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Socio-Economic Appraisal of Farming Households in Marginal Areas in Botolan, Zambales, Philippines

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Abstract

Farm households in four barangays in Botolan, Zambales were studied to make a socio-economic appraisal of their condition after the eruption of Mt. Pinatubo in 1991 and the massive flooding in 2009 that further marginalized their farms. A self-constructed questionnaire was used for 150 farming households. Socio-economic data, farm management practices, production, and income per household were described, pooled, and analyzed descriptively. As of 2018, rice farming was the main source of household income despite the land being less suitable for rice and production area reduced. There was low productivity and a high yield gap compared with the province and the region's yield levels. There was high input cost in rice farming due to various factors including the marginal condition of the farms. There was low income from rice farming during both seasons, but the yield was much lower during the wet season due to lower yield.

Key Words: farm households, lahar, rice, productivity, Botolan

Introduction

In 1991, a wide range of agricultural lands in Zambales, particularly the municipality of Botolan, was devastated due to the massive eruption of Mt. Pinatubo. The impact of the eruption rendered thousands of hectares of agricultural areas unproductive as they were covered with thick ash and lahar, including 81, 895 ha of rice farms, 2,486 ha of vegetable farms, and 2.070 ha of root crop areas (Mercado, Lacsama, & Pineda, 1999). These areas were covered with ash and lahar at a depth of 0.5 to 2.0 meters (Suyat, et al., 1994). Another natural disaster further aggravated the problem, the massive flooding in 2009 which covered the lands with intermediate to high silica content and iron magnetite rendering them unsuited for food production. Many farming households lost their land which is their major source of employment and income.

The Philippine government made tremendous efforts to help the victims of Mt. Pinatubo by pouring in resources for livelihood and infrastructure activities to rehabilitate the affected areas (Dar, 1993). A government structure called Mount Pinatubo Commission (MPC) was established to support the victims of the eruption. MPC aimed to provide funds for immediate relief of the victims, establish resettlement centers, homesites, and townsites, provide livelihood and employment opportunities, and repair, reconstruct, or replace government infrastructure damaged or destroyed by the eruption. From 1992 to 2000, MPC assisted 42,396 families (Leone

& Gaillard, 1999). Moreover, the Central Luzon Agriculture Resources Research and Development Consortium (CLARRDEC) developed and implemented collaborative research and development (R&D) activities to rehabilitate the affected areas (CLARRDEC, 1993).

After more than two decades, while many farmers can till their lands again, sizeable areas remain unproductive and rural households are still poor. It is in this context that the Central Luzon State University (CLSU) with the President Ramon Magsaysay State University (PRMSU) implemented a project entitled "Research and Development Project to Rehabilitate and Enhance Productivity in Lahar and Ash-Laden Areas in Central Luzon" with funding from the Department of Science and Technology-Philippine Council of Industry, Energy, and Emerging Technology Research and Development (DOST-PCIEERD) in collaboration with the provincial and local government units of Zambales. To support this project, this study appraised rice farmers, their rice production practices, and income in 2018, many years after the eruption of the Mt. Pinatubo in 1991, and the massive flooding in 2009 that further marginalized the areas, as the basis of future development efforts and R&D areas. This study: a) determined the socio-demographic characteristics of rice farmers in four barangays in Botolan; b) appraised their rice management practices; and c) analyzed yield and profit from rice production in the crop year 2017 or 2018.

