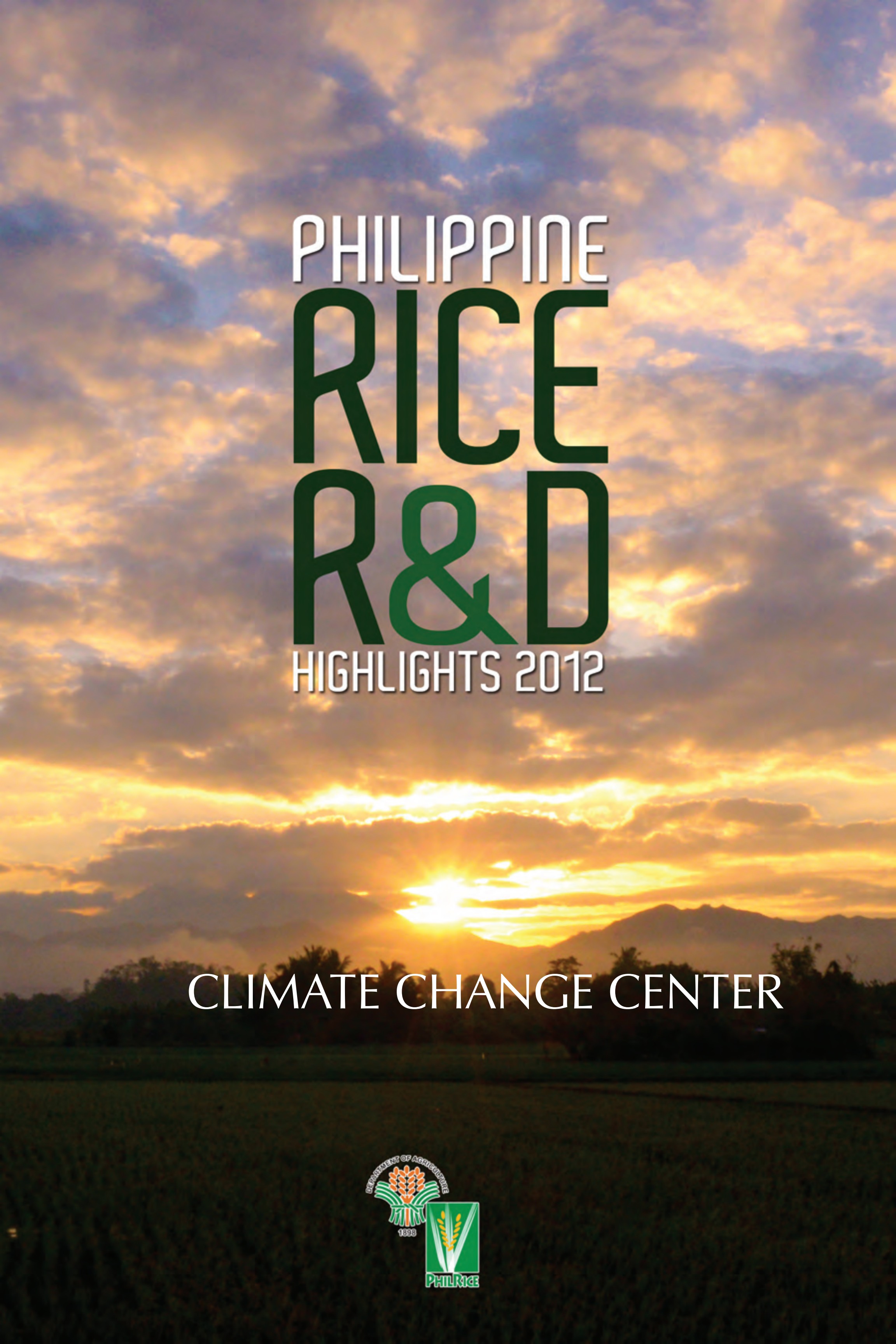

# PHILIPPINE RICE R&D HIGHLIGHTS 2012

## CLIMATE CHANGE CENTER

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# Climate Change Center

Center Director: Ricardo F. Orge

The Climate Change Center (CCC) was established in 2011 by virtue of PhilRice Administrative Order No. 2011-04 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". The Center provides central direction, leadership and coordination of rice and climate change - related research and development activities and ensures optimum utilization of research outputs related to climate change mitigation and adaptation.

In 2012, at least 80 climate change-related studies were implemented by PhilRice. Most of these studies were conducted under two research programs of the Institute, being part of their mandate – like for example, the development of rice varieties resistant to soil salinity, drought, water submergence, and many others. This report covers only those implemented by the CCC which consisted of three projects and a total of 10 studies. Project 1 covers climate risk and vulnerability assessment as well basic studies dealing on the generation of knowledge about the science of climate change. The outputs of this project are expected to provide rice researchers the needed basic knowledge and information in order for them to plan and implement sound research studies dealing on climate change adaptation. Project 2 covers the researches dealing on the development of technologies and the generation of information that would contribute to build the adaptive capacity of the rice and rice-based farming communities to climate change. Since rice farming also generates greenhouse gases (which make it also a contributor to climate change), Project 3 is being added to address issues and concerns on minimizing greenhouse gas emissions in rice production and processing.

## I. Climate Change Vulnerability Assessment and Knowledge Generation

Elmer D. Alosnos

The impacts of global climate change are already felt in the Philippines. Frequent occurrence of devastating droughts and floods, warming temperatures, and increasing weather variability were among the local manifestations of a changing climate. This scenario has negative implications to rice farming communities and must be addressed with urgency through technological support and enabling policies that will elevate the adaptive capacity of farming communities. However, interventions must be tailored to the specific needs of farming communities which are usually hinged to biophysical and socio-economic situations of the area. For a climate change adaptation initiative to become more effective at the farmer's level, information such as exposure of the area to climate-related hazards, crop yield sensitivity to temperature increase or change in seasonal rainfall, and adaptive capacity of the communities are vital inputs in designing and implementing adaptation strategies. This set of information can be captured through a comprehensive and location-specific vulnerability assessment based on the Intergovernmental Panel on Climate Change (IPCC, 2007) impact and vulnerability assessment framework. Hence, this project was implemented to evaluate the effects of climate change on rice production and determine the extent of vulnerability of rice farming communities. Outputs of the project are expected to contribute in the development of appropriate technologies and formulation of policies related to climate change adaptation.

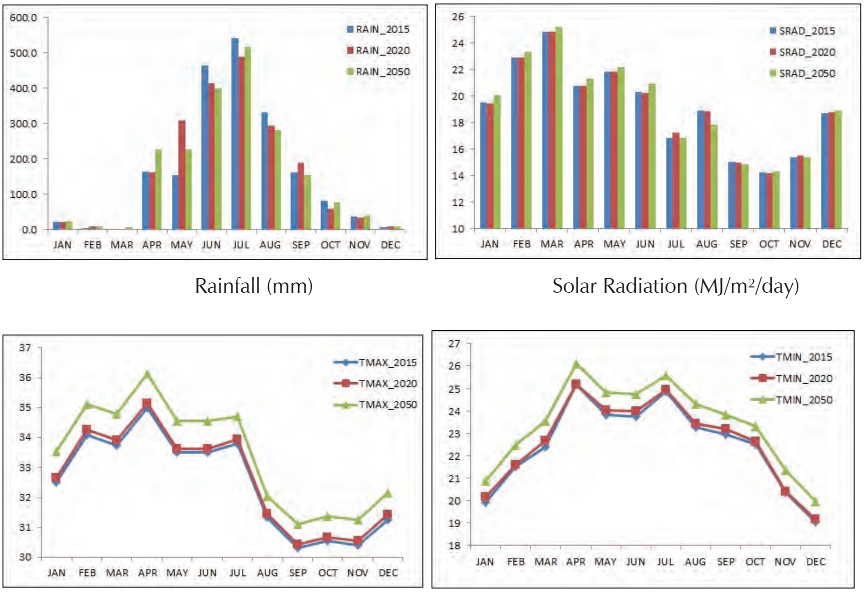
**Climate change impacts and vulnerability profiling of major rice-producing areas in the Philippines**
ED Alosnos, EJP Quilang, PE Mabalot, VT Dimaano, JM Rivera, and AA Corpuz

**Highlights:**

- Developed projections of climate change in pilot areas using the MarkSimGCM stochastic weather generator (Figure 1).

