2019

PHILRICE R&D HIGHLIGHTS

GENETIC RESOURCES DIVISION

Contents

DIVISION

Genetic Resources

Division head: Jonathan M. Niones

Executive Summary

Genetic Resources Division (GRD) plays a key role in conservation management and availability and utilization of rice genetic resources. GRD helps bridge the past and future by ensuring the continuous availability of genetic resources for research and improving seed delivery for a sustainable and resilient rice agricultural system. Aside from that, our division also ensures the high quality of seed in PhilRice seed production for seed growers and farmers. In achieving this goal, GRD implemented three complementary projects on (a) genetic resources conservation and management; (b) characterization for biotic and abiotic stresses and grain quality; and (c) internal seed quality control for PhilRice seed production. The first two project ensures that the genetic resources are conserved and their profile are accessible and available to increase utilization for direct use and for breeding new rice varieties. The last project rigorously monitors the quality of seeds in the seed production to ensure their certification as breeder, foundation, and registered. The three projects significantly contributed to achieving the three strategic PhilRice outcomes: (1) increased productivity, cost-effectiveness, and profitability of rice farming in a sustainable manner; (2) enhanced value, availability, and utilization of rice for better quality, safety, health, nutrition, and income; and (3) science-based and supportive rice policy environment. In addition to these three projects, GRD implemented research and analytical laboratory systems and maintenance to make sure that laboratory equipment are reliable to use, laboratory spaces are safe to work on, germplasm conservation is managed properly, and research outputs are of high quality. We performed continuous regeneration of germplasms to replenish seed stocks. For this year, seeds regenerated increased by 12% compared with 2018 data. These contributed to the availability of 3,854 accessions for distribution. Aside from that, there were 1,663 available traditional rice varieties (TRVs) Deoxyribonucleic acid (DNA) in short-term (-20°) and long-term (-80°) storage to ensure their high quality, purity, and information availability. Some of these conserved germplasms exhibited desirable traits, such as early maturity, short stature, dense panicles, and long grains, that can be useful for the next user. It is interesting to note that in 2019, we identified two accessions, namely; *Tapol* (PRRI006259) and *Wagwag Puti* (PRRI003260), which showed high tolerance to salinity stress at seedling stage. Also, *Binondok* accession demonstrated longest root length with 273.33mm in response to nitrogen deficient conditions. *Caravantos* (PRRI000234) accession had resistant reaction against stemborer.

Improvement of Germplasm Management System (GEMS) includes enriched datasets of germplasm data, added function for seed-to-seed barcoding system (automation from field up to storage), and redesigned system architecture for Digital Object Identifier (DOI) adaptation. PhilRice Genebank is among the first genebanks worldwide to implement DOIs comprising of 1,016 accessions under the Global Information System (GLIS) of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). Sustaining and transforming the basic operations of the genebank through automation secure the diversity of rice and enhance internal seed quality of PhilRice seed production. Also, we are developing a digital genebank of DNA fingerprints data and their associated important traits and make them available for current and future use.

PROJECT 1

Conservation and Management of Rice Germplasm

MC Ferrer, TE Mananghaya, MD Duldulao, JM Niones, RM Comingo, JMZ Nombrere, JBM Alvariño, JR Castro, DO Alfonso, JC Santiago, MAM Rañeses, XGI Caguiat, and MCV Newingham

The project highlighted the significant value of the two main resources of PhilRice Genebank: seeds and information data. This project ensured that potentially useful diversity of germplasm was collected, conserved, characterized, and then made available to support the development of new rice ideotype. The project focused on three studies: (1) Seed conservation, characterization, and distribution of rice germplasm; (2) DNA conservation and characterization of rice germplasm; and (3) Germplasm information management. Acquisition of germplasm covering 131 varieties was held at six provinces with notable 30 landraces from indigenous peoples (IPs) of Sarangani during '*Tuke Fali* Festival'. Currently, there are 17,399 registered genebank collections, in which 7,129 are identified accessions. These conserved germplasms were characterized morphologically and some of these exhibited desirable traits, such as early maturity, short stature, dense panicles, and long grains. Regeneration of old stocks covering 639 entries contribute in the total conserved germplasm available for distribution. This year, 1,011 germplasms were provided to end users mainly for evaluation, reference, education, direct use, and for other purposes. Aside from morpho-agronomic characterization, we initiated and invested the establishment of DNA banking to conserve DNA of traditional rice varieties for present and future seed and molecular profile reference, and also to address the problem on duplication, mismatch, and synonym in naming of selected TRVs. Currently, there are 1,663 available DNA kept in short-term (-20°) and long-term (-80°) storage to assure their high quality, purity, and readily-available information. The management, centralization, and storage of data of all of these genetic resources is supported by its in-house database called Germplasm Management System (GEMS). Improvement of GEMS include enriched datasets of germplasm data, added function for seed-to-seed Quick Response (QR), and barcoding system (automation from field up to storage), and redesigned system architecture for DOI adaptation. With these undertakings, plus efforts to continuously improve and innovate, this project contributed to the Institute's goal of increasing productivity, cost-effectiveness, and profitability of rice farming in a sustainable manner. Our next step is to continue innovating and sustaining the basic operation of the genebank to secure the diversity and seeds availability of rice.

