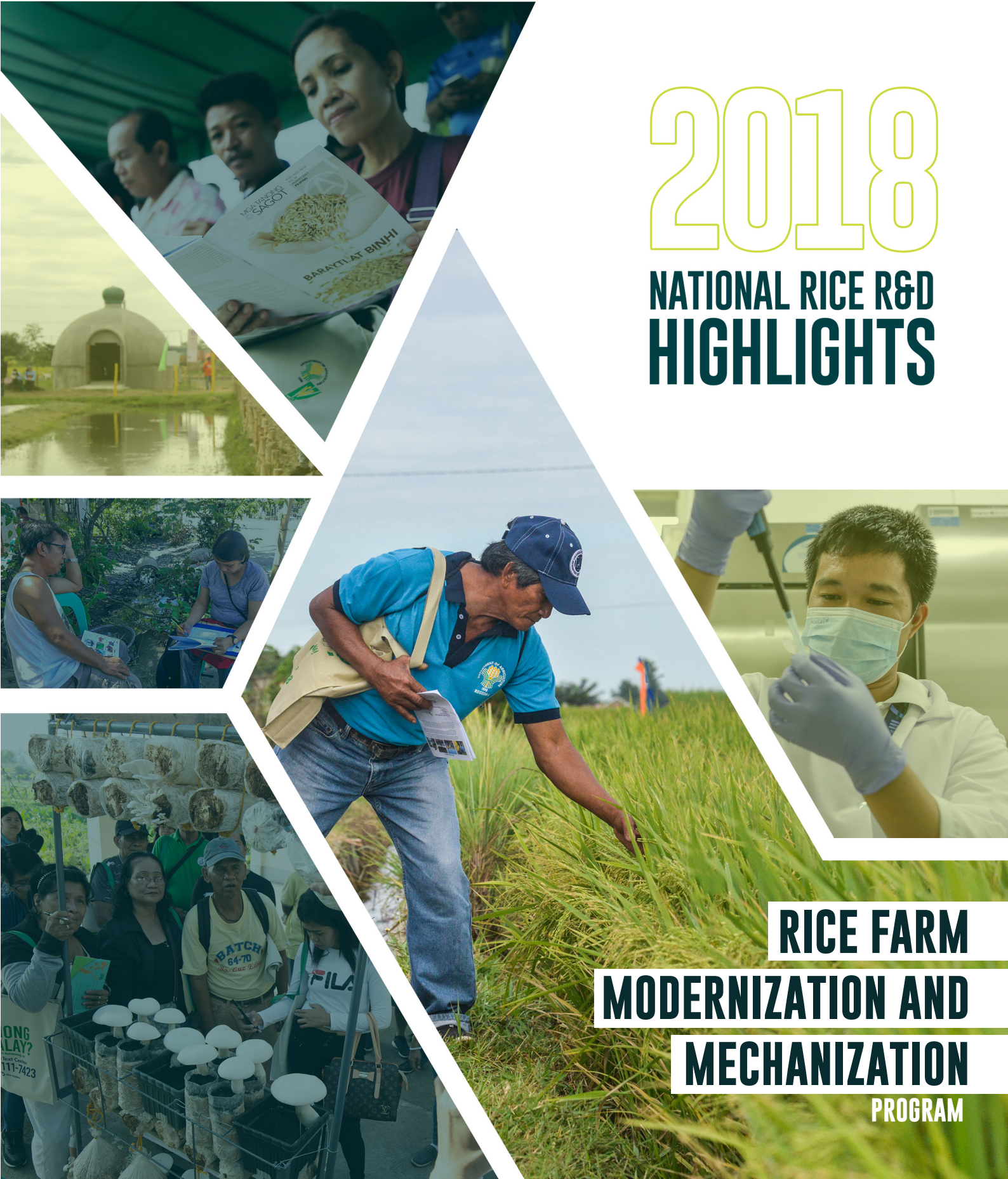


2018

NATIONAL RICE R&D HIGHLIGHTS



RICE FARM MODERNIZATION AND MECHANIZATION PROGRAM



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RICE FARM MODERNIZATION AND MECHANIZATION

Program lead: Jasper G. Tallada

EXECUTIVE SUMMARY

The program aims to help in continually improving the competitiveness of the Philippine rice farming through increasing productivity, reducing costs, and increasing income through mechanizing production and post-production operations, incorporating renewable energy sources, developing higher quality products, and modernizing farming through advance electronic, information, and communication technologies.