- Validated the DENR-MGB flood susceptibility map of pilot areas. In the case of Munoz, Nueva Ecija, the barangays with high susceptibility to flooding (areas with greater than 1 meter flood height) are Bagong Sikat, Catalanacan, Franza, Matingkis, Pandalla, and Villa Santos. These areas are usually flooded for several hours during heavy rains and include landforms of topographic lows such as active river channels, abandoned river channels and areas along river banks. These areas are also prone to flash floods. The validated flood susceptibility maps will be overlaid in the existing rice area maps to delineate flood-prone rice areas.

- Compiled and processed the data of potential vulnerability indicators (increase in temperature, percent change in rainfall, percentage of area prone to drought and flooding, percentage of irrigated area, crop diversification index, land degradation index, literacy rate, rice yield sensitivity index, percent share of agricultural GDP, etc)




Rainfall (mm) | Solar Radiation (MJ/m²/day)

Maximum Temperature (⁰C) | Minimum Temperature (⁰C)

**Figure1.** Climate projections in Munoz, Nueva Ecija for 2015, 2020 and 2050 generated using MarkSimGCM (Ensemble mean for CNRM-CM3, CSIRO-Mk3_5, ECHam5 and MIROC3.2 under A1B Scenario).

**Assessment of climate change adaptation and mitigation opportunities, gaps and barriers in major rice-producing areas**

ED Alosnos, EJP Quilang, PE Mabalot, VT Dimaano, and JM Rivera

**Highlights:**

- Conducted inventory of climate change mitigation and adaptation technologies and best practices in rice production which adopted by farmers in pilot sites. Also, we conducted inventory of other potential technologies and best practices from published literatures for farmers' adoption.

- Developed factsheets of the potential technologies and good practices. The content of the factsheets includes details of the technology and the potential benefits in terms of climate change adaptation and mitigation.

## II. Enhancing the Climate Change Adaptive Capacity of Rice and Rice-Based Farming Systems

Rizal G. Corales

The purpose of the project is to enhance the adaptive capacity towards climate change-resilient rice and rice-based systems. In order to attain this purpose, it is necessary to develop, evaluate and enhance climate change adaption strategies and technologies in the rice-based farming communities.

### Development of weather-based decision support system as coping mechanism to climate change

ED Alosnos, EJP Quilang, PE Mabalot, VT Dimaano, JL de Dios, AC Arocena, RF Orge

The main purpose of PhilRice Climate Change Center - Agrometeorological Observatory is to study and apply meteorological data and information and address weather and climate related problems for optimal crop production. Timely, accurate, and adequate provision of agro-meteorological information is very important to facilitate farmer's operational decision-making. Under favourable climate conditions, agro-meteorological information when aptly utilized by farmers will help increase farm profits, or may reduce farm losses when climate is unfavourable for crop production. PhilRice scientist and researchers also needs climatic data for their research experiments.

**Highlights:**

- Maintained 5 agromet stations and 6 automatic weather stations (AWS) at PhilRice stations. Data of various weather parameters were gathered twice a day using manual instruments or at every 15-minutes interval if using the AWS. Statistical analysis of weather data has been done and generated weekly, decadal, and monthly weather summaries (see Table 1).

- PhilRice online climate database management system (CDMS) has been improved and several features were added. The enhanced version of CDMS served as the main repository of all agro-meteorological data and information which found useful for PhilRice researchers, students, and farmers.

- Developed farm advisories during extreme weather events, and agronomic-tailored seasonal climate forecasts that served as guide for the farmers in response to the climate condition of the incoming season. The information can be accessed through PhilRice website (see Figure 2).

- Deployed 8 units of Field Monitoring Station (FMON) at PhilRice stations in CES, Isabela, Batac, and Bicol (Figure 3). Each FMON station is equipped with multi-parameter weather sensors and wireless network camera that automatically collects data on air temperature, rainfall, humidity, solar radiation, wind speed/direction, evapotranspiration, barometric pressure, leaf wetness duration, depth of field water table, soil moisture and temperature, and real-time field images. The FMON communication system uses a wireless LAN (Wi-Fi) access point to transfer data from the remote FMON stations to the main server. The developed field monitoring system is foreseen as an ideal tool for real-time crop field monitoring with multi-sensing, ubiquitous networking, and image monitoring capabilities.

**Table 1.** Summary of 2012 weather data recorded at PhilRice CES.

| | Sunshine Duration (hrs/day) | Solar Radiation (KJ/m²/day) | Relative Humidity (%) | Rainfall (mm) | Maximum Temperature (°C) | Minimum Temperature (°C) | Wind Speed (kph) | Max. Wind Speed (kph) |
|---|---|---|---|---|---|---|---|---|
| Jan | 7.6 | 17.5 | 78.0 | 13.7 | 32.8 | 21.6 | 10.9 | 51.5 |
| Feb | 7.6 | 18.2 | 80.0 | 7.2 | 33.2 | 20.0 | 8.7 | 40.3 |
| Mar | 6.9 | 21.0 | 80.1 | 40.3 | 34.2 | 19.5 | 7.3 | 37.1 |
| Apr | 10.1 | 23.5 | 75.0 | 33.5 | 38.0 | 21.0 | 4.3 | 35.3 |
| May | 8.1 | 22.0 | 74.1 | 210.2 | 37.8 | 22.5 | 2.9 | 41.8 |
| Jun | 4.8 | 14.7 | 85.6 | 356.0 | 34.6 | 23.0 | 4.0 | 40.3 |
| Jul | 4.9 | 15.5 | 86.7 | 517.5 | 34.7 | 23.3 | 4.1 | 53.3 |
| Aug | 3.1 | 12.9 | 88.9 | 556.7 | 33.8 | 22.8 | 3.2 | 35.3 |
| Sep | 3.7 | 16.3 | 87.1 | 166.4 | 35.1 | 23.0 | 2.7 | 28.8 |
| Oct | 4.9 | 17.2 | 80.7 | 121.2 | 34.5 | 20.8 | 4.5 | 40.3 |
| Nov | 7.5 | 17.5 | 77.0 | 22.0 | 35.9 | 20.4 | 5.9 | 38.5 |
| Dec | 6.5 | 16.0 | 75.3 | 4.0 | 34.6 | 21.0 | 10.0 | 56.2 |
| Annual | **6.3** | **17.7** | **80.7** | **2048.7** | **38.0** | **19.5** | **5.7** | **56.2** |


**Figure 2.** Example of developed seasonal climate forecast posted in PhilRice website

Figure 3. Field Monitoring Station installed at PhilRice Batac and Bicol

**Development and testing of mitigation options for methane emission from rice fields**
CA Asis Jr., FS Grospe, WB Collado, RG Corales, and EJP Quilang

Methane emission mitigation technologies should be developed to lessen the impact of rice production on greenhouse gas emission without affecting the yield. Consequently, reducing methane emissions lessens its effect on global warming and climate change. Because of the possibility of controlling emissions by agronomic practices, paddy field management must be one of the most likely means of mitigating methane emissions.

In this study, the potential of we determine the effect of varying levels of carbonized rice hull (CRH) on methane emission from rice fields. Moreover, we determined the effect of nitrogen management (use of leaf color chart [LCC]) on methane emission from rice. A greenhouse experiment was conducted to elucidate the effects of varying sources of Si-rich materials on the rice growth, yield, and methane emissions under Louisiana soils. The treatments were application of varying rates (0, 4, 8 t/ha) of Si from Si-accumulating crops (CRH, carbonized sugarcane thrash [CST]) and commercial calcium silicate (CCS) fertilizer on rice cv. CL261 planted in two soils (Perry clay and Crowley silty loam) of Louisiana.

Methane measurements were taken between 9:00 am-12:00 noon at different growth stages of the crop by taking gas sample from the headspace of an open–bottom cylindrical chamber. Gas samples were analyzed using gas chromatography (Shimadzu GC 14-A) with a flame ionization detector and electron capture detector. The emission was determined from the slope of three samples taken from 10 minutes, 20 minutes, and 30 minutes sampling period.

The flux (mg CH4 m2h-1) from the temporal increase of the gas concentration inside the chamber per unit time was calculated from the formula: $F = k \bullet h \bullet dC/dt\ (273/T)$, where K = constant for conversion from volume to weight ($CH_4$=0.536), h= chamber height above water level (m), dC/dt) = change in concentration (ppv) per unit time (h), and T= air temperature inside the chamber (oK).

Highlights:

- Methane flux in plots applied with varying levels of CRH tended to be lower than those without CRH application; i.e. plots with CRH had lower 34-46% lower methane emission. However, statistical analysis showed that methane emissions in treated plots were comparable with that of the untreated control plots (Figure 4).

