Quality Rice. Quality Life.

2017
National Rice R&D
Highlights

COPING WITH CLIMATE CHANGE PROGRAM

DEPARTMENT OF AGRICULTURE
1898
Philippine Rice Research Institute
Central Experiment Station
Maligaya, Science City of Muñoz, 3119 Nueva Ecija

TABLE OF CONTENTS

Coping with Climate Change Program

Ricardo F. Orge

Executive Summary

This Program aimed to contribute to the national goal of attaining and sustaining rice self-sufficiency in the country by developing climate-resilient rice-based farming systems that can withstand or recover from climate change-related stresses or shocks. To do this, the Program was established to (1) generate new knowledge and information related to climate change so that science researchers can formulate sound research interventions towards helping the farmers adapt to climate change, (2) develop adaptation technologies/strategies for rice/rice-based farming to minimize possible crop production losses caused by climate change, and (3) develop systems of diversifying the household sources of food and income as a strategy to further enhance resilience of rice/rice-based farming communities.

The Program consisted of three projects with 10 studies. One basic study dealt on gaining understanding on how the increase in ambient temperature would affect the behavior of pests and their natural enemies. Another explored the possibility of utilizing a weather-based indicator as an accurate method of describing rice crop's phonological stages, which may have significant applications in crop management to ensure high yield, among others. The rest were applied studies geared towards the development of technologies/strategies that would help farmers cope with the negative impacts of climate change.

I. Generation and Management of Local Knowledge and Information on Climate Change

Ailon Oliver V. Capistrano

This project aimed to generate information to better understand the effects and impacts of climate change on rice production, related pests, and monitor and record weather parameters across the country for data analysis and public disseminatiom. The project has four studies. The first study examined the effect of increased ambient air temperature on the population of brown planthoppers and their predator Cyrtorhinus while the second study explored the use of the Growing-Degree Day (GDD) as basic physiological information among cultivars particularly for hybrid rice parentals. The third study generated and processed basic weather data across PhilRice stations to develop an agro-climatic monitoring system using automatic weather stations (AWS). The sustainability and environmental impact of rice production as a system through life cycle assessment (LCA) was evaluated in the fourth study.

Impact of Increasing Temperature on Rice Insect Pests and Natural Enemies
GS Rillon and CCB Encarnacion

Climate change is expected to result in an increase in temperature that could influence behavior, development, and interaction of insect pests and natural enemies. Thus, a laboratory experiment was conducted to determine the effect of increasing temperature on brown planthopper and its predator Cyrtorhinus. Results showed that exposure to temperatures 2oC higher than the ambient air temperature killed 100% of brown planthopper and 70% of Cyrtorhinus after seven days. This is an indication that an increase in temperature will have lethal effect to both planthoppers and its important predator, Cyrtorhinus. A follow up study is needed to confirm the result.

Identification of the Growing Degree-Day (GDD) Requirements at Different Phenological Stages of Public Hybrid Rice Parentals
AOV Capistrano, JJE Auñgon, and JEG Hernandez

This study identified the accumulated heat units, expressed in GDD, which are required to reach the flowering stage of both hybrid parentals (A-line and R-line). Results will be used to properly schedule the planting times of A-line relative to R-line for better flowering synchronization and eventually increase F1 seed yield. In doing this, the accumulated heat units per crop stage or phase of 20 different A-line parentals along with the corresponding R-line parentals were profiled. From the lines profiled based on heat units, there were variabilities in duration of different crop stages as well as phases indicating that the flowering time between A and R parentals will likely unsynchronize if both parentals are planted at the same time. This results in poor seed set and low F1 seed yield. To aide in synchronizing the flowering time between A and R parentals, a macro-program in MS Excel was developed to identify the difference in planting dates between the A and R lines with the total heat units to flowering as input information along with the historical temperature data of the location. The prototype macro-program is already functional; however, its effectiveness in synchronizing the flowering time of A- and R-lines are yet to be evaluated in an upcoming separate activity under a proposed Hybrid Rice Research Project.

