HIGHLIGHTS OF R&D ACCOMPLISHMENTS & PERFORMANCE, 2011

Executive Summary

The Philippine Rice Research Institute is the country's leading institution in rice research and development (R&D). As such, PhilRice plays an important role in attaining rice self-sufficiency by strategically developing and implementing a national rice R&D programs to increase rice production and farmers' income.

In 2011, PhilRice puts into operation its "Rice R&D Roadmap in Support of the National Rice Self-Sufficiency Program" or RSSP 2011-2016 to help the rice sector attain national rice self-sufficiency by 2013, ensure its sustainability, contribute in reducing the incidence of poverty and malnutrition, and achieve competitiveness in rice science and technology. Its five main programs are the: **Program 1**: Developing Technologies to Break the Low Yield Barriers in Rainfed, Upland, & Other Adverse Rice Environments; **Program 2:** Developing Technologies to Surpass the Dry Season Irrigated Lowland Rice Yield Plateau; **Program 3:** Natural Products & Value-Adding Systems Development; **Program 4:** Impact Evaluation, Policy Research, and Advocacy, and **Program 5:** Development and Packaging of Location-Specific Rice Technologies for Irrigated, Rainfed, and Upland Areas. In support of these programs, discipline-based and specialized R&D projects were also implemented as well as area-based researches to develop and promote location-specific technologies appropriate for the different rice growing conditions in the country.

A total of 82 projects and 347 studies were conducted out of the 96 planned projects. Said projects were widely distributed among R & D programs, discipline-based, area-based, and specialized R & D projects. Some projects were terminated, subsumed by other projects, or suspended due to the limited and late release of PhilRice's R&D budget in July 2011.

Programs and Projects	Planned		Implemented	
	No. of Projects	No. of Studies	No. of Projects	No. of Studies
Rice R&D Programs	**20**	**180**	**20**	**149**
1. Developing Technologies to Break the Low Rice Yield Barriers in Rainfed, Upland, & Other Adverse Environments	5	76	5	57
2. Developing Technologies to Surpass the Dry Season Irrigated Lowland Rice Yield Plateau	3	34	3	32
3. Natural Products and Value-Adding Systems Development Program	4	46	4	40
4. Impact Evaluation, Policy Research and Advocacy Program	4	17	4	15
5. Development and Packaging of Location-Specific Rice Technologies for Irrigated, Rainfed, and Upland Areas	4	7	4	5
Discipline-Based Projects	**22**	**73**	**22**	**61**
1. Plant Breeding and Biotechnology	1	7	1	6
2. Germplasm and Seed Health	3	12	3	10
3. Agronomy, Soils and Plant Physiology	3	11	3	9
4. Crop Protection Division	4	13	4	8

5. Rice Chemistry and Food Science	2	5	2	5
6. Rice Engineering and Mechanization	3	8	3	6
7. Socioeconomics	1	3	1	3
8. Development Communication	4	9	4	9
9. Technology Management and Services	1	5	1	5
Specialized Rice R&D Projects	**13**	**52**	**12**	**40**
1. Crops Biotechnology Center (CBC)	3	12	3	12
2. Climate Change Research Center (PCCC)	4	11	3	9
3. Open Academy for Philippine Agriculture (OpAPA)	4	10	4	9
4. Pinoy Rice Information Systems and Data Management Center (PRISM)	2	10	2	10
Area-based R&D Projects	**30**	**104**	**28**	**97**
(1) PhilRice Batac (CAR – Abra & Apayao, Region 1 except Pangasinan)	6	15	6	14
(2) PhilRice Isabela (CAR except Abra & Apayao, Region 2)	5	16	4	16
(3) PhilRice Los Baños (Region 4)	4	10	4	11
(4) PhilRice Bicol (Region 5)				
(5) PhilRice Negros (Regions 6, 7, 8)	7	25	7	21
(6) PhilRice Agusan and Midsayap (R&D for Mindanao)	8	38	7	35
TOTAL	**96**	**409**	**82**	**347**

Highlights of Physical Performance

For the year, PhilRice developed different technologies such as varieties, machines, crop management options. To promote these technologies, different strategies or approaches were utilized such as trainings, information materials, exhibits, and others (please see table below). In summary, PhilRice have accomplished 140% of its targets.

Component Activities / Performance Indicator	2011*		
	Targets	Actual	% Acc.
No. machineries improved/ developed/commercialized	**21**	**17**	**81**
Water harvesting	*6*	*6*	*100*
Post production	*8*	*10*	*125*
Post-harvest	*4*	*4*	*100*
Commercialization of matured engineering technologies	*12*	-	-
No. of integrated management options developed	**55**	**31**	**56**
Pest management	*18*	*8*	*44*
Crop management	*17*	*16*	*94*
Nutrient management	*15*	*2*	*13*
Water management	*5*	*5*	*100*
Value-adding activities conducted	**6**	**6**	**100**
No. of varieties released for commercial production	**6**	**32**	**533**
Hybrid rice	*1*	*14*	*1,400*
Irrigated lowland	*1*	*2*	*200*
Special purpose rice	*1*	*2*	*200*
Rainfed lowland	*1*	*9*	*900*
Saline	*1*	*4*	*400*
Upland	*1*	*1*	*100*

No. of training activities conducted	**85**	**48**	**56**
PalayCheck Field Schools Conducted	*68*	*21*	*31*
Rice Specialists Training Course conducted	*2*	*6*	*300*
Teknoklinik conducted	*10*	*4*	*40*
Training capability enhancement for LSTD AEWs conducted	*4*	*5*	*125*
Other trainings	*1*	*11*	*1,100*
No. of participants trained	**2,540**	**1,478**	**58**
Farmers or fishers	*1,940*	*946*	*49*
Extension personnel (rice specialist, AEW, etc)	*200*	*254*	*127*
Others (e.g. fert. & pest. handlers, manufacturers, etc)	*400*	*278*	*70*
Number of Print Materials Distributed	**23,100**	**34,700**	**150**
Technology bulletins	*2,000*	*13,000*	*650*
R&D Highlights	*500*	*500*	*100*
Books/manuals/reports/proceedings/ brochure	*600*	*7,200*	*1,200*
Newsletter	*20,000*	*20,000*	*100*
TV/Radio promotion/online news	**271**	**376**	**139**
Media Releases/Articles uploaded online	*213*	*319*	*150*
Radio interviews/broadcast releases	*52*	*52*	*100*
TV features/coverage	*6*	*5*	*83*

***** *Most project started only during the WS due to budget constraints (2nd semester of 2011)*

These technologies can increase the rice production, for example the new rice varieties developed can contribute 2.266 Mmt if adopted by farmers.

ITEM	Yield Increase (t/ha) *	Potential Increase in Rice Production (mt)	Value in Pesos @ P15/kg (P'000)
Hybrid	1.05	186,881.53	2,803,222.95
Inbred-Certified	1.33	1,945,833.10	29,187,496.50
Rainfed	0.02	26,229.95	393,449.25
Upland	1.02	107,514.30	1,612,714.50
TOTAL		**2,266,458.88**	**33,996,883.20**

In the PalayCheck field schools conducted with more than 1000 farmers, showed an increase in yield of 0.49 t/ha during dry season, and 0.22 t/ha during wet season.

Season	No. of Participating Farmers	Baseline Yield (2010)	2011 Ave. Yield (t/ha)	Yield Difference (t/ha)
Dry	767	3.40	3.93	0.49
Wet	499	2.66	2.92	0.22

Potential increase in rice production (mt): 1,610,507.91
Value in Pesos @ P15/kg (P,000): 24,157,618.65

HIGHLIGHTS OF R&D ACCOMPLISHMENTS, 2011

I. RICE R&D PROGRAMS

1. Developing Technologies to Break the Low Yield Barriers in Rainfed, Upland, & Other Adverse Rice Environments

The program aims to enhance rice production and productivity in the rainfed lowland, upland and other adverse environments, which include the saline-, and submergence-prone areas, and areas prone to high and cool temperature. It will contribute in the government's target of achieving rice self-sufficiency and household food security through development of appropriate technologies in marginal areas where production constraints are enormous. As the target rice ecosystems and growing environments are at high risk to the negative impact of climate change, the expected outputs of the program will, likewise, provide adaptation and mitigation strategies and technologies for resilience to climate change. The following are the expected outputs of the program and its achievements.

(1) Varieties adapted and acceptable in the target ecosystem, with 5 t/ha yield in the absence of abiotic stress and 3 t/ha yield under stressed condition

Two PhilRice-developed varieties were approved for commercial planting: NSIC 2011 Rc272 (Sahod Ulan 2) and NSIC 2011 Rc288 (Sahod Ulan 10) for rainfed dry-seeded culture with 3 t/ha yield.

- 140 traditional varieties (TRVs) collected from Northwest and Northeast Luzon; evaluated, seed increased and purified with duplicate seeds deposited at PhilRice genebank.
- 392 germplasm accessions from the genebank were screened for abiotic stress tolerance; identified 60 (15.3%) cultivars with tolerance to drought at vegetative stage, and 6 (7.1%) of 86 screened exhibited saline tolerance.
- 142 mutant lines developed with tolerance to either drought, salinity or submergence, with improved grain size and shape and softness of cooked rice, mature earlier and shorter than the progenitors; the lines are for field performance evaluation.
- 178 SSR markers surveyed for polymorphism in 192 genotypes, described as Diversity and Stress Adaptation (DSA192) panel; 3 additional candidate gene markers were used to genotype the DSA192 population. The test of SSR marker association with drought tolerance traits, leaf rolling, leaf drying and drought recovery at vegetative stage, identified 16 SSR significantly associated with the traits.
- 295 (34.1%) good performing inbred lines were selected for multi-environment trial (MET) or multi-location on-farm adaptability and acceptability trial.
- Marker-assisted breeding for resistance to blast, 37 advanced breeding lines and varieties screened at IRRI blast nursery harboring 4-5 blast races, 14 of which were observed to have resistance.

- Upland adaptability trial of 24 genotypes conducted in Quezon province, 4 genotypes yielded at least 4.0 t/ha, and 13 selected by farmers for phenotypic acceptability, uniformity and resistance to blast disease.
- Improving popular and high-yielding varieties, PSB Rc82 and NSIC Rc160 for flood-prone areas is accelerated through introgression of the sub1 gene, advanced generations of the two varieties were crossed with IR64-Sub1 are available for further backcrossing and agronomic evaluation.
- In support to breeding, centralized mass screening was conducted with 332 genotypes for seedling drought tolerance, and 543 for salt tolerance
- Adaptability and acceptability trials conducted with 54 PhilRice-developed elite lines were evaluated in 7 drought-prone rainfed lowland sites. Across sites, the grain yield ranged from 2.233 to 3.690 t/ha, 15 of which were selected by both farmers and researchers. 8 elite lines were selected for nationwide testing to the NCT in rainfed areas

(2) Integrated crop management systems or options

- Cost-effective and efficient land preparation and crop establishment technologies are being developed for areas with limited water supply. Cost reducing tillage technologies, zero tillage and furrow slice, which at the same time conserve soil and moisture are being evaluated for rainfed and upland rice cultivation.
- Project on integrated pest management aims to develop environment friendly technologies for abiotic stress-prone ecosystems. Activities focus on understanding the arthropod community structure (key pests and natural enemies) in the target growing areas; indigenous pest management practices and their association in the pest status are also evaluated; diagnostic kits for insect pests and diseases to assist farmers and technicians for effective pest management; and biological control agents and indigenous microorganisms are also being explored.
- A 10% yield increase is the aim of the studies on soil, water and nutrient management technology development. Activities focused on fertilizer management techniques to improve yield and fertilizer use efficiency; nutrient recycling management options to sustain soil fertility and productivity in the rainfed and upland ecosystems; cultural management to mitigate drought and conserve water; Minus-One Element Technique (MOET) and Leaf Color Chart (LCC); and use of soil conditioners to conserve soil moisture and reduce the impact of water stress on rice crop growth and yield.