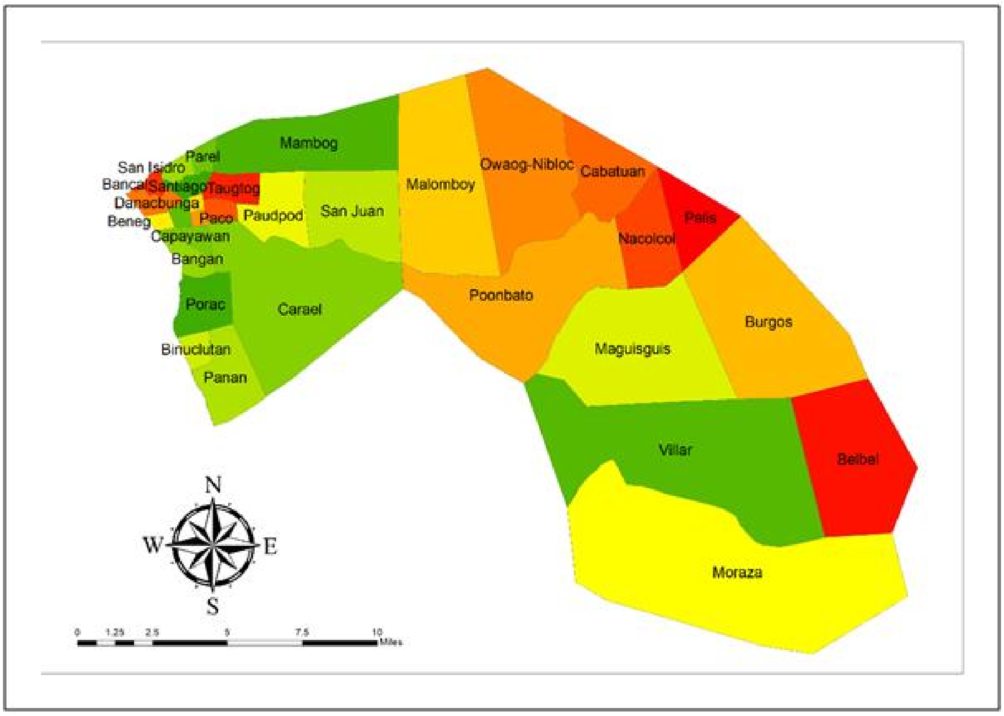
Methodology

Study Sites

The municipality of Botolan is one of the hardest-hit municipalities by two natural disasters. To date, massive areas were rendered unproductive due to ash and lahar from the eruption of Mt. Pinatubo and black sand deposits from flooding. Four barangays in Botolan, Zambales, namely Paco, Paudpod, San Juan, and Carael, were purposely selected as the study sites (Figure 1). These barangays were classified by the Office of the Provincial Agriculture of Zambales (OPA) and the local government unit (LGU) of Botolan as the most affected barangays in the municipality but were previously important agricultural areas before the eruption of Mt. Pinatubo.

Figure 1

Map of Botolan, Zambales Indicating the Study Sites



Respondents and Data Collection

Data for this study were collected through a survey of 150 respondents from farming households in Botolan, presenting about 37 farming households per study site. The size was within the required 5–50 participants for a qualitative study (Dworkin, 2012). The respondents were identified with the help of the barangay officials in charge of the agricultural sector. The following were the criteria in selecting the farmers: a) planted rice before and after the eruption regardless of farm size; b) farm and residence are in the covered barangays; c) accessible; and d) willing to participate in the face-to-face interview. The survey was conducted in Carael and San Juan in November 2017 and Paco and Paudpod in August 2018. Each barangay was divided into four zones (east, west, north, and south) and the respondents were selected from these zones through convenience sampling. Trained project staff conducted face-to-face interviews. Most data were based on recall of household head in the absence of records.

Instrument Used

A structured questionnaire was prepared with reference to the available questionnaires for documentation studies at the Research Office of CLSU. The questionnaire was pre-tested among five farmers from San Juan. These were finalized based on the existing farm conditions, management practices, yield, and cost in rice production. Moreover, the questionnaire was finalized based on how easy or difficult the respondents answered the questions during the pre-test. The final questionnaire was divided into five parts such as socio-economic profile, farm biophysical characteristics, technical and institutional support, crop production management, problems in production, and technology adoption. This characterization was conducted to generate baseline information for future assessment studies, identification of constraints in the production system being practiced, and identification of possible R&D areas.

Data Analysis

Socio-demographic data, farm management practices, production, and income from agricultural production (Wet Season [WS] 2017 and Dry Season[DS] 2018) per household were tabulated on a per-barangay basis and pooled as one unit of analysis. They were analyzed using appropriate techniques for qualitative and quantitative data using the Statistical Package for Social Sciences (SPSS) v26 licensed software at the Socio-Economics and Data Analytic Center (SERDAC), Research Office, CLSU. Descriptive statistics such as frequency, percentage, mean, and SD were used to summarize quantitative data. Moreover, the paper was subjected to grammar screening using the software Grammarly also available at SERDAC.

Results

Appraisal of the Respondents' Socio-Demographic Characteristics

A high percentage of the respondents were male accounting for 73% of the total, a similar finding from most studies of farming households in the Philippines. There were female farmers but they were relatively few (Table 1). This supports the findings of Quimba and Estudillo (2018) that most of the female members of the household are associated with nonfarm activities. Similarly, the results furthered that due to gender classification and traditional beliefs, the percentage of women involved in agriculture dropped from 23.1% in 2005 to 20.9% in 2010, and is expected to decline further to 18.8% in 2015 (Dela Cruz & Bobier, 2016). Furthermore, in this study, the respondents' ages ranged from 30 to 85 years old, an average of 56 years. The result also showed that 44% of the respondents were in the age bracket of 46 to 60 years, and 34% were above 60 years old, indicative of the farmers being relatively old. A study conducted by Palis (2020) indicated that small-scale Filipino farmers' average age is 57 years, while that of Briones (2017) of the Philippine Institute for Development Studies (PIDS) indicated that 33% and 38% have reached or finished elementary or secondary, respectively. While in this study, about 50% of the respondents had reached secondary education and 21% reached tertiary education. This indicates that even those with higher education remained in farming in Botolan. On the other hand, Quimba and Estudillo (2018) stated that members of the household with tertiary education or the most educated appeared to participate more in activities outside farming.