Agro-climatic Monitoring System Using Automatic Weather Stations (AWS)
PJS Quierra and JG. Tallada

AWS are essential components of research especially now that the effect of climate change is being experienced. However, AWS are too expensive to acquire locally. This study aimed to locally develop a research grade AWS capable of measuring weather parameters like rainfall, minimum and maximum temperatures, relative humidity, wind speed, and direction and solar radiation. This study also aimed to create a weather database system that will cater the transmitted data for data processing and countercheck/troubleshoot the current status of AWS on its present location. From this database, monthly farmer's weather bulletin will be formulated to cater to the needs of farmers and researchers.

This study already designed and developed the AWS server prototype using Arduino microcontroller that serves as database for weather parameters generated from AWS of the following stations: PhilRice-Batac, PhilRice-CES (3 AWS), PhilRice-Bicol, and PhilRice-Isabela. The weather data on this database were transmitted real time to a weather forecast engine website www.wunderground.com to create a more accurate and reliable local weather forecast on AWS-covered areas.

Field Evaluation of the Sustainability and Environmental Impact of Rice Production System through Life Cycle Assessment (LCA)
EG Bautista, MJC Regalado, and JA Ramos

The high cost of producing rice is one of the constraints affecting the competitiveness of the Filipino rice farmers. Mechanizing rice production is seen as one of the key options for lowering production cost to make farmers competitive. However, this option may increase energy input that would result in increased GHG emissions that can harm the environment. Thus, this study evaluated the effect of manual and mechanical rice production, hybrid and inbred varieties, and manual transplanting and direct seeding on rice yield, cost of production, energy input and output, and GHG emissions.

Results showed that manually transplanted inbred rice had highest amount of all parameters measured such as energy inputs (11,258 MJ/ha), energy output (38,302 MJ/ha), GHG emissions (2,232 kg CO2 eq), cost of production (P8,700), mandays (67), and machine hour (12). The lowest energy input and energy output in drum seeded hybrid rice was also observed. The drumseeded plot had the lowest cost of production, number of mandays, and machine hour (P5,000, 29 mandays, and 2.5 hours, respectively). Conventional tillage rice production had higher amount in energy input, GHG emissions, cost of production, number of mandays, and machine hour, but lowest in energy output. These results provide farmers basis on deciding, which combinations are acceptable and environment-friendly.

II. Development of Crop Management Strategies, Decision Support Systems, and Other Technologies for Climate Change Adaptation

Ricardo F. Orge

The onset of climate change brought added pressure to the country's agriculture sector, creating greater uncertainty, and posing a serious threat especially to the country's goal of food security. Climate change adaptation-related interventions were prioritized in this project. New innovations for rice and rice-based production are targetted in this project so farmers can cope with climate-related challeges such as drought, strong typhoons, floods, and rainfall variability. A do-it-yourself type irrigation system was field-tested on rice-based crops in conditions where water supply is very limiting. The construction of the second working prototype of Kwebo was also completed. This multi-purpose farm structure is designed to be typhoon-resistant and easy to build, which is now being used as shelter of a paddy dryer. The construction of its third prototype to be used in Palayamanan-related operations is yet to be completed. The development of a new kind of power tiller was started. The machine is expected to perform functions beyond the capability of the existing power tillers and small 4W tractors to help farmers better respond to extreme climate events like droughts and floods. The use of rice hull biochar was also explored to further improve the alternate wetting and drying (AWD) as a water-saving technology.

Design and Development of Prefabricated Components for a Low-cost, Easy-to-build, and Typhoon-resistant Multipurpose Farm Structure

DA Sawey, RF Orge, and LV Leal

A typhoon-resistant multi-purpose farm structure (Kwebo) was developed using prefabricated structural elements called basic construction units (BCU). The use of BCU simplifies the skill requirements of building the structure so that farmers, their family members, and other people in the community can easily build the structure. Specifically, the BCU was designed to satisfy the set criteria for cost and typhoon-resistance of the resulting farm structure. The first prototype of BCU was too heavy for two persons to carry, which made it difficult to assemble in the construction site. Thus, although a Kwebo using this BCU design was successfully built, design improvements were executed to reduce its weight and satisfy other criteria. The improved

BCU design had a circular cross section (60 mm dia. x 3.6m length) and is made from concrete reinforced with bamboo and wire screen. With this new BCU design, the second prototype of the structure (Kwebo 2) was constructed to be used as shelter for paddy dryer and as storage of paddy seeds, farm machines, and other agricultural inputs. This improved BCU design was also used in constructing a larger structure (Kwebo 3) to cater to the day-to-day operational needs of the Palayamanan farm, which is still for completion.

