planted in November in the DS, followed by rice sown in June in the WS. In San Joaquin, DS corn was planted in January, followed by two WS rice in succession were planted during the months of June and September. Both land units are dependent on shallow tube well (STW) during the DS and rainfall but supplemented with STW during the WS.

In Pugo, Cuyapo, Nueva Ecija, an average of 15.96% and 12.87% increase in yields were recorded in rice for 2018 and 2019 WS, respectively. Mungbean yield also posed a 33.33% yield advantage over the farmer's practice. In San Joaquin, Balungao, Pangasinan, 2019 DS corn and 2019 WS rice managed under the study produced 3.19% and 8.0% yield advantage over the farmer's practice, respectively. In terms of productivity, the 7-10% target yield increase for rice and 5% increase for non-rice crop were achieved across sites and seasons except for 2019 corn in Balungao, Pangasinan. Data on sustainability and profitability of the 2019 cropping patterns will depend on the following remaining activities such as post-cropping farmer's interview, result of soil analysis, and yield data from the succeeding crops.

Assessment of Soil Fertility Status of PhilRice CES Rice Paddy Field

AE Espiritu and WB Collado

Understanding the current nutrient status of the soil is essential in establishing the necessary soil requirement to achieve maximum yields. PhilRice CES represents a wide array of cultural management practices ranging from breeding of rice varieties; management of insect pest and disease, nutrient, soil, and water; farm machinery testing; among others. Having these wide spectrum of field researches, this study aimed to assess the soil nutrient fertility status of PhilRice CES paddy field. Random soil sampling was done per block during the fallow period of 2018 DS. Composite soil samples (0-20cm depth) were collected from the different plots of 16 blocks following the standard procedure for soil sampling. Generally, N level is low at PhilRice CES paddy field as expected because it is the most limiting nutrient. Sixty-seven percent of the total soil samples had high available P content while 25% and 8% have medium and low P levels respectively. Low concentration of exchangeable K ranging from 0.06 to 0.19 meq/100g soil was observed in 83% of the samples, and only 17% had medium levels ranging from 0.20 to 0.31 meq/100g soil. Generally, initial results show that CES has medium fertility.

PROJECT 2

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

AOV Capistrano

The project aimed to make collectible soil, weather, and crop information/data useful in farm-level decision-making, specifically in improving crop health, farm productivity and resource use efficiency, through the development or enhancement of automated tools and devices that collect and/or analyze data. The project has three interrelated studies that would make nutrient management for rice more productive and/or efficient in terms of fertilizer use. The LCC App study achieved a working prototype and was validated in actual field conditions against the LCC, SPAD, and recommended rate (RR). Its grain yields were consistently higher than the other treatments across cropping seasons. However, the LCC app needs further improvement in terms of agronomic efficiency of applied N (AEN). With the current consistent results, the LCC App can now potentially substitute the SPAD 502. The second study, which produced an updated version of the MOET App, proved that better grain yield and efficiency can be achieved using the correlations generated between the MOET and Nutrient Omission Plot Technique (NOPT) which made fertilizer recommendations more appropriate and precise relative to the soil and crop needs. The last study showed that MOET App achieved the highest grain yield and best AEN in DS, while SPAD performed the best during WS. Since SPAD 502 can now be substituted by the LCC App, integrating the LCC App with the MOET App can potentially result in achieving the highest grain yield and best AEN in both DS and WS rice cropping.

This GAD-tagged project, through the LCC App, can provide an opportunity for sight-challenged farmers to properly manage the N needs of their rice fields through the cellphone's camera and LCC App. This innovation will do the visual assessment of the rice leaves for correct N-rate application.

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

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

The study aimed to develop the PhilRice LCC App, an android application version of the LCC for Nitrogen (N) fertilizer management in rice. This year, the correlation between SPAD 502 and DGCI were determined for two hybrid rice varieties: NSIC Rc 204H (DS) and Rc 176H (WS). Results of 2019 correlations between SPAD values and DGCI for both hybrids were found better than correlations obtained in 2017 DS (from three inbreds ranging from 0.52-0.64) and 2018 WS (from one inbred at 0.51 and 1 hybrid at 0.59), having R2 values of 0.7888 (Rc 204H) and 0.7549 (Rc 176H). Also, in this year, the LCC App has been field-tested at PhilRice CES Block VI plot VII along with other N-diagnostic tools; namely, SPAD 502 and original LCC, and two control treatments (0N+PK and RR) to evaluate its performance in terms of yield and AEN. Results of 2019 DS yield trial using Rc 216 showed the highest average yield of 7.405t/ha under the LCC App and slightly better by 80kg/ha than RR and 186kg/ha than SPAD. However, these results were statistically similar. Although the LCC App obtained the highest yield among the treatments, its AEN was unfortunately the lowest at 7.50/kg. In 2019 WS using the same variety, the LCC App got the highest average grain yield of 4.574t/ha but was again statistically similar to RR and SPAD 502 treated yields. However, in terms of AEN, the LCC App was comparable to SPAD, but still lower by 2.29kg grain/kg N applied than that of the RR. A hybrid variety (NSIC Rc 176H) was also used to initially test the applicability of the N-rate recommendations for hybrid and was found to produce comparable grain yield and AEN with the RR but lower than the original LCC-managed plot.