- Moreover, methane emission did not vary significantly between LCC-based N and Calendar-based N management, indicating that N management did not influence methane emission during the dry season (Figure 5).

- Results also showed that application of varying rates and source of Si-fertilizer did not increase growth parameters such as tiller number and plant height (data not shown). Environmentally, CCS fertilizer reduced methane emission by 17-22% over that of the control in both soil types. Moreover, CRH and CST did not increase methane emission (Figure 6). Moreover, methane emission did not vary significantly between Perry clay and Crowley silt loam soil.

- The significant reduction in $CH_4$ emission with application of CCS fertilizer could be attributed to free Fe oxide released by the fertilizer. Fe oxide was reported to inhibit $CH_4$ formation and increase oxidation of $CH_4$. Moreover, CCS fertilizer is typically a by-product of the steel industry which harnessed the heat of iron oxidation reaction. Thus, this study showed that application of CCS could be one of the mitigating options for reducing methane emissions from rice fields.

**Methane emission (mg/h/m2)**

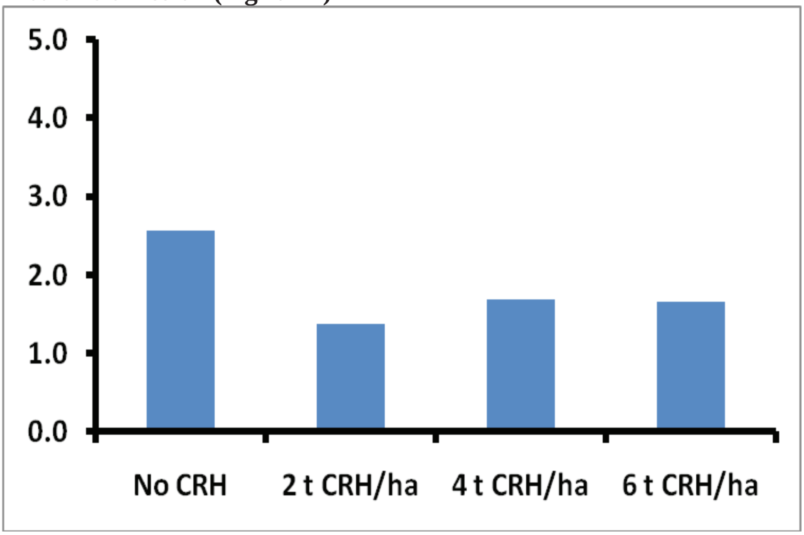



**Figure. 4.** Methane emission from rice fields as influenced by application of varying rates of carbonized rice hull, PhilRice 2012 DS.

**Methane emission (mg/h/m2)**

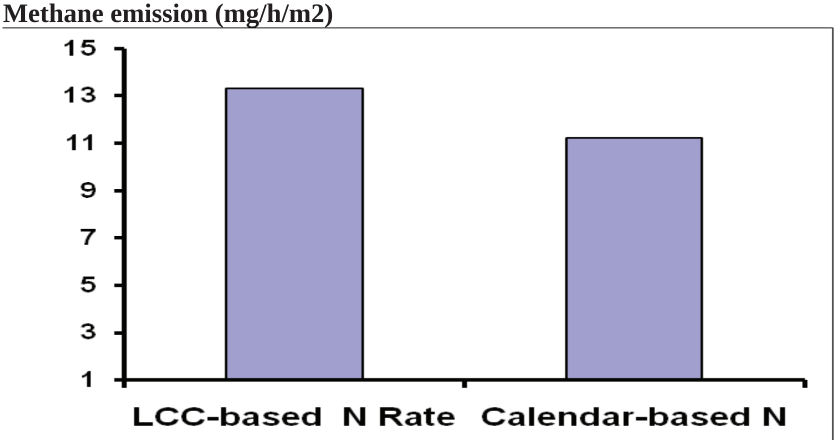



**Figure 5.** Methane emission from rice fields with LCC-based and calendar-based N fertilizer application, PhilRice 2012 DS.

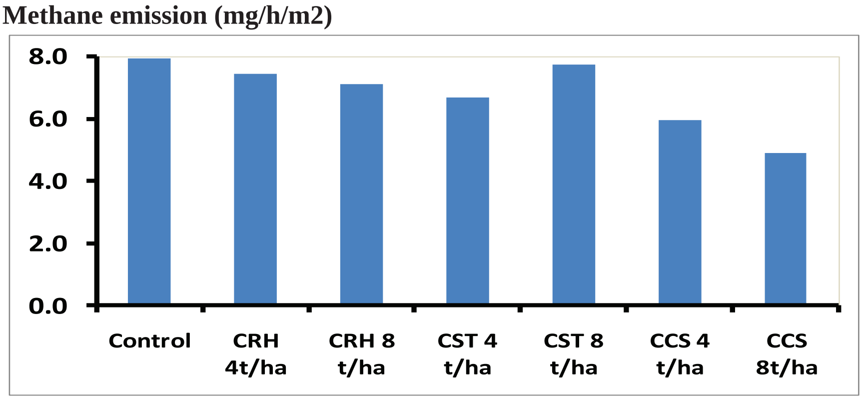



**Figure 6.** Methane emission from rice as influenced by application of varying sources and rates of silicon fertilizer. CRH=carbonized rice hull; CST= carbonized sugarcane thrash; CCS = commercial calcium silicate fertilizer.

**Table 2.** Performance of tomatoes grown in the floating gardens using different planting media. PhilRice CES, Science City of Munoz, Nueva Ecija. DS 2012.

| Planting Soil Media | No. of Fruits/plant* | | Yield/$m^2$ (kg)* | |
|---|---|---|---|---|
| | Diamante Max | Diamante | Diamante Max | Diamante |
| 125 kg/$m^2$ Potting Soil Media (PSM) | 13b | 8b | 2.1b | 1.5b |
| 50 kg/$m^2$ PSM + 0.50 m layer of water hyacinth | 19a | 15a | 3.0a | 2.5a |
| 25 kg/$m^2$ PSM + 1.0 m layer of water hyacinth | 11b | 8b | 1.9b | 1.4b |

*Means having similar letter in a column are not significantly different at 5% LSD

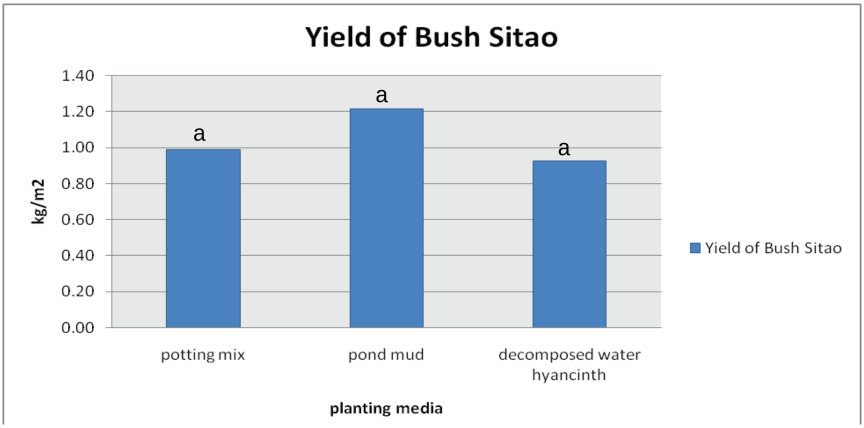



**Figure 7.** Yield of bush sitao grown in the floating gardens at different planting media. PhilRice CES, Science City of Muñoz, Nueva Ecija. WS 2012.

Table 3. Performance of upland kangkong (Ipomea reptans) grown in aquaponics floating raft garden. PhilRice CES, Science City of Munoz, Nueva Ecija. WS 2012

| Planting Media | Germination Rate (%) | Yield | |
|---|---|---|---|
| | | Planting Container (g) | kg/m$^2$ |
| Potting soil media | 50b | 21.1a | 2.1a |
| CRH | 70a | 11.6b | 1.2b |
| Rice hull | 60ab | 4.4c | 0.4c |
| Foam | 30c | 1.9d | 0.2d |


**Figure 8.** Vegetables raised in floating raft gardens.

**Development of rice-based farming systems based on agro-climatic zones**
RGCorales, JMRivera, EDAlosnos, EJPQuilang, VTDimaano and AACorpuz

**Highlights:**

- Collected and collated the solar radiation and wind speed from 1990 to 2009 in Region III

- Identified the agro-ecological zones distribution in Region III (Table 4)

- Conducted survey on the existing cropping patterns and calendars in the representative agro-climatic zone sites (Table 5).