(3) Water-harvesting, conservation and management technologies

- 12 experimental small farm reservoirs were constructed for the evaporation and seepage losses studies.
- A "small footprint" water storage system requiring minimal energy for pumping was designed for rainfed farms; soil and water conservation system-cum-water

harvesting for upland farms; sub-surface water run-off harvesting system was also designed and ready for testing.

- To lift the water from the source to the farm, the treadle pump is currently being improved and a vortex pump utilizing only the energy of flowing/falling water was designed for testing.
- To distribute the water efficiently, a low-cost drip irrigation system for fertigation was developed and being tested. And to provide advisories on optimum crop-livestock-fish mixes under varying water supplies, a linear programming-type model is being developed.
- A low cost drip irrigation system (LDIS) for rice-based high value crop production in the upland is being improved using locally available materials.

(4) Systems/technologies for intensive and diversified crop cultivation

- 9 Community-Based Forest Resource Management (CBFM) of the DENR were baselined for the study
- In Pudtol, Apayao, a 10 ha upland experimental site is being developed for rice cultivation in partnership with the LGU; Sloping Agricultural Land Technology (SALT) is being assessed for enhanced production of rice and rice-based crops in the uplands.

(5) PalayCheck® system for rainfed, upland, saline- and submergence-prone environments.

- PalayCheck system will be developed by integrating available technologies for the different crop production components and best practices in the target areas. The system will serve as a guide in targeting increased and sustained rice production in the marginal areas, while maintaining the integrity of the environment.
- Conducted baseline information on the indigenous cultural practices for rice farming in the rainfed (Aklan, Bohol, Iloilo and Samar), upland (Tarlac), and submergence-prone areas (Ilocos Norte & Sur).

2. Developing Technologies to Surpass the Dry Season Irrigated Lowland Rice Yield Plateau

The continuous development of high-yielding inbred and hybrid varieties resistant to pests and diseases with excellent grain qualities is essential to keep up with the increasing demand for rice. Raising rice yield to its maximum potential under irrigated condition, particularly during the dry season (DS), is the main purpose of the program. To achieve this, location-specific adaptability of rice varieties and use of new breeding tools and methodologies are pursued. The use of hybrid rice technology as a key approach to attaining high yield is one of the major strategies implemented. The application of improved agronomic management technologies for seed production and commercial cultivation that PhilRice developed are fine tuned. These technologies are tested under local conditions toward the promotion of location-specific recommendations and subsequent adoption of farmers.

The program aims to develop new and superior inbred rice for transplanted irrigated lowland areas and for direct wet seeding, hybrid varieties, and seed/seed production technologies and crop management strategies.

(1) 3 varieties were approved for commercial cultivation:
- 1 inbred (NSIC Rc240 or Tubigan 22) with 5.8 to 10.6 t/ha yield; wide spectrum of resistance to blast, sheath blight, bacterial leaf blight and white stem borer; and excellent grain qualities
- 2 hybrids (NSIC Rc244H or Mestiso 29 with and Rc262H or Mestiso 38)

(2) 3 elite inbreds were nominated for approval as new inbred varieties:
- 1 with stable across seasons and locations, yield ranged 5.6 to 5.9t/ha and maximum attainable yield of 10.4 t/ha
- a special purpose rice with better adaptation than the check variety (MS11 or NSIC Rc170SR), low amylose content, short and bold grain and with 100% acceptability in cooked form

- 1 elite line, to be the first NSIC-approved variety specifically for direct seeded cultivation with 5.97 t/ha yield across test locations, with intermediate reaction to BLB, BPH and GLH, low amylose content and had premium, long and slender grains.

(3) In adaptability tests of hybrids conducted in 48 sites across the country, Mestiso 19 and 20 were found to be the most stable among the hybrids tested. During field days, farmers have indicated their interest on these hybrids that led to the implementation of DA-funded hybrid seed production project and planting of public hybrids in 50,000 ha in 2013.

(4) Hybrid seed production trials of Mestiso 19 confirmed that Banay-banay, Davao Oriental is the best location for high yield and high quality seed production.

(5) Genetically pure nucleus and breeder seeds of 12 public hybrids, namely, Mestizo 1, Mestiso 3, 7, 16, 17, 19, 20, 21, 25, 26, 29, and 38 were also continuously produced.

With all these accomplishments, there is a great potential that this program may play a major role to support the national goals of achieving rice self-sufficiency and competitiveness in the country. There is, therefore, a need for a strong national funding support for breeding, seed production research, and other new initiatives of the program to continuously improve and develop new technologies for the irrigated lowland conditions.

3. Natural Products and Value-Adding Systems Development Program

Poverty and malnutrition are sad realities for the rice-based farming households in the country. Aside from low levels of productivity, cheap price of produce, and weak marketing support, poverty also manifests high cost of inputs and hired wages in farming. It is therefore important to empower the members of the farming community to improve their practices, reduce farming cost, increase the value of their produce, and explore additional sources of income in order to improve their economic condition. On the other hand,

malnutrition, a direct or indirect cause of poverty, weakens immune system, which increases risks for the onset of various diseases. Malnutrition is often attributed to inadequate and unbalanced dietary intake of food and essential nutrients.

The most commonly consumed form is milled or white rice, which serves as the main source of carbohydrates for daily energy requirement. However, there are other forms or kinds of rice such as brown rice, pigmented rice, and micronutrient dense rice that offer additional health benefits. There are specialty rices that command higher price in the market. Although utilized mostly as table rice in boiled form, rice can also be processed into various products. The by-products of rice production and other farm biomass are mostly considered wastes because of their limited use, although alternative ways can be explored to utilize them in various valuable processes or products. Natural resources must also be tapped for useful applications.

The program aims to increase the income and improve the nutritional status of the rice-based farming households. It is expected to develop rice with value-added traits; assess and improve quality and utilization of rice variants; utilize rice and other commodities for food applications; maximize the potential of rice by-products, farm biomass, and biotics; and develop rice-based farming systems to improve nutrition and economic conditions of farming communities.

(1) A variety, NSIC Rc210 (Malagkit 5) was approved for commercial planting with 4.5 t/ha average yield, wide spectrum of resistance, and good grain quality; 5 aromatic and 8 glutinous elite lines were included in the multi-location trials; elite lines of micronutrient-dense rice with high iron and zinc were also evaluated in the multi-location trials. A confined field test was conducted to evaluate the performance of advanced lines of golden rice, and started incorporating resistance to tungro and bacterial leaf blight diseases.

(2) Validated high inorganic phosphate (HIP) assay for screening of putative low phytic acid (*lpa*) mutants using mutants from China and PhilRice, which is an important step towards identifying rice varieties or lines with low phytic acid suitable for brown rice production. Fissuring and light polishing treatments improve the cooking and eating qualities of brown rice. Heat stabilization techniques such as autoclave and microwave heating were evaluated to extend its keeping quality.

(3) A prototype of a pedal-operated brown rice mill was fabricated which will facilitate access to brown rice in the community; 96 pigmented rice (black, purple, and red rices) were evaluated for grain quality, anthocyanin content, and antioxidant activity.

(4) Natural fortificants were developed from *malunggay*, squash, and chili pepper leaves and used them in snack foods. Different procedures were evaluated in developing instant *am* for children to make this product safe and readily available. A new rice wine variant (*bignay* wine blended with rice wine) and value-added product from rice wine lees (waste generated from rice wine production) were developed.

(5) Alternative sources of fuel to minimize production costs and reduce farmers' dependence on fossil fuels was also studied: use of rice hull gasification and heat and power cogeneration system for


The improved rice husk gasifier stove (left) was tested using coconut shell shards as fuel (right)

community rice milling; continuous-flow rice hull gasifier as heat source for mechanical drying of *palay;* rice husk gasifier stove for cooking; biogas as source of alternative energy for the *Palayamanan* model farm; boiler-less steam generation using carbonizer-generated heat; rice hull carbonizer-water pump system for the *P*alayamanan; rice straw carbonization, and continuous-type rice hull carbonizer as heat source for drying crops and other commodities; carbonized rice hull as desiccant for drying and storage of *palay*.

(6) Nutritional status of rice-based farming households was assessed: 18% of the 0-10 year-old-children were underweight to severely underweight, and 35% of those over 10 year-olds were found to have below normal body mass index. A guide for food production models was prepared as an initial step in addressing target food/nutrition deficiencies. Rice+duck production system and floating garden were evaluated to further support the nutritional requirements of the farming households.

4. Impact Evaluation, Policy Research and Advocacy Program

The program measures the impacts of R&D to rice yield, farmers' income, and nutritional status of rice-based farming households to inform policymakers and donors, and help in securing financial support for R&D activities in the future. It also analyzes the patterns and constraints to adoption, and social acceptability of rice R&D products. This provides feedbacks to R&D managers, scientists and researchers about the acceptability of rice R&D products to target users, and thus improve the technology development in the process. In addition, the program conducts market, socioeconomic and policy researches to understand better the relation of the rice industry with the national economy. With this information, program puts PhilRice in a better position to recommend appropriate policy actions toward the achievement of rice self-sufficiency, poverty alleviation, and improvement of nutrition status of the population.

In 2011, the program implemented four projects, namely: (1) Social dimensions of rice-based farming systems; (2) Impact evaluation of rice R&D and related production services; (3) Understanding markets and prices of rice, value-added rice products, and farm inputs; and (4) Policy research and advocacy.

(1) Social dimensions of rice-based farming systems project identifies the technology needs of the farmers; determine the level of adoption of different rice technologies; characterize the adopters; and examine various stakeholders involved in technology transfer. The information that will be generated will serve as basis for setting rice R&D priorities, formulate recommendations for fine-tuning rice R&D activities, and the results lead to policy recommendations to hasten technology adoption and adaptation.

(2) Impact evaluation of rice R&D and related production services project examines the potential and actual impacts of PhilRice research products such as varieties, crop management practices, and farm machineries and equipment on rice yield, farm income, and nutrition and poverty status of the farming households. The impacts of related production-enhancing services such as irrigation and training were also assessed, with information about impacts communicated to policymakers for appropriate policies and actions. Evidences of impacts were also conveyed to donors to gain more support for rice R&D. The project also provides feedbacks to

researchers for further improvement of rice R&D services and implementation of related production-enhancing projects.

The project assessed three R&D projects: 1) Location-Specific Technology Development (LSTD) program; 2) Department of Agriculture – Food and Agriculture Organization Small-Scale Irrigation Systems (DA-FAO SSIS) program; and 3) PhilRice – Japan International Cooperation Agency Technical Cooperation Projects (PhilRice-JICA TCP) 4 and 5. This covered 165 sites in 24 provinces with 25 to 30 participating farmers per site. Results show that more than half (59%) of the rice-based farming households in the LSTD sites were considered poor and 47% are food insecure based on the 2006 NSCB-computed poverty and food thresholds. The total annual average household income of poor rice farming households was P28,452, which was only a tenth of the non-poor households' total income of P222,426. Among provinces, Abra, Aklan, Capiz, Ilocos Norte and Negros Occidental have the highest percentages of food insecure households and children with nutrition predicament.

(3) Understanding markets and prices of rice, value-added products, and farm inputs project focused on forecasting palay prices, and assessing the value of seed variety attributes.

The price of paddy is the most important variable affecting the planting decisions of rice farmers and the driving mechanism of the rice agribusiness sector's marketing decisions. With price uncertainty, farmers will not be able to make optimal planting decisions, which in turn can affect the actual national production. Due to the importance of information about expected paddy price, this study was conducted to develop a scientific way of forecasting paddy price and make the information available to stakeholders.

Valuing variety attributes can provide an *ex-ante* picture of the value of varieties under development that can aid policy and decision makers. The seed price, especially of inbred varieties, however, does not reflect the value of variety attributes because the government mostly performs the variety development and there is no discrimination by variety in the pricing of seeds. This study reviews available and applicable methodologies that can recover the value of seed attributes notwithstanding the absence of attribute-reflecting market prices and apply it in the case of the Philippines.