Moreover, 85% were married and the households had an average of four members. Most of the respondents were Catholics (77%), while others belong to other religious groups that abound in the locality as in other areas in the country.

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The respondents were also farmers before the eruption of Mt. Pinatubo, with an average farm area of 7,702.00 sqm as they recalled. They were displaced when the lands they tilled were covered with ash and lahar from the eruption that rendered their land impossible to cultivate. However, they returned to the barangays when they saw the potential for farming again. In 2018, the average farm area was 6,503.73 sqm. It is in this context that their average years in farming was relatively low at 16.48 years (±10.78).

Table 1

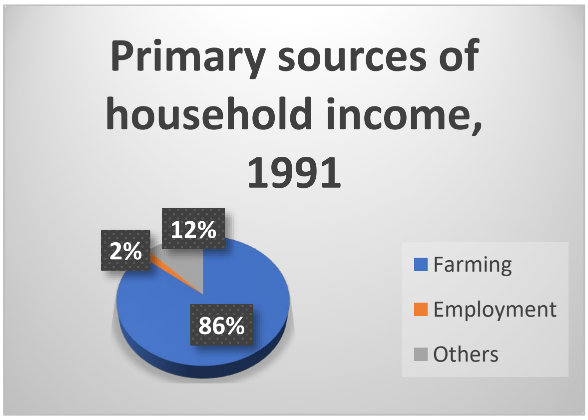
Respondents' socio-economic characteristic

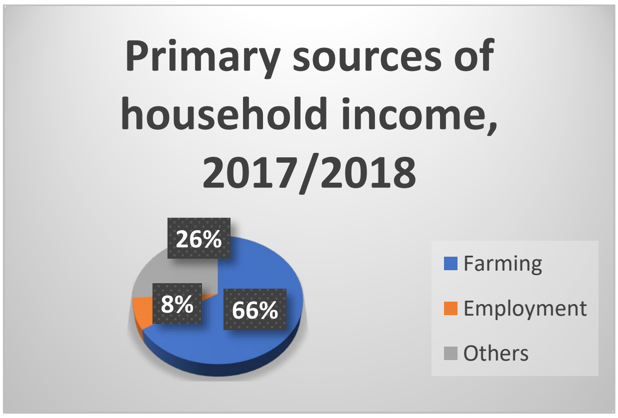
Profile	Frequency n=150	Percentage
Age, year		
30 – 45	33	22.0
46 - 60	66	44.0
> 60	51	34.0
Mean	55.90	
SD	12.36	
Sex		
Male	109	72.7
Female	41	27.3
Marital status		
Single	10	6.7
Married	128	85.3
Others	12	8.1
Family size		
<4	85	56.7
> 4	65	43.3
Mean	4.37	
SD	1.82	
Highest Education Attainment		
Primary education	36	24.0
Secondary education	74	49.3
Tertiary education	32	21.3
Vocational education	8	5.3
Religion		0.0
Roman Catholic	116	77.3
Non-Roman Catholic	25	16.7
N/A	9	6.0
Years in farming		
Mean	16.48	
Farm size, sqm, before the eruption, 1990		
Mean	7,702.620	
Farm size, sqm, after the eruption, 2018		
Mean	6, 503.73	

The respondents reported some primary and secondary sources of income before and after the volcanic eruption. Before the eruption, 86% were engaged in rice farming (Figure 2a), being their primary source of income. About 14% of the respondents' primary income was from employment (2%) and others (12%) such as buy and sell, livestock raising, off-farm labor, and pension. Very few of the household head (37%) had secondary sources of income because there were limited opportunities. Agriculture provided them a good source of employment and income because their farms were fertile. However, household income during that period was not computed because baseline data or records were not available.

Figure 2a and 2b.

Primary Sources of Respondents' Income Before (1990) and After (2018) Eruption





Despite the natural disasters that rendered their farms unsuitable to agriculture, farming was still the primary source of employment in 2017 and 2018. This supported the finding of Garcia et al. (2017) that rice farming remains the primary source of income in the lahar-affected areas in Zambales. However, among the respondents from the four barangays under study, only 66% went back to farming as their major source of income (Figure 1b). Other primary sources were employment as reported by 8% and others by 26% which included buy and sell, livestock raising, construction works, and off-farm labor. In addition, those who had no work but receiving pension from relatives was 7%.

On average, annual household income in 2017 and 2018 from primary sources was about PHP 55,835.00 (77%), while from secondary sources was PHP 17,080.00 (23%), a total of PHP 72,915.00. Despite the decrease in the farm area and its suitability, the household's income was primarily derived from farming. It is in this context that increasing the productivity of the farm is of utmost importance to increase households' income.