This program aimed to 1) design and develop mechanization technologies for rice production encompassing irrigation, land preparation, and crop care and protection; 2) design and develop mechanization technologies for rice harvesting and threshing and post-production technologies from transport, drying, storage, milling and value adding operations, and renewable energy systems; and 3) develop smart technologies leveraging on information and communication technologies, electronics, automation and control, intelligent systems, remote sensing using unmanned aerial vehicles. It has 3 projects/components namely: “Mechanization of rice and rice-based farming”, “Post-production and renewable energy technologies for rice and rice- based farming”; and “Modernized rice farming and strategy thru precision technology and intelligence information systems”. It was carried out at PhilRice-CES.

PROJECT 1:

MECHANIZATION OF RICE AND RICE-BASED FARMING

EG Bautista

This project tested and modified riding-type boat tiller, multi-crop reduced till-planter (MC RTP), riding-type precision seeder, and boat tiller.

PhilRice also developed a gender-friendly mechanized weeding machine made from locally available materials.

Design and development of a lightweight riding boat tiller using molded tough virgin polyethylene (MDPE) plastic for global market

AS Juliano, KC Villota, JA Ramos, EG Bautista, MJC Regalado, JP Miano, and JB Bedonia

Improving and pilot testing a boat tiller with metal and plastic body for shallow and waist-deep mud conditions of fields generally aimed to reduce the cost of land preparation and improve the well-being of farmers. Pilot testing is needed before commercialization to identify potential problems and technical deficiencies of the machine. This study was conducted to test the machine in farmers' fields to evaluate its overall performance. Preliminary testing, modifications, and adjustments were conducted to achieve the desired performance of the machine. Paddling wheel and the transmission were modified. The total diameter of the wheel was 34cm. The 24-cm diameter of the old design drum of the wheel was decreased by 2cm while the 10cm length of the old design spike/blade was increased by 2cm. The transmission length of the prototype was increased with 10cm to further improve the traction of the machine. The length of the new design transmission was 54cm with a weight of 27.5kg.

Pilot-Testing of Multi-Crop Reduced Till-Planter for Improving Labor productivity, Cost and Energy Efficiencies for Rice and Rice-Based Crop in Rainfed Upland Condition

MJC Regalado, KS Pascual, ML Rafael, and AT Remocal

The multi-crop reduced till-planter (MC RTP) was designed and locally developed to improve labor productivity and energy efficiencies for rice and rice-based crops such as corn and mungbean in upland rainfed condition. This study evaluated the field capacity, seeding rate, and field efficiency of MC RTP. Three field trials were established in Pangasinan, Isabela, and Nueva Ecija during 2018 DS. Results showed that the

MC RTP sowed seed at 2-3.04ha/day with a seeding distance of 29-41cm between hills and 50-58cm between rows. This is higher than farmers' practice with a field capacity of 0.14-0.5ha/day and a seeding distance of 24-34cm between hills and 44-59cm between rows. Seeding rate using MC RTP and farmers' practice were 18.2-35.6 and 23-31kg/ha, respectively. In terms of corn yield, MC RTP and farmers' practice are comparable. The field efficiency of MC RTP ranged 51-74%.

Field Testing and Evaluation of Local Riding-Type Precision Seeder

EG Bautista, JEO Abon, and EL Dingle

Direct wet seeding is now becoming popular among Filipino farmers even in areas where field conditions limit the performance of direct-seeded crops, e.g., where water control and land preparation is inadequate. The rising cost of labor, the need to intensify rice production through double and triple cropping, the development of high-yielding short-duration modern varieties, and the availability of chemical weed control methods led to the shift from transplanting to direct seeding (Pandey and Velasco, 2005).

PhilRice developed a manually pulled drum seeder for direct seeding. However, it has limitations as seeds are placed on the surface so seeds are displaced during rains and are exposed to bird and rat damage. Meanwhile, a mechanical riding-type seeder from Korea was demonstrated in areas where farmers commonly practiced direct seeding. The seeder has 8 rows with 25cm spacing between rows and 15cm spacing between hills. It can drop seeds to as low as 2-3 seeds per hill and to as high as 15 seeds per hill. The seeds are drilled at 1cm depth and slightly covered with mud. It has built-in leveler and creates canalet every after 4 rows. Based field trials, the seeder can also be used for rice seed production cultivation and during rainy season without displacing the seeds in the rows.