(4) Policy research and advocacy focused the following activities:

- *Understanding rice self-sufficiency in the Philippines.* The Philippine government created the Food Staple Sufficiency Program (FSSP) 2011-2016 in order to achieve and sustain self-sufficiency in staple food such as rice, white corn, root crops and plantain. The main target of the FSSP is to produce our domestic food staple requirements by 2013 and strengthen the resilience of nation's capacity to produce food staple to impact of climate change beyond 2013. In order to plan for appropriate interventions, mathematical projections of the nation's food requirement and production targets are needed. The yield level and area harvested necessary to achieve the production targets must be calculated. This study was conducted to perform these calculations for rice.

- *Assessment of the regional rice industry for policy formulation.* This consolidates all available information related to the rice industry of the 16 rice-producing regions in the country to help the DA-RFU rice program planners and implementers in crafting appropriate policies to achieve self-sufficiency. The sets of information were collected from various agencies and integrated to have a comprehensive analysis of the situation in each region. Percentages, averages, and ratios were used to measure the trends and status of rice production in each region.
- *Linking rice research to policy and action*. The impact of information from available socioeconomic and policy researches may only be realized if this is delivered to its intended users, the policymakers and other stakeholders. This study serves as an active policy advocacy arm of PhilRice to help policymakers and stakeholders make informed decisions and strengthen the link between rice research and policymaking. The following materials were published/printed:
  - ✓ *Philippine Rice Industry Primer Series* which provides readers with information on trends and status of the rice sector.
  - ✓ Three issues of *Rice Science for Decision-makers were* published to synthesize findings of rice science to help craft decisions relating to rice production and technology adoption and adaptation. These were distributed to policy-makers, PhilRice management and selected staff, DA officials, students, and other rice stakeholders. These are: Is marketed surplus of farmers enough to meet their basic needs?; Fiscal reforms to help achieve food staples self-sufficiency; Pushing for brown rice consumption among low- and middle income families
  - ✓ Organized a "Policy Seminar and Workshop on Mainstreaming Brown Rice to Low- and Middle-Income Families" in support to the celebration of the 9th Development Policy Research Month. Papers about the nutritional aspects of brown rice, its impact on national rice self-sufficiency, methods for improving cooking and storage of brown rice to improve consumer acceptability, and marketing strategies of commercial sellers and civil society organizations were presented in the seminar. A workshop on creating group resolutions to advocate the increase of supply and demand of brown rice was also conducted.
  - ✓ Drafted comments on House Bills 1159, 1772, 3279, 1229, 3833, 4388, and 1469 and Senate Bills 449, 772, and 2347 as requested by the DA Assistant Secretary for Policy and Planning

5. Development and Packaging of Location-Specific Rice Technologies for Irrigated, Rainfed, and Upland Areas

Starting in the wet season cropping of 2009, PhilRice mobilized its seven branch stations to lead in the planning and implementation of location-specific technology development (LSTD), training, and information support service in areas where rice yields were below 4.2 t/ha for irrigated ecosystem, 2.9 t/ha for rainfed areas, and 2.0 t/ha for upland areas.

The LSTD program brought together rice scientists, Local Government Unit-Agricultural Technologists (LGU-ATs), non-government organizations, and other

development workers closer to the real world of the farmers. They worked with the farmers and local leaders in developing and promoting location-specific technologies using the *PalayCheck*® and *Palayamanan*® technology platforms in areas where rice yields were low.

In support of the Food Staples Self-Sufficiency Plan (FSSP), the program continued to scale-up the customization of the community-based PalayCheck® and Palayamanan® technology platforms to suit farmers' fields. The activity calls for a localized and partnership-driven on–farm rice technology development where community leaders are supported by subject matter specialists of PhilRice, Agricultural Training Institute, Bureau of Plant Industry, Bureau of Soils and Water Management, Department of Agriculture-Regional Field Units, LGUs, and AEWS who work together to analyze field constraints and package location-specific technologies.

(1) Since 2009, 170 Location-Specific Technologies (LSTs) were packaged: Each PhilRice station produced the following LSTs: Batac, 10; Isabela, 29; CES, 7; Los Baños, 36; Negros, 29; Midsayap, 49; and Agusan, 10.

(2) In 2011, the program was implemented in 16 regions, 56 provinces, 181 municipalities, and 465 sites or barangays, of which 268 sites in irrigated areas. To accomplish this, 152 Rice Sufficiency Officers (RSOs) were deployed in different locations during DS 2011 with an additional 54 RSOs during the WS 2011.

(3) Internet-based and stand-alone administrative support subsystems was developed that standardized data gathering, storage and retrieval of information from the database. This includes: Monthly reporting (matrix format); Site Characterization; File management for data uploading of different electronic files; Editing and inputting of data and; GIS map of LSTD sites across the country.

(4) 54 RSOs completed the Rice Specialists' Training Course on PalayCheck and Palayamanan Systems from December 6, 2010 to April 29, 2011. While undergoing the season-long training, the RSOs also conducts the PalayCheck Farmers' Field School in seven barangays of the Science City of Muñoz and eight barangays in San Jose City both in Nueva Ecija. A total of 180 farmers from Muñoz, and 183 farmers from San Jose City graduated from the FFS.

(5) A yield increment of 0.22 t/ha during WS, and 0.49 t/ha during DS were obtained by farmer-participants in the PalayCheck field schools. With these results, a potential increase of 1.61M metric tons can be achieved or valued at P24B at P15/kg.

Season	No. of Participating Farmers	Baseline Yield (2010)	2011 Ave. Yield (t/ha)	Ave. Yield Difference (t/ha)
Dry Season	767	3.40	3.93	0.49
Wet Season	499	2.66	2.92	0.22

II. DISCIPLINE-BASED PROJECTS

1. Plant Breeding and Biotechnology

Breeders' search for genetic variability to broaden the gene pool of rice cultivars aims to confront environmental uncertainties that threaten future rice yields. Genes in other alien gene pools such as the wild relatives of *Oryza* are now being tapped, and non-conventional and innovative techniques such as induced mutation and wild hybridization are also being applied to create and transfer variability. Several genes are now being pyramided to increase durable resistance through molecular marker-aided selection. New and better ways of disease diagnostics are also being developed. Studies on the explanation of the genetic basis of some diseases, yield, and grain quality traits are now underway. The pre-breeding materials developed will pave new opportunities to further genetic improvement of our elite lines.

As we recognize the vital role of the rice seed industry in this modern revolution, efficiency in the rapid seed increase of new varieties, and effective maintenance of their genetic purity are critical to increase and sustain rice production in the country. With these interventions, the ultimate objective to develop rice varieties with all the desirable features is foreseeable in the near future. These new generation varieties are expected to make rice farming profitable, sustainable, and competitive.

2. Germplasm and Seed Health

Germplasm and seed health ensures quality and health of germplasm in support of the rice breeding and seed production program. Its main activities include germplasm collection, conservation, and utilization and evaluation for resistance to major pests and diseases, grain quality, and seed health and quality assurance and maintenance. It is also tasked to develop cost-effective and environment-friendly rice seed technologies, and to facilitate all requests of PhilRice breeders and other researchers for germplasm materials locally and internationally.

Acquired and processed registration of 445 rice cultivars into the PhilRice Genebank. The cultivars included 46 traditional varieties, 376 advanced lines, and 23 varieties of international origin. The traditional cultivars were collected from Tarlac, Ilocos Norte (PhilRice Batac), North Cotabato, Zamboanga del Sur, and Negros Oriental. The advanced lines were acquired from the National Cooperative Test (NCT) while the cultivars of international origin were from China, Korea, and Indonesia.

On germplasm distribution and information management the following were done:

- 13 germplasm material transfers between PhilRice and IRRI with complete Standard Material Transfer Agreements were facilitated.
- 28 seed requests, 17 data requests, and 10 combination seed/data requests were served during the year.
- 102 duplicates from the NCT seed entries were identified and were tagged in the database as back-up or active collections
- The passport database was updated upon the addition of 445 entries into the GEMS; 222 two were identified as new collection. The online database was

updated with the addition of 335 new accessions; latest total number of accessions online is now 6,745.

- A layout of 15-page catalogue of traditional varieties has been drafted to showcase the collections of traditional varieties

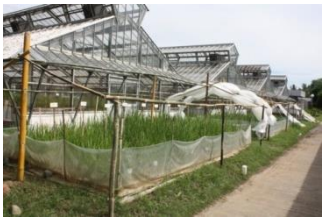
3. Agronomy, Soils and Plant Physiology

The division has implemented 3 projects with a total of 10 studies focus on the following:

(1) Assessment of the long-term use of inorganic and organic fertilizers on the yield of lowland rice, indigenous nutrient supply of rice soils, improvement of nutrient uptake by rice plants, water-use and water productivities of lowland rice varieties.

The use of pure inorganic fertilizers still proved to be effective in attaining the yield potential of lowland rice of 8-9 t/ha with the use of site-specific nutrient management. The combination of inorganic and organic fertilizers at lower nutrient rates gave comparable yield with that of the plants that received pure inorganic fertilizers but the yield level was only 5.7-7.2 t/ha. The indigenous nutrient (N, P and K) supply from Maligaya clay soil were still high.

(2) Evaluation of a raised bed system screening facility for drought tolerance and development of root plastic system for breeding purposes under drought stress.



The system effectively reduced the capillary rise of water below 30 cm depth and thus, created distinct soil moisture content (SMC) differences between the upper and lower soil layers during progressive drought (upper soil layer- USL, 12.5% SMC below the sand layer-BSL, 23%SMC). Seven genotypes showed genotypic variations in terms of potential deep rooting characteristic as determined by their capacity to penetrate the 5 cm gravel layer, which was 22 cm below the soil surface.

(3) Development of the hydroponic culture media for nutritional evaluation purposes, evaluated new products for growth promotion as well as nutrient sources and development of nitrogen-fixing bacterial inoculants

A greenhouse experiment was conducted at PhilRice CES to evaluate the growth mechanisms of radiation-modified chitosan on lowland rice. Similarly, a field experiment was conducted to assess the effectiveness of different biofertilizers on lowland rice. Plant samples were taken for analysis of N to quantify the contribution of nitrogen fixation on the rice plant.

4. Crop Protection

The division focused its activities on developing sound pest management strategies and pest-resistant varieties to help rice farmers improve their pest management decision-making and address their other crop protection needs. Pest management strategies are considered sound if they are ecosystem-based or site specific, protect the environment, and safe to use, economical, practical, and sustainable. In addition, the strategies should be compatible with other farm management options.

(1) *Development of decision guides for pest management.* This made rice pest management more effective by enhancing the impact of dominant predators in the field that will make production system more sustainable. Characterization and mapping were initially undertaken for rice major pests as well as their natural enemies.

(2) *Survey and characterization of weedy rice biotypes in Central and Southern Luzon.* This study focused on determining the distribution and extent of weedy rice infestation in Central and Southern Luzon as well as to determine the morphological and other agronomic characteristics of the different weedy rice biotypes present in those areas through survey.

(3) *Ecological engineering towards a sustainable integrated pest management (IPM) program in rice and rice-based farming system.* Movement and colonization of beneficial organisms, show that predators and parasitoids of rice stem borer and hopper eggs tend to colonize non-rice habitat during fallow periods. It is possible tha*t Palayamanan* serves as refuge to beneficial organisms that can provide a sustainable IPM in surrounding areas with large rice monoculture. Sustainable IPM means less input for farmers and reduction in hazards to humans and the environment. Hence, this investigated the impact of *Palayamanan* on conservation biological control.