Irrigation by Capillarity: Development of an Efficient Method of Irrigation during Extreme Drought

DA Sawey, RF Orge, and LV Leal

Drought in the Philippines is becoming more intense and more frequent, seriously affecting the resource-challenged smallholder farmers. To help them cope with this extreme event, a do-it-yourself type system of irrigating rice-based crops called as capillary irrigation (capillarigation) system (CS) was developed. Its establishment maximizes the use of local materials and is simple enough to be done by the farmers themselves. The arrangement of the system components is almost similar to that of the drip irrigation system (DIS) but some modifications were made to facilitate the use of capillary wicks, which are doing the function of the emitters. Results of our field tests showed that in a field planted with green pepper (Capsicum annuum L.), the CS utilized water more efficiently as it had a higher water productivity of 36.6 g/L than DIS (9.9 g/L). Similar trend was also observed in the other test field planted with eggplants (Solanum melongena esculentum). Unlike the DIS, CS can work with unfiltered water and has a very low operating pressure (15-20cm) and emitter discharge rate (20-30mL/h). More field tests are yet to be conducted to further evaluate system performance under various crop, field, soil, and water conditions.

Development of a Multi-purpose Mini-tractor for Climate Change Adaptation

RF Orge, LV Leal, and DA Sawey

This study aimed to develop a small farm tractor that can operate in extreme field conditions (i.e., knee-deep mud, heavily-flooded fields) and can perform farming operations that are beyond the capability of the existing hand tractors such as digging canals for conveying water or draining fields, constructing small ponds for harvesting rainwater, and drilling shallow tube wells for pumping. After studying existing designs and assessing their strengths and weaknesses, a concept and working drawings of a riding-type mini-tractor was developed. Its features include a screw-type traction mechanism that will make the machine more versatile than the existing power tillers or small tractors particularly when traveling in adverse field/terrain conditions. Fabrication of major working components (traction, drive train, and main frame with installed prime mover) is completed and its first prototype would be ready for laboratory testing by June 2018.

Evaluation of Soil Productivity, Agronomic Performance and Greenhouse Gas Emissions of Combined Effects of Biochar and AWD on Rice Production.
KS Pascual, AT Remocal, FS Grospe, ME Casil, and EB Sibayan

Biochar application has been reported to improve soil quality, reduce greenhouse gas (GHG) emissions, and sequester carbon in an intensive rice production system. However, there is an insufficient field reports on the impacts of biochar application on soil physical properties and gaseous emissions in the Philippine paddy soil. Thus, consecutive field experiments in WS 2016 and DS 2017 were conducted in clay soil to evaluate the soil quality, grain yields, and GHG emissions of combined effects of biochar and AWD. In DS 2017, second application of biochar was employed at different rates (0, 10, 20, and 30 t/ha) before transplanting. In WS 2016, no biochar amendment was done. The physical and chemical properties of the biochar and the soil amended with biochar were analyzed. Methane (CH4) and nitrous oxide (N2O) emissions was also measured using a closed chamber method and calculated the global warming potential (GWP) of these two GHGs. Results showed that P rises with an increasing biochar rate in both seasons while soil pH increases relative to the control. The K significantly increases ($p < 0.05$) regardless of water management after the second biochar application. Biochar application also significantly increased the N content ($P = 0.01$) in AWD and continuously soil flooded condition (CF). On the other hand, the soil bulk density decreases in both CF and AWD and water holding capacity in AWD increases following the application of biochar. There were no significant effects of the treatments on the seasonal CH4, N2O, grain yields, and GWP emissions in WS 2016, but in DS 2017 (third crop cycle), there was a significant effect of biochar rate on the seasonal CH4 emissions, GWP and grain yields. Treatments with 10 t/ha biochar obtained higher CH4 emissions by 35-51% than other treatments. The results suggested that biochar application had positive effects on soil quality and grain yields. It also helps reduce GHG emission during the dry season when the AWD can be properly implemented. However, the effects were not found in proportional to biochar rate.