This study was conducted to develop a local version of the Korean seeder that can drop precise number of seeds per hill and is suitable both for inbred and hybrid cultivation. A local version of riding-type precision seeder was developed with Metal Industries Association of the Philippines (MIAP) and INCA Philippines, Inc and funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development-Department of Science and Technology. The locally-made riding type precision seeder was adapted based on a mechanical riding-type seeder from Korea and manual push-type seeder from China, which would reduce unit cost and make the parts locally available.

The prototype local version of riding-type precision seeder was evaluated to further improve its performance in field conditions. Technical viability (machine performance) and suitability of plastic component for canalet-leveler assembly was conducted.

Development of Gear Transmission Power Tiller with Pivot Mechanism for Multiple Farm Operations

AS Juliano, JA Ramos, JP Miano, and JB Bedonia

The power tiller, while still the popular machine for mechanization in the countryside, lacks mobility and versatility mainly because of its simple chain drive mechanism. The study modified this machine by incorporating a gear transmission with pivot mechanism made of locally available spare parts. Design of its universal prime mover for multiple farm operations was made based on the imported power tiller with gear transmission used by PhilRice. Fabrication of the prime mover was completed using computer aided design. PhilRice shop technicians fabricated the modified machine using common tools and locally-available materials. Preliminary testing of the power tiller was conducted at PhilRice farm, in which it was found that the 2nd gear setting was not functioning and the pivot mechanism of the wheel was not working properly. Bolts/thread on the gearbox housing was loosed causing the gears to slacken. Gearbox housing of the prototype was modified to prevent the bolt/thread on the gearbox from losing. The thickness of the gear box housing was changed from 4mm to 5mm. Afterwards, the bolts on the gearbox housing were tightened. The prototype is now ready for the next testing.

Development of Local Mechanized Weeder for Straight Row Planted Rice Crop

EG Bautista, AS Juliano, JEO Abon, ES Espique, and PR Castillo

Weeds are unwanted plants competing with main crops for nutrients, moisture, and sunlight resulting in decreased crop quality, increased production costs from cultivation and hand weeding, and reduced crop yield. Weeding is one of the most laborious operations in rice farming. Mechanical weed control is very effective as it reduces manual weeding, kills the weeds, and keeps the soil surface loose ensuring soil aeration and water intake capacity. Thus, PhilRice developed a gender-friendly weeding machine made from locally available materials. The machine uses 4-stroke single cylinder gasoline (grass cutter) engine. It comprises with a handle, weeding rotator (wheel), mud guard, and skid. The developed prototype has an initial capacity of 1.5ha/day and rotor width and diameter of 10cm and 40cm, respectively.

PROJECT 2:

POST-PRODUCTION AND RENEWABLE ENERGY TECHNOLOGIES FOR IMPROVED RICE AND RICE-BASED FARMING

JA Ramos

Using combine harvesters will reduce harvesting losses to 2.11%, a half-percent reduction from manual harvesting (Regalado and Ramos, 2016). Despite the introduction of imported rice combine harvesters, the level of using machines during harvesting is still low at 2.16% (Bingabing et al., 2015). Efficient facilities for drying and milling are also insufficient to cater the volume of produce, which compromise rice quality.

Two prototypes of rice combine harvester (cutter bar and stripper combine) were successfully refined and field tested. Field test results showed that performance parameters had improved from the DS to WS data. However, grain loss data must need to improve further, particularly for stripper combine. Two prototypes of brown rice machine (manually-operated & motor-driven) and rice hull gasifier engine pump system with continuous-type reactor are already ready for pilot testing. Construction of modified rice hull furnace was completed. It has mechanism that moves back and forth for auto-feeding of rice hull and discharging of char. Initial test was also conducted. A diagram and layout for heated air monitoring system was also completed with eight probe sensors for relative humidity and temperature measurement, which are all link to Arduino-based micro-controller. Microwave heating system for brown rice was designed with a horizontal configuration, grain hopper, and loader that evenly dispense a thin layer of brown rice onto food-grade. It was also designed with microwave-safe conveyor belt that moves the brown rice through a heating chamber consisting of a series of magnetrons situated above the belt. This design is ready for development. Moreover, postharvest management protocol was validated in the field this DS and WS. Results indicated that harvesting at optimum date using combine harvester resulted in lower harvesting loss of 1.05%. This is relatively lower than the manually harvested paddy at 2.75%. Paddy harvested on-time using combine harvester gave the highest head rice percentage (69.82%), while the lowest head rice percentage was recorded at paddy harvested five days late than optimum date and harvested manually (32.84%). Storage conditions of paddy greatly affect the results of head rice percentage.