**Table 4.** The agro-climatic zones distribution in the different provinces of Region III.

| Provinces | Agro-Climatic Zones |
|---|---|
| Aurora | 1, 3, 4, 8, 10, 12 |
| Bataan | 3, 4, 12 |
| Bulacan | 3, 4, 12 |
| Nueva Ecija | 3, 4, 10, 12 |
| Pampanga | 3, 4, 10, 11, 12 |
| Tarlac | 3, 4, 10, 11, 12 |
| Zambales | 3, 4, 10, 11, 12 |

**Table 5.** Cropping patterns and cropping calendars of the representative sites in the different agro-climatic zones.

| Representative Sites | Cropping Pattern | Cropping Calendar |
|---|---|---|
| Mission, Sta Teresita Cagayan (ACZ 5) | Rice-Rice | Second Cropping (DS): May-Jul to Sept-Nov (June to October)<br>First Cropping (WS): Nov-Jan to Mar-May (Dec to April) |
| | Corn-Corn | June -Oct to Dec-April |
| Malasin, San Mateo, Isabela (ACZ 8) | Rice-Rice | First Cropping (WS): May-June to Sept-Oct (June to October)<br>Second Cropping (DS): Nov-Dec to March-April (Dec to April) |
| | Rice-Rice-Mungbean | First Cropping (WS): July to Oct<br>Second Cropping (DS): Dec to March Mungbean Crop: March to May |
| San Rafael, Bulacan (ACZ 12) | Rice-Rice | First Cropping (WS): May-July to Aug-Oct (May to Aug)<br>Second Cropping (DS): Oct-Feb to Feb-May |
| Magalang, Pampanga (ACZ 12) | Rice-Rice | First Cropping (WS): June to Oct<br>Second Cropping (DS): Dec to April |
| Dinalupihan, Bataan | Rice-Rice-Rice | First Cropping (WS): July to Oct-November<br>Second Cropping (DS): Nov-Dec to Feb-Mar<br>Third Cropping: Mar-May to June-July |

## Validation of rice + duck production system in the rice-based farming communities

JM Rivera, RG Corales, VT Dimaano, AA Corpuz, and RV Valentino

**Highlights:**

- The yield obtained from the conventional rice production (CRP) in 2012 DS was 8.62 t/ha (Table 6) with a net income of P78,132.00/ha (Table 7), while in the conventional rice production + duck (Figure 9), the yield and net income was 9.20 t/ha and P103,494.12/ha, respectively. The integration of duck in the convention rice production system during the dry season had a yield advantage of 0.58 t/ha or income advantage of P25,362.12/ha.

- The yield in the organic-based rice production (ORP) in 2012 DS was 5.78t/ha and a net income of P43,541.00/ha. Duck integration in the ORP produced 1.04t/ha yield advantage or an income advantage of P24,000.00/ha.

- In the WS, the yield in the conventional rice production with duck was 6.04 t/ha or 0.45 t/ha higher than the yield of the conventional rice production system (5.59 t/ha, Table 6). The yield obtained from the organic-based rice production system with or without duck was around 5.2 t/ha. The relatively low yields obtained from all the rice production systems were due to the effect of typhoon.

- In the WS, the net income from conventional rice production with duck integration was P51,979.40/ha (Table 8) or with an income advantage of P 21,573.00 over the conventional rice production. In the organic-based production system, duck integration provided around P16,000.00 income advantage compared with the sole organic-based rice production system.

**Table 6.** Yield and yield components of Dasanbyeo variety under different rice production system with duck integration. PhilRice CES. 2012.

| Production System | Yield (t/ha) | Tiller /m$^2$ | Panicle /m$^2$ | Filled grains/ panicle | % filled grain | Spikelet /panicle | 1000 grain weight (g) |
|---|---|---|---|---|---|---|---|
| | 2012 Dry Season | | | | | | |
| Conventional Rice Production (CRP) | 8.62 | 363 | 363 | 102 | 90.7 | 112.4 | 27.1 |
| CRP + Duck Production System | 9.20 | 413 | 408 | 114 | 92.4 | 124.9 | 26.9 |
| Organic Rice Production (ORP) | 5.78 | 381 | 375 | 104 | 92.7 | 112.1 | 27.4 |
| ORP + Duck Production System | 6.82 | 385 | 383 | 113 | 91.3 | 106.7 | 27.1 |
| | 2012 Wet Season | | | | | | |
| Control | 4.92 | 168 | 162 | 93.87 | 88.02 | 106.6 | 29.4 |
| Conventional Rice Production (CRP) | 5.59 | 200 | 197 | 81.71 | 76.77 | 105.6 | 27.7 |
| CRP + Duck Production System | 6.04 | 210 | 203 | 94.76 | 76.73 | 123.7 | 29.1 |
| Organic Rice Production (ORP) | 5.16 | 177 | 173 | 83.55 | 76.63 | 109 | 29.2 |
| ORP + Duck Production System | 5.25 | 180 | 180 | 85.87 | 74.54 | 135.4 | 29.4 |

**Figure 9.** Mallard ducklings at first day in the rice field (10 days after transplanting). PhilRice CES. 2012 DS.

**Table 7.** Cost and return analysis of different rice production system, PhilRice CES. 2012 DS.

| Particulars | Conventional Rice Production (CRP) | CRP+Duck | Organic-Based Rice Production (ORP) | ORP+Duck |
|---|---|---|---|---|
| Rice Production | | | | |
| Gross Income (Sales of palay @ P15.00/kg) | 130,200.00 | 138,000.00 | 86,700.00 | 120,300.00 |
| Expenses: | 52,068.00 | 53,032.00 | 43,159.00 | 45,095.00 |
| *Net Income* | *78,132.00* | *84,968.00* | *43,541.00* | *57,205.00* |
| Duck Production | | | | |
| Gross Income (1000 ducks @ P130.00/head) | | 130,000.00 | | 120,900.00 |
| Expenses | | 111,473.88 | | 110,563.88 |
| *Net Income* | | *18,526.12* | | *10,336.12* |
| Total Net Income | P78,132.00 | P103,494.12 | P43,541.00 | P67,541.12 |

**Table 8.** Cost and return analysis of different rice production system, PhilRice CES. 2012 WS.

| Particulars | Conventional Rice Production (CRP) | CRP+Duck | Organic-Based Rice Production (ORP) | ORP+Duck |
|---|---|---|---|---|
| Rice Production | | | | |
| Gross Income (Sales of palay @ P15.00/kg) | 72,670.00 | 78,520.00 | 67,080.00 | 68,250.00 |
| Expenses: | 42,228.60 | 44,021.60 | 38,566.40 | 38,885.00 |
| *Net Income* | *30,441.40* | *34,498.40* | *28,513.60* | *29,365.00* |
| Duck Production | | | | |
| Gross Income (1000 ducks @ P130.00/head) | | 130,000.00 | | 127,400.00 |
| Expenses | | 112,519.00 | | 112,259.00 |
| *Net Income* | | *17,481.00* | | *15,141.00* |
| Total Net Income | 30,441.40 | 51,979.40 | 28,513.60 | 44,506.00 |

## Improving productivity and livelihood in swamp and flood-prone rice-based farming communities in Region III

RG Corales, VT Dimaano, LM Juliano, JM Rivera, AA Corpuz, and EJP Quilang

Highlights:

- Technical briefings were conducted in Barangay Del Pilar, Pandaras and San Felipe, San Fernando Pampanga; Candaba, Pampanga; and Barangays Bulusan, Calizon, and Sta. Lucia in Calumpit Bulacan (Figure 10).

- The water hyacinth floating garden model was adapted in Del Pilar, San Fernando, Pampanga in partnership with the Barangay Council of Del Pilar, LGU- City of San Fernando and PAC (Figure 11). Six water hyacinth floating beds with a dimension of 1.5 m x 10 m were established and planted with upland kangkong, eggplant, pepper, and tomatoes. The floating garden survived the monsoon rain (Habagat) with 2 meter flooding In August 2012. The activity was temporarily suspended due to insufficient number of farmers involved in the project.