In 2015, the average farmers' income from various sources should be around PHP 100,000.00 per annum, although this would still make a typical Filipino farmer earning below the poverty line of PHP108,800.00 (Dy, 2017. In 2018, the poverty threshold for a family of five per month in Zambales was PHP 14,638.00 (Philippine Statistics Authority [PSA], 2018) computed at PHP 175,656.00 per annum. In essence, the average households in the study sites were earning lower than the poverty threshold. The income gap was computed at 59%. It is the measure of the average amount of income required by the family to get out of poverty expressed concerning poverty threshold (PSA, 2018). Every month, the respondents' family needs about PHP 8,563.00 to meet the requirement for food and other basic needs.

Description of the Marginal Farms

The soil condition of Botolan was categorized into two Land Mapping Unit (LMU) classes such as VIIIs-5 and IIs-0 with common characteristics of being excessive drainage or doughtiness with limitations on having coarse-textured or excess gravel. Class VIIIs-5 has a whole layer of sand with different levels of coarseness and time of accumulation, while Class IIs-0 has a thin layer of sandy loam or is loamy sand with different levels of coarseness and time of accumulation. Its soil water has an excessive amount of total nitrogen and mostly neutral pH. An excessive amount of nitrogen in the irrigation water can cause problems such as in the production of several commonly grown crops due to over-stimulation of growth, delayed maturity, or poor quality (Food and Agriculture Organization [FAO],2006). The normal pH range for irrigation water is from 6.5 to 8.4 and any change caused by the water will take place slowly since the soil is strongly buffered and resists change (FAO, 2006).

Table 2

Description of the marginal soil in Botolan, Zambales

Profile	Description
Land Mapping Units (LMU) class	ClassVIIIs-5 and IIs-0
Soil properties	Sand to sandy loam
Organic matter content	0.84%
Soil pH	Neutral (7.16) to strongly acidic (4.52)
Cation exchange capacity (CEC)	Average value 7.35cmol/kg Range: 2.37 to 23.52 cmol/kg
Crop suitability	Marginal to low suitability

Major changes in soil properties were recorded after the eruption. From clayey to loamy texture, the soil became pure sand to sandy loam. Percent of gravel is mostly more than 1%, the texture is very coarse; most drainage classes dropped from well-drained to excessively drained with low water content. Soil is mostly composed of volcanic materials undergoing the weathering process. A study of the time series on the development of Pinatubo volcanic-influenced ash soils showed that the weathering cycle is progressing rapidly for many of the affected areas and that lahar deposits will not remain as lahar but weather in time to soil (Carating, Manguerra, & Samalca, 2008). The lahar deposits have not yet developed into the soil even 17 years after the eruption of Mt. Pinatubo, although the surrounding areas characterized by thin deposition of volcanic ash have weathered to soils (Carating, Manguerra, & Samalca, 2008).

The average OM content was 0.84%. Samples were neutral (7.16) to very strongly acid (4.52). Changes in soil pH can be caused by natural processes, such as organic matter decomposition and leaching of cations, but also by human actions with the use of acidifying nitrogen fertilizers and/or liming materials (Cornell University, 2008). The electric conductivity of sands is low (Grisso, Alley, Holshouser, & Thomason, 2009) which reaches an average of 0.34 mmhos/cm on the surface layer and 0.18 mmhos/cm on the sub-layer. Cation exchange capacity (CEC) is low and only reached an average of 7.35 cmol/kg with 2.37 cmol/kg its lowest. Sandy soils have much lower CEC than clay soils due to their low organic matter content which is less than 3 cmolc/kg (Cornell University, 2008). However, some areas had high CEC with a value of 23.52cmol/kg. The soil had an insufficient amount of potassium, phosphorus, and nitrogen. CEC is a good soil quality and productivity indicator (Ross & Ketterings, 2011) as it shows the ability of the soil to provide three vital plant nutrients, namely calcium, magnesium, and magnesium.

Based on their properties, the crop suitability evaluation of most plants was marginally suitable to not suitable in the marginal areas. Stoniness, very poor drainage, low water availability, and coarse soil texture were the limitations; although, there were some areas with true soil layers. Also, based on land productivity index determination, sandy areas had severe limitations and cannot be corrected with LPI ratings of 7.98. According to the study of Dengiz and Saglam (2012), a land productivity index rating of 0–7 is defined as extremely poor or nil.

In general, the soil profile of Botolan had a thick layer of lahar deposits and its extremely coarse-textured sand causes excessive drainage, mostly vegetated with Saccharum or "*talahib,*" wild daisies, pine trees, and wild grasses or other creeping plants. Revegetation of gramineous plant communities is one of the intense revegetation on lahar deposits (Ota, 2002; Yoshida, 2002 as cited by Shoji & Takahashi, 2002). Most lands with this condition were located on low elevated areas along and nearby the Bucao River and were used by the landowners on fish production, pasture for cattle and goats, and black sand mining in the past years.