Improvement and Pilot Testing of Rice Combine Harvesters

JA Ramos, CJM Tado, MJC Regalado, AS Juliano, EG Bautista, RS De Gracia Jr., and ML dela Cruz

This study improved and tested two types of combine harvester: a stripper combine harvester that strips the grain, leaving the straw still intact in the field; and a cutter bar combine that cuts the straw. Prototypes were modified based on tests. Header assembly of stripper harvester was improved during first quarter of 2018. On the other hand, re-orientation of bagger and threshing assembly was done in cutter bar combine. Results of wet season field tests showed that the stripper combine had an effective field capacity of 1.3ha/day operating at speed of up to 2.5kph and field efficiency of 62%. For mini-rice combine harvester, test runs showed that the machine can harvest up to 2.1 ha/day operating at 2.6kph with field efficiency of 76%. Grain loss measurements showed the stripper and mini-rice combine harvester had a total grain loss of 3.75% and 2.98%, respectively. Grain purity output of cutter bar combine was at 97.4%. Results of field test runs conducted during 2018 DS indicated that the stripper harvester did not meet the minimum standard for efficiency, losses, and purity of output. Meanwhile, cutter bar combine met the minimum value for these parameters.

Pilot Testing and Automation of Rice Hull Gasifier Engine-Pump System

JP Miano, AS Juliano, JA Ramos, and JG Tallada

PhilRice developed a rice hull gasifier engine pump system (RHGEPS) to lower the high cost of pumping water in rainfed lowland farms. The machine used rice hull biomass as alternative fuel to pump water. RHGEPS is a cost-reducing technology that can be used as an alternative water harvesting method to provide irrigation in the rice-based communities with limited access from grid water source. Based on results from pilot testing, a reactor that can run the system for continuously 8h was retrofitted with carbonized rice hull discharger. Field tests were conducted using shallow tube well as water and open water source. The system performed well with an average water discharge of 6.38lps (water) and 6.18lps (open water) and rice hull consumption at 6.5kg/h. Average engine shaft speed is lower than the batch type unit due to additional loads (from 1447rpm to 1265rpm). The system continuously ran for 3h and 20min using open water source but its operation was interrupted due to high resistance of water pumping. It was found that the system was not suitable in areas with 3.8m suction head. Further tests must be conducted to optimize the design and attain 8h continuous operation before automation activities.

Improvement of Flatbed Type Mechanical Dryer

JA Ramos, JG Tallada, PJS Quierra, MP Reselva, and ML dela Cruz

This study was conducted to develop a more efficient flatbed drying system by improving some of its key components. It specifically designed a rice hull furnace with an automatic feeding mechanism and a heated air monitoring system to further

improve efficiency in operation with less human intervention during its use. A prototype of auto feed rice hull furnace was designed and constructed for a 6-t capacity dryer. System layout and schematic diagram for heated air monitoring system was also completed. Initial tests was also conducted for furnace, which focused on the functional performance of the rice hull feeder cum ash/char discharger. Results are promising as the system can feed the rice hull from the hopper and push the burned rice hull down the inclined step grate. However, further tests had to be conducted to obtain stable and consistent operation of the furnace.

Development of a Microwave Heating System for Shelf-Stable Brown Rice

MJC Regalado, JA Ramos, ML Dela Cruz, and JJA Batanes

Brown or unpolished rice is a highly nutritious food product for adult women and men. Total milling recovery can increase by at least 10% for unpolished rice. However, short shelf life of brown rice limits its large commercialization and patronage. Its bran layer, which consists mostly of lipids, is prone to oxidative or hydrolytic rancidity. Studies show that the bran could be stabilized through different heat treatments that include microwave heating. This study aimed to develop a pilot-scale microwave heating system with a capacity of up to 50kg of brown rice per hour. A horizontal configuration with a grain hopper and loader that evenly dispense a thin layer of brown rice onto food-grade was designed. It will also be developed with microwave-safe conveyor belt that moves brown rice through a heating chamber consisting of a series of magnetrons situated above the belt.

