2020

PhilRice R&D Highlights

Climate Resiliency for Enhanced Agricultural Trading Efficiency for Rice (CREATE Rice) Program

Contents

PROGRAM

Climate Resiliency for Enhanced Agricultural Trading Efficiency for Rice (CREATE Rice) Program

Program Leader: Ricardo F. Orge

EXECUTIVE SUMMARY

The CREATE Rice Program was established to help the rice farmers cope up with two huge challenges that they are facing today: (1) competition with the much-cheaper imported rice that enters the country freely due to trade liberalization (ASEAN economic integration) and (2) the risks associated with climate change. Thus, it implemented four projects geared towards developing technologies and innovations that would help enhance their climate change resiliency and market competitiveness.

Under Project 1, three technologies were deployed for pilot testing in select sites in Zaragosa, Nueva Ecija. To help diversify sources of income of farmers as a way of enhancing climate change, Project 2 dealt with developing rice-based farming system models targeting an annual net income of PhP50/m^2 area. Project 3 aimed to develop value-adding technologies for rice, by-products, and other crops in the rice environment to help provide additional income and to improve the nutritional status of the members of the rice-based farming community. Project 4 continued to test and evaluate the cost of rice production using the three mechanization-based package of technologies (POT) under irrigated condition during the dry and wet seasons of 2020.

PROJECT 1

Managing Climate-Related Stresses for a Resilient Rice and Rice-Based Production System

Kristine S. Pascual

To enhance and sustain productivity of rice and rice-based farming systems despite the negative effects of climate change, this project has five studies with the following objectives: (1) develop a sprinkler irrigation system to maximize the utilization of water; paddy bag drying system for postharvest handling and drying system for typhoon-affected *palay*; and multi-purpose mini-tractor that can operate both in favorable and in adverse field conditions; and (2) pilot test a multi-purpose and typhoon-resistant farm structure (*Kwebo*) and a do-it-yourself irrigation system called *capillarigation* in selected farmers' organization.

This year, study 1 focused on the field-testing and application of the initial prototype of the sprinkler irrigation system from commercially available rotor sprinkler head and a fabricated collapsible frame, modified nozzle, and retro-fittings in aerobic rice. The system was designed to cover an area of at least 0.25ha (2500m^2) in one setting to reduce operation cost. At field condition, the average uniformity coefficient of the sprinkler varied from 28 to 91% due to the effects of wind speed and operating pressure. In terms of grain yield, the sprinkler irrigation system during dry season yielded 4,760.6kg/ha with water productivity of 0.90kg/m^3. During wet season, the field area was laid out in a circular area (28m diameter) with planted rice and its surrounding area cultivated with vegetables. The grain yield was 5,432.6kg/ha for rice and 4,007.2kg/ha for a variety of vegetables. The estimated cost of the sprinkler was PhP19,860.80, but the projected irrigation cost per m^2 was PhP6.87/m^2 due to low irrigation water use.

Study 2 identified the Ugat Uhay Farmers Association in Mayamot, Zaragoza, Nueva Ecija as the farmers' cooperator for the pilot testing of the bag drying system. Fabrication and construction of the components of the handling and drying system such as the drying bag, bag carrier, multipurpose shelter, and the air heating and conveying components are expected to be completed by December and to be used by 31 organization members (10 female, 21 male).

Design and fabrication of the soil drilling attachment of Makisig 2 was completed and ready for field testing under study 2.

Kwebo and *capillarigation* system in Macarse, Zaragosa Nueva Ecija was pilot-tested in partnership with a farmer-cooperator. Under studies 4 and 5, development of construction aid for the simplified version of ***k**webo* was established. Select farmers were trained on the actual fabrication of the component parts of the *kwebo,* which is designed for poultry house. In addition, feedback on the use of the previously constructed kwebo showed high satisfaction from farmer cooperators who agreed

on its usefulness for housing their mushroom fruiting bags, especially during the recent typhoon *Ulysis.* In c*apillarigation* system, a 900-m^2 area was identified for the installation of the system with estimated total cost of PhP22,960.00 A draft leaflet ason installing and operating the *capillarigation* system was also developed for backyard gardening and small farm area.