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

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

The study aimed to refine the recommendation rates of the MOET App through the establishment of a linear correlation with the NOPT after the 2018 WS field experiment setups. Two dry seasons (2017 DS, 2018 DS) and two wet seasons (2017 WS, 2018 WS) were the sources of data for the correlation analyses. Relatively high R2 values ranging from 0.65-0.84 in the DS and 0.66-0.88 in the WS resulted in the correlation between the biomass obtained from MOET and NOPT at similar crop ages within the vegetative phase per element (NPKS).

Regression equations each for NPKS relative to cropping season were included in the MOET App's algorithm prior to the first yield trial of 2019 DS. The yield trial consisted of three treatments (NPK, MOET App version (v) 1, and MOET App v.2) in four replicates using three varieties (PSB Rc 82, NSIC Rc 300, and NSIC Rc 204H). Results of the 2019 DS yield trial showed consistently high grain yields under MOET App v.2 across treatments and varieties used, while the AEN were significantly very high under MOET App v.2 for Rc 300 (32.84kg/kgN) and Rc 204H (36.19kg/kgN). In 2019 WS, the same yield trial (2nd setup) was established and grain yields were again significantly high, ranging from 5.51-6.69t/ha, under MOET App v.2 across treatments and varieties except for Rc 204H. Furthermore, AEN of MOET App v.2 was observed to be better than MOET App v.1 only in Rc 300 during this cropping period.

Assessment of Existing Diagnostic and Recommendatory Tools for Increasing Nitrogen-use Efficiency

FS Grospe, MD Del Rosario, JEG Hernandez, and AOV Capistano

Evaluation of existing diagnostic tools for increasing nitrogen use efficiency was conducted under field condition at PhilRice CES in 2019 DS and WS to determine which tool can provide the highest fertilizer (nitrogen) use efficiency (i.e. best grain yield at optimum fertilizer input). Four diagnostic support tools for N management namely: LCC; MOET App; Chlorophyll meter (soil plant analysis development/SPAD-502); and, Soil test kit (STK-based N) were used as treatments. Treatments were laid out in RCBD with three replications. N fertilizer rate applied in each plot planted with Rc 216 was based on plant need determined by different diagnostic tools. Results showed that there was no significant grain yield difference among diagnostic tools used in both cropping seasons. Grain yield across treatments ranged from 7.2 to 8.1t/ha in DS and 4.1 to 5.0t/ha in WS. Using MOET App, the highest grain yield (8.1t/ha) was obtained from Rc 216 in DS while SPAD based N obtained 5.0t/ha in WS. The highest AEN (34.3kg per kg N) was obtained using the MOET App in the DS, while SPAD recorded 22.5kg per kg N, the highest during the WS. The latter was due to more grain yield obtained but at lesser N fertilizer applied.

PROJECT 3

Optimization of Crop Management Components for Attaining the Yield Potential of Recently-released Irrigated Lowland Rice Varieties

MD Malabayabas

Optimum crop management is needed to enhance the yield potential of modern rice varieties. PhilRice developed the PalayCheck System for irrigated lowland rice as a guide for proper crop management. However, there are 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 occurrence of pest and diseases is also related to the level of N and K fertilizers applied in the field and can have significant effect on yield. Thus, the project aimed to optimize some of the integrated crop management components that will help achieve the yield potential of recently-released irrigated lowland rice varieties. The project is composed of two studies. The first study focused on determining the optimum N fertilizer rates that enhance the yield potentials of Rc 222, Rc 402, Rc 438, and Rc 442 during 2019 DS and WS. The optimum N fertilizer rate for each variety was also reported.

The second study dealt on identifying the combination of N and K fertilizer levels that will give high yield with minimum stem borer (SB) for Rc 438 and Rc 442, and brown plant hopper (BPH) and Sheath blight (ShB) damage for Rc 438. Results showed that the best combination of N and K fertilizers for Rc 438 was obtained at 210kg N/ha + 40kg K/ha in DS and 135kg N + 80kg K/ha in WS. Meanwhile, Rc 442 had high yield and minimum SB damage at 135kg N/ha alone and 135kg N/ha with 120kg K/ha in DS and 90kg N/ha + 120kg K/ha in WS. NSIC Rc 438 had low BPH damage or hopperburn and high yield at 135kg N/ha + 40kg K/ha in DS. It also had higher yield at 210kg N/ha + 120kg K/ha in DS and 210kg N/ha + 120kg K/ha in WS due to low ShB infection.

