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Sustainable rice farming systems: farmer attribute and land ecosystem perspectives

RESEARCH ARTICLE

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Abstract

This study assesses the sustainability of rice farming through the perspectives of farmer attributes and land ecosystem – sub-categorized as the socio-economic profile of farmers, resources, constraints, investments, and its economic contribution to the economic pursuits of families of farmers. It also proposes a program which can improve rice production in Bulacan, Philippines, and similar contexts. This study discusses the identified rice farming constraints such as inadequate capital, high cost of labor, inadequate supply of farm inputs, poor marketing outlet, high cost of pesticides, high cost of fertilizer, issues on land tenure system, ignorance on the existing rice farming programs of the government, poor storage facilities, high cost of transportation, pests and diseases, and climate change. The contributions of rice farming to the economic pursuits of families of farmers are analyzed in terms of their gross profit, savings, and family living expenditures such as food, clothing, recreation, personal item, health care, education, utilities, transportation, dwelling maintenance, and appliances/furniture. Lastly, the suggestions for sustainable and human health facilitating rice farming in developing countries are discussed.

Keywords: farmer socio-economic attributes, agribusiness, rice farming, Philippines
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1. Introduction

Rice is considered as a very important staple food of the world. It is the third highest produced crop in the world and is very popular in Asian countries (Cago, 2017). In the '70s, the Philippines was self-sufficient in rice and even exported part of the harvest. The golden years of rice production became possible through crop breeding and increased use of fertilizer, pesticides, and irrigation. The 'Green Revolution' and '*Masagana* 99' were the programs implemented during that time. The latter was a government program which targeted average production at the least, of 99 cavans per hectare per season of irrigated rice. Opposite to this scenario, however, the Philippines ranked third on rice importation in the world (James Burton, 2017). This phenomenon resulted from very huge consumption of rice due to increasing population (Philippine Ricepedia, 2018).

The Philippines devoted about 10 million hectares of its total land area of about 30 million hectares to agriculture (Philippine Ricepedia, 2018). It is composed of 70% irrigated rice areas located at Central Luzon and 30% rain-fed and upland found in Northern Luzon, Iloilo Province, and coastal plains of Visayas (Philippine Ricepedia, 2018). In 2010, 4.4 million hectares of the 10 million hectares devoted to agriculture were farmed for rice production, however, the Philippines still imports rice to meet the increasing demand of the increasing population (Philippine Ricepedia, 2018). During 2010 and 2011, the Philippines was tagged as the biggest rice importer in the world (Philippine Ricepedia, 2018). In addition, the increasing demand in rice of Filipino's resulted to a huge consumption from 93.2 kg in 1995 to 123.3 kg in 2009 (Philippine Ricepedia, 2018). This figure serves as an evidence of the huge amount of rice demand by Filipino consumers. Rice prices for consumers are considered to be highest in Asia as per farm-gate prices for farmers.

The rice production in intensively irrigated areas from the major rice producing countries in Asia are profitable in terms of the positive values of net returns per hectare (PRRI, 2015). In effect, the annual household income from rice farming is more than enough to meet the poverty threshold income from all locations due to the interplay of paddy prices, yield, and the magnitude of costs of production. The price per kilogram of paddy is more expensive in intensively cultivated and irrigated areas in importing countries like Philippines, Indonesia, and China than in exporting countries like Thailand, Vietnam, and India. This indicates that exporting countries have advantage in terms of cost competitiveness at farm level compared to importing countries (PRRI, 2015). The labor cost reduction is one the major means to improve competitiveness and increase labor productivity so that rural incomes can increase over the long run (PRRI, 2015). Moreover, a highly competitive and labor-intensive production will lead to low levels of labor productivity. The low level of mechanization in the Philippines had resulted to a higher overall costs and low profit. Thailand, Vietnam, and China are among the countries with high productivity of labor due to less use of labor input and highly mechanized farming operations (PRRI, 2015). The use of combined harvester requires a minimum labor input, thus saving time, labor cost, and potentially reducing losses on harvesting and threshing activities. The common practice of direct seeding method also reduces the labor requirement in crop establishment. As a result, Thailand and Vietnam were able to produce rice more economically than their counterparts due to the adoption of these labor-saving technologies (PRRI, 2015).

Goldratt *et al.* (1986) explained that every collective process including agricultural ones has constraints and focus on these constraints will lead to an enhance productivity. The factors which hinder the production should be identified and eliminated to achieve the target goal. This study conjectures that the quality of farmers and their agribusinesses as human capital and organizations are critical which needs a thorough assessment to solve the problem. Emergent studies look into the productivity of these human force and organizations through the lens of socio-economic attributes and the land ecosystems. The socio-economic factors such as health status, income, environment and education as lifestyle components and measurements of both financial viability and social standing which influence social privilege and levels of financial independence. For instance, Montesano (2017) conducted an analysis of the structural and economic changes in rice farming in Central Luzon, Philippines and reflected on socioeconomic characteristics of the farmers. Another study reflected on the three-rice production system: Upland, Valley Bottom and Irrigated farm lands in the Upper East Region of Ghana, Africa and conjectured that the irrigated rice system had the highest total cost of production while gender of the farmers, years of experience in rice production, labor input, fertilizer usage, and years in formal education have a large impact in rice yields (Thanh and Singh, 2006).

In summary, reflecting on the socio-economic attributes of the farmers and their businesses are necessary to improve our understanding and practices of rice farming. Thanh and Singh (2006) classified the rice farming constraints into three, namely: agro-ecological, technical, and socio-economic and offered an initial hint for proposing an overall analytic framework which covers both the farmer and the land ecosystem. The related studies that have been reviewed in the preceding section focused on the different analyses in relation to economics of rice farming. In addition, most of the prior studies tried to examine the possible methods to analyze and assess the factors that may affect the productivity. However, to our current knowledge, it is possible to conclude that although there have been a number of studies on economic assessment of rice farming and related issues, there may be new discoveries on how the province of Bulacan has coped up with the developments in rice farming since rice farming productivity in other countries and regions may be different. The (ideal) goal of this paper is to offer preliminary but broad-dimensioned analyses for agricultural practices, both for the mostly under-educated farmers and educated policy makers/regulators in our studied and similar areas. Simply put, we wish that even an under-educated farmer in our studied area can read this paper and learn something to put into practices.

2. Materials and methods

2.1 Methodology

This study used the descriptive research design to realize its objectives. The researchers reckon that descriptive research can provide an in-depth analysis of rice farming which will be used for future research. This study did not test specific relationships between variables but it had provided information about the trend and attributes with the goal of reaching a better understanding of the economics of rice farming. Moreover, we employ descriptive quantitative and qualitative research (mixed) method to employ strategies of inquiry which involve the collection of data either simultaneously or sequentially to best understand research problems. The data collection also involved both numerical information from the survey questionnaire as well as text information from the answers from the interview questionnaire so that the final database represents both quantitative and qualitative information.

2.2 Case areas

The Philippines posted an economic growth of ₱s 12,643 billion, with agriculture, accounting for only 10% of Gross Domestic Product (GDP) during 2014 (GDP, 2014). During the second quarter of 2016, the agriculture sector declined by 2.1% while the other sectors such as service and industry grew by 8.4 and 6.9%, respectively, when compared to the same quarter of 2015 (GDP, 2014). Region III (Central Luzon) is the major rice producing region in the Philippines. Bulacan registered an average annual palay (rice at any stage prior to husking – used especially in the Philippines) production of 303,000 metric tons harvested from more than 75,000 hectares of land from year 2000 to 2010, which represent almost 11% of the total production of Central Luzon, the fourth highest among the provinces belonging in the region (Bulacan Provincial Government, 2015).