Improvement and Pilot Testing of Portable Brown Rice Machine For The Household

PR Castillo, AS Juliano, JA Ramos, JP Miano, and SC Andales

While high-income earners can easily afford the healthy brown rice, it is not patronized by low-income earners as it is relatively high priced and only found in supermarkets. Thus, PhilRice developed a gender-friendly brown rice machine with simple design, easy to operate, and affordable that can provide the daily requirements of a family of 5 members that is equivalent to 1kg uncooked brown rice. The manually-operated prototype has a pair of rubber roll huller with the whole assembly mounted in a frame with seat and pedals, commonly found in bicycles. The partition plates where the paddy, rice hull, and brown rice were sliding were optimized to obtain higher percentage of brown rice recovery. The motor-driven prototype adapted the rubber roll huller similar to the manually-operated prototype but with modified rubber roll hullers assembly for efficient hulling and cleaning. After series of tests and refinements, the improved prototype of manually-operated machine produced brown rice at 1.13-2.88kg/h with 73-75% dehulling recovery after two passes. Motor-driven prototype produced 5.81kg/h brown rice with 71% recovery. The machines are recommended for pilot testing in urban/rural households to assess their economic and social acceptability.

Field Validation of Rice Postharvest Management Protocol for Reduced Losses and Improved Rice Quality

MJC Regalado, JA Ramos, TC Juganas, and HB Bonsol

Postharvest management protocol was improved to make rice post-production operations more efficient with less losses and better paddy and milled rice quality. Protocols were validated, and enhanced during dry and wet season. Study results showed that harvesting during the optimum date using combine harvester will lead to lower total harvest loss. During on-time harvesting, result showed that combine harvesting is 1.05%, which is relatively lower than the manually harvested samples (2.75%). This indicates that samples harvested with combine harvester during optimum date had the lowest total harvest losses among the time schedules given. Similar results were obtained during the wet season. The samples harvested during optimum date (1.44% - combine) registered lower total losses, while manually harvested samples (4.61%- manual) consistently recorded high total losses. This was due to but not limited to the processes involved in manual harvesting. The handling from manual harvesting, piling, to threshing contributes to the accumulated losses.

PROJECT 3:

MODERNIZED RICE FARMING AND STRATEGY THRU PRECISION TECHNOLOGY AND INTELLIGENCE INFORMATION SYSTEMS

NL Caballong, RF Barroga, JG Tallada, OE Manangkil, EF Javier, DKM Donayre, EC Martin, PAA Alday, EM Dicen III, PJS Quierra, MP Reselva, DB Fenangad, and JM Mercado

This project intends to contribute to the Outcome 5 of the PhilRice Strategic Plan 2017-2022 - Advanced rice science and technology as continuing sources of growth. It looks at two advanced engineering and computing technology systems, namely: precision technology and intelligence information systems. These concepts are new to Philippine agriculture situation but has great potential in providing support in combatting challenges in rice-based agriculture such as sufficient food supply, climate change, aging farmers, paradigm shift to agriprenurship, trade liberalization, peak oil scenario, and sustainable production.

This project aimed to modernize rice farming operations and provide strategic intelligence through precision technology and intelligence information systems. With the artefacts output from the previous project under The FutureRice Program, this project works on developing model applications of the following technologies: 1) Intelligent information system – to provide intelligence information for PhilRice management in planning programs, campaigns, research studies, development interventions, and other related endeavors; 2) Mobile application tools – to support rice crop and farm management operations of farmers, farm managers, and extension workers; 3) Internet of Things (IoT) – to showcase FutureRice Farm as a smart rice-based model farm of the future; 4) Robotics technology – to improve productivity and efficiency of rice farming machines; and 5) Unmanned Aerial Systems (UAS) – to explore and develop applications of UAS in rice farming.

For 2018, RiceIntel, an intelligent information system for rice RDE planning and executive monitoring was initialized. The baseline backend and frontend of the system was developed. The backend composes an unstructured database using MongoDB platform. It is where some selected data collected from existing databases of internal and external sources are stored.

Binhing Palay 1.0 and *eDamuhan App 1.0* were deployed. *Binhing Palay* catalogs all the 289 released rice varieties in the Philippines; showing the agronomic characteristics, pest and disease resistance, and grain quality information. *eDamuhan* merged the weed photo recognition prototype and the weed species catalog compiled by DKMDonayre, et al. in one mobile application tool. *AgRiDOC App 2.0*, a rice farm management application tool was also developed and launched. Sharing of farm data

to another AgRiDOC account was added as a new functionality along with other bug fixings and enhancements.

For the RIoT component, four new automation sub-systems were developed and installed at the FutureRice Farm: water quality monitoring, pigpen ammonia monitoring, automated drip irrigation, and fishpond feeder. These are addition to the existing rice paddy microclimate sensing, weather station, WiFi connectivity, CCTVs, and Zigbee coordinator node at the farm. Moreover, a database server and a web-based portal called RIoT Dashboard were established and developed to provide access. It also controls the instrumentation component of the RIoT model. Data transmitted by the coordinator node are stored in a MySQL database server. The RIoT Dashboard fetches these data and presents to the users in tables and graphs. It was programmed using Laravel PHP framework together with web interface plugins such as Leaflet Maps, WeatherIO, ChartJS, and Bootstrap.