The optimum N and K fertilizer level that will be identified in study 2 will complement the results of study 1 in attaining the yield potential of the test varieties.

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

MD Malabayabas, AJ Espiritu, and HJG Patricio

The study was conducted in 2019 DS and WS at PhilRice CES to determine the optimum N rate in achieving yield potential of recently-released irrigated lowland rice varieties under Maligaya clay soil condition. Twenty-one-day-old seedlings of Rc 222, Rc 402, Rc 438, and Rc 442 were transplanted at plant spacing of 20cm x 20cm and 15cm x 30cm. The N fertilizer rates were 0, 90, 130, 170, 210, and 250 kg/ha in DS and 0, 50, 90, 130, 170, and 210kg/ha in WS. Results showed that the agronomic AONR ranged from 131 to 161kg N/ha with yield potential of 8.14 to 9.74t/ha in DS. AONR in WS ranged from 154 to 192kg/ha with yield potential of 6.51 to 8.15t/ha. The AONR of the four varieties in DS was not very far from the general N fertilizer recommendation of 120kg N/ha for DS. However, the obtained AONR in WS were surprisingly higher than those of AONR in DS. These were also higher than the AONR obtained in 2018 WS that ranged from 56 to 112kg N/ha. Nevertheless, the 2019 WS results need further validation in the succeeding trial. The agronomic efficiencies of the AEN were also determined. In DS, higher AEN of all varieties were achieved at 90kg N/ha with Rc 402 having the highest AEN among varieties. In WS, higher AEN was achieved at 50kg N/ha in all varieties at 20cm x 20cm plant spacing, while AEN was higher with 90kg N/ha for Rc 402 at 15cm x 30cm. Aside from grain yield, growth data from 2018 DS to 2019 WS were generated from the experiment for future inputs in crop simulation model.

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

FS Grospe, EM Valdez, SE Santiago, JP Rillon, and GD Santiago

The study was conducted at PhilRice CES in 2019 DS and WS to determine the combination of N and K fertilizer rates that will produce high grain yield with minimum SB and BPH damage, and ShB infection. There were five rates of N fertilizer (0, 45, 90, 135 and 210kg/ha) and four rates of K fertilizer (0, 40, 80, and 120kg/ha) applied in both field and pot experiments with fixed rate of 40kg P_2O_5/ha. The SB damage was assessed in the asynchronously planted irrigated lowland rice varieties, Rc 438 and Rc 442, under field condition. On the other hand, ShB infection was determined in the Rhizoctonia solani-inoculated plant samples of Rc 438. Reaction of Rc 438 to BPH infestation at 65 days after transplanting (DAT) was also determined. Results showed that the best combination of N and K fertilizer with high yield of 5.9t/ha and minimum SB damage of 10.7% whiteheads (WH) for Rc 438 was obtained at 210kg N/ha + 40kg K/ha in DS and 135kg N + 80kg K/ha in WS. Meanwhile, Rc 442 had high yield and minimum SB damage at 135kg N/ha alone and 135kg N/ha with 120kg K/ha in DS and 90kg N/ha + 120kg K/ha in WS. NSIC Rc 438 had low BPH damage or hopperburn and high yield at 135kg N/ha + 40kg K/ha in DS. It also had higher yield at 210kg N/ha + 120kg K/ha in DS and 210kg N/ha + 120kg K/ha in WS due to low ShB infection.

PROJECT 4

ASPPD Research and Analytical Laboratory System and Maintenance

AE Espiritu

To support the Agronomy, Soils, and Plant Physiology Division (ASPPD) R&D activities, there is a need to capacitate the laboratory system for quality data and analyses through the Research and Analytical Laboratory Systems and Maintenance Project. This project aimed to sustain and improve the existing laboratory facilities and ensure their availability for use at all times for better quality research output. 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 systems that could further enhance and warrant its sustainability. In 2019, calibration and preventive maintenance of 39 equipment was conducted to guarantee accurate and reliable laboratory results and at the same time improve equipment life. Several hands-on trainings were provided by suppliers to equip laboratory staff not only on proper handling and use of the newly acquired equipment, but also on proper preventive maintenance. Aside from this activity, inventory of chemicals and equipment were regularly updated. ASPPD laboratory had also served as an avenue for laboratory benchmarking of other universities and agencies. Likewise, networking/technical/laboratory assistance and consultations were also provided to On-the-Job Training and thesis students. Compliance to regulatory requirement such as inventory of controlled and regulated chemicals used in the laboratory were also reported. To ensure that the working condition is still operating based on standards, the ASPPD laboratory was subjected to the annual work environment monitoring. The ASPPD Research and Analytical Laboratory Systems and Maintenance Project needs to be strengthened to support the ASPPD R&D activities and capacitate the laboratory system for quality research output.