This study covers the top three major producers of rice in the province of Bulacan such as the Municipalities of San Rafael, San Ildefonso, and San Miguel. The rice production from the three towns range from 33,000 metric tons to 85,000 metric tons with the harvested area ranging 7,000 hectares to 18,000 hectares. The researchers believe that the three towns considered in this study represent the classes of land, such as upland and lowland with irrigated and rain-fed ecosystem. These provide valuable result to the economic assessment and comparison of rice farming in Bulacan.

The barangays with high volume of rice production and huge number of farmers from the selected municipalities of Bulacan are considered as our study area. It includes the barangays of Palapala, Umpucan, and Gabihan from the Municipality of San Ildefonso; Partida, Sta. Lucia, and Camias from the Municipality of San Miguel; and Maronquillo, Caingin, and Pulo from the Municipality of San Rafael. These barangays are composed of 2,451 farmers out of the 9,131 farmers in the Municipalities of San Ildefonso, San Miguel and San Rafael. The researchers employ the stratified random sampling technique in which the population is divided into strata or categories and drawing the members at random proportionate to each stratum or sub-group. A total of one hundred fifty farmers serve as the respondents of this study. The Provincial Agriculturist and the Municipal Agriculturist are also asked to give information about the role of the government in rice farming, the problems encountered in project implementations, and the different programs which addressed the different constraints in rice farming. The data gathering activity is considered difficult due to the remoteness of the study area with some of the farmers not wanting to be involved in the conducted survey and interview.

The data are presented per municipality to differentiate and analyzed deeper the socio-economic characteristics, resources, constraints, investments, and economic contribution of rice farming since the covered towns are located to areas with irrigated and rain-fed ecosystem. Table 1 shows the population of farmers in the selected barangays of the Municipalities of San Miguel, San Ildefonso, and San Rafael.

2.3 Data collection and analysis procedures

This study reflects on the socio-economic characteristics of farmers such as educational attainment, members of the family, other source(s) of income, total household income, land ownership, years of farming experience, and source of capital. We also reflect on the inputs and constraints in rice farming and examine its economic contributions to the families of farmers. For this study, the survey-questionnaire instrument is formulated in which the necessary data are determined. The instrument is reviewed and validated by experts not directly associated with the study. A primary challenge of this paper is the knowledge level and willingness of participation of local farmers. As also reflected in the results, most of the famers in our sampled areas did not accept good education (most of them only had elementary or high school education). In such premise, it is difficult to have many farmers to join our survey study. Thus, to collect effectively answered surveys as many as possible, we accept that local government's suggestion and help for the potential list of raters. With this challenge, we still desire to offer preliminary but broad descriptive analyses for this and similar developing agricultural areas' references. As a result, self-administered questionnaires are distributed to gather information from a total of 150 farmers. Among total sample, Barangay Palapala has 18 farmers, barangay Umpucan has 17 farmers, and Barangay Gabihan has 16 farmers with total sample of 51 farmers in San Ildefonso. In San Miguel, Barangay Partida has 19 farmers, Barangay Sta. Lucia has 19 farmers, and Barangay Camias has 16 farmers with total sample of 54 farmers. In San Rafael, Barangay Maronquillo has 16 farmers, Barangay Caingin has 16 farmers, and Barangay Pulo has 13 farmers with a total sample of 45 farmers.

The questionnaire is structured in such a way that respondents are able to answer it easily. The first part of the survey-questionnaire is focused on the respondent's profile (age, sex, and civil status) and socio-economic characteristics of rice farmers. The second part detailed the resources used in rice farming including production

Table 1. Populations of rice farmers.

San Ildefonso		San Miguel		San Rafael	
Barangay	**No. of farmers**	**Barangay**	**No. of farmers**	**Barangay**	**No. of farmers**
Palapala	293	Partida	316	Maronquillo	269
Umpucan	271	Sta. Lucia	307	Caingin	264
Gabihan	258	Camias	262	Pulo	211
Total	822	Total	885	Total	744

and post-production inputs. The third part is a five-point Likert-scale questionnaire about the rice farming constraints with: (1) indicating never; (2) rare; (3) seldom; (4) often; and (5) most often. The fourth part showed the investments in rice farming in terms of production and post-production costs. The fifth part is also a Likert-scale questionnaire about the economic contributions of rice farming to the families of farmers with: (1) indicating none at all; (2) less extent; (3) moderately extent; (4) great extent; (5) very great extent. The sixth part is a list of semi-structured interview questions for farmers supporting the answers of farmers in the first to fifth part of the survey questionnaire.

3. Results and discussion

3.1 Socio-economic attributes of farmers

■ *Education*

Montesano *et al.* (2017) explained that the number of years of schooling of the farm operators in Central Luzon has improved and those farmers who have a limited number of years in school are among the oldest. In addition, farmers considered non-farming as their additional occupation in 2012 and the most common off-farm works were construction laborer, service and company worker, and buy and sell activities.

Boniphace *et al.* (2015) mentioned that the increase in agricultural inputs is a result of socio-economic factors, however, it decreases the non-farm income owned by the households. The summary of the data gathered in the educational attainment of the farmers (Table 2) shows that farmers are elementary graduate as shown by 36% or 54 farmers, 26% or 39 farmers are high school graduate, 11% or 16 farmers are high school undergraduate, 10% or 15 farmers are elementary undergraduate, 10% or 15 farmers are college undergraduate, 5% or seven farmers have no formal education, 2% or three farmers from San Rafael and San Miguel are college graduate with Bachelor's Degree in Accountancy, Public Safety and Education, and 1% or one of the farmers has vocational training. Farmers in San Rafael, San Ildefonso, and San Miguel are elementary graduates and high school graduates and most of the elementary graduates have an age range of 59 to 71 years old. This indicates that the number of years of schooling of the rice farmers in the study area has improved and those farmers who have a limited number of years in school are among the oldest.

■ *Rice farming experience*

The educational attainment is historical account while experience and knowledge are dynamic and current description of workers' capability (Tsai, 2016). Table 3 shows the frequency and percentage distribution of the socio-economic profile of rice farmers in terms of years of farming experience.

Table 2. Socio-economic profile of rice farmers in terms of educational attainment.

Educational attainment	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
College graduate	1	2	0	0	2	4	3	2
College undergraduate	2	4	3	6	10	19	15	10
Vocational	0	0	0	0	1	2	1	1
High school graduate	15	33	16	31	8	15	39	26
High school undergraduate	5	11	3	6	8	15	16	11
Elementary	16	36	21	41	17	31	54	36
Elementary undergraduate	5	11	6	12	4	7	15	10
No formal education	1	2	2	4	4	7	7	5
Total	45	100	51	100	54	100	150	100

Table 3. Socio-economic profile of rice farmers in terms of years of farming experience.