Intelligent information system for rice RDE planning (RiceIntel)

RF Barroga, PAA Alday, NL Caballong

RDE planning and monitoring is an integral part of PhilRice. Through the use of intelligent information systems (IIS), PhilRice management can be provided with comprehensive and fast information that they can utilize in decision-making and strategy-formulation. This study aimed to develop such information system to assist in planning programs, campaigns, research works, development interventions, and other related endeavors. For 2018, the baseline information system platform for the RiceIntel was developed. The frontend and backend systems, and middleware were established. To complete the proof of concept, 14 initial datasets from different internal and external sources were loaded and overlaid the geographical interface of each region, province, and city/municipality; providing rice situation overviews, partner locations, and extent of reach.

Mobile application tools for rice-based farming (RApps)

NL Caballong, PAA Alday, RF Barroga, DKM Donayre, EC Martin, and PhilRice-NCT Group

This study aimed to support rice crop and farm management operations of rice-based farming households, farm managers, and extension workers thru mobile applications; and innovate rice farming knowledge and information delivery through artificial intelligence and interactive content. It also aimed to improve decision making, strategic planning, and simple auditing of users in rice production or project management; and increase the technical knowledge of users on a subject matter in rice production.

The study implemented the following activities: development of AgRiDOC App version 2.0, a rice crop management application tool; development of *eDamuhan* App version 1.0, a weed species photo recognition and catalog app; and development of *Binhing Palay* version 1.0, a rice variety catalog app. Results/outputs are as follows: MFO 1 - AgRiDOC App version 2.0: a rice farm management application tool with

farm data sharing; MFO 2 - *eDamuhan* App version 1.0: merging the weed photo recognition system and the 78 weed species catalog compiled by DKMDonayre, et al. in one mobile application tool; and MFO 3 - *Binhing Palay* App version 1.0 showed the agronomic characteristics, pest and disease resistance, and grain quality information. These outputs have contributed to achieving the outcome “Advanced rice science and technology as continuing sources of growth”.

Internet of Things (IoT) technology for smart rice-based farms (RIoT)

NL Caballong, PJS Quierra, RF Barroga, JG Tallada, MP Reselva, DB Fenangad, EM Dicen III, and PAA Alday

This study intends to showcase FutureRice Farm as an IoT-enabled (Internet of Things) smart rice-based model farm (RIoT). Possible applications, performance, and method of using IoT technology in rice-based farming are being explored. In 2018, new automations were developed to compose the RIoT - water quality monitoring, pigpen ammonia monitoring, automated drip irrigation, and fishpond feeder. These are addition to the existing rice paddy microclimate sensing, weather station, WiFi connectivity, CCTVs, and Zigbee coordinator node at the farm. A database server and a web-based portal called RIoT Dashboard was established and developed to provide access. It also controls the instrumentation component of the RIoT model.

Automated Rice Farming Machines

JG Tallada and MP Reselva

There is an imposing need for automation on farm machinery due to lack of manpower and manual farming inefficiency. Automation and innovation of existing farm machines can help lessen human intervention, improve productivity and efficiency, and reduce the efforts of aging farmers; thus, attracting younger generations to engage in rice farming activities. Stepper motors were used to control the wheels and the drums of rice drum seeder. As an innovation, this machine can be remotely controlled by an RF controller. The initial prototype was already field tested, but there are more improvements to be done.

Applications of UAV systems in rice farming (R-Drone)

NL Caballong, RF Barroga, PAA Alday, OE Manangkil, LV Gramaje, EF Javier, and JM Mercado

This study aimed to promote the use of drone technology to agriculture stakeholders through a farm drone school. It can be achieved by establishing actual applications and concrete methods of use. In 2018, the supplemental pollination using a quadcopter drone experiment was conducted. Initial results showed that drone-assisted pollination has higher yield per plant and per hectare and almost the same outcrossing rate. The drone application for precision spraying and material spreading was also initiated. PhilRice and New Hope Corp. planned to conduct four experiments and one technology demonstration in 2019 DS. Field mapping was also continued as service in ISD. Several maps were generated for CES, Pangasinan, and Cabanatuan City.

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

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

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

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