Development of a Sprinkler Irrigation System for Rice and Rice-Based Crops

Alaissa T. Remocal, Kristine S. Pascual, and Ricardo F. Orge

Maximizing the use of water during drought is important to sustain rice production. Integration of sprinkler irrigation in an aerobic rice production should be explored as a potential strategy to cope with limited irrigation water. This study developed a sprinkler irrigation system (SIS) for rice and rice-based crops that could cover a service area of 0.25ha in one setting. After series of laboratory tests to come up with appropriate nozzle and retro-fittings, the final prototype was used in an aerobic rice field at Palayamanan farm to test its performance in actual condition. The sprinkler head assembly with a collapsible frame was fabricated in REMD shop and weighs 17kg. It requires 1-2 persons to set-up, which operates 4-6 hours a day. The prototype showed that a 20-mm nozzle diameter had a maximum throw radius of 28.7m and maximum wetted area of 2,857m^2. At field condition, the average uniformity coefficient (Cu) varied from 28 to 91% with an operating pressure of 117-193kPa. The low values of Cu (<70% minimum acceptable value) were due to the effects of wind speed and operating pressure during operation. Sprinkler discharge was 10.56m^3/h in dry season and 14.19 m^3/h^1 in wet season. Lower water use in DS resulted in higher water productivity than in the WS. However, 98% of total water use in WS came from rainfall. Further study is needed to improve the uniformity water distribution of the system to prevent possible localized drought stress during crop growth.

Development of a Paddy Bag Drying System

Derose A. Sawey, Ricardo F. Orge, and Joneil B. Lagmay

This study aimed to come up with a working prototype of a climate-responsive rice postharvest handling and drying system for typhoon-affected *palay*. The system was composed of four components: the drying bag with a capacity of 400 kilograms, the bag carrier, the multi-purpose shelter, and the air heating and conveying component. In 2020, Ugat Uhay Farmers Association of Mayamot,

Zaragoza, Nueva Ecija signified their interest and became the pilot test site. The multi - purpose shelter required an area of 60sqm, must be clear from obstruction and must not be easily flooded during rainy season. It was a tunnel-type that could accommodate eight units drying bags and could house the air heating and drying component. Establishment of the shelter was at 25% completion. Fabrication of the basic construction units (BCUs) and pre-fabricated posts were completed. Installation of the posts, wall panels, and BCUs were completed. The posts have been concreted. Fabrication of the drying bags was 25% completed. The air heating and conveying component consisted of the concrete continuous type rice hull *carbonizer* and a blower. The *carbonizer* panels were completely fabricated and ready for installation. Fabrication of the blower was also completed. Performance evaluation of the system will follow upon completion of all the components.

Development of a Multi-Purpose Power Tiller for Climate Change Adaptation

Ricardo F. Orge, Joneil B. Lagmay, and Derose A. Sawey

This study aimed to develop a riding-type mini-tractor that can operate in favorable and in adverse field conditions (i.e., fields covered with thick layer of mud after being flooded, or those with deep hardpans) and can perform functions that are mostly beyond the capability of the existing hand tractors. The machine could help farmers cope with climate change by through activities like constructing small ponds for harvesting rainwater, drilling shallow tube wells, and digging canals for conveying water. Its design criteria were generated through informal discussions and consultations with farmers (both sexes represented) during field days, field visits, and farmers' trainings. Part of the machine development process was to critically review the design of the existing power tillers and small farm tractors, taking note of the basic operating components and provisions for attachments to carry out farming operations (plowing, harrowing, leveling). In 2020, second prototype was fabricated, which incorporated improvement from the 2018 prototype that was tested in 2019. Despite delay in fabricating caused by the COVID-19 pandemic, the prototype is already 90% complete and was evaluated for the functionality of its critical parts. The new prototype is powered by a 9.7kW (13 hp) gasoline engine and is equipped with a pair of screw wheels and an attachment (100% completed) for trenching and digging shallow tube wells. It is expected to be completed by mid-December 2020 and ready for field performance testing.

Establishment of Kwebo in Selected Farmer's Cooperative

Katherine C. Villota, Ricardo F. Orge, and Derose A. Sawey

This study aimed to demonstrate the construction of a multi-purpose typhoon resistant farm structure or "Kwebo" in farmers' field and gather feedback regarding its construction and function. For 2020, a *kwebo* unit was requested by a farmer-leader in Macarse, Zaragoza, Nueva Ecija to be used as poultry house. The designed unit has 47.3m^2 area that can house 100 heads of free-range chickens. A simplified version of construction is being applied to this structure. Two types of construction aid were designed and fabricated. One for molding of bamboo splits and the other one for fabricating of bamboo roof panels. Training on fabrication of pre-fabricated parts was provided to four farmers who will be involved in the construction *kwebo*.