Years of rice farming experience	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
51-60 years	7	16	6	12	5	9	18	12
41-50 years	6	13	2	4	11	20	19	13
31-40 years	11	24	16	31	15	28	42	28
21-30 years	13	29	17	33	13	24	43	29
11-20 years	7	16	6	12	8	15	21	14
Less than 10 years	1	2	4	8	2	4	7	5
Total	45	100	51	100	54	100	150	100

Table 3 shows that in San Rafael, farmers have 21 to 30 years of rice farming experience as presented by 29% or 13 farmers, 24% or 11 farmers have 31 to 40 years of rice farming experience, 16% or seven famers have 11 to 20 years of rice farming experience, 16% or seven farmers have 51 to 60 years of rice farming experience, 13% or six farmers have 41 to 50 years of rice farming experience, and 2% or one of the farmers has less than 10 years of rice farming experience. Table 3 shows that in San Ildefonso, farmers have 21 to 30 years as presented by 33% or 17 farmers, 31% or 16 farmers have 31 to 40 years of rice farming experience, 12% or seven famers have 11 to 20 years of rice farming experience, the other 12% or six farmers have 51 to 60 years of rice farming experience, 8% or four farmers have less than 10 years of rice farming experience, and 4% or two farmers have 41 to 50 years of rice farming experience. Moreover, table 3 also shows that in San Miguel, 28% or 15 farmers have 31 to 40 years of rice farming experience, 24% or 13 farmers have rice farming experience from 21 to 30 years, 20% or 11 farmers have rice farming experience from 41 to 50 years, 15% or eight farmers have rice farming experience from 11 to 20 years of rice farming, 9% or five farmers have rice farming experience from 51 to 60 years, and 4% or two farmers have less than 10 years of rice farming experience.

In summary, farmers have 21 to 30 years of rice farming experience as presented by 29% or 43 farmers, almost the same with 28% or 42 farmers with 31 to 40 years of rice farming experience. The findings also show that 14% or 21 of the farmers have rice farming experience from 11 to 20 years of rice farming, 13% or 19 of the farmers have rice farming experience from 41 to 50 years of rice farming, 12% or 18 of the farmers have rice farming experience from 51 to 60 years of rice farming, and 5% or seven farmers are in rice farming for less than 11 years. This indicates that farmers have a long and wide experience in rice farming. Most of the farmers in San Rafael and San Ildefonso are in rice farming for 21 to 30 years while 31 to 40 years of experience for rice farmers of San Miguel. There are also farmers with 51 to 60 years of rice farming experience. The length of experience of rice farmers indicates that there is 'graying' population of rice farmers in the study area which can be added to the issue of food security in the country.

■ *Members of the family*

Table 4 shows the frequency and percentage distribution of the socio-economic profile of rice farmers in terms of members of the family who are engaged in rice farming, other activities, and who are unproductive. As seen in Table 4, 89% or 40 farmers in San Rafael stated that there are 1 to 3 members of the family engaged in rice farming and 11% or five farmers stated that there are 4 to 7 members of the family engaged in rice farming. The table also shows that in San Ildefonso, 98% or 50 farmers stated that there are 1 to 3 members of the family engaged in rice farming and 2% or one of the farmers stated that there are 4 to 7 members of the family engaged in rice farming. The table also shows that in San Miguel, 96% or 52 farmers stated that there are 1 to 3 members of the family engaged in rice farming and 4% or two farmers stated that there are 4 to 7 members of the family engaged in rice farming. From the table presented, 95% or 142 farmers stated that there are 1 to 3 members of the family engaged in rice farming and 5% or eight farmers stated that

Table 4. Socio-economic profile of rice farmers in terms of members of the family.

Number of family members	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Members of the family engaged in rice farming								
4-7	5	11	1	2	2	4	8	5
1-3	40	89	50	98	52	96	142	95
Total	45	100	51	100	54	100	150	100
Members of the family engaged in other activities								
8-11	1	2	0	0	0	0	1	1
4-7	8	18	7	14	13	24	28	19
1-3	36	80	44	86	41	76	121	81
Total	45	100	51	100	54	100	150	100
Members of the family that are unproductive								
4-7	11	24	4	8	7	13	22	15
1-3	34	76	47	92	47	87	128	85
Total	45	100	51	100	54	100	150	100

there are 4 to 7 members of the family engaged in rice farming. This indicates that only few of the family members are engaged in rice farming.

Table 4 also shows that in San Rafael, 80% or 36 farmers belong to a family with 1 to 3 members engaged in other activities, 18% or eight farmers belong to a family with 4 to 7 members engaged in other activities and 2% or one of the farmers belong to a family with 8 to 11 members engaged in other activities. From the data presented in Table 4, 86% or 44 farmers in San Ildefonso belong to a family with 1 to 3 members engaged in other activities and 14% or seven farmers belong to a family with 4 to 7 members engaged in other activities while none of the farmers belong to a family with 8 to 11 members engaged in other activities. The study also shows that in San Miguel, 76% or 41 farmers belong to a family with 1 to 3 members of the family engaged in other activities and 24% or 13 farmers belong to a family with 4 to 7 members of the family engaged in other activities while none of the farmers belong to a family with 8 to 11 members engaged in other activities. From the table presented, 81% or 121 farmers belong to a family with 1 to 3 members of the family engaged in other activities, 19% or 28 farmers belong to a family with 4 to 7 members of the family engaged in other activities and 1% or one of the farmers belong to a family with 8 to 11 farmers in family engaged in other activities. Moreover, this table also shows that in San Rafael, 76% or 34 farmers belong to a family with 1 to 3 members of the family are unproductive and 24% or 11 farmers belong to a family with 4 to 7 members of the family are unproductive. The table also shows that in San Ildefonso, 92% or 47 farmers belong to a family with 1 to 3 members of the family are unproductive and 8% or four farmers belong to a family with 4 to 7 members of the family are unproductive. The study also shows that in San Miguel, 87% or 47 farmers belong to a family with 1 to 3 members of the family are unproductive and 13% or seven farmers belong to a family with 4 to 7 members of the family are unproductive.

■ *Source of capital and other income*

The rice farmers need a capital to supply the inputs needed in rice farming. It can be from internal and external financing. Internal Financing is the means of a firm to use its profits as a source of capital for new investment while external financing is used to describe funds that firms obtain from outside of the firm or borrowing from other parties. The government supports the rice farmers with different financing programs. The '*Sikat Saka* program' was launched in partnership with Land Bank of the Philippines to support the Government's Food Staples Sufficiency Program. The program aimed to assist the palay farmers in financing their palay production requirements in a timely manner and at an affordable cost, to improve the viability of palay production by ensuring availability of irrigation and extension services, and market as well as to expand the credit outreach and increase palay production for food self-sufficiency. Table 5 shows the frequency and percentage distribution of the socio-economic profile of rice farmers in terms of source of capital.

Table 5 shows that the source of capital of rice farmers in San Rafael is from external financing based on the 29 or 64% of respondents while 16 or 36% is from internal source. The table also presents that in San Ildefonso, the source of capital of rice farmers is from external financing based on the 27 or 53% of respondents while 24 or 47% is from internal source. Table 11 also exhibits that in San Miguel, the source of capital of rice farmers is from external financing based on the 22 or 41% of respondents while 32 or 59% is from internal source. Based on the table shown, the main source of capital of rice farmers is external financing based on the 78 or 52% of respondents while 72 or 48% is from internal source. The farmers in San Rafael finance their rice farming activity through external financing. Most of the farmers are engaged in other activities but the income generated is not enough to capitalize the rice farming requirement during wet cropping season. In San Ildefonso and San Miguel, there is almost equal distribution of financing options since most of the farmers have regular income generated from vegetable farming and other activities.

Farmers set aside part of their profit from rice farming to capitalize the next cropping season while other farmers utilized their profit from other activities. These are the means of the farmers to capitalize rice farming activity internally. The rice farmers are also engaged to external financing. It includes the informal loan system called '5-6' which facilitated by their rich individuals from the community and Indian nationals or '*bumbay*'. There are also multi-purpose cooperatives in the area and lend money to farmer members to finance rice farming activities. In addition, the local government also support rice farmers through '*Sikat Saka* program' in cooperation with the Land Bank of the Philippines which aims to assist the palay farmers in financing their palay production requirements in a timely manner and at an affordable cost.