Specifically, farmers were asked about their appraisal of their farms' soil condition under crop production during the study period. Based on the appearance of the soil and the crop condition, about 49% of the farmers assessed their farms as with moderate fertility, 27% said low, 10% as very low, and 12.7% as high. This was quite different from their recall that before the eruption, their farms had high fertility according to 62% and moderate fertility to 35%.

Appraisal of Rice Farming Practices in Marginal Soils

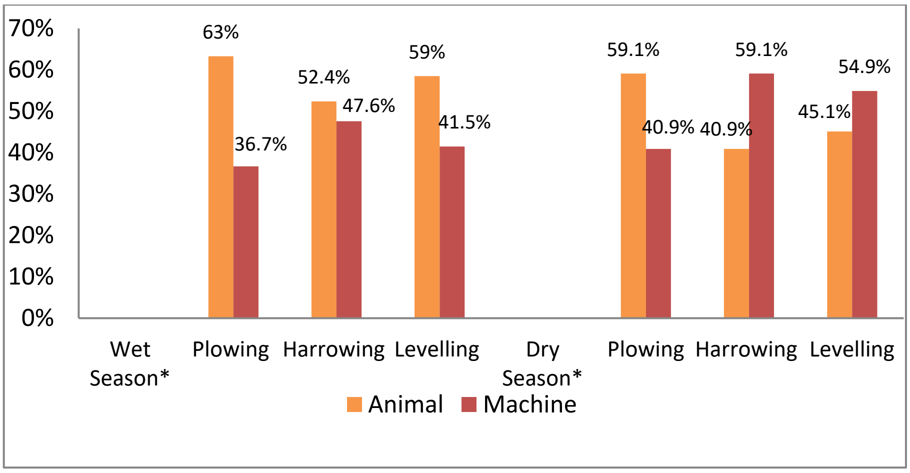
Agriculture statistics in the country indicated that the majority of the farmers plant rice during wet and dry seasons covering about three million hectares. Of which, only 1.6 million hectares are covered by irrigation, 1.4 million hectares are rainfed, and 0.2 million hectares constitute upland rice areas (*2013 Quickstat of Zambales (Region III (Central Luzon))*, 2013; Fernandez, 1998 as cited by Velasco & Cabanilla, 2003). Rice production is important for the Philippine economy and is the only crop mostly grown by farmers (Benson, 1997). According to Garcia et al. (2017), rice production remains the primary source of income in the lahar-affected areas of Zambales. This study had the same findings in terms of rice being a primary crop. Rice was still the major crop planted by the respondents in the study sites from 2017 to 2018. It was grown twice a year, i.e., during wet seasons (WS) and the dry season (DS) depending on the availability of irrigation. WS generally covered the months of July to December, while DS covered January to June.

During WS, about 70% of the respondents planted rice in an average farm size of 0.58 ha. Almost all of their farm areas were planted with rice because other crops were less favorable due to the danger of flooding during rainy days. However, during DS, only 42% of the respondents planted rice in 0.56 ha. During this period, irrigation was a problem, hence many of the respondents did not go into crop production. Only a few planted crops such as cassava, eggplant, bitter gourd, and sweet potato, albeit in a much smaller area.

Complete land preparation was employed by plowing, harrowing, and leveling. These were done using man-animal and man-machine power implements (Figure 3), both during wet and dry seasons. During WS, more of the farmer-respondents utilized animal-drawn power in land preparation. However, during DS, more farmers utilized hand tractors; the highest reporting was 59%. In a developing country like the Philippines, the contribution of animal power in farming operations is very important specifically in land preparation, hilling up and off-barring operations, and hauling (Dela Cruz & Bobier, 2016).

Figure 3

Use of Animal and Machine Power in Land Preparation in Rice Production, Wet Season and Dry Season, Botolan, 2017–2018