III. Enhancing the Adaptive Capacity of Rice Farmers through Diversification of Household Sources of Food and Income
Ricardo F. Orge

Enhancing resilience to climate change can be achieved through diversification of sources of income. Hence, this project aimed to enhance the adaptive capacity of rice farmers through diversification of their farming activities so they need not rely mainly on rice production, which is highly sensitive to weather conditions. Anchored in the Palayamanan, the project employed the strategies of maximizing use of land, and value adding to attain its objectives. This year, the rice+duck+azolla farming system was evaluated and found to have economic advantage over rice monocropping. In addition, the performance of a biomass reactor, an added attachment to the CtRH carbonizer, was designed, fabricated, and evaluated.

Maximizing the Use of the Continuous Rice Hull (CtRH) Carbonizer in Generating Additional Sources of Income for Enhanced Climate Change Resiliency of Rice Farming Communities
LV Leal, RF Orge, and DA Sawey

This study aimed to develop a biomass reactor as additional attachment of the CtRH carbonizer for the production of bio-fuel from agricultural wastes so as to help reduce energy cost and dependence of farmers on fossil-based fuels. The system comprises of the PhilRice CtRH carbonizer as source of heat and a prototype batch-type reactor that pyrolyzes biomass to produce bio-oil and syngas. The system was tested using dried chopped wood (from tree branches) and rice straw. From the series of test trials, results showed that the gas flow rate of the chopped rice straw (50-110 mm length) was 28.4 L/h and the bio-oil and char recovery were 38.33% and 10%, respectively. For the chopped wood (average dimension of 16.2mm dia x 81.4mm length), the bio-oil and the char recovery was the same (36.67%). Samples of the produced bio-oil and syngas had been collected for laboratory analysis.

Rice-duck Based Farming System for Enhanced Climate Change Resiliency of Farming Households
JM Rivera, RG Corales, FS Grospe, and EM Valdez

The integration of ducks in rice field offers a lot of potential in diversifying sources of income as it requires no additional piece of land. Rice fields provide food sources for the ducks while the ducks could also help in controlling the pests. Azolla may enhance the integration as it can grow in rice fields and can provide additional nitrogen to the plants while also serving as food for the ducks. Thus, this study aimed to (1) determine the effect of incorporating duck+azolla on productivity of and income from rice farming and (2) determine its effect in controlling arthropod population from vegetative to reproductive stage in rice farming. The study was conducted at PhilRice CES in 2017 Dry and Wet Seasons. The experiment was laid out in Randomized Complete Block Design with three replications. The treatments were T1) 0-40-40 kg NPK/ha, T2) recommended fertilizer rate (RFR: DS: 120-40-40 kg NPK/ha and WS: 90-40-40 kg NPK/ha), T3) RFR + 1 ton azolla/ha, T4) RFR with 500 heads/ha duck, and T5) RFR+1 t/ha Azolla with duck. Fifteen-day old mallard ducklings were released in the rice paddies at 500 heads/ha and at 20 days after transplanting and retrieved at heading stage. Data on tiller number, panicle number, percent filled grain, and 1,000 grain weight were collected to estimate yield for each treatment.

Results showed that the integration of 500 heads mallard ducks/ha combined with the RFR (T4) recorded more yield (200 kg/ha) than RFR alone (T2) and was 1.86 t/ha higher than 0-40-40 kg NPK/ha (T1). The integration of ducks also provided an additional income of more than P10,000 per season. No effect on rice yield nor income was observed in Azolla-treated plots.