On the other hand, other income is also linked on farmers' sources of capital. It can be gleaned from Table 6 that 44% or 20 farmers in San Rafael are engaged in agricultural activities such as fishpond operations, livestock operation, sampaguita growing, and vegetable farming, 33% or 15 of the farmers had no sources of income but rice farming, 11% or five farmers are engaged in business activities such as candle making, soft

Table 5. Socio-economic profile of rice farmers in terms of source of capital.

Source of capital	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
External financing	29	64	27	53	22	41	78	52
Internal financing	16	36	24	47	32	59	72	48
Total	45	100	51	100	54	100	150	100

Table 6. Socio-economic profile of rice farmers in terms of other source(s) of income.

Items	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Business	5	11	0	0	7	13	12	8
Agriculture	20	44	30	59	9	17	59	39
Service	5	11	7	14	6	11	18	12
Pension	0	0	0	0	1	2	1	1
None	15	33	14	27	31	57	60	40
Total	45	100	51	100	54	100	150	100

drinks dealership, Public Utility Jeep (PUJ) operation, sari-sari store business, while the other 11% or five farmers are engaged in rendering services such as construction works, laundry services and tricycle driving.

Moreover, table 6 also shows that in San Ildefonso, 59% or 30 farmers are engaged in agricultural activities such as fishpond operation, livestock operation, sampaguita growing, and vegetable farming, 27% or 14 of the farmers have only rice farming as source of income, 14% or seven farmers are engaged in rendering services such as construction works, laundry services and tricycle driving. The study shows that in San Miguel, 57% or 31 farmers have only rice farming as source of income, 17% or nine of the farmers are engaged in agricultural activities such as fishpond operation, livestock operation, sampaguita growing, and vegetable farming, 13% or seven farmers are engaged in business activities such as candle making, soft drinks dealership, PUJ operation, sari-sari store business, 1% or six farmers are engaged in rendering services such as construction works, laundry services and tricycle driving, the remaining 2% or one of the farmers is receiving pension. In summary, 40%, or 60 of the farmers have only rice farming as source of income, 39% or 59 farmers are engaged in agricultural activities such as fishpond operation, livestock operation, sampaguita growing, and vegetable farming, 12% or 18 farmers are engaged in rendering services such as construction works, laundry services and tricycle driving, 8% or 12 farmers are engaged in business activities such as candle making, soft drinks dealership, PUJ operation, sari-sari store business, while 1% or one of the farmers is receiving pension.

■ *Rice farming income contribution to the farmer families*

Income has a great impact to daily living and expenditures of farmers. Krapf *et al.* (2017) explained that rice farming contributes to the economic pursuits of families in the farming industry. The different aspects of contributions are volume of production, savings, and family living expenditures. The farmers will use the generated profit from rice farming depending on the priority of the expenditure. The low income in rice farming is due to lower grain returns. The total family living expenses are divided into categories such as food, clothing, recreation, entertainment, personal item, health care, education, utilities, transportation, dwelling maintenance, furniture, and household appliances. Household can increase their income from rice-based farming activities. The mean age of the Filipino farmer is 54 and the age bracket 40 to 59 years old increased by 7% and those 60 and above by 2%. More college graduates have been attracted to rice farming since almost half of the Department of Agriculture budget is allocated in the rice program. The models of diversification in rice farming for optimum incomes have enticed the college graduate to this occupation.

This section shows the contribution of rice farming to the economic pursuits of the families of farmers in terms of gross profit, savings, and family living expenditures. After the gross profit analysis, the economic contributions of rice farming income to the families of farmers are described in terms of savings and family living expenditure such as food, clothing, recreation, personal item, health care, education, utilities, transportation, dwelling maintenance, and appliances/furniture. Table 7 shows the analyzed contribution of rice farming to the economic pursuits of the families of farmers in terms of gross profit.

Table 7 shows that based on gross profit, rice farmers of San Rafael generated an average gross profit of P 79,235 with gross profit margin of 49%. San Ildefonso, Bulacan have no generated profit since all of the respondents have no rice farming activity during dry cropping season while San Miguel generated an average gross profit of P 106,049 with 59% gross profit. The rice farmers from the three towns of Bulacan generated an estimated average of P 61,761 of gross profit presented by 54% of gross profit margin during dry cropping season. In addition, table 7 shows that during wet cropping season, San Rafael generated an average gross profit of P 146,299 with gross profit margin of 48%, San Ildefonso generated an average gross profit of P 156,618 with gross profit margin of 52% while San Miguel generated an average gross profit of P 211,679 with gross profit margin of 53% during wet cropping season.

This is an indication that the farmers of San Rafael and San Miguel are earning profit from rice farming except San Ildefonso since there is no rice farming activity during dry cropping season. The farmers of San

Table 7. Contribution of rice farming in terms of gross profit.

Municipality	**Dry cropping season**				**Wet cropping season**			
	Average total production in Pesos	**Total average expenditure**	**Average gross profit**	**Average gross profit margin**	**Average total production in Pesos**	**Total average expenditure**	**Average gross profit**	**Average gross profit margin**
San Rafael	162,836	83,601	79,235	49%	305,491	159,192	146,299	48%
San Ildefonso	0	0	0	0%	299,367	142,749	156,618	52%
San Miguel	179,685	73,636	106,049	59%	397,397	185,718	211,679	53%
Total	114,174	52,412	61,761	54%	334,085	162,553	171,532	51%

Rafael, San Ildefonso, and San Miguel are earning profit from rice farming during wet cropping season. The study findings are in line to the study of Egbodion and Ahmadu (2015) about the profitability of rice farming in terms of average gross margin, net profit, return per naira and high level of cost efficiency and concluded that the cost of the inputs had positive and significant effect on the total cost of rice production.

3.2 Rice land ecosystem

The rice land area in the Philippines is classified into two ecosystems, namely: irrigated and rain-fed rice areas. More than half of the rice land area in the Philippines is irrigated. The irrigation may be applied as a supplement in the rainy season and/or during the dry season depending on the availability of water supply. The adequate irrigation water can supply two or even three crops of rice in a year. Availability and control of water help reduce the risk of crop failure resulting to willingness of farmers to apply more purchased inputs resulting in higher yields. Rain-fed rice areas have a limited supply of water for irrigation and prone to experience drought than irrigated rice farm areas. Different varieties and management systems were used compared to the irrigated ecosystem to help manage some of these risks. The rice produced in irrigated lowland areas are higher than rain-fed lowland rice areas. Furthermore, there are two types of rain-fed ecosystem: rain-fed upland and rain-fed lowland. The rain-fed upland is considered to be fragile and usually located in mountainous areas. The seeds are broadcast or dibbled in dry soil prior to or during the rainy season. There is the presence of oxygen throughout much or all of the growing season. It is expected that the yield levels are typically low and one rice crop is grown per year.

■ *Resources used and production inputs*

Farmers employed different considerations in rice farming, which include production inputs and post-production inputs. There were different inputs used in rice production, which may affect the rice production and profitability of rice farmers. Listed below are the most common resources in rice farming. The section presents the resources used in rice farming. This study assesses the current economic state of rice farming in the province of Bulacan by describing the resources used in production and post-production of rice farming. The information provided a summary of the samples obtained from the survey in form of descriptive statistics.

■ *Production inputs*

The resources used in rice farming for dry and wet cropping seasons include production inputs such as type of seeds, type of rice land, rice farm size, types of fertilizer used, types of pesticides used, labor requirement in terms of land preparation, planting, nutrient management, and pest control; and ownership of technology used in production.