- One of the project sites established was in Barangays Bulusan, Calizon, and Sta. Lucia in Calumpit Bulacan in partnership with the Bulacan Agricultural State College (BASC) and LGU-Calumpit (Figure 12). Thirty six (36) farmer beneficiaries (16 farmers in Bulusan, 10 farmer in Calizon, and 10 farmers in Sta. Lucia) were recipient to the hybrid rice production component. Each beneficiary was provided with one bag Mestiso 19 hybrid seed and one bag urea. Another 10 farmer beneficiaries were recipient of 100 ducklings each and net for the rice+duck production component. All the inputs provided to the farmer beneficiaries will be subjected to capital roll-over scheme.
- The farmer beneficiaries undergo Farmer Field School on PalayCheck System which started in October 2012 (Figuger 12d).


**Figure 10.** Technical briefings conducted in (a) Calumpit, Bulacan, (b) San Fernando, Pampanga, and (c) Candaba, Pampanga).

**Figure 11.** Floating Garden Component in Del Pilar San Fernando, Pampanga.


**Figure 12.** Activities conducted in Calumpit, Bulacan (a) project launching, (b) ceremonial transplanting, (c) establishment of floating seedbed (d) farmer field school.

**Development and evaluation of a rice vulnerability assessment tool for climate change impacts in rainfed rice ecosystem of Region III**
AOV Capistrano

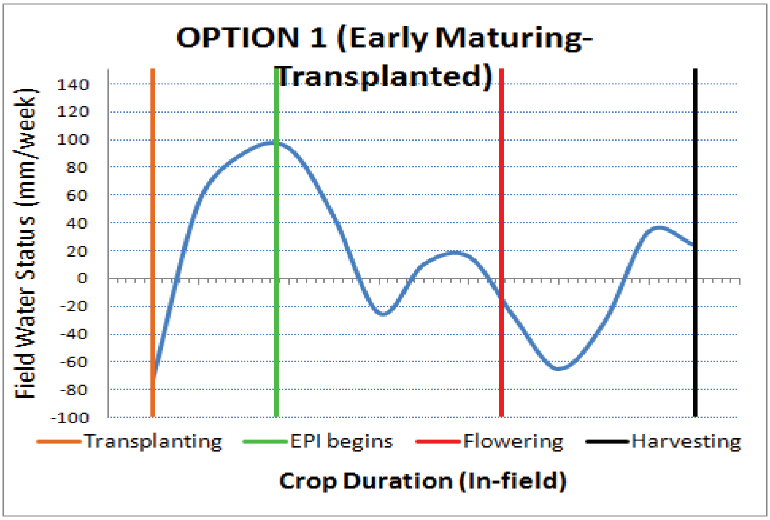
**Highlights:**

- Actual field percolation rates ranged from 3-290 mm/day from the 24 sites monitored in Region III via the modified lysimeter. These rates has not yet been correlated with the soil texture data from BSWM.

- Soil samples from the 24 sites have been collected, processed and submitted for analysis to BSWM last December 2012. Data are already available but have not been retrieved because the payment for the analysis has not been released yet.

- Historical weather data of at least 10 years have already been collected for Baler, Iba, Cabanatuan, Subic and Clark PAGASA stations. Data collected are inclusive of rainfall, temperature and solar radiation.

- A prototype MS Excel-based model for projecting seasonal rainfall was already created that could present a graphical representation of the pattern as it coincides with the rice crop duration in the field (Figures 13).



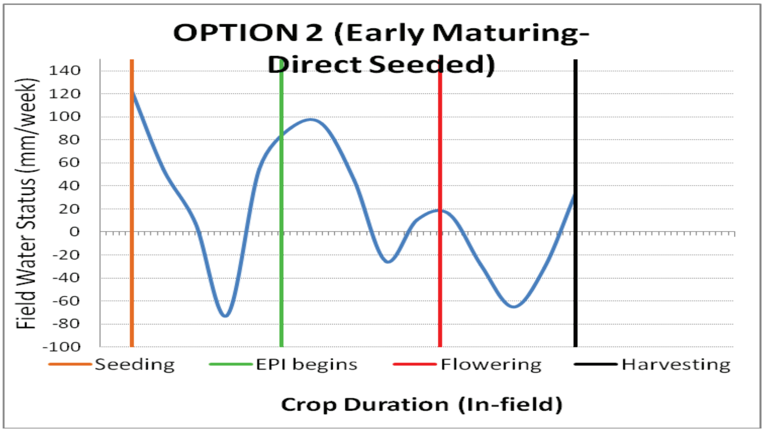




**Figure 13** Sample graphical representations of rainfall coinciding with crop duration for early maturing varieties under transplanted (top) and direct-seeded (bottom) mode of establishments.

## Delineation of rice ecosystems in Central Luzon using Synthetic Aperture Radar (SAR) Images

MRO Mabalay, M Barroga, P Mabalot, ED Alosnos and EJP Quilang

Remote sensing particularly the use of Synthetic Aperture Radar (SAR) images offers an effective method in obtaining the actual condition on rice crop, its distribution, and acreage assessment. Rice ecosystem in the Philippines may be classified as either irrigated or rainfed. These two ecosystems differ in terms of source of irrigation supply, cropping pattern, planting dates, varieties used, and management aspects. It is necessary to discriminate and to map these two ecosystems to promote the efficient and effective transfer of location-specific technologies, farm management practices, and cropping systems. The only available map showing the delineation of the rice-based ecosystems covering the whole country were derived in 1986 from land-use paper maps of the Bureau of Soils and Water Management (BSWM) created under the Land Resources Evaluation Project (LREP) with a scale of 1:250,000. It is important to validate and update this paddy area map as discrepancy was observed on the calculated areas from this map with the latest rice production statistics (Asilo, 2007). Hence, this study will map the rice-based agriculture in irrigated and rainfed areas using multi-temporal SAR for two cropping seasons in Central Luzon to help the rice industry and different stakeholders in planning and formulating policy.

**Highlights:**

- A total of 316 Synthetic Aperture Radar (SAR) images from ENVISAT ASAR have been acquired over Region 3 and Pangasinanas shown in Table 9. The images from wide swath (WS) mode acquired from 2003-2012 were used to determine the rice extent map that will serve as a baseline of cultivated rice. The images from strip map acquired from 2010-2012 were used to determine the actual rice area cultivated during 2010 WS, 2011 WS and 2012 DS.

- RICEscape, mapping software, being developed by SARMAP for mapping the rice area in the country is used in this study. The advantage of this software is its capability to process the datasets from the different sensor and the processing is done in fully automatic way and can deal with parallel multiple processing.

- Since farmers do not plant their rice crop at the same time, the delineation of rice fields cultivated at different times during a rice production season is a challenge. The use of multi-temporal ASAR images could determine the cultivation pattern of the different stages of rice as a result of differences in planting dates provided that the dates of acquisition of the images capture the complete growth cycle of rice starting from flooding to harvest as shown in Figure 14. The information on cultivation date is important in determining the farmers' practices in the area for an effective transfer of technology.

- The rice extent map for Central Luzon and Pangasinan with 1 hectare ground resolution (Figure 15)provides general information of rice cultivated on ground since the information from the images acquired from 2003-2012 were consolidated to produce a final map. The rice area map for Central Luzon and Pangasinan with 15-30 meters ground resolution is shown Figure 16.This map will provide the actual area planted during 2010 WS, 2011 WS and 2012 DS.

- The systematic grid sampling for map validation developed by sarmap is adopted where 15km by 15km distance between clusters were employed. Each cluster has 16 ground control points with 250m by 250m distance. A total of 9 clusters with 624 points were visited to determine the present and previous land use of the observation points. Results of the accuracy assessments for rice extent map and rice area map for Central Luzon and Pangasinan is 73% and 79%, respectively.