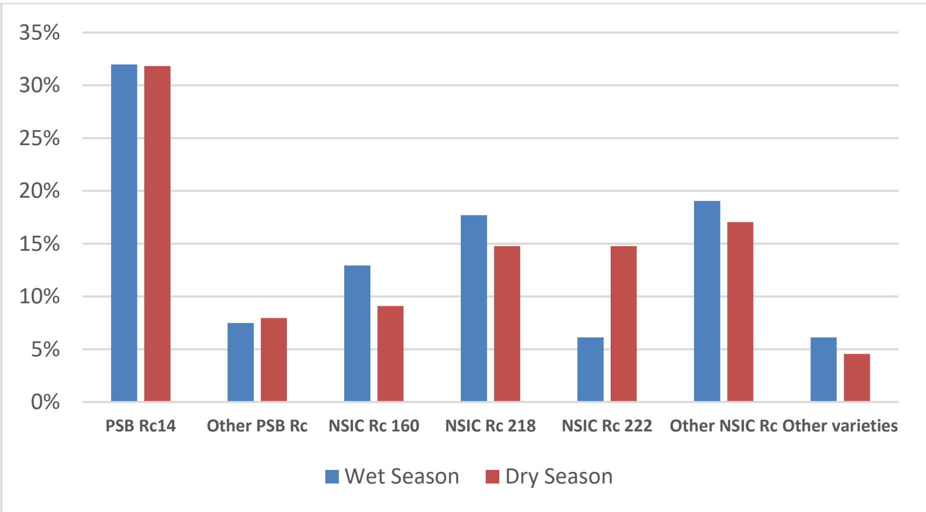
Farm mechanization is being done but to a lower degree than animal-drawn power. The Philippines is classified at a low-mechanization level (Suministrado, 2013 as cited in Bautista et al, 2017). They identified several reasons such as low buying power of farmers, abundance of rural labor, very small landholdings per farmer, high cost of machines, and government policies not favorable to mechanizing agriculture. Amongo & Larona (2015) reported that mechanization in land preparation in rice as well as in corn and sugarcane have intermediate to high levels because imported and locally fabricated hand tractors are available for plowing and harrowing operations. Malanon and Dela Cruz (2017) reported that the power utilized in land preparation among other farm operations in rice has a 62% share in 13 regions studied in 2012–2013. There is a higher level of mechanization in land preparation in general in the country but not in other operations which are still done manually. Bautista et al. (2017) reported that for hand tractors, commonly used for rice production, the Philippines ranks second with an estimated one million units and third in estimated total capacity of 10 million horsepower.

Several rice varieties were used by the farmers during wet and dry seasons, a total of 19 varieties and 17 varieties, respectively (Figure 4). But generally, similar varieties were used such as 3 PSB Rc varieties during both seasons, 12 and 10 NSIC Rc varieties during wet and dry seasons, respectively, and four (4) other varieties during both seasons. However, the number of farmers who reported using specific varieties varied significantly. During the wet season, 32% used PSB Rc varieties, 56% NSIC Rc, and 6% used other varieties. Among all varieties combined, PSB Rc 14 was the most widely used as reported by 32%, followed by NSIC Rc 218 by 18%, and NSIC Rc 160 by 13%. The remaining varieties were used by 1% to 6.1% of the farmer respondents.

During the dry season, the same trend in terms of the most commonly used varieties was recorded. PSB Rc 14 and NSIC Rc 218 were the leading varieties, with 32% and 15% of farmers reporting, respectively, and also, NSIC Rc 222 was reported by about 15%. PSB Rc14, popularly known as the Rio Grande, was bred at the University of the Philippines Los Banos (UPLB) for a rainfed ecosystem in 1992. As reported by Sebastian et al. (FAO, n.d.), the maximum yield of PSB Rc 14 in test sites was 5.10 mt/ha, while the average yield was 3.10 mt/ha. NSIC Rc218 was bred in 2009 by PhilRice for irrigated lowland. It has an average yield of 3.8 mt/ha with a maximum reported yield of 8.0 mt/ha. NSIC Rc160 was bred in 2007 also by PhilRice for the same ecosystem. The average yield is higher at 5.6 mt/ha with a maximum reported yield of 8.2 mt/ha. Meanwhile, NSIC Rc 222 was bred in 2009 by IRRI with a higher average and maximum yield of 6.1 mt/ha and 10.0 mt/ha, respectively, under lowland irrigated conditions (PhilRice, 2018).

Figure 4

Percent of Farmers by Rice Variety Planted during the Wet and Dry Season, 2017-2018



In terms of crop establishment, most of the respondents practiced the transplanting method during wet and dry seasons (Table 3). This supports the study of Garcia et al. (2017) that the transplanting method is the predominant method of planting in the Mt. Pinatubo affected areas. Specifically, about 62% practiced the "waray method," while 48% practiced the straight method, indicating that a few farmers used both practices at a given season. Bautista and Javier (2008) described a straight-planting method wherein a baseline of 20 cm planting distance is first transplanted with rice seedlings. Such baseline becomes the transplanters' guiding row as they plant by moving backward at undefined planting distance per hill. Under, the Waray method, planting distance between row and hills is not defined, and no baseline is followed.

Table 3

Crop management practices in rice production in marginal soils in Botolan, Zambales, 2018

Other Management Practices	Description
Planting method	Transplanted (Waray or straight)
Fertilizer applied	Inorganic
Irrigation	Flooding
Weed control	Manual weeding
Insect pest control	Chemical control
Rodent Control	None applied
Disease control	Chemical control
Harvesting and threshing	Manual harvesting and machine

All of the farmer-respondents applied fertilizer to ensure plant growth. On average, there were 2 applications per season, although a few farmers had third to fourth applications. Inorganic materials were broadcasted and foliar were sprayed. Urea (46-0-0) was applied by the majority of the farmer-respondents along with 14-14-14 and 21-0-0. On average, 5.5 bags of Urea, 4.3 bags of 14-14-14, and 3.7 bags of 21-0-0 were applied amounting to 197 kg N, 30 kg P, and 30 kg K, a total of 258 kg NPK. There were a few who applied 16-20-0 and only one applied organic fertilizer. According to Rola (2000), it is not sustainable in the long run to use pure inorganic fertilizers for continuous cultivation and nutrient ratios must be carefully managed to sustain soil productivity. Despite marginalization, rice and other crops could still grow well in the few regions of Botolan, however, it would require higher amounts of inorganic fertilizer (Reyes & Neue, 1991; Dacanay, 1997).