Table 8 shows the frequency and percentage distribution of the production inputs used during dry and wet cropping seasons in terms of type of seeds.

Schultz (1968) conceptualized the high payoff input theory as creating and providing the farmers new and higher-payoff technology in terms of equipment and other inputs. The theory suggested that growth of the economy of the agricultural sector is dependent on the availability and price of modern high pay off inputs. The success and profitability of agricultural production will be associated with low cost of agricultural inputs such as fertilizers, higher yielding seeds, technology, and manpower. The constant improvement and innovation on the type of seeds, fertilizers, pesticides, planting processes, irrigation system, usage of different mechanized equipment and machineries as the technologies employed in rice farming will result to an increase productivity and profitability. Concurred with the argument, Table 8 shows that farmers in San Rafael have used certified seeds presented by 91% or 41 farmers while 9% or four farmers use breeder seeds. The table also shows that in San Ildefonso, farmers use certified seeds presented by 98% or 50 farmers while 2% or one of the farmers use hybrid seeds. The table also shows that farmers in San Miguel use certified seeds presented by 91% or 49 farmers while 9% or five farmers use hybrid seeds. Based on the table presented, farmers use certified seeds presented by 93% or 140 farmers while 7% or 10 farmers use hybrid seeds.

Based on the table presented, farmers are using certified seeds in rice farming during dry and wet cropping season. Certified seed is the most common and available type of seeds in the study area. The government gives assistance to farmers to lessen the cost of seeds by giving at least 50% subsidy on certified seeds. The International Rice Research Institute (2010) explained that certified seed is grown by farmers under prescribed conditions of culture and isolation and subjected to field and seed inspections prior to approval by the certifying agency. Harvest from this class is used for commercial planting which explains the reason why majority of rice farmers used certified seeds in rice farming. The research findings are also in line with the study of Bordey (2010) that inbred or certified varieties and high-quality seeds are used as the main sources of the production growth.

■ *Rice farming processes*

Rice farming involves the different procedure before it will be harvested. It includes land preparation, planting the rice, nutrient management, and pest control. Each process requires a thorough assessment to make rice farming output productive and profitable.

Land preparation. It is important to achieve the best physical condition of the soil for crop growth before rice can be planted (Philippine Ricepedia, 2018). The process of plowing and harrowing are also essential activities before planting the rice crops. In addition, an easy establishment of seedlings, less effort in crop management, and improved grain quality will be achieved if the land leveling is effective (Philippine Ricepedia, 2018). Typically, hoes and rice farming equipment are used in preparing the land. Traditionally, draft animals such as cows and carabaos are utilized by farmers in tillage activities.

Planting the rice. The International Rice Research Institute (2019a) discussed that the rice crop is either direct seeded or transplanted. The rice farmers usually plough or harrow the dry soil surface in incorporating

Table 8. Production inputs during dry and wet season in terms of type of seeds.

Type of seeds	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Hybrid	4	9	1	2	5	9	10	7
Certified	41	91	50	98	49	91	140	93
Total	45	100	51	100	54	100	150	100

the seeds in rain-fed ecosystem. Farmers monitor the seed quality, soil tilth, amount of seed, and expected availability of water to arrive at a good plant establishment. Direct seeding requires less labor but more seeds which are exposed to different pests. The alternative establishment of planting and explained that transplanting requires less seed, but much more labor, and the crop takes longer to mature because of the transplanting shock. Moreover, the majority of rice fields in Asia are manually transplanted, but there are machines designed and manufactured for transplanting.

Nutrient management. The International Rice Research Institute (2019b) explained that nutrient management is a critical aspect of rice farming and the unique properties of flooded soils make rice different from any other crop. The macro-elements and micro-elements are essential for a rice plant to grow and develop properly. The macro-elements are needed by plants in large amounts and these include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. The micro-elements are needed by plants in lesser quantities and these include iron, manganese, copper, zinc, molybdenum, boron, chlorine. Organic materials are materials which come from plant or animal waste or by-products can also be considered in nutrient management to improve soil fertility and soil organic matter content. The rain-fed environments are more often affected by abiotic stresses like drought, submergence, or salinity than irrigated rice-based systems which resulted to the low fertilizer usage. The Filipino farmers ranked third among the six Asian rice producers in terms of nitrogen application in both seasons while lowest in phosphorus application and second to the least in potassium application (PRRI, 2015). On average, farmers in the Philippines only apply fertilizer thrice during high yield season and twice during low yield season, which is less frequent compared with Vietnamese farmers who consistently apply around four times every season (PRRI, 2015). A greater frequency of application could improve the efficiency of nutrient uptake of the rice plant, which could be part of the reason for the higher yield in Vietnam compared with that in the Philippines (PRRI, 2015).

Pest control. The rice plant can be infected by a wide array of insects and pests in the field which include rodents, harmful insects, viruses, diseases, and weeds (Philippine Ricepedia, 2018). The farmers control the weeds through water management, proper land preparation, hand weeding, and herbicide application. Farmers observe the interactions among pests, natural enemies, other organisms, and the environment to determine the necessary pest control to be applied. Insects, birds, weeds, rats, snails, and pathogens or the organisms which because diseases are the common type of pest in the rice paddy (Philippine Ricepedia, 2018). Odoemenem and Inakwu (2011) determined the effect of production inputs on rice output and mentioned that the variation in output of rice is explained by variation in pesticides application and the varieties of rice planted.

Most of the farmers relied heavily on pesticides for rice crop protection while insecticides and herbicides are the most common types of pesticides used by the farmers in all countries at any cropping seasons (PRRI, 2015). In addition, fungicides are popularly used in Vietnam, Thailand, and Indonesia. Rats seem to be a less common problem among rice farmers. Rice farmers in the Philippines are the least users of pesticides among farmers in other countries due to relatively high prices, strong educational campaigns on the dangers associated with pesticide use, and adoption of integrated pest control (PRRI, 2015). The farmers in Vietnam applied more pesticides for crop protection resulted to huge rice yields (PRRI, 2015).

Table 9 and 10 present the labor requirement per rice farming process for dry and wet cropping season such as land preparation, planting, nutrient management, and pest control.

Table 9 shows that in San Rafael, 64% or 29 farmers do not hire farm workers for land preparation, 33% or 15 farmers hire 1 to 5 farm workers for land preparation, and 2% or one of the farmers hire 6 to 10 farm workers for land preparation during dry season. The table also shows that in San Ildefonso, 98% or 50 farmers do not hire farm workers for land preparation and 2% or one of the farmers hire 1 to 5 farm workers for land preparation during dry season. The table also shows that in San Miguel, 70% or 38 farmers do not hire farm workers for land preparation and 30% or 16 farmers hire 1 to 5 farm workers for land preparation during dry cropping season.

Table 9. Production inputs during dry season in terms of labor requirements per process.

Labor requirements	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Land preparation								
6-10	1	2	0	0	0	0	1	1
1-5	15	33	1	2	16	30	32	21
None	29	64	50	98	38	70	117	78
Total	45	100	51	100	54	100	150	100
Planting								
1-50	16	36	1	2	16	30	33	22
None	29	64	50	98	38	70	117	78
Total	45	100	51	100	54	100	150	100
Nutrient management								
6-10	1	2	0	0	0	0	1	1
1-5	15	33	1	2	16	30	32	21
None	29	64	50	98	38	70	115	78
Total	45	100	51	100	54	100	150	100
Pest control								
6-10	1	2	0	0	0	0	1	1
1-5	15	33	1	2	16	30	34	21
None	29	64	50	98	38	70	115	78
Total	45	100	51	100	54	100	150	100

Table 9 also shows that in San Rafael, 64% or 29 farmers do not hire farm workers for planting while 36% or 16 farmers hire 1 to 50 farm workers for planting during dry cropping season. The table also shows that in San Ildefonso, 98% or 50 farmers do not hire farm workers for planting and 2% or one of the farmers hire 1 to 5 farm workers for planting during dry season. The table also shows that in San Miguel, 70% or 38 farmers do not hire farm workers for planting and 30% or 16 farmers hire 1 to 5 farm workers for planting during dry season.