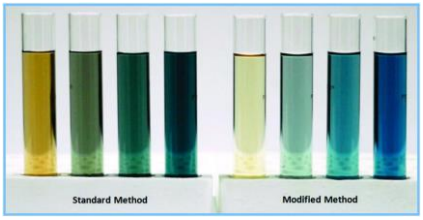
5. Rice Chemistry and Food Science

The division plays important role in rice breeding by evaluating the grain qualities of early generation and advanced rice lines. Likewise, it establishes grain qualities preferred by stakeholders like various consumer groups and the industry. Essential grain quality characteristics have to be supplied to breeders at critical stages of varietal development so they can decide whether the lines can be further improved or elevated to advanced stages of varietal development. This strategy can help save resources and maximize efforts in rice breeding.

- 1,095 breeding and elite lines submitted by various breeding groups were evaluated for grain quality. Of this number, 297 breeding lines were analyzed for milling recovery and 160 lines passed the standards set. Most of the entries were in the low to intermediate amylose class.
- Consumer acceptability of different forms of rice (freshly cooked, staled, refrigerated, and reheated) was assessed. Low amylose-low gelatinization temperature types of rice remained highly acceptable even when staled at room and refrigerated temperatures.
- Many factors affecting milling and head rice recoveries have been cited, which includes crop management, temperature, harvest moisture content, and even physical

structure (hardness, chalkiness, and dimensions). Milling and head rice recoveries tended to increase as grain length and shape decreased regardless of whether a laboratory and commercial milling machine was used. Chalkiness, amylose content, crude protein content, and gelatinization temperature type had no relationship to milling yield.

- An improved amylose method was developed featuring the use of a new coloring reagent, colorimetry at alkaline pH, a distinctive blue and stable color, minimal lipid and amylopectin interference, and good accuracy across amylase classes (from waxy to high amylose). To complement the improved method, a rapid amylose field test kit was re-evaluated and optimized.



- PCR markers associated with eating quality were validated to formulate a marker-based assessment and prediction method of the eating quality of cooked *indica* rice and to generate molecular descriptors of the accessions of the PhilRice genebank. Molecular markers for amylose, gelatinization temperature, gel consistency, and fragrance were identified for assessment of rice eating quality. Marker validation is performed alongside conventional methods of determining milling potential, physicochemical properties, and aroma.

6. Rice Engineering and Mechanization

Rice farms in the country have low productivity because of poor crop management and low mechanization level. Several priority field operations have to be mechanized in order to improve productivity as well as reduce costs. Farmers consume around 30 man-days per hectare with manual harvesting and axial-flow threshing. Combine harvesters reduce this expense including losses accrued from the manual system since handling, time and climate effects, as well as machine factors to losses and grain damage are minimized.

The direct effects of mechanization on crop yield include timeliness, precision in the conduct of operations especially in direct seeding or transplanting, provision of sufficient water during critical stages of the plant, and reduction of field losses in harvesting up to drying.

There are several ways to improve our country's level of rice mechanization and labor productivity. One of these is to provide and enable farmers or cooperatives to acquire the machines they need through easy access to, and liberal credit terms for, farm equipment loans. Another is to promote the use of farm machinery/equipment that are tested and proven to be efficient, appropriate, and adapted to local conditions through pilot utilization of technologies. The following machines and protocols are being developed:

(1) *Development of a ride-on stripper harvester.* Stripping is a harvesting principle which involves combing or detaching the grain from plants without cutting the stems. The theory of stripping using the stripper rotor has been extensively researched and proven to work well in harvesting rice under Philippine conditions. However, research findings indicate that the machine's performance is optimum at speeds higher than a comfortable operator walk (Tado, 2002). This is the main reason why the walk-behind stripper harvesters never became popular in the country. A stripper combine, where the operator rides on the machine, can therefore harness the full potential of the stripping principle.

(2) *Improvement of the 1.3 m combine harvester.* The current design of mini-combine rice harvester has proven its efficient performance in dry field condition. Although introduced throughout the country in previous years, the level of adaptation is still very low. This study will further improve the performance of the 1.3m combine harvester under soft soil condition, and its difficulty in adjusting the header and noticeable cracked grains harvested. Completed and tested the redesigned lifting device of the combine harvester. A simple hydraulic system replaced the common hydraulic jack that manually pumps to lift the header and reduced the operator's drudgery during harvest operations.

(3) *Adaptation of the 4-ton Vietnamese reversible dryer in the Philippines.* In early 90s, PhilRice introduced the 6-ton flatbed dryer to farmers, which gained wide acceptance due to its high capacity, low drying cost, and ease of installation and operation. Vietnamese engineers designed and successfully applied a new series of flatbed dryer for drying high-moisture crop and reducing labor costs. This new series, with capacity ranging from 4 to 12 tons/batch, is called reversible air dryer. The construction and operating principle of the reversible dryer is similar to the current flatbed dryer. The only difference lies in the reversibility of the drying air.

Detailed plan of shed, drying bin, blower, and rice hull furnace was completed. A unit was constructed at PhilRice Los Baños and was ready for testing. A unit of blower-furnace set for Kaanib Foundation in Bukidnon was finished and will be tested.

(4) *Development of PalayCheck protocol for land preparation.* A well-prepared land facilitates good management on water, nutrient, weed, and pest. Proper leveling in the field, for example, solves more than 50% of the problems in rice production. However, in the Palay Check System, Key Check of a well-leveled soil with 2-3 cm water depth is difficult to achieve in actual field condition. Hence, a protocol on land preparation must be developed.

(5) *Pilot-testing of brown rice milling system.* Traditionally, brown rice is produced using mortar and pestle. PhilRice has developed two prototypes of brown rice milling machines with promising output. The first prototype assembled together a dehulling unit has an aspirator and a single layer separator. The second comprised a Satake SB10 single pass rice mill (to produce brown and white rices), 4-layer paddy separator (for separating brown rice and unhulled paddy), and a bucket elevator (for loading input paddy and recirculating unhulled paddy). These prototypes have promising dehulling/separation capacities of 150kg/hr and 500kg/hr, respectively. Quality of brown rice produced by both prototypes has 99.5% purity.

(6) *Development of an Integrated Postharvest Management System for the rice postproduction industry.*

- Milled rice quality needs to be further improved. Good quality milled rice is rice with whole grains and is called head rice in the trade. The grain is well-polished, free of contaminants, and possesses the preferred cooking and eating qualities. The latter is mainly a varietal characteristic, and the cooking and eating quality of rice is associated by consumers with varieties or brand names, and not with grades set by the Philippine Trade Standards (PTS). A 2002

nationwide survey indicates that 68% of milled rice sold in retail markets qualifies only as PTS Grade No.2. This is due to non-uniformity in polish, high percentages of broken grains, and the presence of discoloured kernels and other contaminants. These are considered failures in the postproduction and marketing system.

- Starting right: quality of raw material palay. The production of good quality milled rice starts with good quality palay. Similarly, the production of a uniform-sized palay, of a single variety that matures uniformly, starts with certified seeds that are planted with the proper agronomic care. Timely harvesting minimizes field losses and the presence of unfilled or immature kernels. The purity of rice harvest is anywhere from 90 to 95% sound kernels. The desired moisture content of 14% or lower is critical. Wet harvests contain a moisture content of about 21% for the summer crop, and 24% for the wet season crop. When it is raining, moisture goes up as high 28%. The wet harvest is unstable, and the metabolic heat of grain respiration causes discoloration. Wet grains not immediately dried due to lack of mechanical dryers result in heavily discoloured grains

- Rationalizing the milled rice market grades. Milled rice is retailed in public market rice stalls and is displayed in open boxes. Filipinos prefer the well-polished softer textured varieties, but will settle for the lower priced PTS Grade No.2 rather than the premium grade No.1. On the other hand, restaurants look for fluffier varieties. Supermarkets sell graded rice that is packaged using their own brands, or use parodies of well-known brands. The grades and standards do not reflect the cooking and eating properties of rice, and consumers have to depend on variety or brand names. There is a lot of misrepresentation and quality inconsistency in the brands sold.

- Reducing postharvest losses. Postharvest losses can be as high as 30% of production depending on processing and handling circumstances. Physical losses are mainly due to spillage or pest infestation. The more critical losses are loss in quality due to bio-deterioration and damage to the grain during drying, storage, and milling. Qualitative losses are also due to discoloration, presence of contaminants, varietal mixing, and grain fissures that wind up as broken kernels during milling. Severe grain fissuring causes a reduction in milling recovery, and broken grains sell for only half the price of head rice. All of these losses can be minimized through technology, information dissemination, and training of technicians. A focus on producing good quality rice automatically reduces postharvest losses.

- Postharvest technology minimizes grain losses. Minimizing postharvest losses and producing good quality milled rice are two sides of the same coin, and is dependent on the farming system and associated practices of producing good quality palay and downstream processing industry. The use of technology is required in post-production system such as harvesting machines to provide timeliness, mechanical dryers to arrest biodeterioration of the wet harvest, good storage facilities, and efficient rice milling machines. However, the country has an obsolete post-production system despite rice being the staple food. This project was conducted to develop and test the PalayCheck® system for integrated rice postproduction management, develop clusters of rice varieties according to their similarities in physical, chemical, cooking, and

eating characteristics, and improve trade standards for paddy (*palay*) and milled rice.

7. Socioeconomics

The division conducts research and policy studies to help develop an efficient, competitive and sustainable rice industry, nurtured by sound policy environment. It supports PhilRice's function of providing timely information to the industry. The division is conducting the project, Statistical Series on the Rice Economy to address the need to gather, process, and update rice statistics and make available the information to primary rice stakeholders.

Statistics play a vital role in planning and implementing projects as well as making policies in rice R&D. With enormous thrust on government accountability, policymakers enjoined researchers and developmentalists to present project impacts quantitatively. Moreover, statistics gathered periodically will create trends in the rice economy of the Philippines. Understanding the rice trends will have great implications on planning and implementation of rice programs that will be beneficial to the rice industry especially to the rice-based farm households in the country. Past rice statistics will also inform policymakers and researchers if government investment in agriculture is worth it. If not, statistics will also provide the necessary rationale to avoid the same gaffe in future programs for the rice industry.

8. Development Communication

As an R&D organization, PhilRice is mandated to generate information and knowledge that must be communicated to its various stakeholders to facilitate learning, trigger innovations, and inform decision-making. The division contributes largely to this mandate of the Institute through the strategic and innovative use of communication for and about development interventions and results. Key accomplishments of the division were:

- Production of some 25 titles/issues of knowledge products (KPs) to cater to the different information needs of PhilRice stakeholders. Evaluation of selected KPs, with results showing that the Rice Science for Development and the Golden Rice tarpaulin banners were found attractive and the information contained in them were considered understandable and useful. It was suggested, however, to improve the consistency and accuracy of information being shared.
    - ✓ *PhilRice S&T Magazine* – includes human interest stories, news, and other sections that popularize rice industry concerns for the general public. Four issues were published of 5,000 for every issue with themes covered were: "New Technologies, Love for Rice and Tributes to Superwomen Behind Rice"; Upland Farming; Golden Rice, in coordination with the Golden Rice Team of the Plant Breeding Division; and, Pest Busters: the IPM CRSP Special Issue.
    - ✓ *Rice Science for Decision Makers* - a policy advocacy material published quarterly, meant to synthesize findings in rice science to help craft decisions relating to rice production and technology adoption and adaptation. Three issues were released: 1) "Is Marketed Surplus of Farmers Enough to Meet Their Basic Needs?"; 2) "Fiscal Reforms to Help Achieve Food Staples Self-Sufficiency", and 3) "Pushing for Brown Rice among Low- and Middle-Income Families". These were published at 1,000 copies each, distributed to members of the Upper and Lower Houses of Congress, government agency heads, and civic groups.