Seed Conservation, Characterization, and Distribution of Rice Germplasm

MC Ferrer, JM Niones, XGI Caguiat, TE Mananghaya, MD Duldulao, MCV Newingham, JR Castro, JMZ Nombrere, MAM Rañeses, and JC Santiago

Seed conservation has a vital role in the preservation of genetic variability, which includes activities on acquisition, conservation, regeneration, characterization, and distribution of rice germplasm. In 2019, 131 rice varieties were collected from different provinces wherein 64 are traditional. Attending festivals, such as the *Tuke Fali* in Sarangani and *Lenong* Festival in Ifugao, served as great venued in the collection of traditional rice varieties. To date, there are 17,399 registered genebank collections in which 7,129 are identified accessions. These conserved germplasms were characterized morphologically and some of these exhibited desirable traits such as early maturity, short stature, dense panicles, and long grains. These include 84 on data of passport and 1,379 germplasm accessions for morpho-agronomic (vegetative to post-harvest) characterization. This year, 1,011 varieties were distributed to different stakeholders for characterization, evaluation, reference, demonstration, direct use, and repatriation. Following this, regeneration is continuously performed to replenish seed stocks, and this year, 639 entries produced enough seeds and conserved. Currently, 3,854 rice accessions conserved at PhilRice genebank are available for distribution.

DNA Conservation and Characterization of Rice Germplasm

TE Mananghaya, MC Ferrer, RM Conmigo, JBM Alvariño, MD Duldulao, NMM Muñez, DR Arceo, and JM Niones

Establishment of institutionalized DNA banking system and molecular profile of rice germplasm is a significant milestone of PhilRice Genebank, as it provided access to information in the identity, diversity, and presence of desirable traits of these germplasms. Collected leaf samples from the field were subjected to DNA extraction and quality checking to be used in fingerprinting and characterization using simple tandem repeats (STR) and functional markers, respectively. DNA extracted from 847 TRVs were stored in short-term storage. In 2018 to 2019, 1,083 stored DNA were labeled with barcode and QR code. Of the 736 TRVs subjected to DNA fingerprinting, three were found to be genetically similar, namely *Binangkuro* (PRRI000915), *Binangkuro* (PRRI000918), and *Binato* (PRRI000921), while *Binangkuro* (PRRI000916) was closely related to the three forming a group. Meanwhile, 17 TRVs were found to be closely related to one another. High genetic diversity of 85% was observed in the population. For molecular characterization, 960 TRVs were genotyped using nine functional markers, with 203 showing a positive allele to three to six important traits. *Enano* (PRRI000025) has gene for six multiple traits and five traits for *Rinara* (PRRI000032), *Pangasinan* (PRRI000440), and *Saigarot* (PRRI002880).

Germplasm Information Management (GEMS)

JM Niones, MD Duldulao, MC Ferrer, XGI Caguiat, MCV Newingham, JMZ Nombrere, and JR Castro

Access to genetic resources and information held at PhilRice Genebank is essential for current and future needs of rice improvement programs. The Germplasm Management System (GEMS) is designed to facilitate access to germplasm data on passport, morpho-agronomic characterization, grain quality, pests, diseases, and abiotic stress reactions. Its current version, 'GEMS v2.1', runs under FileMaker Pro 17 software installed in iMac computer. GEMS holds dataset related to more than 17,000 collections, of which the profile of 46% (1414/3063) priority Philippine traditional rice varieties are available for access upon request. Efforts are continuously being made to complete these datasets, thus uploading of vast rice germplasm data coming from various studies and projects in the division were conducted. The use of barcode or QR code technology, a new system function was also deployed in support to the automation in handling seeds harvest from field set-up up to seed packaging in the genebank. As a dynamic database management system, GEMS was recently redesigned to adapt the use of Digital Object Identifier (DOI) for improved tracking of germplasm movement thus meeting the legal obligations under the Standard Material Transfer Agreement (SMTA). The online version of GEMS is underway and significant increase in the utilization of germplasm in support of breeding new varieties is expected once accessed thru PhilRice Intranet Portal.