Development of Organic-based Nutrient Management for Paddy Rice and Management of Productive and Environment-friendly Paddy Soils

EF Javier

After several years of focusing on the physico-chemical and biological sciences of the continuous application of organic fertilizer to flooded soils, it is the target of the project to come up with an organic-based nutrient management (OBNM) for paddy rice production (OBRice) that can sustainably yield 4t/ha all throughout the seasons. The science-based output and result of the Study 1 (assessing different farm wastes as organic-basal nutrient supplement that started in 1998), and Study 2 (assessing different green manure as organic-based topdress N sources, that started in 2015 under the Farming without Fossil Energy (FFE) Program until 2017) of the project led to another study – Study 3 which aimed to package and optimize an organic-based nutrient management (OBNM) that could sustain and increase the target yield potential comparable to the grain yield from the current inorganic-based nutrient management (IBNM) of the PalayCheck system. To narrow down the yield gap was still the challenge of the project.

Previous researches show that the sole use of organic-based basal fertilizer have lower grain yield compared with those applied with inorganic fertilizers. Further, the the soil N, depending on the organic fertilizer (OF) use, increased but had also decreased 28-30 days after the OF application. The need for more N from mid-tillering to flowering was observed. Hence, in 2015, one study dealt with assessing some green manure (Indigo, Sesbania, Aeschynomene, Vigna) as potential organic-based topdress fertilizers (FFE program, Annual Rice R&D 2015, 2016). The use of Azolla spp was the best and more practical because its aquatic habitat is similar to rice plants. Three or more applications of Azolla (at 10, 30, 45 and 60 DAT) were found to give better yield than when applied only once at 10 or at 30 DAT (Study 2, 2018 and 2019) .

In packaging the best components of the OBNM, rice straw with chicken manure and rice straw with vermicompost were evaluated as organic-based basal fertilizer in Study 3 (2019). Rice straw is a great contributor to the increase of soil K starting at three years of continuous application, while chicken manure is a potential source of K (Javier et al 2002). The vermicompost, having shown in another 2015-2016 study (Javier et al, 2018. Discussion Paper series, PhilRice) as having good total quality, even better than the commercial organic fertilizer (COF), was used in comparing its effect with that of chicken manure. The Azolla microphylla, as screened to be a heat-tolerant variety, was then used as the potential organic-based topdress N source (FFE program annual Report 2015, 2016). The grain yields of both the hybrid and inbred variety increased. Comparing the packaged NM and the PalayCheck system, IBNM showed additional yield increase when given an organic-based nutrient management. Apparently, this showed that the two packaged nutrient management are complementary to each other, and not necessarily contradicting. In the 2019 trial, NSIC Rc 204H, which was expected to demand a higher rate of nutrients, showed higher yield under the OBNM. It even performed better when it was complimented by full or half the IBNM than the inbred variety, PSB Rc 82. Furthermore, the target yield of at least 4t/ha was attained.

Lastly, subjecting the OBNM to two different soil conditions, higher yield by the PSB Rc 82 was observed under the continuously flooded soil than in the well-drained or saturated soils.

To support the alternative organic-based topdress N source, Azolla production was maintained as part of the system. 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. Aside from ensuring family food security, growing vegetables above the Azolla production pond can also be an additional income if the farmers will sell them for a profit. Vegetables grown along with the Azolla production are organically grown, and therefore had added value.

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

AE Espiritu, EF Javier, M Fernandez, and CA Santin

Continuous application of organic fertilizers/waste in continuously irrigated or submerged soil conditions, like rice production, differs from aerated or dry soils in terms of soil chemical reactions. Therefore, this study is set to provide 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 optimize a sustainable level of grain yield and soil health and productivity in a close nutrient cycling system. Due also to the increasing costs of fertilizer input, some commonly available farm wastes were considered as treatments: rice straw, chicken manure, green manure, and vermicompost. These were applied alone and in combination with half and with full recommended inorganic NPK rate for DS and WS. Unfertilized plots were used as indicator of the current indigenous nutrient supply. PSB Rc 82 was used as test plants. After 15 years of continuous application of organic materials, the trends in the yield of the organic-based nourished rice plants were similar to that of the inorganically applied plants during the 2005 WS, 2007 WS, 2011 WS, 2013 WS, 2016 WS, 2018 WS, and 2019 WS. Likewise, the soil pH has not significantly changed since 2003 with the application of either organic or inorganic NPK fertilizer. This was also observed with soil carbon (soil C) or soil organic matter (SOM) at 2-3%. No significant increase was observed on soil residual N, while soil P was increasing from soils applied with chicken manure (CM) and soil K was increasing due to rice straw. Soil Zn, Cu, Mn were decreasing, while soil Fe was increasing. However, these values were still within the normal ranges in paddy soils for rice normal growth.