Pilot testing of the *capillarigation* system in selected farmers' cooperatives

Derose A. Sawey, Ricardo F. Orge, and Joneil B. Lagmay

The study aimed to pilot test the *capillarigation* technology in selected farmer's field and home yard. It also gathered feedback on the use of the said technology. For 2020, a pilot site in Macarse, Zaragoza, Nueva Ecija was identified for the installation of the system. A field planted with *calamansi* with an area of 900m^2 was used for the installation of the *capillarigation* technology. The layout was prepared and the cost of materials was estimated at PhP22, 960.00. Farmer-cooperator provided 50% of the total cost. Installation and training of farmers were delayed due to the restrictions under COVID-19 pandemic and the onset of rainy season. A draft leaflet as field guide on installing the *capillarigation* system was developed for backyard gardening and vegetable growing with limited area.

PROJECT 1

Palayamanan Smart: Development of Highly Productive and Climate-resilient Rice-Based Farming Systems

Myrna D. Malabayabas

The project aimed to enhance the climate change resiliency of men and women-farmers in rice-based farming communities by developing rice-based farming system models (FSMs) that will increase and diversify their sources of income. Study 1 continually tested and improved highly profitable climate-resilient farming system models that were established in 2018 at PhilRice CES. In 2020, the highly intensified production system model (HIPS)- Sorjan System composed of alternating raised beds and sinks generated a gross margin of PhP47,054.36 with an income/m^2 of P49.53. The income could have been even higher if planting activities were not disrupted by the pandemic. The target PhP50/m^2 was almost achieved. The improved vertical garden made of sturdier material generated a gross income of PhP1,090.58 but with negative gross margin because of the initial investment cost. Hopefully, this will incur profit in the next cropping season. The rice+duck+cash crop production model generated a gross margin of PhP46,362.51 with PhP26.19 income/m^2. Similar to the Sorjan System model, taro planted in canals gave the highest income/m^2. Despite being affected by the African swine fever (ASF), the swine+vegetable production model generated gross margin of PhP9,437.60. The upland kangkong planted on top of the miniature pigpen also generated an income of PhP790 for just one harvest.

This 2020, the study conducted consultation meeting with mayors, municipal agriculturist, and agricultural technicians in Zaragoza, Nueva and La Paz, Tarlac. The Palayamanan components were presented to the mayors who signified their commitment to the study. The proposed site in Zaragoza, Nueva Ecija was already identified and focus group discussion was already scheduled. In La Paz, Tarlac three potential sites were validated through the assistance of agricultural technicians. Focus group discussion with farmers did not push through with the PhilRice management declaring force majeure.

Development of Highly Productive Climate-Resilient Farming System Models

Myrna D. Malabayabas, Rizal G. Corales, Jesusa M. Rivera, Jerome M. Mercado, Ricardo F. Orge, Derose A. Sawey, Dianne A. Gabriel, and Julius T. Sajor

The study continually tested and improved highly profitable climate-resilient farming system models that can provide alternative and diversified sources of income for farming families especially during adverse climate events. In 2020, the highly intensified production system model (HIPS)- Sorjan System composed of alternating raised beds and sinks generated a gross margin of PhP47,054.36 with an income/m^2 of PhP49.53 - few cents short of the the target P50/m^2 . Income would have been higher if planting activities were not disrupted by the pandemic. Meanwhile, the improved vertical garden made of sturdier material generated a gross income of PhP1,090.58, but with negative gross margin because of the initial investment cost. The rice+duck+cash crop production model generated a gross margin of PhP46,362.51 with PhP26.19 income/m^2. Similar to the Sorjan System model, taro planted in canals gave the highest income/m^2. The swine in the swine+vegetable production model was affected by ASF but the projected gross margin was PhP9,437.60. The upland kangkong planted on top of the miniature pigpen generated an income of PhP790 for just one harvest.

