2023 PhilRice R&D Highlights

RICE ENGINEERING AND MECHANIZATION DIVISION

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Rice Engineering and Mechanization Division

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EXECUTIVE SUMMARY

The Division has developed innovative technologies to mechanize and modernize farming practices. These advancements aim to minimize production expenses, reduce post-harvest losses, maximize the utilization of resources such as land and water, and boost the efficiency and productivity of rice-based farming operations. By adopting these technologies, rice farmers can enhance their market competitiveness and resilience to the impact of climate change.

Six major projects were managed by the division: (1) Support to REMD-R4D, (2) Division Operation and Services, (3) Pre-commercial Development of Promising REM Technologies for the Future, (4) Development of Agricultural and Biosystems Engineering (ABE) Technologies for Enhanced Farmers' Productivity, Income, and Resilience, (5) Development of an Automated Mechanization Systems at REMD Model Farm (Phase II), and (6) Sustainable Operation of PhilRice CES Farm Service Center (FSC). The first project supports the division's R4D through the promotion of sustainability and well-balanced growth of the FSC. The second project provides support to the institute's research activities and service delivery by providing workshop services for custom fabrication and related metalworking activities. It also covers Agricultural and Biosystems Engineering (ABE) services, which include extending technical assistance to clients and partners, offering engineering support to operation and branch stations, providing farm consolidation and mechanization services, and maintaining the institute's weather stations. The third project facilitates the transfer of advanced rice engineering and mechanization (REM) technologies to agricultural machinery manufacturers for mass production. It develops and executes effective marketing and promotion strategies that encourage rice farmers to adopt and utilize REM technologies, even as it accelerates the pre-commercialization of promising REM technologies. The fourth project develops REM technologies that can enhance the competitiveness of both men and women farmers on a global scale. It promotes resilience to the impacts of climate change through the creation of innovative technologies. The fifth project further improves the REMD farm as a model of mechanized and modernized rice farms by integrating important and emerging technologies for

rice production. For modernization purposes, the project improves the delivery and renewable energy systems for efficiently managing the irrigation water of the farm. For mechanization purposes, it establishes a mechanized and climate-resilient rice post-harvest system (i.e., establishment of Kwebo, laser-levelling technology). Finally, the sixth project establishes a systematic farm service center for research and seed production areas.

CORE PROJECTS

REM-230-000: Support to REMD-R4D

Paulino S. Ramos

The Farm Service Center utilizes an institute-wide system where farm operations requests are submitted and received by the field operations supervisor. There were 408 farm operations requests received and all were served while 95 units were assessed and maintained. A revised preventive maintenance program was established and implemented to ensure timely maintenance before the field operation starts.

The purpose of the support fund for REMD research for development is to promote the sustainable and well-balanced growth of FSC. To enhance staff productivity, field operations, and repair and maintenance, and general maintenance, the FSC should make sure that activities are optimized and more effectively utilize the resources.

REM-231-000: Division Operation and Services in Support of R4D

Joel A. Ramos

The project achieved its objective of supporting R4D activities of PhilRice by providing workshop and ABE-related services to clients and partners. In CY2023, the 36 workshop services completed worth PhP1,321,108.53 collected and a notably high customer satisfaction rating particularly in terms of product quality and service excellence are good indicators that the project has fulfilled its commitment to its clients. Promptly addressing 33 farm machinery inquiries from Luzon, Visayas, and Mindanao is a proof that the project had ensured seamless communication with its clients and addressed specific concerns from their inquiries. The project also conducted training sessions and capacity-building initiatives among ABE staff in the branch stations as well as farm machinery and

postharvest facility assessments that empower ABE unit personnel with practical skills and knowledge that they can employ in their respective stations. Moreover, the project provided technical assistance in repair and maintenance activities of postharvest equipment and facility of the institute that contribute to conducting the processing activities on time. Additionally, this project regularly maintained the PhilRice Agromet station, ensuring the accuracy and reliability of weather data it generated.