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

EF Javier, MLM Sevilla, XXG Sto. Domingo, and JM Mercado

In supplementing the insufficiency of the organic basal nutrient supplement to rice to achieve a sustainable 4t/ha, several green manures like Azolla, Sesbania, Aeschynomene, and Indigo were tested for paddy rice in the last two years. Because paddy rice grows in an aquatic environment, only the Azolla spp. thrived as potential alternative nitrogen sources for topdress fertilizer. Hence, this study was conducted to assess and optimize Azolla spp. as potential alternative organic nitrogen sources for topdress supplement in irrigated lowland rice ecosystem. Likewise, a component activity was also done under greenhouse condition to screen the best Azolla spp. as potential alternative organic-based N supplement in saline and acidic soils. Different Azolla spp. were tried in normal (Maligaya), acidic, and saline paddy soils for trials under greenhouse experiment. Azolla microphylla was consistently found to be tolerant in hot and humid environment and can still grow and sporulate normally, whereas, other Azolla spp had been found to slightly decrease salinity and increase soil pH, with their biomass greatly decreased. In the field trial, Azolla microphylla was tested and optimized as organic-based topdress N source. Peñaranda (PSB Rc 82) and Mestiso 20 (NSIC Rc 204H) were used as test plants. Two organic-based basal fertilizer were used: Rice straw plus chicken manure and rice straw plus vermicompost. Topdressing A. microphylla was done 2-3 times at different growth stages. In 2019, contrary to the result of 2018, hybrid rice variety, Mestizo 20 yielded 6.54t/ha in DS and 5.16t/ha in the WS as it responded to the application of organic fertilizers at basal. This was followed by the conventional inorganic NPK fertilizer application, which was higher even to its yield under the pure inorganic fertilizer. Mestiso 20 yielded higher (5.81t/ha) during the DS when nutrient demand is higher, compared to its yield of 4.98t/ha in the WS, under the pure OBNM or using rice straw with chicken manure as basal, and Azolla as topdress applied three times.

Optimization of Different Packaged Organic-based Nutrient Management for Irrigated Rice

EF Javier, MLM Sevilla, XXG Sto Domingo, JM Mercado, and MD del Rosario

The study was conducted to evaluate and assess different nutrient management techniques under saturated or well-drained soil and continuously flooded soil conditions, but with emphasis on the packaged OBNM as compared to the IBNM of the PalayCheck System. A 3,000-m2 lot was subdivided into 24 lots to accommodate the following cases replicated four times: (1) Standard PalayCheck System or the conventional/pure IBNM at the rate of 120-40-60kg NPK/ha in the DS and 90-40-40kg NPK/ha in the WS; (2) pure OBNM (the application of rice straw with chicken manure as basal nutrition, and 4x application of 500kg/ha Azola microphylla at 10, 30, 45 DAT and at early panicle initiation (EPI); (3) Organic-based Palaycheck system (or OBPC; application of rice straw with chicken manure at 10:1 ratio as basal nutrition and still following the IBNM of the PalayCheck System); and (4) OBNM Rice production Plus (rice straw with chicken manure as basal nutrient source and application of Azolla plus half inorganic NPK fertilizer rate as topdress at 10, 20, 38 and 45 DAT).

At PhilRice's FutureRice Farm, two sets of these packaged rice production technique were subjected in two different soil water management systems. One partially followed the alternate wetting and drying technique and the other was continuously flooded. To observe uniformity, consistency, and sustainability of the treatments, the four showcases were replicated twice.

The PalayCheck system showed additional yield increase under the OBNM. Apparently, this showed that the two nutrient management packages were complementary to each other. OBNM plus only half of the inorganic NPK rates also showed potential for a sustainable 4t/ha or higher in both DS and WS, regardless of the applied organic-based basal fertilizer. Likewise, 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. 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 and family food security, as well as an additional income if the farmers will sell them for a profit. Since the vegetables are organically grown, that made an added value to the vegetables produced in the Azolla production.

PRISM: Philippine Rice Information System (PRISM) – Operation

EJP Quilang

Rice is an indispensable staple food and source of livelihood for more than two million farming households in the Philippines. Due to its cultural and economic importance, there is an urgent need to develop an operational system for large-scale rice monitoring in the country that would identify the scale and magnitude of production gaps for planning and decision-making and enable the rapid response to emergency situations based on transparent and accurate information. To address both these concerns, the Department of Agriculture (DA) through the PhilRice, in collaboration with the International Rice Research Institute (IRRI), has successfully developed the Philippine Rice Information System (PRISM) envisioned to continuously provide reliable, timely, and location-specific seasonal information on the extent of rice cultivated area, yield estimates, and rice areas affected in the event of flood and drought. PRISM uses state-of-the-art technologies, such as radar remote sensing, crop growth simulation modeling, smartphone-based field surveys, and information and communication technologies (ICT) to revolutionize the way data and information on the rice crop is generated and shared. PRISM data and outputs are made accessible to project partners and decision-makers through the online portal and bulletins. As PRISM is on its first year of operationalization, the continuous improvement of the system, technical support, engagement of emerging partners and potential users, and capacity building are seen crucial for PRISM's sustainability.