Evaluation of Rice Germplasm for Biotic and Abiotic Stresses, and Grain Quality and Phytochemicals

XGI Caguiat, JP Rillon, GD Santiago, SE Santiago, KMB Guarin, AV Morales, EH Bandonill, JM Niones, JC Santiago, MAM Rañeses, and RD Buluran

Rice germplasm and its wild relatives stored at PhilRice Genebank contain an immense amount of genetic variation, including variants conferring superior yield, enhanced nutritional quality, and improved abiotic and biotic tolerances in achieving impact through developing improved and new rice varieties. The objective of this project was achieved through the implementation of six studies: (1) Evaluation of PhilRice germplasm collection for biotic stresses; (2) Evaluation of PhilRice germplasm collection for grain quality; (3) Evaluation of germplasm materials in response to progressive drought stress; (4) Evaluation of rice germplasm for salinity and submergence stress; (5) Evaluation of rice germplasm for zinc deficiency tolerance in Caraga Region; and, (5) Characterization of root elongation of germplasm accessions in response to N-deficient conditions.

There were 640 rice accessions from PhilRice Genebank that were evaluated for resistance to major rice diseases and insect pests. Four hundred sixty-three entries were resistant to blast, while 71 entries had intermediate reaction to the disease. Four entries had intermediate reaction to bacterial leaf blight and eight entries had intermediate reaction to sheath blight. All entries were susceptible to tungro under induced method. In terms of insect pest evaluation, 32 accessions had resistant reaction, while 340 entries had intermediate reaction to brown planthopper. Thirty-three and 321 entries had resistant and intermediate reaction to green leafhopper, respectively. Noteworthy was *Caravantos* (PRRI000234), which was the only accession resistant reaction to stemborer, while 43 entries had intermediate reaction to this insect pest. For abiotic stresses, the germplasms were evaluated against drought, salinity, submergence, and zinc deficiency. Of the 1,012 rice accessions evaluated, 163 were tolerant to drought under field condition. There were 860 rice accessions that were screened at seedling stage against salinity stress. Two accessions showed high tolerance: *Tapol* (PRRI006259) and *Wagwag Puti* (PRRI003260), while 15 accessions were tolerant and 38 accessions were moderately tolerant.

On grain quality (GQ), 560 rice accessions were received for analysis. Two hundred forty-four were completely analyzed for GQ parameters, while 316 accessions were analyzed for amylose content (AC) and gelatinization temperature (GT) owing to limited seed amount. Of the 316 samples, 245 were evaluated for AC and 272 were analyzed for GT. Majority of the samples passed the recommended standard values for brown rice, milled rice, and head rice recovery, immature grains, grain length, AC, and GT.

Eight out of 192 TRVs showed root length with >200mm, of which *Binondok* had the longest with 273.33mm in response to nitrogen deficient (5μM concentration of NH_4+) conditions. Thus, continuous profiling of the rice germplasm is a useful source of information that can be utilized in varietal development and new gene source for future research.

Evaluation of PhilRice Germplasm Collection for Biotic Stresses

JP Rillon, GD Santiago, KMB Guarin, SES Santiago, and XGI Caguiat

Rice germplasm possesses useful genes or traits (i.e., resistance) that help mitigate the negative effect of major biotic stresses. Identified resistant accessions can be used as parent materials in breeding program. This study focused on the evaluation of germplasm accessions against the major pests and diseases in rice. Six hundred forty-four germplasm accessions were exposed (induced and natural) to pest and disease infection at the field and screenhouse, following the National Cooperative Testing protocol. Results indicated that 463 entries were resistant to blast, while 71 entries had intermediate reaction. Four entries had intermediate reaction to bacterial leaf blight, while eight entries had intermediate reaction to sheath blight, and all entries showed susceptibility to tungro. Thirty-two entries had resistant reaction and 340 entries had intermediate reaction to brown planthopper, while 33 entries had resistant reaction and 321 entries had intermediate reaction to green leafhopper. Germplasm accession PRRI000234 was resistant to stemborer (whitehead), while 43 entries had intermediate reaction.