- ✓ *Q&A Series:* Two were released, namely Golden Rice in Filipino and revised edition at 2,000 copies, and "Climate Change and Rice Production" at 3,000 copies.
- ✓ *Technology Brochure:* the brochure on Technologies for Rice Self-Sufficiency with 1000 copies
- ✓ *Technology Bulletins/RTBs:* Three titles: "Reducing Methane Emissions from Irrigated Ricefields"; "Rice Hull Gasifier"; "Saclob"; and "Kontroladong Pagpapatubig" were produced/circulated at 3,000 copies each.
- ✓ *Field Guide on Major Disorders:* the field guide was reprinted at 2,000 copies
- ✓ *Posters:* prototype for the poster on Controlled Irrigation was pretested, finalized, then published and circulated (with 1000 copies; other posters produced were on Saclob and Zero Tillage).
- ✓ *Handouts:* The following topics were IGO bestsellers in RTB formats. Their contents were condensed as handouts then forwarded to OpAPA for uploading to the PinoyRKB portal: (1) Planthopper, (2) Stem Borer, (3) Weeds, (4) Salt-affected Soils, (5) Green Manure, (6) Palayamanan, and (7) Household Farming.
- ✓ *Leaflet.* A leaflet on the Eight Key Checks of PalayCheck was produced and pretested.
- ✓ *Video.* Three videos were also produced, namely: (1) use of the Minus-one element technique and (2) management of Golden Snail by farmers from Aurora province using the participatory approach, and (3) Hope and a New Day (A Day in the Life of PhilRice) was produced to boost the corporate image of PhilRice.
- ✓ *Calendar* - The 2012 Farmers' wall calendar contains recommendations and technologies, which farmers can try based on their region's climate type. Each calendar highlight different practices suited for specific climate type: Type 1, 2, 3, and 4. Each type of calendar will be circulated at 3,000 copies.
- ✓ *R&D Conference 2011 Souvenir Program:* Last March 2011, 300 copies of the Souvenir Program were distributed to Conference speakers, delegates and guests.
- ✓ *Corporate Profile Brochure.* A new profile, promoting the Institute's Rice Science for Development credo, was highlighted in the brochure. 1,000 copies of the brochure were distributed to partner agencies and other stakeholders.

- Implementation of campaigns on Golden Rice, Rice Science for Development, and Rice Conservation, wherein new partners and strategies (i.e. use of social media, celebrities, student organizations) were tapped to widen the reach of the campaign.
- Intensification of knowledge management activities to facilitate access, production, and services. Resource bases (i.e. photos, KPs, videos) were strengthened/created and training programs conducted to guide the use of these resources.
- Under corporate communication, launching of the improved corporate website and tapping of social networking sites to improve awareness about PhilRice and its thrusts. PhilRice also developed new partnerships with media groups and was featured in major television and radio networks in the country, including a few coverage by the international media
- In the project, enhancing knowledge sharing and learning (KSL) to promote location-specific technology development (LSTD), scoping work and initial data gathering

activities using qualitative methods have been conducted at Midsayap, North Cotabato LSTD sites, namely: Patindeguen, Lagumbingan, and Palonguguen. The data gathered seemed to indicate that knowledge is shared and learned among farmers in various ways and these can still be possibly enhanced by tapping as pathways the areas they frequently go to. Farmers could well-articulate the use of certified seeds, and nutrient, pest, and water management.

9. Technology Management and Services

The Department of Agriculture (DA) through the Rice program identified several strategic components to further increase the total rice production in the country. Recent updates and advances in rice science and technologies are available to farmers to further improve their agricultural productivity and profitability, thereby alleviating poverty and reduce malnutrition in rural areas. Among these technologies are better and high-yielding rice varieties, improved crop management practices (*PalayCheck* System), diversified farming systems (*Palayamanan*), and new postharvest technologies that reduce crop losses.

However, in order for these technologies to reach the farmers, there is a need to accelerate the introduction and delivery of latest technologies as well as appropriate logistical and information and communication supports, and train new generation rice specialists and extensionists from the private and public sectors who can continuously develop and deliver these technologies to the rice farmers through dynamic and relevant approaches. To address this, the division conducted the following trainings:

(1) compiled Palayamanan training modules for review and final drafting by the SMS;

(2) developed and distributed 1,000 copies each of instructional posters on *ampalaya* and eggplant production;

(3) drafted instructional poster on tomato production and revised the Controlled Irrigation poster (Tagalog version);

(4) revised the *PalayCheck* flipchart and printed 60 copies distributed to the Rice Sufficiency Officers (RSOs) and other techno promo partners;

(5) enhanced the capacities of thousands of AEWs, RSOs, farmers, and other stakeholders through various trainings and customized courses on rice and rice-based production technologies;

(6) informed and technically briefed more than 3,000 farmers, AEWs, legislators, and other rice stakeholders through S&T Updates and Field Days, and solved immediate field problems of hundreds of farmers through mobile rice technoklinik (MRT);

(7) established technology demonstration plots and participatory trials which served as learning fields of hundreds of training participants, as well as showcase technologies to thousands of PhilRice visitors; and

(8) evaluated the activities of the AEWs and other workers after participating in season-long rice specialists' training courses. The courses supported the rice self-sufficiency plan, and evaluated the effectiveness of the PalayCheck flipchart developed and promoted to these development workers.

(9) developed databases on trainings conducted and managed, as well as the list of farmer-beneficiaries in LSTD sites for monitoring, evaluation, and other purposes.

III. SPECIALIZED RICE R&D PROJECTS

1. Crops Biotechnology Center

PhilRice has been designated as the lead agency for crops biotechnology R&D through DA Administrative Order No. 21 Series of 2005. The Biotech Center plays a central role in the R&D of major crops addressing specifically production constraints through varietal development using biotechnological tools. The Center draws its strength from the solid record of PhilRice in molecular genetics of rice diseases and hybrid biology, rice germplasm characterization and rice varietal development. Serving as the core scientists are PhilRice biotechnologists who received advanced training, have active collaborations and consultancies with local and international partners and well-qualified to elevate biotechnology in other crops. The Center supports research efforts that will help realize the goals not only of PhilRice but the whole nation in attaining food sufficiency.

Biotechnology has become an integral part of research to develop agricultural products. Several biotechnological tools have been proven useful and effective not only to improve research quality, but also to achieve better results in a shorter span of time. Through the use of molecular markers and other modern biotechnology tools for research, development of superior varieties can be achieved within a shorter period and in the long run in a cost-effective way. The Center currently hosts the following three projects with 12 studies:

(1) *Molecular characterization, diversity analysis and utilization of crop germplasm* - to develop an STR DNA profiling system for rice that can be used to uniquely identify each Philippine rice varieties; establish standard operating procedures to be used in the DNA profiling of rice cultivars suitable for legal proceedings; develop a system that can be routinely and reliably used for seed authenticity and purity test; to transfer drought tolerance and other important traits from wild rice donors into elite background through wide hybridization, and evaluate the comparative performance of derived elite breeding lines under field condition.

(2) *Gene discovery and marker development for agronomically important traits* to study the molecular genetics of rice important traits such as root plasticity in response to drought, stress seedling vigor under submergence stress, heat tolerance, crack resistance, and low phytic acid (lpa). It aims to breed rice varieties that can tolerate higher temperatures, drought, submergence, anaerobic germination with resistance to blast and tungro, and other important traits (crack resistance, low phytic acid, etc.). Gene discovery and marker development of these agronomically important traits are the keys to the solution of global rice shortage in the coming centuries. With the anticipated global climate change that will affect rice important traits, rice production and food security is at stake.

(3) *Marker-assisted line development.* DNA-based molecular markers have been proven to be a valuable tool in the genetic improvement of crops. In model crop species such as rice, two approaches have been developed: (1) to use linked markers for the indirect selection of major genes, and (2) to use genomewide markers to increase allele frequencies of genes controlling quantitative traits. The objective of this project was to utilize DNA markers in the development of stress-resistant and high-yielding inbred lines and hybrid parent lines.

2. PhilRice Climate Change Research Center.

The center was established and institutionalized in February 2011 to develop and extend a comprehensive and judicious understanding of the current and future impacts of

climate change, including variability and extremes on the Philippine rice farming system, and to cushion its possible negative effects on the realization of rice self-sufficiency. It envisions climate-risk resilient, healthy, safe, and self-reliant Philippine rice and rice-based farming communities with productive ecosystems.

The Center conducts rice and climate change-related R&D activities particularly those that could not be addressed by other PhilRice R&D programs. In 2011, three project with nine studies were implemented:

(1) *Assessment of climate change impacts, risks, vulnerabilities and response strategies in rice production systems* – to determine and analyze the extent of impacts of current and future climate change (including climate variability and extremes) on rice and rice-based farming systems, and formulate site-specific response strategies that have large impacts on attaining rice-self sufficiency, livelihood security of the farmers, and environmental sustainability

(2) *Development, evaluation, and enhancement of mitigation and adaptation technologies and strategies.* One of the major challenges of the national rice RDE is how to increase rice production with declining natural resources in an adverse environmental and changing climate condition. The project aims to develop technologies and strategies to help farmers and communities to increase their resiliency against the negative impacts of climate change, and to develop and evaluate climate change adaptation and mitigation strategies in the rice-based farming communities.

(3) *Inventory, measurements, and monitoring greenhouse gases in rice production.* Inventory, measurements, and monitoring of greenhouse gases (GHG) are important since the Intergovernmental Panel on Climate Change (IPCC) identified wetland rice as one of the primary sources of GHGs. In the agriculture sector, the Philippines' initial (1994) and second (2000) National Communications to the United Nations Framework Convention on Climate Change (UNFCCC) indicated that rice production is the highest contributor of GHG emissions. Rice production is one of the most vulnerable sectors in the agriculture industry because of its aggregate impact on global warming and climate change. Rice plant's sensitivity to water and temperature stresses and other climate-related extreme conditions directly influence the quantity and quality of rice production. Producing rice in irrigated lowland soils also contribute to global warming and climate change because rice fields emit greenhouse gases such as methane and nitrous oxide.

3. Open Academy for Philippine Agriculture (OpAPA)

Harnessing ICT for Rice and Rice-Based Research, Development, & Extension

Farmers' inadequate access to new rice production technologies is a major constraint to improving rice productivity in many areas of the country. As most of these farmers are smallholders scattered in rural areas, it is difficult to reach them by the traditional methods of extension alone. New strategies are therefore required to effectively disseminate relevant information on appropriate technologies to farmers in the countryside.

In recent years, the dissemination of information through the use of the internet and information and communications technology (ICT) has become popular and affordable to

many people. The Open Academy for Philippine Agriculture (OPAPA) was established to enable agricultural extension workers (AEWs) and farmers to have access to up-to-date agriculture information, advisory services, on-line and distance learning, and trainings.

Started in 2004 to 2011, OPAPA has generated and provided services, which are proven to benefit the agricultural extension workers and farmers in terms of faster access to information and technologies. OPAPA employs various platforms and strategies to ensure that information is made available to extension workers, farmers, and other stakeholders. These services include:

(1) *Pinoy Farmers' Text Center (09209111398).* Texting or the use of short messaging service (SMS) is still one of the cheap and effective means in reaching out to farmers. Owing to the popularity of cellular phones in the Philippines, ease of operation, the use of local dialect, low cost of ownership, and economical cost of texting, this mobile phone service was tapped to provide farm advisory services to the farmers. At P1.00 per text message, farmers can now ask questions and get answers directly from rice experts. The text center receives an average of 5000 messages per month. Seeds/varieties and pest management are most frequently inquired information from texters mostly coming from Nueva Ecija, North Cotabato, Isabela, Pangasinan, and Cagayan.

(2) *Rice and Rice-Based Knowledge Bank*. The Pinoy Rice Knowledge Bank (www.pinoyrkb.com) or PinoyRice is a localized one-stop information source for rice knowledge intermediaries such as extension workers, development specialists, farmer organizations, NGOs, LGUs, and media practitioners. PinoyRice also aims to assist these stakeholders in localizing farm practices by providing results of the Location-Specific Technology Development (LSTD) program.