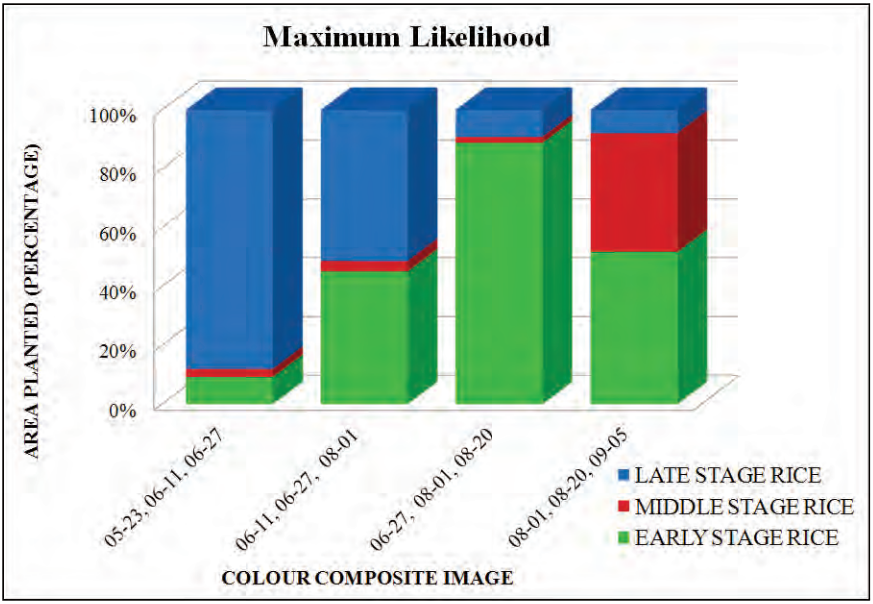



**Figure 14.** Pattern of rice cultivation in the study area derived from the multi-temporal ASAR images during 2010 WS.

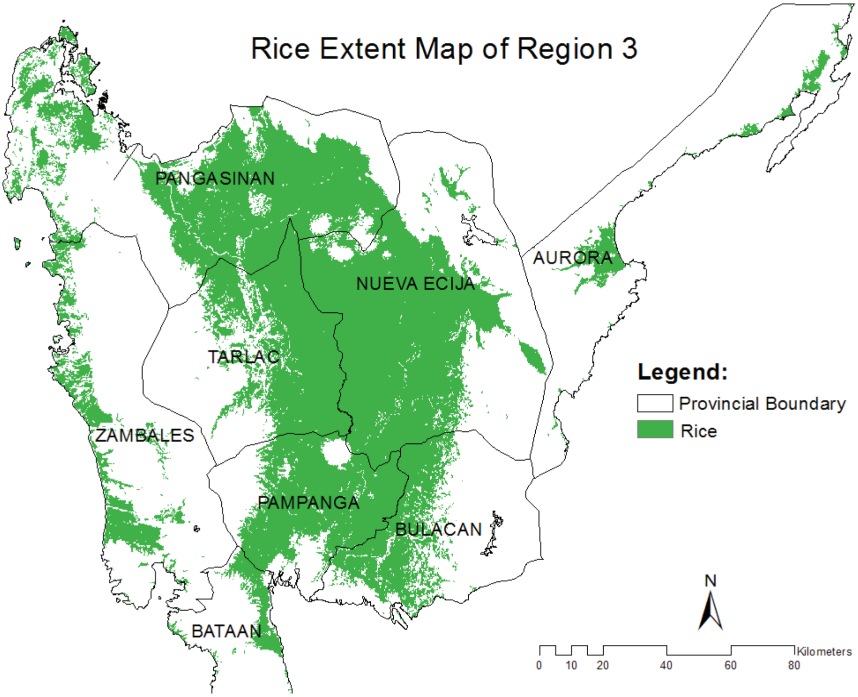



**Figure 15.** Rice extent map for Central Luzon and Pangasinan.

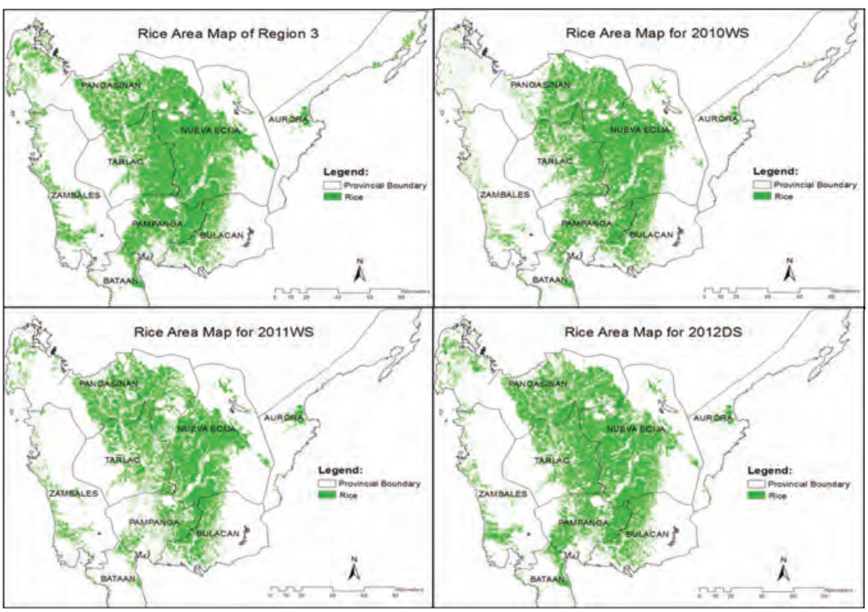



**Figure 16.** Rice area map for Central Luzon and Pangasinan.

**Table 9.** The number of images acquired from ENVISAT covering Region 3 and Pangasinan for mapping of rice areas.

| Type of Sensor | Mode | Coverage | Number of Images |
|---|---|---|---|
| ENVISAT ASAR | WS | July 3, 2003-April 7, 2012 | 109 |
| ENVISAT ASAR | strip map | May 7, 2010-April 4, 2012 | 207 |
| ***Total*** | | | 316 |

**Table 10.** Accuracy of rice extent map using ground-truth points.

| | | Wide Swath Map (predicted) | | | |
|---|---|---|---|---|---|
| | | Rice | Not Rice | Total | % Correct |
| Ground truth | Rice | 341 | 21 | 362 | 94.2 |
| | Not Rice | 200 | 267 | 467 | 57.2 |
| | Total | 541 | 288 | 829 | 73.3 |

**Table 11.** Accuracy of rice area map using ground-truth points.

| | | ASAR (15m) Map (predicted) | | | |
|---|---|---|---|---|---|
| | | Rice | Not Rice | Total | % Correct |
| Ground truth | Rice | 330 | 28 | 358 | 92.2 |
| | Not Rice | 148 | 323 | 471 | 68.6 |
| | Total | 478 | 351 | 829 | 78.8 |

## III. Inventory, Measurements, Monitoring, and Effects of Greenhouse Gases in Rice Production

Constancio A. Asis Jr.

Inventory, measurement, and monitoring of greenhouse gases (GHG) in rice production systems are important components in a climate change mitigation programme since the Intergovernmental Panel on Climate Change (IPCC) has identified that wetland rice is one of the primary sources of GHG. 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. Moreover, rice production is one of the most vulnerable sectors in the agriculture industry to aggregate impact of global warming and climate change. Rice plant is very sensitive to water and temperature stress and other climate-related extreme conditions which have a direct influence on the quantity and quality of rice production. However, 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.

**Effects of different rice varieties on methane emission from rice fields**
CA Asis Jr. and FS Grospe

**Highlights:**

- During the dry season, methane emission was significantly higher in NSIC Rc196H than that of PSB Rc72H (6.93 mg/h/m2). Moreover, methane emission did not vary significantly between inbred cultivars (Table 12). Grain yield was higher (9.67 t/ha) in cultivar NSIC Rc160 and significantly higher than that of NSIC Rc216 (7.10 t/ha). However, grain yields did not vary significantly between hybrid cultivars.

- Methane emission potential significantly varied among cultivars. NSIC Rc160 had lower emission potential than that of NSIC Rc216 owing to its higher grain yield than the latter. Although NSIC Rc196H had higher seasonal methane emission than that of PSB Rc72H, its shorter growth duration and higher grain yield made methane emission potential comparable between hybrids.

- During the wet season, methane emission also varied among genotypes. Rice mutant PYT 27 had higher seasonal methane emission and methane emission potential than that of PYT 42 owing to higher grain yield of the former and comparable growth duration between mutants. Moreover, both promising lines had comparable methane emission potential despite higher seasonal methane emission of IL35 than that of IL34. This was attributed by the higher grain yield of the IL35.

- Results showed that methane emission varied significantly among rice genotypes. Methane emission potential of the cultivar is lower in high yielding varieties. These results indicate that selection of early maturing, high yielding cultivars, and low methane emitting cultivar is a promising option to reduce methane emission from rice fields.