Evaluation of PhilRice Germplasm Collection for Grain Quality

AV Morales, XGI Caguiat, MC Ferrer, EH Bandonill, RB Rodriguez, RD Camus, and JMC Avila

Grain quality (GQ) dictates consumer acceptability and marketability of rice, and is therefore considered as one of the important components in the rice breeding program. Long to extra-long grain length and slender shape are generally more preferred, while raw rice with low to intermediate AC have tender cooked rice, indicating good eating quality. This study aimed to characterize the GQ of rice germplasm. Five hundred sixty rice germplasms were received for analysis, in which 244 were completely analyzed for GQ parameters, and 316 were analyzed for AC and/or GT owing to limited amount. Of the 316 samples, 245 were completely evaluated for AC and 272 were analyzed for GT. Majority of the samples passed the recommended standard values for brown rice, milled rice, head rice recovery, immature grains, grain length, AC, and GT. However, most of the samples were below the standards in terms of chalky grains and slender grain shape. The data generated were stored in GEMS database system and could be used in rice breeding program for superior grain quality traits.

Evaluation of Germplasm Materials in Response to Progressive Drought Stress

JM Niones, RR Suralta, MCJ Cabral, VAC Marcelo, and RJM Gonzaga

Diverse germplasm materials stored in PhilRice genebank may contain desirable traits that may not have yet been explored, such as tolerance to abiotic stresses. Moreover, these accessions/collections can be utilized in breeding and varietal improvement in rice. Drought stress is one of the many manifestations of climate change that may greatly affect rice production, particularly in rainfed ecosystems and irrigated lowland with insufficient irrigation system. This study was conducted to identify and evaluate the response of germplasm collections to drought stress. One thousand and twelve germplasm collections were subjected to mass drought screening under field condition. Field drought screening was done in 2019 DS (January 31). Each entry was planted in 5x5 matrixes per entry with 20x20cm planting distance between rows and hills. Four cycles of drought treatment were implemented at 31 days after transplanting (DAT), 40 DAT (panicle initiation stage), 59 DAT (reproductive stage), and 82 DAT (late reproductive stage). Among the germplasms screened, 163 performed better and produced yield despite four cycles of drought. Plant height of 27 germplasms were considered tall (>110cm), while 413 were considered semi-dwarf (<79cm). Two among the 1,012 germplasms screened on drought condition were noted as having very high tiller count, while there were 60 germplasms with very low tiller count. *Pasacaw* (PRRI003233; 130g/plot) and *Inasana* (PRRI002915; 106.32g/plot) showed the highest yield among the ten entries that yielded more than 50g/plot. Maturity of these germplasms using days after sowing (DAS) as reference ranged from 104-142 days. Further screening of these 10 identified germplasms using the line source sprinkler (LSS) system is needed to verify their tolerance and characterize their root system under different soil moisture intensities.

Evaluation of Rice Germplasm for Salinity and Submergence Stress

XGI Caguiat, JC Santiago, and RD Buluran

Major abiotic stresses, including salinity and submergence, represent a serious threat to sustainable rice growth, quality, and productivity. This continuing project aimed to evaluate genebank rice accessions against salinity and submergence stresses at the glass house and water tank facility, respectively. Scoring of reaction was done using standard evaluation system for rice. The findings showed that two accessions were highly tolerant to salinity stress: *Tapol* (PRRI006259) and *Wagwag Puti* (PRRI003260). Fifteen accessions were also tolerant to salinity stress. All data were submitted to the database for easy access and retrieval. The tolerant accessions could be potential sources of parentals and guide for breeders in breeding new rice lines that provide satisfaction to farmers for climate resilient varieties.

Evaluation of Rice Germplasm for Zinc Deficiency Tolerance in Caraga Region

HA Jimenez, XGI Caguiat, and JM Niones

Soil-zinc deficiency stresses are among the factors affecting rice production in Caraga Region. Using tolerant varieties is an efficient and sustainable management option to mitigate the problem. The study aimed to characterize the response of germplasm accessions to soil-zinc deficiency. The experiments were established in augmented row column design, and zinc tolerance scoring was rated following the Standard Evaluation System (SES). There were 299 accessions that were evaluated for Zinc (Zn) deficiency tolerance in Caraga Region. The results showed 18% of accessions were tolerant in 25 DAT, while 28% were tolerant in 40 DAT.

Characterization of Root Elongation of Germplasm Accessions in Response to N-deficient Conditions

JM Niones, VAC Marcelo, RJM Gonzaga, and AS Cruz

Improvement of root system architecture (RSA) is an economically important trait to enhance nutrient uptake, resulting in increased grain yield. This study profiled 192 germplasm accessions for root elongation (maximum root length) trait under N-sufficient (500µM) and N-deficient (5µM) conditions at seedlings.