PRISM delivered information on rice area and planting dates (monthly, mid-of-season, and end-of season), yield (mid-of-season and end-of season), area at risks and flooded and drought affected rice areas. The total area planted to rice in the Philippines during the first semester was 1,811,096ha. These estimates were lower by 13% (257,412ha) from the PSA harvested area for the same semester. For the second semester, the total area planted to rice in the Philippines was 2,241,287ha. These estimates were lower by 18% (431,467ha) and 19% (474,979ha) than the PSA estimate in second semester of 2018 and 2017, respectively. The overall accuracy of the rice area maps for 2019 first and second semesters (both 92%) was higher than the overall accuracy of rice area maps produced from 2015 second semester to 2018 second semester (ranged from 85% to 90%). On the other hand, descriptive analysis of aggregated data on rice yields showed that the national average yield was relatively lower during the first semester (3.8t/ha) than in the second semester (3.9t/ha). At the regional level, the highest average yields were recorded in Central Luzon (5.1t/ha) and Northern Mindanao (4.6t/ha) during first and second semester, respectively. In comparison to the previous year's yield performance officially reported by PSA, the national average yields this year was relatively lower by 7.29% during first semester and slightly higher by 1.03% during second semester. The observed decline in yields during the first semester can be attributed to the persistence of dry spells and drought conditions that affected some rice-producing regions, such as Cagayan Valley, ARMM, Northern Mindanao, and Zamboanga Peninsula. Moreover, eight special bulletins for flood assessment and one for drought were submitted. The special bulletin contains information on the estimates of rice areas at risk, flooded/drought-affected rice areas, and flood, and drought maps.

PRISM-Field Monitoring of Rice Areas in the Philippines

DKB Matias, HF Gonzaga, MV Conado, G Bello, CKL Galvan, E Carino, Martin, GB de Mesa, DB Bañares, G Flancia, HA Yonson Jr., BP Gepiga, JA Peligro, MPA Philline Tejada, and JA Calapit

Data on rice area, seasonality/planting dates, seasonal yield, and flood- or drought-affected area were gathered through the use of satellite data, remote sensing, geographical information system (GIS), and crop modelling. Generated information was validated through field monitoring by 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 on monitoring field locations, farm profile, photos, field status, crop growth stages, crop management practices, production, and crop damages due to flood or drought.

In 2019, over 2,389 farmers' fields across the Philippines were monitored. Data on field profile (2,263), cultural management (1,964), crop status (15, 674), production data (1,404), and validation points (3,753) were collected. A total of 18 typhoons and several LPAs were monitored by the team and field damage assessment were conducted in seven regions; namely, MIMAROPA, Bicol, Zamboanga Peninsula, Ilocos, Cagayan Valley, Central Luzon, and Western Visayas. Drought assessment was also conducted in 2019 DS in the regions of Cordillera, Ilocos Region, Cagayan Valley, CALABARZON, MIMAROPA, Bicol, Western Visayas, Zamboanga Peninsula, Davao, SOCCSKSARGEN, and Caraga. These data were used for the analysis and interpretation of satellite imagery, calibration of the thresholds used for rice classification, and accuracy assessment of rice area, yield, and flooded/drought-affected rice maps.

Mapping of Rice Areas in the Philippines Using Remote Sensing Technology

MRO Mabalay, SL Asilo, DKB Matias, MV Conado, HF Gonzaga, PE Mabalot, and J Mirandilla

The PRISM precisely map rice-growing areas by using multi-temporal synthetic aperture radar (SAR) imagery, semi-automated image processing, rule-based classification, in-season field monitoring, and end-of-season validation. Semestral maps of rice area and start of season (planting dates) have been generated since the 2014 second semester using MAPscape-RICE® to process multi-temporal high-resolution (20m) SAR images. Monitoring of rice fields and field data collection were carried out by regional partners using smartphones from land preparation until harvesting. The data collected from field monitoring were used for threshold adjustment, calibration, and accuracy assessment of rice area maps.

The total area planted to rice in the Philippines during the 2019 first semester was 1,811,096ha. These estimates were lower by 13% (257,412ha) from the PSA harvested area of the same semester. For the 2019 second semester, the total area planted to rice in the Philippines was 2,241,287ha, which was lower by 18% (431,467ha) and 19% (474,979ha) than the PSA estimate in second semester of 2018 and 2017, respectively. The overall accuracy of the rice area maps for both semesters was 92% based on 1,932 and 1,941 ground-truth points of rice and non-rice areas collected across the country for 2019 first and second semester, respectively. PRISM successfully demonstrated the feasibility of rice detection at a national scale using multi-temporal SAR images and a robust threshold-based classification method based on the temporal dynamics of the rice crop.