REM-232-000: Pre-Commercial Development of Promising REM Technologies for the Future

Elmer G. Bautista

Notable progress has been made under Objective 1, particularly with the Multicrop Reduced-Till Planter. Achievements include establishing partnerships with farmer associations, conducting two-season field tests in Balincaguing, San Felipe, Zambales, and garnering interest from ACT Machineries and Metal Craft Corporation for manufacturing engagements. Additionally, the Portable Brown Rice Machine completed a successful technology assessment, potentially paving the way for licensing to manufacturers. Objective 2 focuses on pilot-testing REM technology prototypes, such as the Combined Conduction Far-Infrared Radiation (CCFIR) Paddy Dryers in Agusan Del Norte and San Jose, Occidental Mindoro, yielding good initial results. Despite challenges in gasifier management, initial feedback and successful fabrication and assembly in Occidental Mindoro indicate substantial progress. Moving forward, sustained collaboration and refinement efforts are vital to ensure the eventual commercialization and widespread adoption of REM technologies, ultimately enhancing agricultural productivity and sustainability.

REM-233-000: Development of Agricultural and Biosystems Engineering (ABE) Technologies for Enhanced Farmers' Productivity, Income, and Resilience

Kristine S. Pascual

A riding-type precision (paddy) seeder was designed and developed, equipped with a gear transmission drive with two gear shifts, a drive-cum steering wheel, and a seed metering assembly mounted on a pontoon with a protrusion at the bottom that creates furrows for the seed and excess water. The machine's field performance showed an actual seeding rate ranging from 15.4kg/ha to 45.7kg/ha in two seasons with an actual field capacity of 71-74.2%.

A Philippine version of the rice stripper combine harvester (RSCH) was also developed with an improved design and field performance. The prototype has a working speed of 3.8kph with a theoretical capacity of 3.7ha/day. The actual field capacity was measured at 3.3ha/day with an efficiency of 89.6%, and average field losses were measured at 3.04%, which is lower than the 3.45% losses.

A new gasifier reactor, designed with a swing-type grate for easier unloading of carbonized rice hull was fabricated and installed in the gasifier system. The system's flow rate was tested using an open water source, and the performance testing involved measuring the average pump speed, which ranged from 1459 to 1128 rpm, with a suction/lift head of 1.7m. During the two hours of operation, the system consumed 17kg of rice husks, which is equivalent to an average of 8.5kg/h. The system's average flow rate was 10.72lbs, with a range of 9.43-12.20lbs.

A new model, 6D-BRM, was designed to develop a compact, integrated brown rice machine system. It integrates a pre-cleaning unit intended for removing impurities and other matters from the paddy grains, including small stones that are mixed with the grains. The test run showed an actual capacity of 100kg/h with 70% brown rice recovery, suggesting promising results in performance with acceptable hulling efficiency and purity of output that complies with the existing national standards.

A pilot-scale infrared heating system (IHS) was developed to extend the shelf-life and preserve the quality of brown rice. Performance evaluation of the system showed that heater temperature and the distance of the heater from the conveyor belt significantly influenced grain temperature after heat treatment and grain moisture reduction rate. The optimum settings for grain temperature after heat treatment were 350°C, with 0.026m/s linear speed of the conveyor and 22.5cm distance between the heater and conveyor belt. For optimum grain moisture

reduction rate, the settings were 250°C, 0.02m/s, and 12.5cm. And for optimum grain throughput of 72.5kg/h, the settings were 250°C, 0.026m/s, and 12.5cm.

An improved version of a riding-type small farm tractor or Makisig V.2 was designed to be more versatile than the existing ones with enhanced stability, traction, and maneuverability in challenging rice field terrains. The prototype features screw wheels with a sophisticated conical geometry, expanding from a diameter of 114mm to 218mm in the middle, before tapering back. Performance testing demonstrated that the improved prototype is more efficient and easier to use, especially when it comes to attaching and detaching wheels.