Pilot-testing of Rice-based Farming Systems Models (FSMs) in Climate-vulnerable Rice-based Communities

Jesusa M. Rivera, Rizal G. Corales, Myrna D. Malabayabas, Ricardo F. Orge, and Derose A. Sawey

This study was conducted to pilot test ready-to-deploy farming system models (FSMs) and assess their adaptability in climate-vulnerable rice-based farming communities. In 2020, several consultation meetings were conducted with mayors, municipal agriculturist, and agricultural technicians in Zaragoza, Nueva and La Paz, Tarlac. The Palayamanan components were presented to the mayors who signified their commitment to the study. The proposed site in Zaragoza, Nueva Ecija was already identified and focus group discussion was already scheduled. In La Paz, Tarlac three potential sites were validated.

PROJECT 1

Development of Value-Adding Technologies

Marissa V. Romero

Value-adding is a key process that enhances the aesthetic appeal, other important properties, and market value. This is particularly applicable to the agriculture sector because marketing crops in raw or fresh form is generally not very profitable because of their low price. For instance, paddy rice is sold as low as PhP10/kg these days. Therefore, an excellent way to help increase farmers' income is by adding value to their produce through appropriate postharvest management, processing, and packaging which translates to better premium price. Moreover, the by-products generated from rice production (straw, hull, and bran) or other farm waste materials can be transformed into something with economic value or even contribute to reducing production cost. For some by-products with heating values, this could result in reducing dependence on fossil-based energy sources.

Aside from providing opportunities to generate additional income, this Project also contributes to food and nutrition security at the level of the rice and rice-based farming households, shielding them from the impact of food and energy crises brought about by climate change and the economic depression brought about by the ASEAN economic integration.

The main purpose of this project is to develop value-adding technologies for rice, by-products, and other crops in the rice environment to help increase the income and improve the nutritional status of the members of the rice-based farming community. Value-adding systems are utilized to bring about enhancement of quality, nutrition, shelf-life, market value, and profitability. Under this Project, five studies were implemented: (1) Upscale production of gamma-aminobutyric acid (GABA) rice and its potential as base ingredients for instant and ready-to-eat foods; (2) Rice-based complementary foods and beverage: Value-added products for enhanced nutrition and income among rice-based farm households; (3) Utilization of stabilized rice bran as food ingredients for functional food products; (4) Formulation, characterization, and efficacy testing of nanosilica structured biofertilizer for rice production; and (5) Development of carbonizer attachments for recovering heat as source of energy for processing Palayamanan products.

The first study simulated field-soaked paddy rice and used it for the production of GABA rice. Based on color values, pH, water activity, and sensory properties, the samples were comparable with the control GABA rice prepared using standard protocol. Ready-to-drink (RTD) GABA rice milk was also developed using four commercially available powdered cow's milk. The samples were compared with the previously developed NutriRice Milk (buffalo's milk with germinated brown rice) in terms of sensory properties. All RTD GABA rice milk, except for one, obtained very high overall acceptability (80%).

PROJECT 2

Study 2 concentrated on developing nutritious and adaptable value-added foods and beverage from a specific combination of rice and local agricultural crops intended for older infants, young children, and school children. The developed complementary food, rice malt-based soy milk beverage, instant *am*, and enriched versions with carrot, sweet potato, and banana were subjected to shelf-life evaluation through determination of their microbial load, sensory, physical, proximate, and physicochemical properties. Complementary food packed in an aluminum pouch stored at ambient condition had acceptable microbial load and no significant difference in sensory properties for both powdered and reconstituted forms for eight months. Rice malt-based soy milk using a high-density polyethylene bottle stored at 4°C has a shelf-life of up to 20 days. Instant *am*, sweet potato-, and banana-enriched instant *am* had acceptable microbial count up to 4 months and up to 2 months for carrot-enriched *am*. Sensory properties of instant am, sweet potato-, and banana-enriched instant *am* did not change significantly until 4 months and until 2 months for carrot-enriched. The pH of all samples was stable while water activity and moisture content was low; thus, ensuring product stability and safety. Moreover, the dietary fiber, Vitamin A, calcium, iron, sodium, and potassium of the products increased after enrichment with carrot; Vitamin B3 and iron with sweet potato; and sugar with banana. Thus, enrichment with other crops is an effective way of improving the nutritional content of instant *am*.