(3) *Distance Learning.* A new site, www.palayaralan.com was created. Eleven courses were uploaded, namely: Management of Armyworm and Cutworm, Rice Postproduction Technologies, Minus-One Element Techniques, Nitrogen Fertilizer Management using LCC, Production and Use of Rice Straw-based Organic Fertilizer, Management Options for Golden Kuhol, Management of Rice Blast Disease, Management of Rice Black Bugs, Modified Dapog Technology, Controlled Irrigation, and Management Option for Ricefield weeds.

(4) *Cyber Communities* were established in Nueva Ecija, Ilocos Norte, Laguna, Negros, North Cotabato, Agusan del Norte, Davao del Norte, Davao del Sur, and Davao Oriental. These cyber communities were either municipal-, coop-, and barangay-based. Provided with a computer unit, Internet connection, and digital knowledge resources, a cyber community serve as a local access point of agricultural information and technologies.

4. Pinoy Rice Information Systems and Data Management Center

Agricultural Information System (AIS) is an innovative tool in agricultural research and development, technology demonstration and deployment, and production. It provides data and expedites information flow for different stakeholders across time and geographical barriers. Internet and mobile phones are efficient, economical, and commonly available technologies among rice stakeholders. Hence, the exploitation on the potential uses of AIS and communication technology infrastructures are being explored in rice agriculture to attain the Institute's goals.

Generally, information systems (IS) are combination of hardware, software, and trained personnel organized to facilitate learning, planning, control, coordination, and

decision making. In rice, IS can be an integrated set of components for collecting, transmitting, filtering, storing, and processing data and delivering information, knowledge, and other digital products for the use of each stakeholder.

Agricultural Information Systems can simplify the presentation of complicated processes. For example, during the technology matching, several factors are being considered like site characteristics that includes biophysical (soil, plant, agro-climate, pests, season, stresses) and socioeconomic (indigenous knowledge, practices and coping mechanisms, cultural, absorbing capacity of target clientele, seed systems) components on specific area of interest. The spatial distribution of data throughout an area is also very important for land evaluation, planning, agricultural research and development, and extension activities. This can be clearly presented online using the geographical information system (GIS) interactively. It summarizes and presents geo-related data and information on a specific location.

Through the innovations in AIS, in which the ISD is exploring, interactive electronic maps and webpages, real-time field data collection models, online databases, and directories are now available online, free, and easy-to-use.

IV. AREA-BASED R&D PROJECTS

1. PhilRice Batac (CAR – Abra & Apayao, Region 1 except Pangasinan)

PhilRice Batac as the Center for Dryland Agriculture focused its projects, studies and activities on the development and improvement of rice-based farming systems. Intended for semi-arid areas of the country 14 R&D researches and activities were conducted in 2011 to achieve self-sufficiency in rice and contribute to the attainment of the country's food self-sufficiency.

Since 1999, the station spearheads the development of rice-based farming systems technologies suitable for the rainfed and other stress-prone areas of the country, which are projected to be affected by water scarcity and frequent recurrence of El Niño in future. While the other branches concentrate solely on developing technologies for rice, Batac is also engaged in generating technologies for dryland crops. The very dry climate in Ilocos allows growing of rice only during the wet season in most areas.

It develops appropriate technologies that are not only region-specific but are also adoptable in other drought-prone areas characterized by a distinct climatological pattern of wet for at most four months, and dry for the rest of the year. Agriculture in these areas is mostly rainfed and the unavailability of water, especially during the dry season, gravely limits their productivity. As such, farmers in these areas remain poor but with appropriate technologies, the semi-arid areas can be made sustainably productive, thus, increasing the income of the farmers and improving their quality of life.

Hence R&D activities towards improving the rice and rice-based productivity of this ecosystem would address the need of the time to attain food security and to address production sustainability and reduce, if not, eliminate poverty.

2. PhilRice Isabela (CAR except Abra & Apayao, Region 2)

PhilRice Isabela was boosted as the hybrid rice center to develop, package, and promote hybrid rice-related technologies. The station also pursues activities on nutrient, water, and pest management, and socio-economic and policy. Through the station's support, Region 2 has become the country's main producer of hybrid rice seeds.

Studies in Isabela, though focused on hybrid rice technology, are directly addressing problems posed by the alarming climate change. Some of the technologies or management practices being developed and improved are two-line hybrids and assessment of pests and diseases, with a developed map guide. Studies also dealt with upland rice cultivation and seed quality enhancement through seed hydration. Initial findings on the effect of using different techniques in upland rice farming were recorded, but further validation is needed. Seed quality enhancement, on the other hand, used the process of seed hydration to increase germination rate and uniformity, and improve seedling vigor and growth.

3. PhilRice Los Baños (Region 4)

PhilRice Los Baños, in partnership with research institutions and local government units (LGUs), has been conducting major activities in plant breeding, crop protection, agronomy and soils, rice chemistry and food science, and technology promotion and development. Its strong collaboration with IRRI, UPLB, and members of the rice R, D & E network has led to the development of location-specific rice varieties and technologies. The station implemented the projects focused on increasing productivity in rainfed and upland areas regions 4 and 5 through varietal development, integrated pest and nutrient management, technology promotion (training and demonstration):

(1) *Increasing lowland rice productivity in Regions IVA, IVB, and V through pest and nutrient management.* With the different unexpected changes in rice environment, systematic and integrated approach of addressing rice problems should be considered. Scientists and researchers of different specializations are working together, to analyze and address the problem using systems approach, wherein each research field is considered vital to other research fields. This project is addressing rice production and profitability problems in the region through integrated rice research with participation of DA regional field units and local government units. It aims to improve profitability of rice-farming households and other rice stakeholders in the region.

(2) *Rice genetic improvement for rainfed lowland rice and drought-prone environment*. Drought is a major production constraint of rainfed lowland rice. Damage from drought may occur at the seedling and tillering stages, and on some occasions, the damage is also severe at the reproductive stage. Yield losses caused by drought at the combined anthesis and seedling stages were about double those caused by weeds, which was the second-ranked constraint. This project aims to develop rice varieties with high and stable yield, good grain quality, and durable resistance to rice blast for rainfed and drought-prone environments through the integrated application integrated application of the conventional and non-conventional breeding methods.

(3) Development of integrated crop and nutrient management for upland ecosystem. Appropriate soil, nutrient, pest, and cultural management of traditional varieties or

use of improved varieties that suit the climatic and social conditions are some of the strategies to improve upland rice production. The specific objectives of the project are (1) to characterize the climatic, physical, and chemical characteristics of the soil and socioeconomic condition of the upland rice areas; (2) to validate and utilize the upland MOET as a diagnostic tool in determining the nutrient deficiencies of upland soils; (3) to develop an integrated crop and soil nutrient management for upland using both organic and inorganic fertilizer sources; (4) to characterize and develop integrated pest and disease management for upland rice; and (5) to evaluate the effects of various nutrient management regimes on the grain quality of upland rice cultivars

4. PhilRice Bicol (Region 5)

The station's initial R&D activities focused on adaptability trials of newly released and promising inbred and hybrid lines/varieties in irrigated areas. The station also to produce high quality seeds of adaptable varieties in the locality.

5. PhilRice Negros (Regions 6, 7, 8)

PhilRice Negros is tasked to conduct R&D and promotion of science and appropriate production technology for rainfed and organically-grown rice and, secondarily, for irrigated rice, produce seeds of nationally-released and special-purpose rice varieties for the Visayas, and serve as testing, evaluation, and demonstration center for rice engineering and mechanization. The station implemented eight projects with 19 studies with the following highlights:

(1) 10 genotypes were evaluated of which 2 were selected for low-fertilization rate under drought-prone rainfed lowland condition; 110 genotypes were evaluated for early maturity to escape drought, but only 41 had good tillering ability and general crop stand, which were able to withstand crop yellowing.

(2) Efficacy of glutamate was evaluated as possible substitute for proline to mitigate drought effects; glutamate was found half less effective than proline, and its efficacy decreased with increasing dosage.

(3) A soil series guidebook containing information on soil characterized and evaluated in Negros Island, Panay Island, Bohol, Leyte, and Samar were produced; guidebooks for Negros and Panay are now ready for validation. A fertilization map for the low-producing seed production areas of the station has been developed based on Nutrient Omission Plot Trial (NOPT). A computational method for field fertilizer rates based from MOET biomass results was found effective, and has shown that fertilizer level computed was lower than the NOPT recommendation.

(4) Different compost inoculants to decompose rice straw were evaluated. Varying levels were obtained for carbon/nitrogen ratio, total N, available P, and K from the inoculants 4 weeks after incubation indicating different efficacy of the inoculants.

(5) Rice tungro was the most prevalent disease affecting inbreds (PSB Rc14, NSIC Rc146, NSIC Rc160, NSIC Rc220, PSB Rc10, NSIC Rc82, and NSIC Rc128) and hybrids (NSIC Rc132H and NSIC Rc198H). Other minor disease occurrences were narrow brown spot, bacterial leaf streak, bacterial leaf blight, sheath blight, and sheath rot which affected PSB Rc10, NSIC Rc120, and NSIC Rc218. Pesticides were applied to control weeds (*Sphenoclea zeylanica, Hydrolea zeylanica, Paspalum distichum*, and *Echinochloa* spp), insect pests (mostly to manage RTV vector), and golden apple snail. *Cyperus difformis* L and *C. iria* L were the most prevalent weeds

in the rainfed experiment area. Use of pre- and post-emergence herbicides was more efficient than hand-weeding.

(6) In a survey of farmers in rainfed areas of Negros, average yields were 3.13 and 2.40 t/ha during the 1st and 2nd cropping, respectively, from an average of 0.42 ha farm. About 89-92% of farmers interviewed used transplanting as their method of establishment, and 99% used seeds from their farm or from their neighbors. Land preparation lasted 13 days before seeding. *Fimbristylis miliacea* was the most prevalent weed species, followed by *Ischaemum rugosum* and *Cyperus difformis* and *C. iria*. To control weeds, 87% of farmers used water, followed by hand-weeding.

(7) In a survey conducted in 3 organic rice communities of Bago City in Negros Occidental, Masipag lines were the most widely used rice varieties. The most dominant group of weeds was the broadleaves, particularly *Hydrolea zeylanica*, followed by sedges, particularly *Fimbristylis miliacea*. Narrow brown spot is the most prevalent injury, followed by whiteheads. Whorl flies had the highest population among insects, followed by green leaf hopper and whitebacked plant hopper. And spiders were the most common natural enemies.

(8) To increase the productivity of hybrid rice seed production, the influence of planting dates on the flowering behaviors of parents of Mestizo 19 and 20, the new Thermo-Genic Male Sterile (TGMS) hybrids were determined. The male parent of Mestizo 19 (TG101M) flowered earlier than the female parent (PRUP TG101), and the difference between the flowering times of Mestizo 19 parents became closer from 5 to 2 days when planted every 2 weeks from 1 June to 15 July. On the other hand, the female parent of Mestizo 20 (PRUP TG102) flowered earlier than the male parent (TG102M), and the difference of the flowering times of the parents of Mestizo 20 became longer from 1 to 7 days when planted mid-June until 15 July. When planted earlier than 16 June, the male parent flowered earlier than the female by 2 days.

(9) In coordination with the DA-RFU 6, PhilRice evaluated 10 varieties in 21 different locations representing 14 soil series in Region 6. The top varieties based on frequency of occurrence at the top in the different sites were the following: NSIC Rc222 (90%), NSIC Rc15 (67%), NSIC Rc224 (57%), NSIC Rc216 (57%), NSIC Rc9 (33%), and NSIC Rc188 (33%). RTV and blast were found prevalent in some sites and affected some varieties. The highlights pointed out some interactions of varieties and the soil series.

