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CROP PRODUCTION MANAGEMENT PRACTICES: ITS IMPLICATIONS TO SOIL FERTILITY ON A RICE-BASED PRODUCTION SYSTEM IN GUIMARAS

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ABSTRACT Soil fertility is primarily a problem in rice-based production systems resulting in reduced yields. There are various factors affecting soil fertility problems and crop production practices are seen to have a major contribution. Hence, the study was conducted last December 2018 within the Bureau of Soil and Water Management (BSWM) clustered soil fertility assessment sites in the whole Province of Guimaras. The study utilized 500 respondents equally distributed to the five (5) municipalities. Based on the study, most of the respondents have ages ranging from 61 years old and above, males, married, elementary graduates, have 0-1 dependents, and owned their farm. The majority of them managed a farm with a total area of 0-1 hectare, with rice farms of 1 hectare, have their farms close to their household (0-1 km), with farming as their primary source of income. They have payments of PhP 5,001 to PhP 10,000. They generally stay in the community for more than 26 years, were members of the rice cluster association, and were Roman Catholics. Most of them managed their farms under rainfed conditions, inbred rice varieties for planting, used certified seeds and used hand tractors to prepare their farms. They plow their farms twice and practice less than 7 days between the last harrowing and crop establishment. Most of them observed a fallow period of 3-4 months do not have any bases for fertilizer application while others rely on rice crop managers. All respondents practiced chemical application for weeding and pests and diseases. The majority of the respondents said they convert rice straws into composts and others said they incorporate them during land preparation. Among the problems identified were pests and diseases, followed by capital and adverse climatic condition. Other problems included the high cost of farm inputs, and very few responded that they have problems with fertilizer sources. In terms of soil fertility, the majority of the respondents' farms were low in nitrogen (N), low in Phosphorus (95 or 95%), moderately high in Potassium (K) (84 o 84%), and high in soil pH (66 or 66%). In terms of general fertility, 94 of 94% of the farms were moderately low.

Keywords: soil fertility, soil fertility management, soil fertility status, soil fertility evaluation

INTRODUCTION

The productivity of the rice-based cropping system is poor and continuously declines due to the worsening soil-related constraints (Chaudhury, Mandal, Sharma, Ghosh & Mandal, 2005). Continuous cropping and inappropriate replenishment of nutrients removed in harvested materials or lost through erosion, leaching, or gaseous emissions deplete soil fertility and cause soil organic matter levels to decline (Matson, P. A., Naylor, R. & Ortiz-Monasterio, 1998; Bationo, Kihara, Vanlauwe, Waswa, & Kimetu, 2007). Vegetated land has undergone human-induced soil degradation and loss of productivity that resulted from poor fertilizer and water management, soil erosion, and shortened fallow periods (Tilman, Cassman, Matson, Naylor & Polasky, 2002). These management practices include inappropriate use of fertilizers, irrigation, and improper cultural management practices (Takankhar & Salve, 2012; Ilagan, Tablizo, Barba, & Marquez, 2014). However, the use of cover crops, manure and compost applications, and reduction or elimination of synthetic fertilizers and pesticides affect nutrient availability to crops either directly by contributing to nutrient pools or indirectly by affecting the soil chemical and physical environment (Clark, Horwath, Shennan, & Scow, 1998; Kavitha & Sujatha, 2015). Hence, maintaining or enhancing soil fertility depends on understanding how the soil responds to agricultural land use (Gregorich, Carter, Angers, Monreal & Elert, 1994; Roming, Garlynd, Harris & McSweeney, 1995). Soil nutrient depletion is still one of the most serious global problems threatening food production (Hartemink, 2006). Hence, it is imperative to understand the interrelated factors to improve management practices necessary to sustain food production (Mowo, Janssen, Oenema, German, Mrema, & Shemdoe, 2006).

Crop productivity must be enhanced per unit of land area to meet future food and fiber demand increases soil nutrient removal and the importance of replenishing soil fertility through efficient nutrient management practices (Havlin & Heiniger, 2020). Any agricultural activity disturbs the ecological balance of a given environment. Methods such as plowing and hoeing enhance organic matter decomposition and losses of nutrients and soil particles through increased erosion, leaching, export of harvest products, and burning of crop residues. Cropping systems are no longer stable as losses of nutrients and organic matter during the cropping period exceed the gains under natural vegetation during the fallow period. Cropping systems are no longer stable as losses of nutrients and organic matter during the cropping period exceed the gains under natural vegetation during the fallow period. The nutrient balance of cropping systems has turned negative inducing deterioration of soil physical properties, thereby affecting soil fertility. Good crop production practices and an improved cropping system, therefore, the restitution of mineralizable organic matter together with an elevated level of soil nutrients, including, if possible, a positive nutrient balance allowing for sustained or increased yields.

The Province of Guimaras, renowned for being the "producer of the sweetest mangoes in the world" also produces rice for the Guimarasnons, as rice is their staple food. The province has a total rice production area in 2017 of around 19,864 hectares with a yield of 55,322 MT. In 2016 and 2015, it has production areas of 15,377 and 15,531 with yields of 42,649 MT and 40,154 MT, respectively (PSA, 2018). If we look at the figures, rice production areas and yield increased in the three years. However, if you look at the average rice production, it only ranges from 2.6 to 2.8 MT per hectare, which is much lower than the national averages of 3.91 MT (2015), 3.96 MT (2016), 4.09 MT (2017). Rice production could have been higher than the national average if crop production management practices were appropriate and soil fertility improved. With these, the need to determine the management practices rice production is necessary to assess soil fertility that might have affected rice productivity in the province.