Abbreviations and acronymns

ABA – Abscicic acid
Ac – anther culture
AC – amylose content
AESA – Agro-ecosystems Analysis
AEW – agricultural extension workers
AG – anaerobic germination
AIS – Agricultural Information System
ANOVA – analysis of variance
AON – advance observation nursery
AT – agricultural technologist
AYT – advanced yield trial
BCA – biological control agent
BLB – bacterial leaf blight
BLS – bacterial leaf streak
BPH – brown planthopper
Bo - boron
BR – brown rice
BSWM – Bureau of Soils and Water Management
Ca - Calcium
CARP – Comprehensive Agrarian Reform Program
cav – cavan, usually 50 kg
CBFM – community-based forestry management
CLSU – Central Luzon State University
cm – centimeter
CMS – cystoplasmic male sterile
CP – protein content
CRH – carbonized rice hull
CTRHC – continuous-type rice hull carbonizer
CT – conventional tillage
Cu – copper
DA – Department of Agriculture
DA-RFU – Department of Agriculture-Regional Field Units
DAE – days after emergence
DAS – days after seeding
DAT – days after transplanting
DBMS – database management system
DDTK – disease diagnostic tool kit
DENR – Department of Environment and Natural Resources
DH L– double haploid lines
DRR – drought recovery rate
DS – dry season
DSA - diversity and stress adaptation
DSR – direct seeded rice
DUST – distinctness, uniformity and stability trial
DWSR – direct wet-seeded rice
EGS – early generation screening
EH – early heading
EMBI – effective microorganism-based inoculant
EPI – early panicle initiation
ET – early tillering
FAO – Food and Agriculture Organization
Fe – Iron
FFA – free fatty acid
FFP – farmer's fertilizer practice
FFS – farmers' field school
FGD – focus group discussion
FI – farmer innovator
FSSP – Food Staples Self-sufficiency Plan
g – gram
GAS – golden apple snail
GC – gel consistency
GIS – geographic information system
GHG – greenhouse gas
GLH – green leafhopper
GPS – global positioning system
GQ – grain quality
GUI – graphical user interface
GWS – genomwide selection
GYT – general yield trial
h – hour
ha – hectare
HIP - high inorganic phosphate
HPL – hybrid parental line
I - intermediate
ICIS – International Crop Information System
ICT – information and communication technology
IMO – indigenous microorganism
IF – inorganic fertilizer
INGER - International Network for Genetic Evaluation of Rice
IP – insect pest
IPDTK – insect pest diagnostic tool kit
IPM – Integrated Pest Management
IRRI – International Rice Research Institute
IVC – in vitro culture
IVM – in vitro mutagenesis
IWM – integrated weed management
JICA – Japan International Cooperation Agency
K – potassium
kg – kilogram
KP – knowledge product
KSL – knowledge sharing and learning
LCC – leaf color chart
LDIS – low-cost drip irrigation system
LeD – leaf drying
LeR – leaf rolling
lpa – low phytic acid
LGU – local government unit
LSTD – location specific technology development
m – meter
MAS – marker-assisted selection
MAT – Multi-Adaption Trial
MC – moisture content
MDDST – modified dry direct seeding technique
MET – multi-environment trial
MFE – male fertile environment
MLM – mixed-effects linear model
Mg – magnesium
Mn – Manganese
MDDST – Modified Dry Direct Seeding Technique
MOET – minus one element technique
MR – moderately resistant
MRT – Mobile Rice TeknoKlinik
MSE – male-sterile environment
MT – minimum tillage
mtha^{-1} - metric ton per hectare
MYT – multi-location yield trials
N – nitrogen
NAFC – National Agricultural and Fishery Council
NBS – narrow brown spot
NCT – National Cooperative Testing
NFA – National Food Authority
NGO – non-government organization
NE – natural enemies
NIL – near isogenic line
NM – Nutrient Manager
NOPT – Nutrient Omission Plot Technique
NR – new reagent
NSIC – National Seed Industry Council
NSQCS – National Seed Quality Control Services
OF – organic fertilizer
OFT – on-farm trial
OM – organic matter
ON – observational nursery
OPAg – Office of Provincial Agriculturist
OpAPA – Open Academy for Philippine Agriculture
P – phosphorus
PA – phytic acid
PCR – Polymerase chain reaction
PDW – plant dry weight
PF – participating farmer
PFS – PalayCheck field school
PhilRice – Philippine Rice Research Institute
PhilSCAT – Philippine-Sino Center for Agricultural Technology
PHilMech – Philippine Center for Postharvest Development and Mechanization
PCA – principal component analysis
PI – panicle initiation
PN – pedigree nursery
PRKB – Pinoy Rice Knowledge Bank
PTD – participatory technology development
PYT – preliminary yield trial
QTL – quantitative trait loci
R - resistant
RBB – rice black bug
RCBD – randomized complete block design
RDI – regulated deficit irrigation
RF – rainfed
RP – resource person
RPM – revolution per minute
RQCS – Rice Quality Classification Software
RS4D – Rice Science for Development
RSO – rice sufficiency officer
RFL – Rainfed lowland
RTV – rice tungro virus
RTWG – Rice Technical Working Group
S – sulfur
SACLOB – Sealed Storage Enclosure for Rice Seeds
SALT – Sloping Agricultural Land Technology
SB – sheath blight
SFR – small farm reservoir
SME – small-medium enterprise
SMS – short message service
SN – source nursery
SSNM – site-specific nutrient management
SSR – simple sequence repeat
STK – soil test kit
STR – sequence tandem repeat
SV – seedling vigor
t – ton
TCN – testcross nursery
TCP – technical cooperation project
TGMS – thermo-sensitive genetic male sterile
TN – testcross nursery
TOT – training of trainers
TPR – transplanted rice
TRV – traditional variety
TSS – total soluble solid
UEM – ultra-early maturing
UPLB – University of the Philippines Los Baños
VSU – Visayas State University
WBPH – white-backed planthopper
WEPP – water erosion prediction project
WHC – water holding capacity
WHO – World Health Organization
WS – wet season
WT – weed tolerance
YA – yield advantage
Zn – zinc
ZT – zero tillage