Table 9 also reveals that in San Rafael, 64% or 29 farmers do not hire farm workers for nutrient and pest control, 33% or 15 farmers hire 1 to 5 farm workers for nutrient and pest control, and 2% or one of the farmers hire 6 to 10 farm workers for nutrient and pest control during dry season. The table also shows that in San Ildefonso, 98% or 50 farmers do not hire farm workers for nutrient and pest control and 2% or one of the farmers hire 1 to 5 farm workers for nutrient and pest control during dry season. The table also shows that in San Miguel, 70% or 38 farmers do not hire farm workers for nutrient and pest control and 30% or 16 farmers hire 1 to 5 farm workers for nutrient and pest control during dry season.

Based on Table 9, 21% or 32 farmers hire 1 to 5 farm workers for land preparation, 1% or one of the farmers hire 6 to 10 farm workers for land preparation. The remaining 78% or 117 farmers do not hire farm workers for land preparation since they do not use their farmland for rice farming in dry cropping season. The table also shows that 22% or 33 farmers hire 1 to 50 farm workers as labor requirement in planting process, the remaining 78% or 117 farmers do not hire farm workers for planting since they do not use their farmland for rice farming in dry cropping season. The table also shows that 21% or 32 farmers hire 1 to 5 farm workers as labor requirement in nutrient management, 1% or one of the farmers hire 6 to 10 farm workers as labor requirement in nutrient management, the remaining 78% or 78 farmers do not hire farm workers for nutrient management since they do not use their farm land for rice farming in dry cropping season. The table also shows that 21% or 32 farmers hire 1 to 5 farm workers as labor requirement in pest control, 1% or one of the farmers hire 6 to 10 farm workers as labor requirement in pest control, the remaining 78% or

78 farmers do not hire farm workers for pest control since they do not use their farm land for rice farming in dry cropping season.

Table 10 shows that in San Rafael, 98% or 44 farmers stated that they hire 1 to 5 farm workers for land preparation and the remaining 2% or one of the farmers hire 6 to 10 farm workers for land preparation during wet season. In San Ildefonso, all of the respondents hire 1 to 5 individuals for land preparation during wet season. The table also shows that in San Miguel, all of the respondents hire 1 to 5 farm workers for land preparation during wet season.

Table 10 shows that in San Rafael, 93% or 42 farmers hire 1 to 50 farm workers for planting and 7% or three farmers hire 51 to 100 farm workers as labor requirement in planting. The table also shows that in San Ildefonso, 86% or 44 farmers hire 1 to 50 farm workers for planting, 12% or six farmers hire 51 to 100 farm workers as labor requirement in planting, and the remaining 2% or one of the farmers hire 151 to 200 farm workers as labor requirement in planting during wet season. The table also shows that 91% or 49 farmers in San Miguel hire 1 to 50 farm workers for planting, 7% or four farmers hire 51 to 100 individuals as labor requirement in planting, and the remaining 2% or one of the farmers hire 151 to 200 farm workers as labor requirement in planting during wet season. The table also shows that in San Rafael, 98% or 44 farmers hire 1 to 5 farm workers for nutrient and pest control and the remaining 2% or one of the farmers hire 6 to 10 farm workers as labor requirement in nutrient and pest control during wet season. In San Ildefonso and San Miguel, all of the respondents hire 1 to 5 farm workers for nutrient and pest control during wet season.

Based on Table 10, during the wet cropping season, 99% or 149 farmers hire 1 to 5 farm workers for land preparation and the remaining 1% or 1 of the farmers hire 6 to 10 farm workers for land preparation. 90% or 135 farmers hire 1 to 50 farm workers for planting, 9% or 13 farmers hire 51 to 100 farm workers as labor requirement in planting and the remaining 1% or 2 farmers hire 151 to 200 farm workers as labor requirement in planting. 99% or 149 farmers hire 1 to 5 farm workers for nutrient management and the remaining 1% or 1 of the farmers hire 6 to 10 farm workers as labor requirement in nutrient management.

Table 10. Production inputs during wet season in terms of labor requirements per process.

Labor requirements	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Land preparation								
6-10	1	2	0	0	0	0	1	1
1-5	44	98	51	100	54	100	149	99
Total	45	100	51	100	54	100	150	100
Planting								
151-200	0	0	1	2	1	2	2	1
101-150	0	0	0	0	0	0	0	0
51-100	3	7	6	12	4	7	13	9
1-50	42	93	44	86	49	91	135	90
Total	45	100	51	100	54	100	150	100
Nutrient management								
6-10	1	2	0	0	0	0	1	1
1-5	44	98	51	100	54	100	149	99
Total	45	100	51	100	54	100	150	100
Pest control								
6-10	1	2	0	0	0	0	1	1
1-5	44	98	51	100	54	100	149	99
Total	45	100	51	100	54	100	150	100

99% or 149 farmers hire 1 to 5 farm workers for pest control and the remaining 1% or 1 of the farmers hire 6 to 10 farm workers as labor requirement pest control.

The findings from the Table 9 and Table 10 indicate that there is a labor requirement for farm workers in land preparation, planting, nutrient management and pest control. Most of the famers are hiring 1 to 5 farm workers in land preparation, nutrient management, and pest control on the basis of the size of farmland of rice farmers which is 1 to 3 hectares. The mechanized farming equipment helps the farmers in land preparation while nutrient management and pest control do not require many farm workers due to ease in applying fertilizers and pesticides. Planting process requires 1 to 50 farm workers since most of the rice farmers are using transplanting method of seeding. IRRI explained that transplanting requires less seed but much more labor, and the crop takes longer to mature because of the transplanting shock. Manual transplanting of seedlings is very labor intensive and requires 30 to 40 people a day to plant 1 hectare of rice depending on the soil.

■ *Technology in rice farming*

The application of scientific principles and modern technologies in rice farming increase the rice yields of farmers. Different technologies were introduced to rice farmers, including FutureRice Farm, breeder seed production, and on-farm learning center (PRRI, 2015). The Department of Agriculture is also promoting the use of machine in planting and high-quality seeds most suited to their field. Devi and Ponnarasi (2009) studied the impact of modern rice farming technology to the farmers and concluded that modern and high-end machines and methodologies can reduce rice production cost and uplift socio-economic status of rice farmers. Table 11 shows the frequency and percentage distribution of the production inputs used during dry and wet cropping seasons in terms of technology used.

Based on Table 11, farmers in San Rafael use and own mechanized farming equipment presented by 56% or 25 respondents while 44% or 20 farmers use and rent mechanized farming equipment during dry and wet cropping season. The table also shows that in San Ildefonso, 59% or 30 farmers use and rent mechanized farming equipment while 41% or 21 farmers use and own mechanized farming equipment during dry and wet cropping season. In San Miguel, 54% or 29 farmers use and own mechanized farming equipment while 46% or 25 farmers use and rent mechanized farming equipment during dry and wet cropping season. The table also shows that common tools and equipment are used and owned by farmers in San Rafael, San Ildefonso, and San Miguel. The table also presented that majority of the farmers said that irrigation system is not applicable in their area since most of the land is in rain-fed ecosystem.