6. PhilRice Agusan and Midsayap (R&D for Mindanao)

Developing Technologies to Propel the Growth of Mindanao as the Next Philippine Rice Bowl

Mindanao has 1.063 M harvested rice areas or 23% of the total harvested rice areas of the country. There is still a great opportunity to further increase the yield level from 3.61 t/ha 5 t/ha which is the yield level at 100% rice self-sufficient national level. To fully exploit the rice production potential of the region, a unified rice R, D & E is needed to be led by the two PhilRice branch stations in Agusan del Norte and North Cotabato.

PhilRice Midsayap focuses on rice research that addresses rice pest problems in Mindanao. The station is also active in seed production and in the development of integrated pest management technologies because of the prevalence of rice pests within the locality.

Tungro, for example, is one of the major problems in the area hence the station develops and promotes tungro-resistant rices such as the Matatag rice lines. The station covers Regions 9, 12, and ARMM.

(1) Development of varieties adaptable to Mindanao biotic and abiotic stresses

Breeding for pest resistance project at PhilRice recognizes the contribution of host plant resistance as an important component of pest management systems. With new rice accessions from IRRI and PhilRice germplasm, new hope is set to identify new sources of resistance gene for rice tungro virus (RTV), bacterial leaf blight (BLB), blast, sheath blight (ShB), rice black bug (RBB), and white stem borer (WSB). Hence, the primary objective of this study is to screen and identify breeding materials with resistance to these major insect pests and diseases of rice.

Of the 120 lines evaluated for pest resistance, 21 were rated resistant to rice tungro disease, 7 entries to BLB, 1 to sheath blight, 107 to rice blast, and 2 to WSB whiteheads; 27 lines were identified with resistance to more than 1 pests. For characterization of blast isolates, only the monogenic line IRBL12-M showed resistance to all blast isolates from irrigated and upland ecosystem. Under upland condition, 18 entries were planted for adaptability trial. Most entries flower at 70 DAS and had a short duration of maturity (98-104 DAS); 3 entries have the most phenotypic acceptability.

(2) Development of appropriate diagnostic tools and IPM options for Mindanao condition

The study on assessment of biophysical and cultural management practices on WSB control shows that natural enemies (predators and parasitoids) of WSB are more prevalent in barangays under Cluster 5 (Irrigated rice + inland swamp + inland marsh) compared to Cluster 1(irrigated rice + coconut +banana + vegetable).

Five rice straw management practices, 4 insect pests management control methods, and 2 indigenous management practices were identified as the common practices employed by the farmers' where higher yield was noted in fields with rice straw incorporation (3.0 t/ha) than rice straw burning (2.0 t/ha).

Three methods for cutting heights namely, 26-30 cm, 46-50 cm, 51-55 cm, and 2 methods for crop establishment (wetbed transplanting [dapog and lap-lap], and direct seeding). Higher stubble heights had higher number of WSB and its natural enemies population.

In Midsayap, planting time varies from 1 season to another. Five schedules of planting time were identified during 2011 WS (February–June), while 4 in 2012 (September–January). The variation in the cropping calendar indicates presence of different crop stages. Farmers who planted late had a higher population of insect pests, which consequently experienced higher pest damage.

Three provinces were also monitored for pest occurrence namely, North Cotabato, South Cotabato, and Sultan Kudarat. Green leafhopper was most abundant in both the DS and WS. White stemborer infestation was also observed across seasons as

evidenced by crop damages at 7–14 days after transplanting, and reproductive phase with mean ranging from 11.91 to 16.80 percent. Among the rice diseases, sheath blight, leaf blast, and narrow brown spot had higher percent incidence.

Among the fermented concoctions tested *in vitro*, indigenous microorganisms-fermented rice (IMO-FR), fish amino acid (FAA), and vermitea were rated very effective against rice blast (*Pyricularia oryzae*). The organic herbal nutrient (OHN) was moderately effective against *Ralstonia solani*. Combination of IMO-FR + FFJ was found very effective (VE) against bacterial leaf bight pathogen of rice, and IMO-R (IMO from Fermented Rice, OHN (Organic Herbal Nutrient) were found effective against bacterial leaf blight and rice blast pathogens. A combination of OHN + Vermitea was also effective (E) against the bacterial leaf blight pathogen.

The evaluation of rice-duck farming systems for pest management shows that lower population of insect pests (GLH, GAS and RBB) was observed on plots herded with ducks at 15 to 60 days after released of ducklings.

(3) Strategic promotion and advocacy of location-specific technologies responsive to socio-cultural diversity in Mindanao: *Area-based Technology Promotion in Southern Mindanao*

As center for the development and promotion of pest management technologies, strategies, and approaches responsive to pest problems the station implemented the following:

The promotion of rice and rice-based technologies was conducted to create awareness among farmers and other stakeholders on cost-reducing technologies to increase their farm yield and income. The promotion focused on exhibits and displays, on-station field day, airing of radio plugs, and distribution of reading materials in Regions 9, 12, and Autonomous Region in Muslim Mindanao (ARMM).

A 2-day training on *Rice S&T Updates for AEWs in Mindanao* was conducted to enhance the technical knowledge and skills of rice coordinators from Western and Southern Mindanao on recent advances in rice science and technology. There were 11 rice coordinators coming from 2 regions, 6 provinces, and 3 cities in South and Western Mindanao (Figure 1). The training highlighted the following rice production technologies: (a) Twoline hybrid rice, (b) PhilRice modified dapog, (c) (MOET, (d) LCC, and controlled irrigation.

Diversified and an integrated rice-based farming system, Palayamanan model farm were established to ensure food availability and increased farm family income and farm sustainability. There were 2 existing sites in Tacurong City. Farmers continuously adapt diversified farming system and planted corn after rice.

PhilRice Agusan is being strengthened to serve as PhilRice's nutrient management center. Zinc deficiency is among the prevalent problems of rice farmers in the area because of frequent rainfall. The station participates in the yield trials for the national cooperative testing project and seed production. It also conducts technology promotion activities in partnership with the local government units. The station covers regions 10, 11 and 13.

(1) Development of varieties adaptable to Mindanao biotic and abiotic stresses

Rice breeding research is one of the major undertakings - testing and evaluating shuttle breeding lines intended to address location-specific problems such as low solar radiation and occurrence of pests. This resulted in the release of some locally-selected rice varieties such as Angelica and PJ7, which dramatically increased rice yields and farmers' income. Ten lines were selected from the medium-late maturing group with yields ranged from 5.81 t/ha - 6.46 t/ha comparable to check varieties; six rice lines that performed better than the check variety (PSB Rc82) with yields ranged from 5.68 t/ha to 6.06 t/ha; a line was selected from direct seeded with 5.02 t/ha yield and with excellent phenotypic acceptability that explains its high yield.

(2) Development of appropriate diagnostic tools and IPM options for Mindanao condition

Rice pest is one of the major problems affecting rice production in the country, specifically in Mindanao. Although management for insect pests, diseases, and other pest problems were already developed, still there is a need to improve pest management strategies to address location-specific conditions in Mindanao and the multiple impacts of the changing climatic conditions that reduce the effectiveness of current pest management strategies leading to greater crop loss. Understanding pest behavior under different rice ecosystems is needed to develop and improve pest management technologies for Mindanao condition. Studies focused on assess of rice pest risk zones; evaluation and utilization of indigenous botanicals for storage insect pest management; enhancement of beneficial organisms through soil amendments; utilization of microbial agents for controlling stemborer and other emerging pest problems.

(3) Development of appropriate ICM diagnostic tools and decision support system for different rice ecosystems in Mindanao

This component aims to improve rice production in irrigated areas in Mindanao where poor soil conditions have been depriving farmers of the full benefit of modern varieties. Primarily, this project will address the technical needs of irrigated rice areas in Mindanao with yields of <4 t/ha, and areas with adverse agro-ecological conditions (rainfed, upland, submergence, and saline-prone areas). Specifically, to (1) identify site-specific soil and climatic factors limiting yield of modern rice varieties in Mindanao, (2) develop/Improve diagnostic tool/methods for soil related problems, (3) generate appropriate technologies that would sustain rice yields in calcareous, light-textured, and degraded soils with multi-nutrient imbalance, and (4) generate location-specific crop management technologies for adverse rice ecosystems (submergence-prone, saline-prone, upland, and rainfed area). Studies focused on improvement of diagnostic method and correction of soil fertility constraints; nutrient management for yield maximization in irrigated lowlands; INM practices for sustainable production in upland areas; and identification of soil fertility constraints in submergence-prone areas.

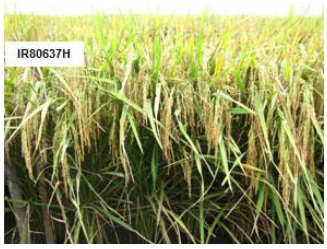
SPECIAL PROJECTS

The National Cooperative Tests (NCT) for Rice

The multi-location testing in the NCT system adapted well in identifying varieties for nationwide and/or location-specific needs. The varieties that were made available to the farmers kept pace with the increasing complex problems in the rice industry. With climate change having a major impact in our ability to grow rice, researchers intensified developing technologies that could mitigate or ease the extreme effects of weather event s or disasters.

With NCT, the ultimate output can be high yielding rice that will provide a supply buffer for farming communities even during periods of climate change. Varieties with biotic and abiotic stress tolerance that were thoroughly evaluated and accepted by farmers are the focus of the new recommendations to the National Seed Industry Council (NSIC). However, in our quest for rice self-sufficiency, high yielding inbreds and hybrids are also developed for favorable conditions.

Rice Technical Working Group (RTWG) recommended 32 varieties and were endorsed by the Technical Secretariat, and eventually approved by the NSIC. These were 2 inbreds and 14 hybrids for irrigated lowlands; 9 for rainfed lowland drought-prone areas; 4 for saline-affected areas; 1 for the uplands; and 2 as specialty rices, a glutinous and a japonica type.



- 14 hybrids for irrigated lowlands: NSIC Rc244H to Rc270H with 6.57 t/ha average yield
- 2 irrigated lowland rice varieties: NSIC Rc238 and Rc240 (Tubigan 21, Tubigan 22) with 5.7 t/ha and 5.3 t/ha average yields, respectively
- 2 irrigated lowland rice varieties (special purpose): NSIC Rc242 (Japonica 2) with 3.74 t/ha average yield; NSIC Rc210 (Malagkit 5) with 4.5 t/ha average yield
- 9 rainfed lowland rice varieties: NSIC Rc272 to Rc288 (Sahod Ulan 2-10) with 3.05 t/ha average yield

Continuing Collaboration with UPLB: Sustainable Development And Utilization Of Resources Program For Rice-Based Agroecosystems (SURPRESA)

Farmers practicing rice-based farming systems in rainfed areas are not much benefited by advances in agricultural technologies. Gaps are identified during technology generation, radiation, and adoption phases. Apparently, these gaps are attributed to the currently dominant top-down flow of technology, which is flawed by ineffective matching of generated technologies and the adoption or adaptation by end-users. Such situation is commonly prevailing due to the absence or minimal participatory involvement of the concerned stakeholders.

The SURPRESA Program would like to minimize the occurrence of the aforesaid situation by focusing on the development of dynamic, responsible and sustainable farmers and farming communities through participatory identification of agricultural problems and development of technologies appropriate to their needs.

The entry point in the communities will be through the LGUs' Comprehensive Land Use Plans, wherein rice-based agricultural priorities are identified at the grassroots level. The initial information will be validated by the collaborating stakeholders and, eventually, the basis in planning the community-specific agricultural strategies, and in setting of attainable and time-lined milestones. Thus, the program will carry out the basic activities of entry, access, control, and empowerment in a community within the context of participatory research and development.

The SURPRESA program aims to develop dynamic communities, and form groups of enlightened and learned farmers who can serve and unselfishly share with other farmers their new knowledge and skills on rice-based farming systems in order to be highly productive, innovative, competitive, and enterprising while protecting the natural resource base.