PRISM IT Systems Development and ICT Infrastructure

HD Cayaban, JL de Dios, AC Arocena, M Barroga, and MAN Dela Cruz

This study aimed to ensure that data and information of PRISM are available and secured using available infrastructure and technology. This study also developed a web geographic information system (GIS) prototype to integrate PRISM resources for decision makers and other stakeholders. In 2019, full management of PRISM information and communication technology (ICT) were conducted by use of hosting and domain provider, development of website and analytics, improvement of PRISM Collect, and partnership with DOST-ASTI and DA-ICTS to sustain the project. Servers and workstation replaced the cloud processing and web service. Likewise, domain hosting was housed under the PhilRice domain and premise. Collaborations with other government agencies were established to ensure PRISM data and information security and continuous processes. The data and information produced by PRISM were classified, stored, organized, and processed in a secured server with remote mirror and can be accessed, processed and downloaded through the PRISM official website/portal with identified level of access. Remote servers were established in ASTI and DA-ICTS with the use of HPC for redundancy. The design and functionality of the website was enhanced by developing the Infolib module to aid the operational monitoring of PRISM data, information, files, and other functionalities. Moreover, a map server was established for yield. For data backup and infrastructure 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.

Monitoring of Flooded or Drought-affected Rice Areas

SL Asilo, MRO Mabalay, DKB Matias, MV Conado, HF Gonzaga, G Bello, E Carino, N Martin, GB de Mesa, Flancia, HA Yonson Jr., MPA Tejada, JA Calapit, JM Maloom, ED Alosnos, EDO Radam, PE Mabalot, and J Mirandilla

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 the occurrence of El Niño Southern Oscillation. El Niño in 1997-98 severely affected about 70% of the country, resulting in an estimated P3B in damage to rice and corn (maize) crops (De Guzman 2009). Rice yields are adversely affected by a lack of water, particularly during the reproductive stage, when the rice crop is most sensitive to water stress (Matsushima 1970).

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

This study aimed to estimate the rice areas affected by extreme weather events by using Synthetic Aperture Radar (SAR) images for flood and optical images for drought detection, and help the DA in making informed decisions and planning interventions and emergency response to affected areas through the delivery of remote sensing-derived information. A protocol for assessing extent of flood and drought-affected rice areas using remote sensing and field surveys were developed and implemented to deliver estimates of rice areas at risk and rice areas affected by drought or flood to the DA. Data on rice areas at risk of flood damage due to tropical cyclones (December 2018 to November 2019) and areas at risk to drought damage (November 2018 to March 2019) were submitted to DA. Consequently, flood maps for the eight tropical cyclones were generated. Lastly, nine special bulletins (8 for flood and 1 for drought) containing the abovementioned information were submitted.

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

ED Alosnos, EDO Radam, PE Mabalot, and HD Cayaban

The study enhanced the PRISM rice yield monitoring system to ensure the continuous and timely generation of high-quality data/information on rice yields and productivity in the Philippines. This was achieved through integration of various state-of-the-art technologies, such as crop growth simulation modelling, remote sensing, smartphone-based field data collection, and database management. In 2019, PRISM successfully generated the data on mid-season yield forecasts and end-season yield estimates for both first semester (S1) and second semester (S2). These data products were made available to end-users through regular bulletins, PRISM website, and online database. Descriptive analysis of aggregated data on rice yields showed that the national average yield was relatively lower during S1 (3.8t/ha) than in S2 (3.9t/ha). At regional level, the highest average yields were recorded in Central Luzon (5.1t/ha) and Northern Mindanao (4.6t/ha) during S1 and S2, respectively. On the other hand, BARMM obtained the lowest average yields in both S1 (2.2t/ha) and S2 (2.7t/ha). At provincial level, the highest average yields were recorded in Nueva Ecija (5.7t/ha) and Bukidnon (4.8t/ha) during S1 and S2, respectively. The lowest average yields were recorded in Maguindanao (2.2t/ha) and Basilan (1t/ha) during S1 and S2, respectively. In comparison to the previous year's yield performance officially reported by PSA, the national average yields this year was relatively lower by 7.29% during S1 and slightly higher by 1.03% during S2. The observed decline in yields during S1 can be attributed to the persistence of dry spells and drought conditions that affected some of rice-producing regions such as Cagayan

Valley, ARMM, Northern Mindanao, and Zamboanga Peninsula. Strengthening institutional collaboration and end-user engagement, maximizing regional data usability, and harmonizing data were among the identified key strategies to ensure the operational sustainability of PRISM rice yield monitoring system.