Under N-deficient (5µM concentration of NH_4+), eight out of 192 TRVs showed longest root length with >200mm, with *Binondok* (15259) recording the longest root (273.33mm). However, *3 Buwan* (14258) and *Kabiraya* (16104) had the shortest root lengths with 55mm. Under the N-sufficient condition (500µM concentration of NH4+), three accessions had the longest roots with >150mm, *Awot* (12800-A) having the longest SRL at 180.63mm, while *Inumay* (13921) recorded the shortest root length at 48mm. TRVs with high MRL, attributed to improving RSA, were selected as potential sources of root elongation genes in response to deficient nitrogen concentration.

PROJECT 3

Seed Quality Assurance in PhilRice Seed Stock

SR Brena and RC Ramos

Seed quality plays an important role in the rice seed production. Characteristics, such as purity or trueness of variety, appearance, viability, percentage germination, and vigor, are important to seed growers and farmers. Achieving and maintaining high seed quality are the goals of every professional seed producer. However, without a steady supply of high-quality seed, yields and crop quality would be greatly decreased. PhilRice established the seed technology unit whose mainly function was to ensure the internal seed quality of PhilRice seed production, such as Breeder (BS), Foundation (FS) and Registered (RS) Seed production. The project consisted of two studies, namely: (i) internal field inspection of seed production areas and (ii) seed testing of buffer stock and carry over seed lots, to ensure seed growers/farmer clients receive high genetic purity and quality seeds. There were 114 varieties (80 for BS; 14 for FS, and 20 for RS) that were inspected and monitored from vegetative stage until postharvest in 2019. Twenty-six out of 45 varieties were considered 100% pure BS before harvest, but only six varieties passed the standard criteria for the laboratory varietal purity test. In BS production, the internal seed quality inspection team observed that in dry season (DS) seed production, the first-in, first-out policy was not observed and strictly followed. The drying process was done in one day after harvest, but seed cleaning was delayed for 40 days after drying. Twenty-one and 18 BS varieties from 2018 DS and 2018 WS, respectively, were tested for viability after every 6 months. The seed quality of BS was high regardless of production season, after six months of storage. A significant decline in seed quality was observed in DS for NSIC Rc 194, Rc 334, Rc 420, and Rc 480.

Internal Field Inspection of Seed Production Areas

SR Brena, RC Ramos, and MCS Natividad

All BS production of the Plant Breeding and Biotechnology Division, and FS and RS production of the Business Development Division were monitored and inspected. The internal field inspection of the seed production is done to ensure high physical and genetic purity of the produced seeds. Field inspection was done four times during the cropping season, 20 DAT, maximum tillering, on-set of flowering, and 2 weeks before harvest. Three replications were done every inspection per variety planted under each class. In BS, FS and RS productions, a 20x25cm hills or 500 plants and 32x32 cm hills or 1,024 plants were pegged with bamboo sticks, and then inspected, respectively. In 2019 DS, 45 varieties were inspected in BSP. Fourteen varieties each were inspected in FSP and RSP, respectively. Off-types were not observed in BSP, FSP, and RSP at 20 DAT. In DS, the average field purity before harvest in all varieties planted ranged 99-100%, except PSB Rc 82 with only 97.5%. Three varieties, namely: NSIC Rc 158, Rc 302, and Rc 356, were rejected owing to differences in plant characteristics. NSIC Rc 300 was also rejected in all seed classes planted owing to its similar morphological characteristics with NSIC Rc 160. In 2019 WS, 35 varieties under BSP and six varieties under RSP were inspected. NSIC Rc 158, Rc 224, Rc 238, Rc 434, and Rc 530 under BSP were rejected owing to too many off-types.