Table 11. Production inputs during dry and wet season in terms of applied technology.

Applied technology	San Rafael		San Ildefonso		San Miguel		Total	
	No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Mechanized farming equipment								
Owned	25	56	21	41	29	54	75	50
Rented	20	44	30	59	25	46	75	50
Total	45	100	51	100	54	100	150	100
Common tools in farming								
Owned	45	100	51	100	54	100	150	100
Irrigation								
Owned	0	0	1	2	2	4	3	2
Rented	16	36	0	0	14	26	30	20
None	29	64	50	98	38	70	117	78
Total	45	100	51	100	54	100	150	100

The table also shows that in San Rafael, 64% or 29 farmers stated that irrigation is not applicable to their area while 36% or 16 farmers rent and pay fees to National Irrigation Authority. In San Ildefonso, 98% or 50 farmers stated that irrigation is not applicable to their area while the remaining 2% or one of the farmers owns a deep well as an irrigation system during dry season. The table also shows that in San Miguel 70% or 38 farmers stated that irrigation is not applicable in their area, 26% or 14 farmers are paying fees to National Irrigation Authority, and the remaining 4% or two farmers own an irrigation facility in the form of fishpond and deep well. Based on the table presented above, 50% or 75 farmers own mechanized farming equipment and the other half or 75 farmers rent mechanized farming equipment in dry and wet cropping season.

The table also shows that all of the farmers own common tools in rice farming presented by 100% or 150 respondents. The table also shows that majority of the farmers said that irrigation system is not applicable to their location since most of them have a land with rain-fed ecosystem presented by 78% or 117 farmers, 20% or 30 farmers are paying fees to National Irrigation Authority, and 2% or 3 farmers own an irrigation system through the use of deep well and fishpond. Based on table presented, the farmers use technology in the study area. The farmers use mechanized farming equipment, common tools in farming and irrigation system for irrigated rice land. This is in line to the high-pay off input theory explained by Schultz (1968) which focused on the ways to increase labor productivity and the growth of economy from the agricultural sector is dependent on the availability and price of modern high-pay off inputs. There is a trade-off between the use of technology and profitability of agricultural production. This is also congruent to the conjecture of Bordey that non-conventional inputs such as irrigation, adoption of hybrid and third generation modern inbred varieties, attendance at rice production training sessions, use of high-quality seed, and machine ownership are the main sources of the production growth.

The accelerator theory of investment suggested that capital investment is a function of output (Pettinger, 2010). If there is an increase in output, investment will rise to meet the expected demand. The simple accelerator model suggested that a fall in the growth rate can lead to lower investment and accelerator effect can explain how an economic slowdown leads to a recession. This theory described the various decisions of an entity related to production activities to maximize the profit such as decisions about the process of a given amount of output in a given plant size and equipment, the volume of units to be produced, and the discernment of the size and equipment of the plant facility. The results of this study offer further support and more details for this theory.

3.3 Constraints in rice farming

Table 12 shows the identified common problems encountered in rice farming and its frequency of occurrence. The common constraints in rice farming include inadequate capital, high cost of labor, inadequate supply of farm inputs, poor marketing outlet, high cost of pesticides, high cost of fertilizer, land tenure system, awareness in existing programs in rice farming, poor storage facilities, high cost of transportation, problem of pests and diseases, and climate change. The researcher used a five-point Likert scale model in identifying the frequency of experience of rice farming constraints and presented the averages of each constraint (the frequency and average is represented by M and VI in Table 12 respectively).

As what can be gleaned on Table 12, the highest mean value of 4.80 interpreted as 'most often' experience constraints by rice farmers in San Rafael is high cost of fertilizers, high cost of pesticides with a mean of 4.69, problem in pest and diseases with a mean of 4.67, climate change with a mean of 4.53. The farmers also stated that they 'often' experience inadequate capital in rice farming with a mean of 4.31. The farmers 'seldom' experience high cost of transportation with a mean of 3.31, poor marketing outlet with a mean of 3.16, awareness in existing programs in rice farming with a mean of 3.09, and high cost of labor with a mean of 2.78. Rarely, inadequate supply of farm inputs is experience with a mean of 2.38. Land tenure system and poor storage facilities are 'never' a problem for farmers in selected areas in Bulacan with a mean of 1.02.

Table 12. Descriptive measures of constraints in rice farming.[1]

Constraints in rice farming	San Rafael		San Ildefonso		San Miguel		Summary	
	M	VI	M	VI	M	VI	M	VI
Inadequate capital	4.31	often	4.31	often	3.28	seldom	3.97	often
High cost of labor	2.78	seldom	3.31	seldom	2.98	seldom	3.02	seldom
Inadequate supply of farm inputs	2.38	rare	2.27	rare	3.19	seldom	2.61	seldom
Poor marketing outlet	3.16	seldom	3.27	seldom	3.54	seldom	3.32	seldom
High cost of pesticides	4.73	most often	4.59	most often	4.74	most often	4.69	most often
High cost of fertilizer	4.80	most often	4.75	most often	4.80	most often	4.78	most often
Land tenure system	1.02	never	1.29	never	1.07	never	1.13	never
Awareness in existing programs in rice farming	3.09	seldom	3.35	seldom	3.07	seldom	3.17	seldom
Poor storage facilities	1.02	never	1.37	never	1.11	never	1.17	never
High cost of transportation	3.31	seldom	3.57	often	3.39	seldom	3.42	seldom
Problem of pests and diseases	4.67	most often	4.75	most often	4.81	most often	4.74	most often
Climate change	4.53	most often	4.84	most often	4.83	most often	4.74	most often

[1] M=frequency; VI=average.

In addition, Table 12 reveals that the highest mean value of 4.84 interpreted as 'most often' experience constraints by rice farmers in San Ildefonso is climate change, high cost of fertilizers with a mean of 4.75, problem in pest and diseases with a mean of 4.75, high cost of pesticides with a mean of 4.59. The farmers also stated that they 'often' experience inadequate capital in rice farming with a mean of 4.31 and high cost of transportation with a mean of 3.31. The farmers 'seldom' experience awareness in existing programs in rice farming with a mean of 3.35, high cost of labor with a mean of 3.31, poor marketing outlet with a mean of 3.27. Rarely, inadequate supply of farm inputs is experience with a mean of 2.27. Poor storage facilities and land tenure system are 'never' considered as problem for farmers in selected areas in Bulacan with a mean of 1.37 and 1.29, respectively.

The most common constraints experienced in San Rafael, San Ildefonso, and San Miguel are high cost of fertilizers, climate change, pests and crop diseases, high cost of pesticides, and inadequate capital. Farmers have nothing to do with the increasing price of inputs and changing climate since these items are beyond their control. The farmers also encountered problems in selling their product particularly the selling price dictated by the trader. Farmers sell their palay right after the harvest to settle their obligation incurred during the cropping season. This scenario is taken advantage by the traders giving the farmers no opportunity to sell the palay at a higher price. According to some farmers interviewed by the researchers, the palay acquired by the traders will be dried, milled then stored in their warehouse and wait for the price of rice in the market to rise. This became an opportunity for the trader to gain more profit over the farmers.

Farmers are aware of the programs being implemented by the government to support rice farming and improve productivity through Local Department of Agriculture in the municipality. These programs are coordinated to the Barangay Officials and associations of farmers. Meetings and seminars are also conducted to farmers to improve rice farming and implementation of the government support program. Most of the programs experienced by the farmers are assistance of the government in seeds and fertilizers. The government distributes to the farmers certified seeds and fertilizers for a lesser value and sometimes for free.