The next study focused on the shelf-life evaluation of stabilized rice bran (SRB) and its utilization in the development of food products. SRB was monitored for color values, aroma, free fatty acid (FFA) content, and lipase activity throughout the storage period of nine months. SRB-based biscuit and black rice bran juice were also developed and characterized. Sensory evaluation showed that the developed biscuit with 25% SRB had significantly higher ash, protein, fat, and fiber content than the control biscuit. Both SRB-based biscuit and black rice bran juice (20% calamansi extract, filtered) were highly acceptable to the consumers due to their high rating scores. This study showed that SRB is an excellent ingredient that can improve the nutritional quality and health-promoting property of food products.

Study 4 conducted activities that aimed to help address the challenges of fertilizer use in agricultural production. Nowadays, there is dearth in the resources for manufacturing conventional fertilizers and prices are continually increasing. Intensive rice production system poses an increasing concern due to excessive and inappropriate use of chemical fertilizers. This resulted in rice ecosystem degradation such as soil mining, soil acidity, downstream silting and eutrophication. Consequently, the key ecosystem functions provided by rice fields are compromised. Hence in this study, nanostructured biofertilizer was formulated and characterized. Subsequently, the effects of different biofertilizer formulations and their efficacy on agronomic yield performance of irrigated rice were conducted. Formulated nanostructured foliar fertilizer was found to have complementary effect with recommended rate of inorganic fertilizer and paclobutrazol in increasing the morphological characteristics of irrigated rice. This study on nanotechnology application offers an alternative farming technology

addressing the negative impacts of conventional fertilizers into the rice ecosystem while increasing rice yield.

Study 5 optimized the use of PhilRice-developed continuous-type rice hull (CtRH) carbonizer. Specifically, it developed heat recovery attachments (HRAs) for use in food processing as well as make use of the carbonizer-generated heat as alternative source of energy for pumping water. The newly fabricated prototypes of the multi-purpose (MP) dryer and of the MP steam generator were tested for their performance. The MP dryer attachment can also function as an oven with high heat recovery, as observed when it was used to dry tilapia (with surface temperature readings ranging from 82.4 to 114.3°C). For it to function as a dryer, there is a need to introduce ambient air, which can easily be done by either partially opening its door or by installing a blower. On the other hand, performance test results of the MP steam generator showed that it can generate atmospheric steam at a rate of 1.7kg/h. Moreover, a new design and prototype of a small capacity water pump was generated in addition to the one fabricated in 2019. Furthermore, in preparation for the creation of additional income opportunities for the farmers using a custom-designed heat recovery attachment for the carbonizer, three dehydrated products from tomato and eggplant were developed: candied tomato, tomato leather, and eggplant flour.

In the product development activities, male and female participants were tapped in the group discussion and as sensory panelists to gather data and feedback from different perspectives. This is very important in optimizing subsequent formulations to obtain products with the best characteristics that can contribute to their premium price.

This Project generated value-adding technologies from rice, diversified rice-based farming products, and by-products that contribute to the outcome on enhanced value, availability, and utilization of rice, diversified rice-based farming products, and by-products for better quality, safety, health, nutrition, and income.

Upscale Production of Gamma-Aminobutyric Acid (Gaba) Rice and its Potential as Base Ingredient for Instant and Ready-To-Eat Foods

Rodel M. Bulatao, Maricar B. Castillo, John Paulo A. Samin, and Marissa V. Romero

This study aimed to upscale the production of GABA rice and to develop GABA rice-based food products as convenient and calamity foods. For this year, simulation

of field-soaked paddy rice for the production of GABA rice and development of ready-to-drink (RTD) GABA rice milk were conducted. Paddy-soaked GABA rice was produced by soaking the paddy rice of NSIC Rc160 in tap water for 0, 3, 6, 9, 12, and 24h. The soaked samples were wrapped in cheese cloth, allowed to sprout for 24h, and oven-dried at 40°C for 2h. Paddy-soaked GABA rice samples were compared with the control (GABA rice produced using standard procedure) in terms of color values, pH, water activity, and sensory properties. Results showed that all paddy-soaked GABA rice samples had comparable color values (L*: 67.8-68.9, a*: 3.4-3.8, and b*: 18.7-19.9), pH level (6.2-6.4), and water activity (0.63-0.66) with that of the control sample. Paddy-soaked GABA rice samples had 8.8-11.8% moisture, 7.1-7.4% crude protein, 1.2-1.5% crude ash, and 2.0-2.4% crude fat content, which was also similar with that of the control. The cooked form of all paddy-soaked GABA rice samples had comparable sensory qualities with that of the control, which was characterized by having no aroma, bland taste, slight to moderately intense brown color, and with moderate glossiness, cohesiveness, tenderness, and smoothness. All samples had no off-odor and off-taste. On the other hand, raw paddy-soaked GABA rice samples had no aroma, no rancid and fermented odor, moderately intense brown color, and slightly glossy grains. For the general acceptability, all cooked GABA rice samples had high rating scores of "like moderately" (7.25-8.67) while their raw forms had a rating score of "like slightly" (4.7-4.1).