Abbreviations and acronyms

AYT - Advanced Yield Trial
ABE - Agricultural and Biosystems Engineering
AEW - Agricultural Extension Worker
ATI – Agriculture Training Institute
AESA - Agro-ecosystem Analysis
AC - Amylose Content
BLB - Bacterial Leaf Blight
BLS -Bacterial Leaf Streak
BCA - Biological Control Agent
BS - Breeder Seeds
BPH -Brown Planthopper
BPI - Bureau of Plant Industry
CGMS - Cytoplasmic Genic Male Sterility
COF - Commercial Organic Fertilizer
CDA - Cooperative Development Authority
DAS - Days After Sowing
DAT - Days After Transplanting
DF - Days to Flowering
DM- Days to Maturity
DAR - Department of Agrarian Reform
DA-RFOs - Department of Agriculture-Regional Field Offices
DoF - Department of Finance
DOLE - Department of Labor and Employment
DTI - Department of Trade and Industry
DSR - Direct-seeded Rice
DS - Dry Season
FBS – Farmers' Business School
FC - Farmers' Cooperative
FSM - Farming Systems Models
FAA - Fish Amino Acid
FGD - Focused Group Discussion
FSP - Foundation Seed Production
FRK - Farm Record Keeping
GABA - Gamma-aminobutyric Acid
GT - Gelatinization Temperature
GAD - Gender and Development
GYT - General Yield Trial
GCA - Genetic Combining Ability
GIS - Geographic information system
GEMS - Germplasm Management System
GAS - Golden apple snail
GL - Grain length
GQ - Grain quality
GW - Grain Weight
GY - Grain Yield
GLH - Green Leafhopper
GOT - Grow Out Test
HR - Head Rice
HRA - Heat Recovery Attachment
HIPS – Highly-intensified Production System
HQS - High-quality Rice Seeds
HON - Hybrid Observational Nursery
HPYT - Hybrid Preliminary Yield Trial
ICT - Information and Communication Technology
IEC - Information Education Communication
IBNM - Inorganic-based Nutrient Management
ICM - Integrated Crop Management
IPM - Integrated Pest Management
JICA - Japan International Cooperation Agency
IRRI - International Rice Research Institute
IA - Irrigators' Association
KP - Knowledge Product
KSL - Knowledge Sharing and Learning
LCC - Leaf Color Chart
LFT - Local Farmer Technicians
LGU - Local Government Units
LPS - Low Pressure Steam-operated
SB - Stemborer
LE-CYPRO - Lowland ecotype Cyperus rotundus
MFE - Male Fertile Environment
MSE - Male Sterile Environment
MAS - Marker-assisted Selection
MRL - Maximum Root Length
MR - Milled Rice
MER - Minimum Enclosing Rectangle
MOET - Minus-one Element Technique
MC - Moisture Content

MAT - Multi-Adaptation Trials
MCRTP - Multi-crop Reduced Till Planter
MET - Multi-environment Trial
MYT - Multi-location Yield Trial
NAAP - National Azolla Action Program
NCT - National Cooperative Test
NFA - National Food Authority
NRAM - National Rice Awareness Month
NSIC - National Seed Industry Council
NSQCS - National Seed Quality Control Services
N - Nitrogen
NBSP - Nucleus and Breeder Seed Production Project
NFGP - Number of Filled Grains Panicle
ON - Observation Nursery
OSIS - One Stop Information Shop
OBNM - Organic-based Nutrient Management
PL - Panicle Length
PW - Panicle Weight
PVS - Participatory Varietal Selection
PWD - Person with Disabilities
PhilMech - Philippine Center for Postharvest Development and Mechanization
PRISM - Philippine Rice Information System
PhilRice - Philippine Rice Research Institute
PSA - Philippine Statistics Authority
PTC - PhilRice Text Center
P - Phosphorus
PVS - Plant Variety Selection
K - Potassium
QTL - Quantitative Trait Loci
RCBD - Randomized Complete Block Design
RSP - Registered Seed Production
RBB - Rice Black Bug
RCEF - Rice Competitiveness Enhancement Fund
RCEP - Rice Competitiveness Enhancement Program
RCM - Rice Crop Manager
RHGEPS - Rice Hull Gasifier Engine Pump System
RPH - Rice Planthopper
RSTC - Rice Specialists' Training Course
RTV - Rice Tungro Virus
RBFHS - Rice-based Farming Household Survey
KQ - Kernel Quality
SV - Seedling Vigor
ShB - Sheath Blight
ShR - Sheath Rot
SMS - Short Messaging Service
SNP - Single Nucleotide Polymorphism
SWRIP- Small Water Reservoir Irrigation Project
SRB - Stabilized Rice Bran
SUCs - State Universities and Colleges
SB - Stem Borer
TESDA - Technical Education and Skills Development Authority
TDF - Technology Demonstration Farm
TRV - Traditional Rice Varieties
TOT - Training of Trainers
TPR - Transplanted Rice
URBFS - Upland Rice-Based Farming
WS - Wet Season
WCV - Wide Compatibility Variety
YSB - Yellow Stemborer

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

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