4. Conclusions and suggestions

This study assessed the economics of rice farming through socio-economic profile of farmers, resources, constraints, and economic contribution of rice farming to economic pursuits of families of farmers. It aims to recommend course of actions for rice farmers to improve their productivity and profitability. We reflected on 150 farmers from the selected Barangays of San Rafael, San Ildefonso, and San Miguel, Bulacan. are considered as sample and area of this study. An interview to the Provincial Agriculturist and Municipal Agriculturist of San Rafael, San Ildefonso, and San Miguel is also conducted as part of the triangulation process to gain insights about the constraints in rice farming.

Farmers will still engage in rice farming since they only had less education and fewer options in life. There is a declining number of a farmer due to lack of interest of their generation to farming. There is openness to nonfarm jobs in the study area and these become their source of income during off-season. Farmers set aside part of their profit from rice farming to capitalize next cropping season while other farmers engaged to 5-6 facilitated by their rich neighbors and Indian nationals or '*bumbay*'. On the other hand, the harvests from certified seeds is used for commercial planting which explains the reason why majority of rice farmers used certified seeds in rice farming. Irrigation is a problem at areas with rainfed ecosystem and farmers have no rice farming activity during dry cropping season due to unavailability of water supply. There is a demand for inorganic fertilizers due to ease in preparation and application and pesticides to eliminate pests and diseases. Farmers used transplanting method in planting which require 30 to 40 farm workers per one hectare while combined harvesting machine '*halimaw*' is used by farmers in post-production. Moreover, farmers most often experience high cost of fertilizers, problem in pests and diseases, climate change as, and high cost of pesticides as constraints in rice farming.

Furthermore, rice farmers have no rice farming activity particularly in San Ildefonso during dry cropping season due to rainfed land ecosystem and engage in other agricultural activities during off season. Farmers in the barangays with rice farming activity during dry and wet season invested more on the production inputs such as labor, fertilizers and seeds. In addition, the farmers of San Rafael, San Ildefonso, and San Miguel are earning profit from rice farming based on the computation of the production volume and production costs but not enough based on the economic contribution. Savings was not a priority for farmers. Farmers continue rice farming to supply the needs of their children particularly education and for family consumption.

This study suggests to strengthen the farmer's cooperative in the Philippines. The set-up of cooperative is a voluntary association of people who want to improve their economic status through joint effort voluntarily and open to everyone for membership (Chimoriya, 2015). A cooperative uplift the condition of poor section of the society. Some of its role includes financial assistance and fulfillment of various needs of members. In rice farming, cooperative is a very important agency for farmers to finance externally the capitalization of rice farming activity every cropping season. In the fulfillment of the various needs of farmers, a multi-purposed cooperative provides loans, supply improved seeds, fertilizers, agricultural tools and other necessary goods and services and advantage of these items have suitable terms and conditions. Afolami *et al.* (2012) analyzed the socioeconomics of rice farmers and determined the effects of group formation on rice production and conjectured that groups were established as the linkages for farming services and inputs providers.

There are three farmers' cooperatives from the nine barangays of San Rafael, San Ildefonso, and San Miguel covered in the study which aim to provide credit, improved seeds, agricultural implements, fertilizers, sanitation, health and other provisions for farmers. These include Allied Christian on Agrarian Reform located in Partida, San Miguel, Bulacan, Umpucan Palay and Vegetable Producers Cooperative in Umpucan, San Ildefonso, Bulacan, and Maronquillo MPC in Maronquillo, San Rafael, Bulacan. Moreover, this study also recognizes the '*Palayaman*' program which is a high-level integration of rice with other high-value crops and trees, fish, poultry, livestock and biomass recycling in a piece of land. Its key concept is the use of idle farm resources and their interconnections (PRRI, 2015). We conjecture that if this program is integrated to the programs of cooperatives and implemented properly by farmers, it will create value and induce growth for rice farming households and community.

Since rice farmers in the study area are considered to be at the mandatory age of retirement, it is recommended that rice farmers should encourage and engage their children specially the youth to be more interested in rice farming. The farmers in the areas in Bulacan which generates huge rice yields should increase the members of the family engaged in rice farming. Farmers should shift from the idea of engaging to rice farmers due to lack of education to an idea that rice farming is very vital in dealing with food security since rice is a staple food for Filipinos. In addition, off-rice farming activities are encouraged to support the daily living of the families engaged in rice farming during off season of rice farming particularly at areas with rainfed ecosystem.

The condition necessary for rice farming sustainability is that large numbers of farming households must be motivated to learn the indicator of sustainability and proper utilization of resources. The limitation placed upon the production of rice due to high cost of inputs, lack of supporting inputs and scarcity of complimentary inputs should be removed so that rice farmers will be encouraged to produce more when rice production inputs like seeds, fertilizers, and pesticides are available and affordable. The association of farmers should be active and should lead the way to improved productivity and profitability of the farmers within the area. Commercial fertilizers and appropriate pesticides should be made available within the location of farmers to lessen transportation cost. The farmers should leverage the use of combined harvesters '*halimaw*' since it will provide huge saving in labor costs in the harvesting process. Moreover, farmers should accept the other machineries in the future to support large productivity. It is also recommended that outsourcing of labor-intensive tasks to contractors be made by farmers and pay through certain percentage agreed between parties.

Rice farmers in the Philippines should not sell their rice lands to real estate developers and for commercial purposes since it will decrease the rice production. In line with this, the Local Government Unit should tighten the policy of issuing clearance to landowners who will sell their farmland for industrialization and urbanization to minimize the problem in land conversion and address the issue in food security. Moreover, the agricultural policies should be revised by the implementing agencies to a more practically and efficiently manner since there are different policies and programs in support to rice farmers. It is also recommended that the implementing agency should have a concrete plan and action towards the proper monitoring and implementation of the different rice farming programs. We also encourage the government to support the rice farmers from upland areas in building irrigation facility such as '*pagtatabon*' for the farmers with rainfed land to generate income in second cropping.

The researchers recommend that the percentage contribution of rice farming income to the family living expenditures of farmers be studied further to assess the economic contribution of rice farming to the economic pursuits of families of farmers. It is also recommended that an impact study should be made and use the variables considered in this study to analyze its effect on rice productivity and profitability. Lastly, we suggest that future study be conducted regarding the effects of the different constraints identified in rice farming to better solve the problem of food security in the country.

For a concluding remark, in addition to existing relevant studies (Bui *et al.*, 2018; Jin *et al.*, 2017a; Khalid *et al.*, 2018; Wang *et al.*, 2018; Yang *et al.*, 2017; Zhang *et al.*, 2018), this study offers valuable and practical references to the studied and similar rice farming contexts. As knowledge level of the researched subjects can truly affect their actions in practices (Jallow *et al.*, 2017; Jin *et al.*, 2017b) as well as the intention to participate in or learn from scientific studies, a subject-friendly (here, farmer friendly) report is necessary to generate practical impacts. Through detailed but comprehensive analyses and reporting, we wish a fast knowledge distribution can be made to facilitate rice farming practices and policy/regulation in regions where mid-to-under-educated farmers can also work based on scientific wisdom.

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Author contributions

Bo Hou finished the first drafts; Eugene B. Mutuc collected and data and conduct the analyses; Linhai Wu is a major writer for the R&R stages; Hsiu-Yu Lee and Kun-Hwa Lu provided invaluable inputs for practical and theoretical implications.

Conflicts of interest

The authors declared no conflicts of interest.

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