There were several sources of water for irrigation during both seasons such as the national irrigation system, pump, creek, and spring, with the national irrigation system as the main source during the dry season. Luzon has the most covered areas with good irrigation facilities since the 1970s, although the total agricultural area covered by irrigation has not significantly increased over time (Velasco & Cabanilla, 2003). On average, irrigation through flooding was done 22.5 times during the wet season and 32 times during the dry season. At about two weeks before harvest, the field was drained to hasten crop maturity and prevent lodging, and to harden soil for easy harvesting. Moreover, rainfall provided additional water for rice production during the wet season. It is also vital in rice production (Muhammad-Lawal & Salau, 2012) because other farmers had no or limited irrigation source, and rainfall reduced irrigation expenses.

Similar in other producing areas, weeds, insect pests, and diseases were mentioned as problems by farmers in varying degrees. About 79% and 82% mentioned problems on weed, 90% and 92% on pests, and 71% and 62% on diseases during WS and DS, respectively. Despite problems on weed, hand weeding was done by a majority, and a few (28% and 36% during the wet and dry season, respectively) used herbicides.

Whereas, 10% to 52% of the farmers reported insect pests such as rice bug and stemborer during both seasons. Other insect pests were also reported by less than 10%. More than 84% used chemicals, while 16% did not apply any control against insect pests. According to Rola & Pingali (1993, as cited in Bordey, 2010), the use of a zero-pesticide strategy was more profitable given the cost of health damage that insecticide inhalation could cause to farmers. Similarly, Herdt, Castillo, and Jayasuriya (1984, as cited in Bordey, 2010) reported that rice farmers who did not apply insecticides had higher expected returns than farmers who applied insecticides on a preventive basis. Also, rodents are known as one of the pests in rice and can decrease yield by 50% (Bautista & Javier, 2008). According to 52% and 48% of the respondents, rodents were also a problem but they could not estimate the damage. No control measure was done to eradicate the rodents; hence it is presumed that the damage was minimal. Meanwhile, tungro was reported by 11% and 20% during the seasons, respectively. Also, yellowing of the leaves was reported by as much as 42%, a symptom of a deficiency in water and nutrient uptake. More than half of the respondents used fungicide as a control measure, while others did not apply.

Harvesting and threshing, on the other hand, was done manually as reported by about 62% during the wet season and 72% during the dry season. Only a few, 38% and 28%, respectively, used mechanical harvester and thresher. This supports the findings of Malanon and Dela Cruz (2017) that among 1,235 rice farmers in 13 producing regions in the country in CY 2012–2013, power utilized in harvesting and threshing is relatively low at 7% and 24%, respectively, far behind power used in land preparation of 61%. Amongo and Larona (2015) also reported that despite the availability of mechanization technologies in the country, some operations in the production of rice are still predominantly done manually, particularly in harvesting. The application of agricultural mechanization, along with other farm inputs (e.g., fertilizers, irrigation, crop care, etc.) contributes to crop, labor, and land productivity. Furthermore, Amongo et al (2015) indicated that even with considerable advances in agricultural mechanization, most farmers still use inefficient manual tools resulting in a disparity in agricultural productivity.

Appraisal of Rice Productivity and Profitability in Marginal Soils

The computed rice yield during the wet season was 3,600 kg per ha and 4,350 kg per ha during the dry season. As in other areas in Luzon, yield in four barangays in Botolan was higher during the dry season than during the wet season by about 20%. Farmers from Carael had the highest yield at 4,350 kg/ha and 5,050 kg/ha during the wet and dry seasons, respectively. Those from the three other barangays have similar yields of about 3,400 kg/ha and 4,200 kg/ha during the two seasons, respectively. In essence, only those from Carael had an average yield higher than the mean yield in all sites. When irrigation water is available, higher yield is expected during the dry season because there is usually a lower incidence of pests and diseases due to more favorable weather. Nonetheless, rice production anywhere in the country is beset by production problems attributed to various factors that are beyond farmers' control such as unexpected calamities/natural phenomenon, climate uncertainties, cost of inputs, lack of capital, an unstable supply of irrigation, pests, and disease infestations, and the availability of manpower (Dar, 1999). In the study sites in Botolan, the problem was further aggravated by the physical condition of the farms brought about by ash, lahar, and sand that covered the farms after the Mt. Pinatubo eruption in 1999 and the flooding in 2009.