**Table 12.** Methane emission potential of rice cultivars, PhilRice 2012.

| Cultivar | Methane Emission ($kg\ CH_4/ha$) | Growth Duration (days) | Grain Yield (t/ha) | Methane Emission Potential ($g\ CH_4/kg$ grain) |
|---|---|---|---|---|
| *Dry Season* | | | | |
| NSIC Rc160 | 202.33a | 122 | 9.67a | 20.93c |
| NSIC Rc216 | 190.85a | 112 | 7.55b | 25.28a |
| PSB Rc72H | 204.57a | 123 | 8.63a | 23.71b |
| NSIC Rc196H | 217.04b | 103 | 9.01a | 24.09ab |
| *Wet Season* | | | | |
| PYT 27 | 228.04a | 111 | 4.34b | 50.67a |
| PYT 42 | 171.79c | 113 | 5.10a | 32.78b |
| IL34 | 176.01c | 112 | 5.43a | 32.42b |
| IL35 | 214.97b | 114 | 5.75a | 38.80ab |

**Effects of soil types on methane emission from rice fields in major rice producing areas in the Philippines**

FS Grospe and CA Asis Jr.

Highlights:

- Methane emissions varied among soils (Figure 17). Emission rates during rice growing period ranged from 2.41 mg h-1 m-2 to 8.14 mg h-1 m-2. The highest CH4 emission rate was observed from Silay sandy clay loam soil (PhilRice Negros) at flowering stage (70 DAT). Moreover, there were no significant differences of emission rates among Maligaya clay loam, Sta Rita clay loam, Butuan clay loam and Kabacan clay loam soils.
- The average CH4 emission from Silay sandy clay loam and Tinamaga sandy clay loam (Tacurong Sultan Kudarat) soil were significantly higher than that of Sta Rita clay loam (Sta. Barbara, Iloilo), Kabacan clay loam (PhilRice Midsayap), Butuan clay loam (PhilRice Agusan), and Maligaya clay loam soil (PhilRice CES) (Figure 18).
- Average methane emission showed significant correlation with the soil physical properties. Soil clay and silt content showed a significant inverse relationship with the seasonal average methane emission rates. Soils with more clay or silt content had low methane emission (Figure 19). Moreover, there was a significant positive relationship between soil sand content and seasonal average methane emission. Soil with high sand content showed high methane emission (Table 13)
- Results indicate that variation of CH4 emission rates among soils may be attributed to differences in soil properties.

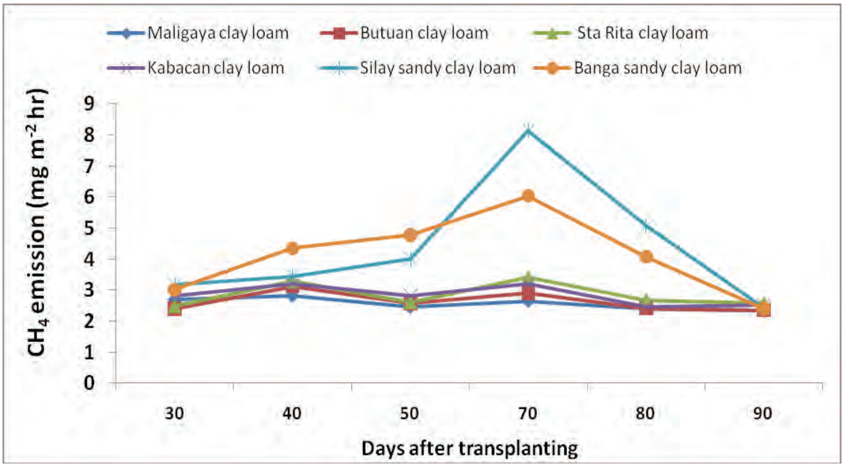



**Figure 17.** Methane emission from rice NSIC 160 planted in varying rice soil types, PhilRice 2012.

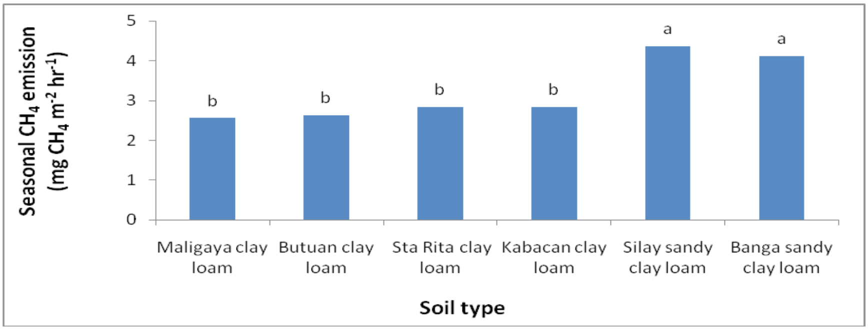



**Figure 18.** Mean of methane emission from rice NSIC 160 planted in varying rice soils, PhilRice 2012.

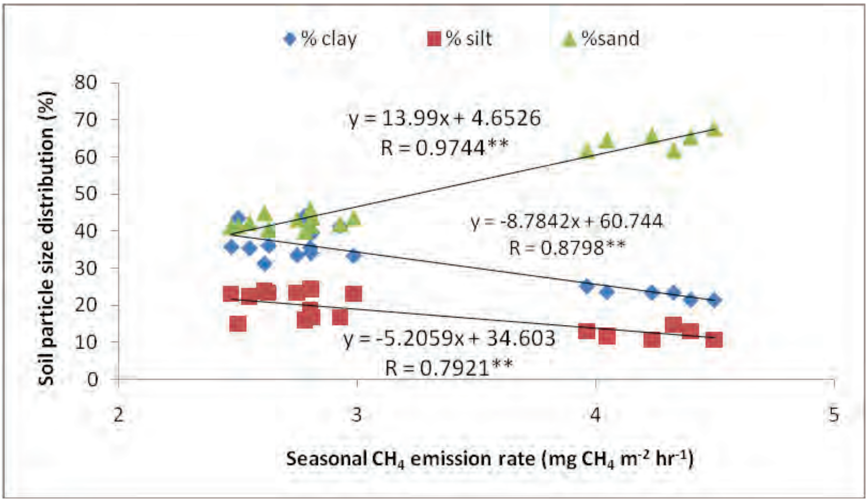



**Figure 19.** Relationship between mean seasonal metane emission and soil physical properties.

**Table 13.** Relation ship between mean seasonal methane emission rate and soil chemical properties.

| Soil chemical properties | Correlation coefficient (r) |
|---|---|
| Total nitrogen (N) | -0.446 ns |
| Organic matter (OM) | -0.563* |
| Available Phosphorous (P) | -0.438ns |
| Available potassium (K) | -0.253ns |
| Available sodium (Na) | -0.664 ** |
| Soil pH | -0.397 ns |

**Greenhouse gases inventory in Palayamanan and PalayCheck Areas**
JMRivera, RGCorales, EJPQuilang, AACorpuz, VTDimaano, EDAlosnos AAGuansing and CAAsis, Jr.

**Highlights:**

- The mean methane emission from rice fields in 8 selected barangays of San Ildefonso, Bulacan was 0.00199 GgCO2 eq per hectare. The total emissions from 3399 hectares (965 ha irrigated and 2436 ha rainfed) cultivated by 1761 farmers during the 2010 dry and wet cropping season was 6.79 GgCO2 eq (Table 14). Methane emission from each barangay varied with farmer cooperators, the cropping system and cultural management.

- Total greenhouse methane emission from 107,223 heads of livestock (carabao-931, cattle-180, goat-742, poultry-100,395 and swine-1975) was 3.4 GgCO2 eq. (Table 15). Enteric methane emitted was 1.4 GgCO2 eq, manure methane (0.4 GgCO2 eq), manure nitrous oxide (0.7 GgCO2 eq) and soil nitrous oxide (1.0 GgCO2 eq).

- New set of GHG inventory questionnaire was developed and pre-tested in 2 barangays in Balungao, Pangasinan. The data will be analyzed using the new version of the ALU software.