To improve the shelf-life of our previously developed NutriRice Milk (germinated brown rice with buffalo's milk), the fresh buffalo's milk was replaced with commercial powdered cow's milk such as Alaska, Anchor, Bear brand, and Birch tree. The developed RTD GABA rice milks were compared with the NutriRice Milk (control) to determine their similarity in terms sensory properties using the duo-trio test (N=12). Based on the sensory evaluation, all panelists were able to distinguish the control from the reformulated GABA rice milks in all sets (100%) indicating a significant difference to their sensory properties. All RTD GABA rice milks obtained a very high overall acceptability (80%), except that sample prepared using Alaska (20%). Among the powdered cow's milk, the most preferred RTD GABA rice milk was those produced from Birch Tree followed by Achor, Bear brand, and Alaska.

Rice-Based Complementary Foods and Beverage: Value-Added Products for Enhanced Nutrition and Income Among Rice-Based Farm Households

Riza G. Abilgos-Ramos, Xenia Portia S. Fuentes, Amelia V. Morales, Evelyn H. Bandonill, Princess R. Belgica, Raffy B. Rodriguez, and Marissa V. Romero

The study was designed to develop nutritious and adaptable value-added foods and beverage from a specific combination of rice and local agricultural crops intended for

older infants, young children, and school children. The developed complementary food, rice malt-based soy milk beverage, instant *am* and *am* individually enriched with carrot, sweet potato, and banana were subjected to shelf-life evaluation through determination of their microbial load, sensory, physical, proximate, and physicochemical properties. Complementary food packed in an aluminum pouch stored at ambient condition had acceptable microbial and no significant difference in sensory properties for both powdered and reconstituted form for eight months. Rice malt-based soy milk using a high-density polyethylene bottle stored at chilled condition of 4°C has a shelf-life of up to 20 days. The beverage had no significant difference from 0 to 20-day of storage in terms of sensory properties, titratable acidity, and microbial load. Instant *am*, sweet potato-, and banana-enriched instant *am* had acceptable microbial count up to 4 months and up to 2 months for carrot-enriched *am.* Sensory properties of instant *am*, sweet potato-, and banana-enriched instant *am* did not change significantly until 4 months and until 2 months for carrot-enriched *am* except for a slight increase viscosity and aroma of sweet potato-enriched sample. The pH of all samples was stable while water activity and moisture content was low thus, ensuring product stability and safety. Results also showed that dietary fiber, Vitamin A, calcium, iron, sodium, and potassium of the product increased after enrichment with carrot; Vitamin B3 and iron with sweet potato; and sugar with banana. Thus, enrichment is an effective way of improving the nutritional content of instant *am.*

Utilization of Stabilized Rice Bran as Food Ingredients for Functional Food Products

John Paulo A. Samin, Rodel M. Bulatao, Maricar B. Castillo, and Marissa V. Romero

This study focused mainly on the stabilization and development of food products from rice bran. For this year, NSIC Rc160 bran was used in the production of stabilized rice bran for shelf-life evaluation and development of stabilized rice bran biscuit. For shelf-life evaluation, stabilized rice bran samples were collected every 2 weeks and analyzed for their color values, aroma, free fatty acid (FFA) content and lipase activity. Two products such as stabilized rice bran biscuit and black rice bran juice were also developed and characterized. Result of shelf-life evaluation showed that the color values and pleasant aroma of both stabilized rice bran and control did not change after 9 months of storage, regardless of packaging and temperatures. Likewise, stabilized rice bran samples showed slight significant increase in FFA content (0.27-2.69%) and lipase activity (0.26-0.37 U/) after 9 months of storage. On the other hand, significant increase was observed on the FFA content (0.37%-14.4%) and lipase activity (2.19-2.34 U/g) of the control

sample during storage. Sensory evaluation showed that the developed stabilized rice bran biscuit (25% substitution) and black rice bran juice (20% calamansi extract, filtered) were highly acceptable to the consumers due to their high rating scores on their sensory attributes. Proximate analysis showed that stabilized rice bran biscuit had significantly higher ash, protein, fat, and fiber content than the control biscuit. Therefore, it can be concluded that stabilized rice bran can be an excellent ingredient to improve the nutritional quality (fat and fiber) and health-promoting property of various food products.