A yield gap analysis was done for the study sites by determining the difference between the average yield in the province and the region. This gap reflects constraints such as biological, soil and water, and socio-economics that compel farmers to use inputs at a level below the technical optimum (Sebastian et al, 2000). However, this study did not analyze which of these constraints were significant in the study sites. Determining the yield difference provides preliminary information of how far yield in marginal areas in the study barangays falls short of the provinces and the regions. Data from PhilRice Rice Statistics indicated an average yield of 4.51 tons/ha under all ecosystems in Central Luzon in July to December and 5.53 tons/ha in January to June 2018. The same report indicated an average yield of 3.69 tons/ha under all ecosystems in Zambales in July to December and 4.22 tons/ha in January to June 2018. In this context, yield in the study sites falls short of the provincial average, much more of the regions.

Cost and return analysis was done to present the profitability of rice production during wet and dry seasons in the different sites. We had chosen to examine the cost and return of two barangays, Carael with the highest yield and Paco with the lowest (Table 4).

Table 4

Profitability analysis of rice production, 2 barangays, Botolan, Zambales 2018

	CARAEL		PACO	
	Wet Season	Dry Season	Wet Season	Dry Season
Yield, kg/ha	3,437.00	3,990.00	2,607.00	3,279.00
Gross Income	58,429.00	67,830.00	46,926.00	62,301.00
Cash Expenses				
Labor	25,080.50	25,742.82	24,331.64	25,815.71
Material inputs	25,891.20	24,806.48	22,142.66	20,881.05
Total	50,971.70	50,549.30	46,474.31	46,696.76
Net Cash Income	7,475.30	17,280.70	451.69	15,504.24

Rice production in the study sites is relatively less productive and profitable. Gross income per ha during the wet season is relatively low due to low yield, PHP 58,429 for farmers from Carael and PHP 46,926 for Paco.

The difference was about 20% or PHP 11,503 per ha. Price was relatively high at PHP17.00 per kg, the National Food Authority's (NFA) buying price for palay. Total cash expenses during the wet season were PHP 50,971 in Carael and PHP 46,474 in Paco. In Carael, about 50% each was spent on labor and material inputs, while in Paco, more was spent on labor (52%) than material inputs (48%) by about PHP 2,200. Labor expenses were on land preparation, transplanting (including pulling of seeds and hauling), care and management, harvesting and threshing, and other post-harvest activities. Expenses were highest on harvesting and threshing representing more than 45% of the total labor cost. This finding is similar to Hayashi et al. (2018) that labor represents a substantial cost in rice farming in North Sumatera and West Nusa Tenggara, Indonesia, 43% and 63%, respectively, and the cost of harvesting and threshing is about 70% of the labor cost. Moreover, expenses on material inputs of the sample farmers from Botolan were on seeds, fertilizer, chemicals, and sacks, of which the cost of fertilizer was highest with more than 70% share. Net cash income was relatively low, but those from Paco had lesser income than those from Carael, attributed largely to the difference in yield of 830 kg.

During the dry season, a higher yield was recorded among farmers from both barangays, and again, there was a higher yield in Carael by 711 kg. This explained the higher gross income of those from Carael, PHP 67,830.00 as compared to Paco's PHP 62,301.00. Total expenses and share of labor and material inputs to total expenses were relatively the same as in the wet season in both barangays. Higher net cash income was again recorded for farmers from Carael, and in both barangays, there was higher net cash income in the dry season than in the wet season by as much as PHP 9,800.00 and PHP 15,000.00, respectively.

Conclusion

The eruption of the Mt. Pinatubo in 1991 and the flooding in 2009 resulted in rice farms being marginalized, especially in Botolan, Zambales. However, years after the eruption, farmers returned to farming despite their farms being covered with ash, lahar, and black sand rendering the farms less, if not suitable for farming. Rice was the major crop planted during wet and dry seasons. Rice yield was relatively low during both seasons, lower than the provincial's and regional's average yield. None of the four barangays had an average yield at par with the province's and the region's in 2018. The yield gap reflects constraints such as biological, soil and water, and socio-economics that compel farmers to use inputs at a level much below the technical optimum. Moreover, the gap was further aggravated by the physical condition of the farms covered by ash, lahar, and sand. The cash costs for labor and material inputs were relatively high, representing 93% and 75% of the total income during the wet season and dry season, respectively. High cash costs were recorded in land preparation, fertilizer materials, and harvesting and threshing. The high cash expenses and the low yield resulted in relatively low net income from rice farming. The respondents rely heavily on rice farming as a source of employment and income. Therefore, productivity has to be increased. Government agencies should develop and disseminate to farmers appropriate rice production practices in marginal soil. In return, the farmers need to adopt these practices to optimize the use of their limited resources and generate higher yield and income.

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