**Table 14.** Greenhouse gases emissions from rice methane in selected barangays' in San Ildefonso, Bulacan Cropping Year 2010.

| Site/ Barangay | Number of farmers | Ecosystem | | Area Planted (ha) | | Gg $CO_2$ eq | Gg $CO_2$ eq (emitted per hectare) |
|---|---|---|---|---|---|---|---|
| | | Irrigated | Rainfed | DS | WS | | |
| Bubulong Munti | 225 | 186 | 217 | 186 | 403 | 1.00 | 0.00249 |
| Gabihan | 233 | 138 | 289 | 138 | 427 | 0.82 | 0.00192 |
| Maasim | 190 | 158 | 139 | 158 | 297 | 0.34 | 0.00115 |
| Palapala | 234 | 73 | 378 | 98 | 451 | 1.22 | 0.00269 |
| Sapang Dayap | 154 | 131 | 179 | 131 | 310 | 0.40 | 0.00130 |
| Sapang Putik | 201 | 100 | 384 | 100 | 476 | 0.89 | 0.00187 |
| Sumandig | 195 | 34 | 328 | 34 | 362 | 1.03 | 0.00285 |
| Umpucan | 329 | 145 | 522 | 145 | 667 | 1.09 | 0.00163 |
| Total | 1761 | 965 | 2436 | 990 | 3393 | 6.79 | 0.00199 |

**Table 15.** Greenhouse gases emissions from livestock in selected barangays' in San Ildefonso, Bulacan Cropping Year 2010.

| Area | No. of farmers | No. of animals | Enteric methane | Manure Methane | Manure Nitrous oxide | Soil Nitrous oxide | Total GHG (Gg $CO_2$ eq) |
|---|---|---|---|---|---|---|---|
| Bubulong Munti | 200 | 1430 | 0.41 | 0.03 | 0.12 | 0.23 | 0.79 |
| Gabihan | 213 | 991 | 0.14 | 0.13 | 0.16 | 0.15 | 0.57 |
| Maasim | 120 | 605 | 0.17 | 0.04 | 0.06 | 0.08 | 0.35 |
| Palapala | 110 | 1120 | 0.11 | 0.06 | 0.11 | 0.13 | 0.40 |
| Sapang Dayap | | 1020 | 0.25 | 0.04 | 0.09 | 0.14 | 0.53 |
| Sapang Putik | 95 | 887 | 0.05 | 0.01 | 0.02 | 0.04 | 0.13 |
| Sumandig | 50 | 100805 | 0.09 | 0.04 | 0.13 | 0.14 | 0.40 |
| Umpucan | 90 | 365 | 0.15 | 0.01 | 0.03 | 0.06 | 0.25 |
| Total | 878 | 107223 | 1.4 | 0.4 | 0.7 | 1.0 | 3.4 |

## Abbreviations and acronymns

ABA – Abscicic acid
Ac – anther culture
AC – amylose content
AESA – Agro-ecosystems Analysis
AEW – agricultural extension workers
AG – anaerobic germination
AIS – Agricultural Information System
ANOVA – analysis of variance
AON – advance observation nursery
AT – agricultural technologist
AYT – advanced yield trial
BCA – biological control agent
BLB – bacterial leaf blight
BLS – bacterial leaf streak
BPH – brown planthopper
Bo - boron
BR – brown rice
BSWM – Bureau of Soils and Water Management
Ca - Calcium
CARP – Comprehensive Agrarian Reform Program
cav – cavan, usually 50 kg
CBFM – community-based forestry management
CLSU – Central Luzon State University
cm – centimeter
CMS – cystoplasmic male sterile
CP – protein content
CRH – carbonized rice hull
CTRHC – continuous-type rice hull carbonizer
CT – conventional tillage
Cu – copper
DA – Department of Agriculture
DA-RFU – Department of Agriculture-Regional Field Units
DAE – days after emergence
DAS – days after seeding
DAT – days after transplanting
DBMS – database management system
DDTK – disease diagnostic tool kit
DENR – Department of Environment and Natural Resources
DH L– double haploid lines
DRR – drought recovery rate
DS – dry season
DSA - diversity and stress adaptation
DSR – direct seeded rice
DUST – distinctness, uniformity and stability trial
DWSR – direct wet-seeded rice
EGS – early generation screening
EH – early heading
EMBI – effective microorganism-based inoculant
EPI – early panicle initiation
ET – early tillering
FAO – Food and Agriculture Organization
Fe – Iron
FFA – free fatty acid
FFP – farmer's fertilizer practice
FFS – farmers' field school
FGD – focus group discussion
FI – farmer innovator
FSSP – Food Staples Self-sufficiency Plan
g – gram
GAS – golden apple snail
GC – gel consistency
GIS – geographic information system
GHG – greenhouse gas
GLH – green leafhopper
GPS – global positioning system
GQ – grain quality
GUI – graphical user interface
GWS – genomwide selection
GYT – general yield trial
h – hour
ha – hectare
HIP - high inorganic phosphate
HPL – hybrid parental line
I - intermediate
ICIS – International Crop Information System
ICT – information and communication technology
IMO – indigenous microorganism
IF – inorganic fertilizer
INGER - International Network for Genetic Evaluation of Rice
IP – insect pest
IPDTK – insect pest diagnostic tool kit
IPM – Integrated Pest Management
IRRI – International Rice Research Institute
IVC – in vitro culture
IVM – in vitro mutagenesis
IWM – integrated weed management
JICA – Japan International Cooperation Agency
K – potassium
kg – kilogram
KP – knowledge product
KSL – knowledge sharing and learning
LCC – leaf color chart
LDIS – low-cost drip irrigation system
LeD – leaf drying
LeR – leaf rolling
lpa – low phytic acid
LGU – local government unit

LSTD – location specific technology development
m – meter
MAS – marker-assisted selection
MAT – Multi-Adaption Trial
MC – moisture content
MDDST – modified dry direct seeding technique
MET – multi-environment trial
MFE – male fertile environment
MLM – mixed-effects linear model
Mg – magnesium
Mn – Manganese
MDDST – Modified Dry Direct Seeding Technique
MOET – minus one element technique
MR – moderately resistant
MRT – Mobile Rice TeknoKlinik
MSE – male-sterile environment
MT – minimum tillage
$mtha^{-1}$ - metric ton per hectare
MYT – multi-location yield trials
N – nitrogen
NAFC – National Agricultural and Fishery Council
NBS – narrow brown spot
NCT – National Cooperative Testing
NFA – National Food Authority
NGO – non-government organization
NE – natural enemies
NIL – near isogenic line
NM – Nutrient Manager
NOPT – Nutrient Omission Plot Technique
NR – new reagent
NSIC – National Seed Industry Council
NSQCS – National Seed Quality Control Services
OF – organic fertilizer
OFT – on-farm trial
OM – organic matter
ON – observational nursery
OPAg – Office of Provincial Agriculturist
OpAPA – Open Academy for Philippine Agriculture
P – phosphorus
PA – phytic acid
PCR – Polymerase chain reaction
PDW – plant dry weight
PF – participating farmer
PFS – PalayCheck field school
PhilRice – Philippine Rice Research Institute
PhilSCAT – Philippine-Sino Center for Agricultural Technology
PHilMech – Philippine Center for Postharvest Development and Mechanization
PCA – principal component analysis
PI – panicle initiation
PN – pedigree nursery
PRKB – Pinoy Rice Knowledge Bank
PTD – participatory technology development
PYT – preliminary yield trial
QTL – quantitative trait loci
R - resistant
RBB – rice black bug
RCBD – randomized complete block design
RDI – regulated deficit irrigation
RF – rainfed
RP – resource person
RPM – revolution per minute
RQCS – Rice Quality Classification Software
RS4D – Rice Science for Development
RSO – rice sufficiency officer
RFL – Rainfed lowland
RTV – rice tungro virus
RTWG – Rice Technical Working Group
S – sulfur
SACLOB – Sealed Storage Enclosure for Rice Seeds
SALT – Sloping Agricultural Land Technology
SB – sheath blight
SFR – small farm reservoir
SME – small-medium enterprise
SMS – short message service
SN – source nursery
SSNM – site-specific nutrient management
SSR – simple sequence repeat
STK – soil test kit
STR – sequence tandem repeat
SV – seedling vigor
t – ton
TCN – testcross nursery
TCP – technical cooperation project
TGMS – thermo-sensitive genetic male sterile
TN – testcross nursery
TOT – training of trainers
TPR – transplanted rice
TRV – traditional variety
TSS – total soluble solid
UEM – ultra-early maturing
UPLB – University of the Philippines Los Baños
VSU – Visayas State University
WBPH – white-backed planthopper
WEPP – water erosion prediction project
WHC – water holding capacity
WHO – World Health Organization
WS – wet season
WT – weed tolerance
YA – yield advantage
Zn – zinc
ZT – zero tillage

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Department of Agriculture
PHILRICE
PHILIPPINE RICE RESEARCH INSTITUTE

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

We accomplish this mission through research and development work in our central and seven branch stations, coordinating with a network that comprises 58 agencies and 70 seed centers strategically located nationwide. To help farmers achieve holistic development, we will pursue the following goals in 2010-2020: attaining and sustaining rice self-sufficiency; reducing poverty and malnutrition; and achieving competitiveness through agricultural science and technology.

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


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