Lastly, to digitally transform rice food production and cope with the rapidly evolving digital landscape in agriculture, three agricultural robots were designed and fabricated in 2023. The AgriBot served as a simple learning platform for robotic control and autonomous navigation. The AutoBoat Tractor, intended as a tillage machine, was designed and fabricated. Finally, the RoboSeeder was fabricated, assembled, and functionally tested.

REM-234-000: Development of Automated Mechanization Systems at REMD Model Farm (Phase II)

Paulino S. Ramos

The project generally aims to further improve the REMD farm as a model of mechanized and modernized rice farms by integrating important and emerging technologies for rice production. For modernization purposes, the project aims to improve the delivery and renewable energy systems for efficiently managing the irrigation water of the farm. These are being addressed by constructing a 587-m concrete irrigation canal that connects the ditch canal of REMD farm and the NIA canal, providing 16 solar-powered automated gates along its ditch irrigation canal, and developing a mobile 1-kW solar pump as an alternative source of irrigation water. For mechanization purposes, the project aims to establish a mechanized and climate-resilient rice post-harvest system by establishing a 30-m2 Kwebo to house a 2-ton capacity net bag dryer with a continuous-type carbonizer as the heat source. Likewise, laser-leveling technology that allows the formation of 1/3-ha rectangular-size and well-leveled plots for optimum machine operation was applied in the additional 1.67ha area of the farm. To verify the advantages of developing a mechanized and modernized farm in terms of mechanization, the farm is being used as a testing and evaluation site of the prototype machines such

as paddy seeder, gear-type power transmission with paddy seeder attachment, and mechanical weeder. Meanwhile, in terms of productivity, the farm is being used as the site for validating the performance of direct seeding technologies such as drum seeder, seed spreader, drone, and manual broadcast, and for the production of quality seeds.

FSC-210-000: Sustainable Operation of PhilRice CES Farm Service Center (FCS)

Paulino S. Ramos

The Center (FSC) caters to the farm service needs of CES and its extension areas. It also provides support and assistance to the Business Development Division (BDD) and other researchers. The FSC offers services including water pumping, land preparation, transplanting, harvesting, drying, and milling.

FSC utilizes an institute-wide system where farm operations requests are submitted and received by the field operations supervisor. A total of 408 farm operations requests were received and all were served. A record of completed requests was submitted to the Admin, Billing and Inventory Section for billing. To ensure smooth FSC operation, 95 units were assessed and maintained. A revised preventive maintenance program was established and implemented to ensure timely maintenance before the field operation starts. Advance procurement of supplies and spare parts of farm machinery were significant factors two months before the maintenance schedule. Availability of budget was also a key factor to fast-track the procurement of spare parts.

Maintenance of access roads and canals for irrigation and drainage was implemented smoothly. Making the monthly schedule of activities for cleaning the access road facilitated the maintenance. Timely cleaning of the irrigation and drainage canals before the start of the planting season facilitated the access of water for irrigation and draining the excess water in the farm without affecting the rice production. To improve the mobility of farm machines and other transportation and prevent accidents, roads are re-graveled and leveled. The maintenance of the Airstrip is also prioritized since it creates a beautiful and comfortable environment for visitors and PhilRice employees.

For the year 2023, FSC generated a gross income of PhP7,279,844.18. The sources of income are from fuel, oil, and lubricants with PhP1,523,252.24, irrigation fees with PhP625,052.91, Equipment rental with PhP1,338,331.34, custom services with land preparation generating PhP1,182,889, and harvesting generating PhP2,433,252.19, repair and maintenance with PhP88,672.50, and other services generating PhP88,394.

The Farm Service Center generated a net income of PhP1,700,377.50, which provides insight into its 2023 financial performance. The net income of the Center offers valuable insights into the unit's capability to invest in machinery and other equipment to foster its growth and development.