Seed Testing of Buffer Stock and Carry Over Seedlots

SR Brena, RC Ramos, and MCS Natividad

Seeds are the main product of PhilRice; thus high-quality seeds need to be produced and made available to seed growers/farmers on time. In this study, seed quality assurance required regular monitoring of seed viability and health of the stored seed lots in the previous season harvest. The assurance of the inbred breeder varieties produced were assessed for varietal purity after threshing and seed cleaning. The off-types determinants of the submitted sample were grain shape, color, width, and presence and absence of awn. Carry-over seed lots of BS in DS and WS were stored in cold room after seeds were certified by BPI-NSQCS and were assessed for seed quality every 6 months. Thirty BS varieties produced in DS were evaluated for varietal purity. Six varieties were free from off-types in both postharvest operations. Some varieties were free from off-types after threshing but off-types were observed after seed cleaning. Postharvest operation, particularly seed cleaning, was delayed and varieties harvested early were processed late. Storage for the first six months resulted in high viability and vigor. However, prolonged storage to 12 months resulted in variable viability values in BS varieties stored. BS varieties produced in DS with low seed quality after 12 months were NSIC Rc 192, Rc 334, and Rc 420. Among these three varieties, Rc 420 had the lowest seed quality. For varieties produced in WS, decline in seed quality was observed in Rc 480.

PROJECT 4

Genetic Resources Division Research and Analytical Laboratory Systems and Maintenance

SR Brena and RC Ramos

Initial operation of the new Genetic Resources facility was formally started in March 2019. This facility is composed of three laboratories, namely: seed conservation, DNA fingerprinting, and seed technology. Currently, our challenges are instituting an efficient and effective maintenance program for laboratory equipment and establishing safe working laboratory environment to achieve better quality research output. Cleaning and calibration of 20 units of pipettes, four thermo-hygrometers, two digital calipers, ten thermocouple wires and digital thermometer (Testo) were carried out. Validation of the temperature of old 15 freezers and four convection ovens using digital thermometer was conducted on July 30, 2019, and internal calibration of three old weighing balances were conducted by trained personnel of the Rice Chemistry and Food Science Division. One pipette and one digital caliper were found to be defective and recommended by outsourced calibrators to be condemned. Cleaning and calibration of two PCR machines and one RT-PCR are underway. Molecular activities of GRD studies were still performed in Molecular Genetics Laboratory of PBBD upon completion of equipment needed in DNA profile.

Abbreviations and acronyms

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

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

Editorial team

Managing Editors
Anna Marie F. Bautista
Julianne A. Suarez

Layout Artist
Anna Marie F. Bautista

Editorial Assistants
Recille G. Aquino
Glendaline L. Kalaw
Joybeth N. Lisondra
Laarnie L. Mandia

Language Editors
Charisma Love B. Gado-Gonzales
Leylani M. Juliano
Rosaly V. Manaois

Assitant Editor
Hanah Hazel Mavi B. Manalo

Technical Reviewers
Division Heads
Project Leaders
Program Leaders
Station Directors
R&D Coordinators
Corporate Services Division

Editorial Advisers
Karen Eloisa T. Barroga
Eduardo Jimmy P. Quilang
Ronan G. Zagado

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) 456-0354

BRANCH STATIONS:

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 Isabela, Malasin, San Mateo, 3318 Isabela
Mobile: 0908-875-7955; 0927-437-7769; Email: isabela.station@philrice.gov.ph
PhilRice Los Baños, UPLB Campus, College, 4030 Laguna
Tel: (49) 536-8620; 501-1917; Mobile: 0920-911-1420; Email: losbanos.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 Negros, Cansilayan, Murcia, 6129 Negros Occidental
Mobile: 0949-194-2307; 0927-462-4026; Email: negros.station@philrice. gov.ph
PhilRice Agusan, Basilisa, RTRomualdez, 8611 Agusan del Norte
Telefax: (85) 343-0768; Tel: 343-0534; 343-0778; Email: agusan.station@philrice.gov.ph
PhilRice Midsayap, Bual Norte, Midsayap, 9410 North Cotabato
Telefax: (64) 229-8178; 229-7241 to 43 Email: midsayap.station@philrice.gov.ph

SATELLITE STATIONS:

Mindoro Satellite Station, Alacaak, Sta. Cruz, 5105 Occidental Mindoro
Mobile: 0917-714-9366; 0948-655-7778
Samar Satellite Station, UEP Campus, Catarman, 6400 Northern Samar
Mobile: 0948-754-5994; 0929-188-5438
Zamboanga Satellite Station, WMSU Campus, San Ramon, 7000 Zamboanga City
Mobile: 0910-645-9323; 0975-526-0306

PhilRice Field Office, CMU Campus, Maramag, 8714 Bukidnon
Mobile: 0916-367-6086; 0909-822-9813
Liaison Office, 3rd Flor. ATI Bldg, Elliptical Road, Diliman, Quezon City
Tel/Fax: (02) 920-5129

DEPARTMENT OF AGRICULTURE
PHILRICE
PHILIPPINE RICE RESEARCH INSTITUTE