Formulation, Characterization and Efficacy Testing of Nanosilica Structured Biofertilizer for Rice Production

Juvy J. Monserate, Marilou M. Sarong, Rodel M. Bulatao, and Marissa V. Romero

This study was conducted to synthesize, characterize, and evaluate the efficacy of nanostructured foliar fertilizer. The silica nanoparticles from rice hull and calcium nanoparticles from eggshells were synthesized and characterized. Nanostructured bio-fertilizer was developed and characterized prior to experimental field testing to assess its efficacy on the growth and yield performance on irrigated lowland rice. Formulated nanostructured foliar fertilizer was found to have complementary effect with the recommended rate of inorganic fertilizer and paclobutrazol in increasing the morphological characteristics of rice. This study on nanotechnology application offers an alternative farming technology addressing the negative impacts of conventional fertilizers into the rice ecosystem while increasing rice yield.

Development of Carbonizer Attachments for Recovering Heat as Source of Energy for Processing *Palayamanan* Products

Joneil B. Lagmay, Derose A. Sawey, Ricardo F. Orge, Rosaly V. Manaois, Riza G. Abilgos-Ramos, Amelia V. Morales, Xenia Portia S. Fuentes, Raffy B. Rodriguez, and Alcel B. Atanacio

In general, this study helped diversify the sources of income in rice farming communities, as a strategy to enhance resilience against climate change through the PhilRice-developed continuous-type rice hull (CtRH) carbonizer. Specifically, it aimed to develop heat recovery attachments (HRAs) for use in food processing

and make use of the carbonizer-generated heat as alternative source of energy for pumping water. In 2020, the newly-fabricated prototype of the multi-purpose (MP) dryer and MP steam generator were performance tested. Test results showed that the MP dryer attachment can also function as an oven with its high heat recovery when tested on drying tilapia (with surface temperature readings ranging from 82.4 to 114.3^{o}C). To function as a dryer, there is a need to introduce ambient air, which can easily be done by either partially opening its door or by installing a blower. Meanwhile, performance test results of the MP steam generator showed that it can generate atmospheric steam at a rate of 1.7kg/h. Follow up tests yet to be done to determine its performance in generating pressurized steam. Moreover, a new design and prototype of a small capacity water pump was generated, in addition to the one fabricated in 2019. Performance testing of these two prototypes (with varied designs) is yet to be conducted to determine which of the two can satisfy the set performance target of at least 1m^3 of pumped water per hour of operation. In preparation for the creation of additional income opportunities for the farmers using a custom-designed heat recovery attachment for the carbonizer, three dehydrated products from tomato and eggplant were developed that include candied tomato, tomato leather and eggplant flour.

PROJECT 3

Innovations for Enhancing and Sustaining Rice Productivity, Profitability and Efficiency in Irrigated Lowland Systems

Arnold S. Juliano

The project consisted of three studies focusing on the development of rice production technologies for both irrigated areas: (1) from the 10-5 challenge output, (2) usage of mechanical rice transplanter, and (3) usage of plastic drum seeder. These technologies are combination of new farming innovations and matured technologies within PhilRice, which can help enhance grain yield, increase income of farmers, and showcase best rice management practices and technologies for farmers' adoption. Establishment of the studies was scheduled one month earlier than the schedule of PhilRice CES. Inbred seed (PSB Rc 222) were used for dry season and wet season . Results showed that the manually transplanted crops achieved the highest yield of 9.03t/ha with an input cost of P6.79/kg for DS. For the WS, the mechanically transplanted crops recorded the highest yield of 6.47t/ha at PhP6.40/kg. It was observed that yield is indirectly proportional to the input cost. The unexpected yield of mechanically transplanted rice during DS was affected by the low organic matter (OM) content of the soil, which resulted in higher input cost. Additionally, using direct-seeding method, yield and input cost was recorded at 7.46 t/ha and PhP6.98/kg for DS and 6.28t/ha and PhP6.14a/kg for WS, respectively. The project showed promising results as targets for the wet season for all technology or methods were achieved. Material inputs were accounted for and labor cost was computed based on the 10% percentage share in the community. Computation of machine rental and dry paddy price of PhP18/kg for DS and PhP15/kg for WS was based on the prevailing price during the harvesting season, which is significantly lower than the previous seasons. With these findings, the project concluded that adoption of PAckage of Technologies) POTs could increase yield and enhance farmers' income. However, it should be noted that POTs should be site-specific and should not be promoted as a ''one-fit-all solution'' across environments (Bouman et al., 2001).