PRX-230-000: Field-Level Testing and Fine-Tuning of PhilRice Combine Harvester

Joel A. Ramos

The project aims to fine-tune the Rice Combine Harvester in partnership with Davao Beta Spring Inc. (DBSI). Within six months, this project progress including series of meetings, MOA drafts, and technical discussions. However, the project faced challenges due to internal issues of partner manufacturer, DBSI, which have caused delays in achieving targets. DBSI is requesting more time to negotiate project continuation internally, particularly in producing the rice combine harvester units leading to several MOA revisions. PhilRice's participation in a MIAP-Davao meeting shows its continued support to partners. Above all, the meetings with local manufacturers have shown that this industry needs extensive support from the government to keep the industry growing and fulfill its role of developing homegrown farm machinery products for the locals.

PRX-230-007: Advancing Sustainable Rice Production: Field Testing Performance of UR Tractor, Roller Crimper, Power Coulter, and No-till Seeder for Conservation Agriculture

Paulino S. Ramos

Conservation Agriculture (CA) offers a sustainable approach to farming. It prioritizes protecting soil, water, and biodiversity for long-term agricultural success which can be achieved with three key practices: minimizing soil disturbance (like no-till farming), maintaining permanent soil cover with crop residue, and diversifying the crops planted. In support of this, PhilRice CES in collaboration with PhilRice Negros, RU Foundry together with Dr. Manny R. Reyes of the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CESAIN) collaborated for the testing of the 3 attachments of the Open Systems Agriculture Machinery

Manufacturing (OSAMM) for rice production in the Philippines: (1) roller crimper, (2) no-till seeder, and (3) power coulter. These are attachments to the Ugon tractor designed by Ronnie Baugh with local name UR tractor during its manufacture in the Philippines. These are preliminary activities undertaken and an initiative of adopting the concept of CA in rice production.

This project has mainly utilized online platforms in its coordination activities mainly led by Dr. Reyes to connect every agency working on the CA concerns. PhilRice team has conducted two face-to-face meetings with partners, 1 briefing with REMD and stakeholders who visited PhilRice, 1 testing with CPSU in Kabankalan City, Negros Occidental for the no-till seeder on vegetable production, and 1 functionality testing of the no-till seeder for rice attached to the UR Tractor. The machine was fully funded by the partner manufacturer hence testing activities were dependent on the availability of the machine as determined by the manufacturer. Overall, based on initial testing few things for improvement were noted on the UR tractor, the roller crimper, and the no-till seeder to adapt to the Philippine condition.

EXTRA-CORE PROJECT

RTF-004-356: Pilot Testing of a Local Riding-type Rice Transplanter

Arnold S. Juliano

In pursuit of enhancing the developed local riding-type rice transplanter, the project embarked on Phase 2 of the pilot-testing project funded by DOST-PCAARRD that aimed to improve the machine and ensure it meets preferences of farmers to facilitate its adoption. Several activities were undertaken which included consultations and discussions with Rollmaster Machinery & Industrial Services Corp., a collaborating partner for the project. The team also visited the target pilot-test sites in Bagong Buhay ng Mabini Multipurpose Cooperative (BBMMPC) in Mabini, Sto. Domingo, and Ugat Uhay Farmers Association (UUFA) a RiceBIS Community located in Mayamot, Zaragoza, Nueva Ecija to discuss the project objectives and activities.

The pilot-test units were modified based on initial test results, addressing issues on the power transmission, gear shifting, and steering to improve functionality and efficiency. Subsequent tests were conducted to validate the improvements made. The need to replace worn-out rocker arms for durability was identified during this period. Additionally, rotary-type planting arms have been replaced with single-action ones to simplify design and fabrication requirements. To resolve

recurring power transmission issues, material enhancements were explored with significantly higher cost compared to the original design specifications. As a recourse, a shift to using a simpler, lighter power transmission design has been considered to address issues on weight and cost without compromising functionality. And subsequently, the transplanting assembly originally mounted on the 4WD prototype was then retrofitted to the existing single-wheel-drive (1WD) power transmission drive that is currently used in the riding-type paddy seeder being tested by PhilRice. The prototype underwent field testing which recorded an average forward speed of 1.83kph and an effective operating width of 1.8m. The theoretical field capacity was determined to be 0.33ha/h. Its field mobility was improved but still showed limitations that need to be addressed in order to achieve a fully functional machine prototype.