The basic research component was conducted at UPLB experimental area, strategic/applied research and development in Batangas and Quezon provinces. Typical rainfed rice areas were selected to serve as entry points in implementing the scheduled projects and activities of the program. Pertinent activities related to its implementation were done in consultation with LGUs.

DA-PhilRice-IRRI R&D Project, "Accelerating Rice Self-Sufficiency through Integrated Research, Training, and Extension"

The project was approved in 2009 for three-year implementation as part of the operationalization of the R&D and capacity-enhancement components of the Philippines' Rice Self-Sufficiency Plan of the Department of Agriculture (DA).

The project is composed of three inter-related sub-projects that will develop high-yielding, cost-reducing, and location-specific rice technologies; and strategies and models to promote these technologies to farmers for adoption. It will also develop/use a methodology to map rice areas, and produce a geographically detailed assessment of current and future pest (diseases, insects) risks for rice.

Supportive of the common objectives to attain rice self-sufficiency, improve productivity, and increase income of rice farmers, the following are the project's three areas with their highlights of accomplishments:

Sub-Project 1: Strategic Assessment of Yield-Limiting and Reducing Factors in the Philippines

The application of Synthetic Aperture Radar (SAR)-based methodologies in rice crop area monitoring was demonstrated to PhilRice and IRRI researchers by sarmap (a Swiss company) in 2010. Nineteen sites were identified across the Philippines which are being monitored on dates that correspond to the remote sensing imagery dates. The observations are used to calibrate the rice mapping algorithm so that it can detect key stages in the growing season such as flooding, emergence, and harvesting.

A second training course was conducted by sarmap at IRRI on April 4-8, 2011 on the use of SAR for monitoring rice areas. The new version (version 4.3) of RICEscape was demonstrated and revised, and the acquisition plan for the 2011

wet season was developed (around 500 images). This new version supports SAR data acquired by ENVISAT ASAR, ALOS PALSAR, and COSMO-SkyMed as well as optical data acquired by Landsat (5 TM and 7 ETM+). A field trip was conducted in Laguna to assess the accuracy of the new RICEscape software, which was found to be highly accurate. The next season's activities are to complete the processing of images collected to come up with rice area maps; arrange the third training on the software to be conducted by sarmap; and develop a training manual for rice mapping with the RICEscape software.

On rice pest assessment, a capacity-building process on crop health was proposed to be established in the Philippines. This will focus on preventing risks in rice crop health and will complement the efforts of other countries in rice pest surveillance systems and risk management. As part of this process, workshops were conducted to discuss the implementation of the IRRI survey portfolio for the characterization of yield-reducing factors in selected sites.

Seven trainings/workshops were conducted in 2009-2011, participated in by 239 personnel from PhilRice, DA, ATI, local government units, and state universities, aimed to: (1) share basic knowledge and demonstrate the identification of rice diseases, animal pests, and weeds; (2) demonstrate procedure for collecting data on crop health and production situation in farmers' fields using the IRRI Crop Health Characterization Portfolio; (3) share information on crop health management, and methods in data analysis and modeling; and (4) train participants in data processing.

A total of 184 farmers' fields were surveyed from 2009 to 2010 covering three cropping seasons. Data on crop health and production situation were collected according to the procedure described in the IRRI Crop Health Characterization Portfolio. The portfolio involves 70 variables that are collected and measured in farmers' fields - 35 variables refer to field location, variety, agroecology, crop stage and status, management and yield; others pertain to injuries caused by diseases, animal pests, and weeds. The surveys were conducted in Isabela, Cagayan, Nueva Ecija, Iloilo, Negros Occidental, Agusan del Norte, and North and South Cotabato. These sites represent very contrasting production environments and are considered as important rice production areas of the Philippines.

Sub-Project 2: Accelerating the Development and Adoption of High-Yielding Rice Varieties and Associated Technologies for the Major Ecosystems of the Philippines

Multi-location testing of elite breeding lines/cultivars was conducted in irrigated (Isabela, Nueva Ecija, Laguna, Camarines Sur, Bohol, Agusan del Norte, and North Cotabato); and rainfed (Ilocos Norte, Iloilo, Negros Occidental, Aurora, and Nueva Ecija) lowland rice areas. A total of 120 test entries from PhilRice, IRRI, and UPLB were evaluated in the said sites during 2009 WS to 2011 WS. Of these, 21 entries (9 from IRRI and 12 from PhilRice) were nominated to NCT for nationwide testing. These were selected because of their high-yielding potentials, excellent grain qualities, and resistance to biotic and abiotic stresses.

In 2011, a multi-environment testing (MET) system was employed to improve overall breeding efficiency. The MET system is sequential beginning with the early-generation breeding materials that will be evaluated in a wider range of environment within the irrigated lowland ecosystem. It comprised 900 test breeding lines developed by the various breeding programs (hybrid and inbred) of IRRI and PhilRice.

Developing breeding lines and varieties for direct seeding. Diversity and stress adaptation (DSA) panels comprising more than 200 entries were established in Pangasinan, Ilocos Norte, Nueva Vizcaya, and Nueva Ecija. Considering overall performance in terms of grain yield, vigor, and phenotypic acceptability across locations, 34 entries were selected for further hybridization with elite varieties in 2010 WS. A total of 26 populations were advanced to 2011 WS.

Developing appropriate water and weed management techniques under dry row-seeding crop establishment. Three water management techniques: saturated soil condition (SSC), alternate-wetting and drying (AWD), and aerobic rice field condition (AFC) were used under dry row-seeding during the 2010-2011 dry seasons (DS). Grain yields varied from 2.06-3.08 t/ha 2010 DS, and 5.17-5.66 t/ha in 2011 DS. There was no significant effect of water management on grain yields in both seasons. Water productivities with respect to irrigation (WP_I) ranged from 0.30 - 0.33, and 0.96 -1.24 kg rice per cubic meter of water in 2010 and 2011 DS, respectively. Highest WP_I was achieved by AWD and AFC in 2010 and 2011 DS. With less water requirement in direct seeding and less water use in SSC, AWD and AFC, substantial water savings can be achieved without significant effect on grain yield.

Improving implements for direct-seeded and minimum tillage under dry row-seeding crop establishment. The rising labor cost and the need to intensify rice production have led to changes in crop establishment methods for rice. The traditional transplanting method is being slowly replaced by direct sowing on dry-tilled soil (dry seeding). Dry seeding offers advantages over wet planting considering the water and cost requirements. Higher efficiency is also expected in dry seeding method. Changes in crop establishment practices have important implications on farm operations including primary tillage, weeding, and water management.

A tillage equipment prototype adapted from the PhilRice-developed rototiller was fabricated. Residual soil moisture appropriate for tillage operation was optimized. The seeder attachment was developed and tested based from the plastic drum seeder. The machine has a field capacity of 1.56ha/day at forward speed of 1.62pkh; seeding rates are 23.08-51.31kg/ha and 37.01-99.17kg/ha for long and short grains, respectively. Further tests and modifications are required to improve the seeder's performance.

Marker-assisted selection to accelerate breeding for tolerance to major biotic and abiotic stresses. For bacterial blight resistance, marker-assisted selection was used for *Xa4*, *xa5*, *Xa7, Xa21.* Two (RM336 and RM21800) of the seven SSR markers for the tungro resistance gene from Utri Merah (*tsv1*) showed a good resistant-susceptible allele pattern between the donor lines and commercial cultivars.

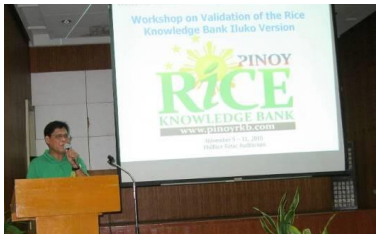
A total of 38 advanced lines were selected with at least two of the following resistance genes *Xa4*, *xa5*, *Xa7,* and *Rtv-* flanking markers for evaluation in MET. In the F_6, a total of 81 lines were confirmed to contain at least two *Xa* genes during 2011 WS evaluation.

New resistance sources were obtained from IRRI in 2011 DS for bacterial blight, blast, and brown planthopper resistance genes. These sources will be integrated into the PhilRice irrigated lowland breeding program starting in 2012 DS.

Putative markers for drought tolerance identified by IRRI from four mapping populations were initially tested for polymorphism between tolerant and susceptible parents and NILs. A cross between IR74371-3-1-1 (*DTY12.1*) and NSIC Rc160 was made in 2010 DS, followed by three cycles of backcrossing to NSIC Rc160 in 2010 WS, 2011 DS, and 2011 WS. The backcrosses will be planted in 2012 DS for target gene genotyping and selection for phenotypic acceptability. This backcrossing scheme is being pursued to improve the drought tolerance of NSIC Rc160 and make it adaptable for drought-prone rainfed lowland conditions.

Production of high-quality parental seeds of hybrids. Nucleus and breeder seeds of released public hybrids (bred by IRRI and PhilRice) were produced. These are the parental lines of IR68284H (Mestizo 1), IR75217H (Mestiso 3), IR78386H (Mestiso 7), PRUP7 (Mestiso 19), PRUP 9 (Mestiso 20), and IR83199H (Mestiso 21).

Sub-Project 3: Unified Capability-Building Support



The Philippine Rice Knowledge Bank (PRKB) has been established, known as Pinoy Rice (www.pinoyrkb.com), to serve as a single source of rice information and technology options that will support the requirements of farmer-intermediaries and farmers. Five PRKB workshops were conducted to translate information materials (e.g., fact sheets and other information resources) into the Tagalog, Cebuano, Hiligaynon, Iluko, and Kapampangan languages.

Pinoy RKB was launched on November 5, 2010 during PhilRice's Silver Anniversary celebration with Sen. Francis Pangilinan as guest. It showcased the website's contents - images (graphics and photos), video clips, audio files, PowerPoint presentations, handouts, broadcast releases, knowledge products, training announcements, basic rice statistics, a seed growers' directory, rice facts, maps, rice recipes, rice production plan/proposal formats, answers to frequently asked questions, a rice e-dictionary, rice business (marketing), links to other existing virtual platforms such as e-forums, e-commerce, and e-learning, and location-specific information on Philippine rice farming.

The Website Analytics Report in December 2011 presented an average of 4,647 visitors of PRKB per month, 60% of them unique. July has the most visitors as it coincides with the start of the wet season planting.

A pool of multi-agency Filipino rice experts who will serve as resource persons in training regional, provincial, and local agricultural trainers and extension workers has been mobilized. Several workshops and trainings were conducted nationwide. Five island-wide Training of Trainers (TOT) sessions were conducted with more than 150 farmer-intermediaries composed of trainers from ATI, DA-RFUs, LGUs, Academe, IAs, and other partners.

Two batches of refresher Courses on Participatory Adaptive Research were conducted for 52 researchers and extension workers of DA-RFUS and LGUs. The courses were developed to support the technology needs of the Rice Self-Sufficiency Program (RSSP), and are based on on-farm adaptive research (OFAR) that facilitates the participatory technology adaptation process and encourages farmers to adapt and use technologies implemented in actual field conditions.

Information materials such as fact sheets, compact discs/videos, a provincial quick guide on climate change-ready technologies, and water and nutrient management were distributed to extension workers and trainers around the country. Foundation seeds of selected varieties for drought, submergence, and saline-soil ecosystems were distributed in Pangasinan, La Union, Ilocos Norte, Ilocos Sur, and Palawan for seed multiplication.

Network and stakeholders' partnerships. Meetings and workshops were conducted for the establishment of a technical working group in Agusan del Norte. An agreement was forged with the Philippine Association of State Universities and Colleges VI and the West Visayas State University for the conduct of survey in Iloilo.

Monitoring, assessment, and documentation. Baseline surveys were conducted in Agusan del Norte, Iloilo, and Isabela with 936 farmer-participants of FFS/LSTD. The surveys covered DS/WS 2010 farm input use, production and disposal, Knowledge-Attitudes-Practices, adoption and use of rice technologies, and learnings from government trainings attended.