Development of Best Package of Technologies from the 10-5 Challenge Output

Tyrone C. Juganas, Arnold S. Juliano, Isagani P. Pineda

The Palayabangan 10-5 Challenge was one of the projects, which integrated the best management practices and technologies for rice production. Through this

participatory development approach spearheaded by PhilRice, the key players in the rice industry showcased their innovative and best technologies in actual field conditions (Malasa, et.al, 2015) to increase farmers' yield and income. The promising results of this project paved the way for the PhilRice CREATE-Rice Program to adapt its output and validate its replicability. With the ultimate goal to enhance grain yield, increase the income of farmers, and produce the best POTs for rice production. This study aimed to achieve a yield of 9t/ha at PhP8/kg production cost for dry season and 6t/haat PhP7/kg cost for wet season. As shown in Annex Table 1, 9.03t/hawith P6.79/kg input cost was recorded during the 2020 dry season. In the wet season, the recommended group recorded a grain yield of 6.36t/ha and an input cost of PhP6.58/kg. Both seasons passed the target for this year, which can be attributed to the revision of the package of technologies applied during field trials. Problems encountered from the previous year were addressed and solutions for these problems were added to the revised POT. This included early crop establishment, labor management, improved land preparation and nutrient management, and the use of strategic baits to manage pests such as rodents and birds.

Development of Best Package of Technologies for Mechanized Farming with Rice Transplanter as Major Intervention in Rice Production

Tyrone C. Juganas, Arnold S. Juliano, Isagani P. Pineda

High cost of inputs, low price of palay, lack of capital, labor problem, lack of postharvest facilities, pests and diseases, and irrigation system significantly affect rice production (Arida, 2019). Thus, farm mechanization is being introduced to address these problems and help increase the productivity and labor efficiency of the country. To catch up with the competitive farming technologies around the globe, combine harvesting and mechanical transplanting are among the technologies being promoted to the rice farmers. This study was conducted in dry and wet season, following a detailed rice production practice using mechanical transplanter (Annex Table 5). The target of 9t/ha with PhP8/kg input cost for dry season and 6t/ha at PhP7/kg cost for wet season were set for 2020. In the dry season, 7.60t/ha was achieved with an input cost lower than the target cost (PhP7.41/kg). This can be attributed to the low organic matter content (OM) of the experimental area, which only accounts for 1.59, much lower than the 2.35 average OM of the surrounding plots. Although the target for input cost was attained, low yield still affected the production cost for this season negatively, as yield is indirectly proportional to input cost. In the wet season, yield of 6.47t/

ha and cost of PhP6.40/kg was attained. This can be credited to the revision of POT, which addressed the problems during previous establishments. Cost can be lowered down through some interventions such as reduction of manual labor.

Mechanized Rice Farming with Plastic Drum Seeder in Rice Production

Isagani P. Pineda, Arnold S. Juliano, John Eric O. Abon, and Tyrone C. Juganas

Rice farming is primarily carried out through transplanting or direct seeding. Transplanting methods usually give higher yield than direct-seeding but requires higher cost. Through drum seeder, expenses on seeds and labor cost can be reduced as this machine cuts down seeding rate and labor days. Conducted at PhilRice Central Experimental Station following the best management practices on direct-seeding for irrigated areas (Annex Table 5), two field set-up were established in the 2020 dry and wet season. Using plastic drum seeder, this study aimed to attain a grain yield of 7t/ha at PhP8/kg input cost for dry season and 5t/ha at PhP7/kg for wet season. As shown in Annex Table 1, yield of 7.46t/ha with PhP6.98/kg input cost was recorded in the dry season. In the wet season, grain yield of 6.28t/ha and input cost of P6.14/kg were achieved.