Philippine Rice Research Institute
Central Experiment Station
Maligaya, Science City of Muñoz, 3119 Nueva Ecija

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).

PhilRice Central Experiment Station; Maligaya, Science City of Muñoz, 3119 Nueva Ecija; Tel: (44) 456-0277 • Direct line/Telefax: (44) 456-0112; Email: prri.mail@philrice.gov.ph; PhilRice Text Center: 0917 111 7423; Websites: www.philrice.gov.ph; www.pinoyrice.com

BRANCH STATIONS:

PhilRice Agusan, Basilisa, RTRomualdez, 8611 Agusan del Norte; Telefax: (85) 343-0768; Tel: 343-0534; 343-0778; Email: agusan.station@philrice.gov.ph
PhilRice Batac, MMSU Campus, Batac City, 2906 Ilocos Norte; Telefax: (77) 772- 0654; 670-1867; Tel: 677-1508; Email: batac.station@philrice.gov.ph
PhilRice Bicol, Batang, Ligao City, 4504 Albay; Tel: (52) 284-4860; Mobile: 0918-946-7439 ; Email: bicol.station@philrice.gov.ph
PhilRice Isabela, Malasin, San Mateo, 3318 Isabela; Mobile: 0908-895-7796; 0915-765-2105; Email: isabela.station@philrice.gov.ph
PhilRice Los Baños, UPLB Campus, Los Baños, 4030 Laguna; Tel: (49) 536-8620; 501-1917; Mobile: 0920-911-1420; Email: losbanos@philrice.gov.ph
PhilRice Midsayap, Bual Norte, Midsayap, 9410 North Cotabato; Tel: (64) 229-8178; 229-7241 to 43; Email: midsayap.station@philrice.gov.ph
PhilRice Negros, Cansilayan, Murcia, 6129 Negros Occidental; Mobile: 0932-850-1531; 0915-349-0142; Email: negros.station@philrice.gov.ph
PhilRice Field Office, CMU Campus, Maramag, 8714 Bukidnon; Mobile: 0916-367-6086; 0909-822-9813
Liaison Office, 3rd Floor, ATI Bldg, Elliptical Road, Diliman, Quezon City; Tel: (02) 920-5129

SATELLITE STATIONS:

Mindoro Satellite Station, Alacaak, Sta. Cruz, 5105 Occidental Mindoro; Mobile: 0908-104-0855
Samar Satellite Station, UEP Campus, Catarman, 6400 Northern Samar; Mobile: 0948-800-5284