The study aims to evaluate the crop production management practices and their implication to soil fertility on a rice-based production system in Guimaras. Specifically, it aims to determine the profile of the farmer-respondents, crop production practices, and soil fertility status.

METHODOLOGY

A Descriptive Research design was used to gather information. The study evaluates soil fertility status by determining farmers' profiles, crop production management practices, and soil nutrient status. It utilized a structured questionnaire. The questionnaire had close-ended questions. The survey was conducted in all clustered rice farms in Guimaras Province. Cluster sampling technique was utilized in this study. One hundred respondents were chosen from among the clustered farms that were soil sampled during the soil survey conducted by the Bureau of Soils and Water Management (BSWM), Manila last 2017. The result of the STK analysis from the soil survey of the Bureau of Soils and Water Management, Manila was used to support the soil fertility data of the study. The STK determines the pH, Nitrogen, Phosphorus, and Potassium. It is a qualitative type of testing and through color comparison, the deficiency or sufficiency of the element can be assessed. A preliminary interview was facilitated to gather data from rice respondents, agricultural instructors/professors, and researchers concerning soil fertility and soil fertility management practices. To answer the stated specific objectives the frequency and means of the profile of respondents, crop production management practices, and soil fertility status were determined using Microsoft Excel.

RESULTS AND DISCUSSION

Demographic profile of the respondents

Respondents' demographic profiles were categorized according to age, sex, civil status, educational attainment, number of dependents, farm ownership, farm size, distance from household to farm, number of years in rice farming, the main source of income, an alternative source of income, monthly income, number of years in the community, group affiliation, and religion. There were a total of 100 respondents in this study.

Figure 1 shows the age of the respondents. Results show that most of the respondents (41%) in the Municipality of San Lorenzo were 61 years old and above. The same trend was also observed in the Municipality of Jordan with 44%. On the other hand, ages ranging from 51-60 years old were the most numbered in the Municipalities of Sibunag (40%), Nueva Valencia (48%), and Buenavista (39%). This shows that majority of the respondents were elderly.

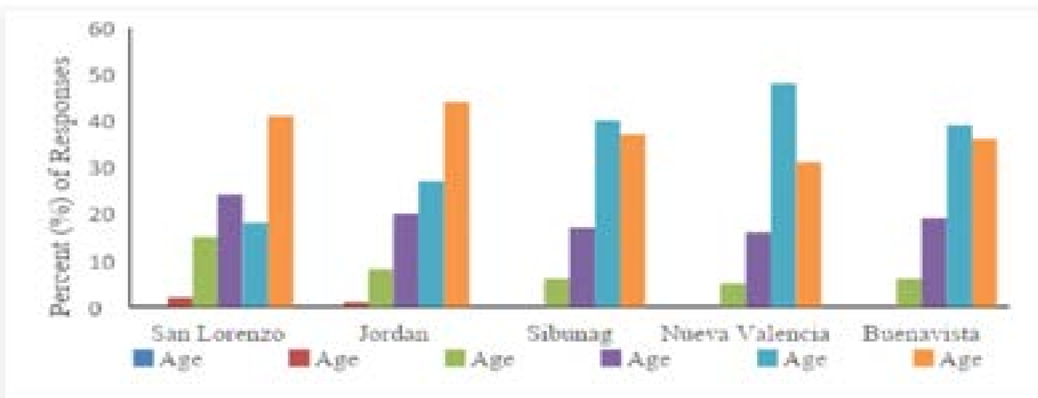

Figure 1. Age of respondents

The respondents were males, with 55% in San Lorenzo, 63% in Jordan, 61% in Sibunag, 57% in Nueva Valencia, and 76% in Buenavista (Figure 2). This indicates a male predominance among the respondents. Buenavista has the highest percentage of males involved in rice farming among the municipalities. It is expected since agriculture had traditionally been dominated by males.

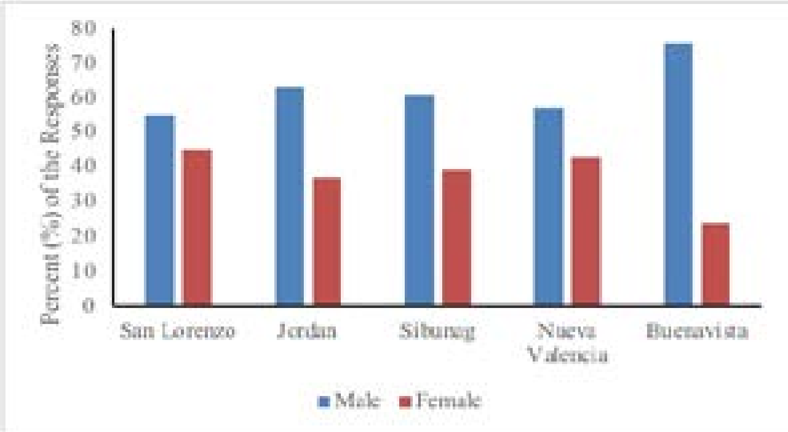

Figure 2. Gender of respondents

As to civil status, most of the respondents were married with 85% responses in San Lorenzo, 85% in Jordan, 86% in Sibunag, 78% in Nueva Valencia, and 85% in Buenavista.

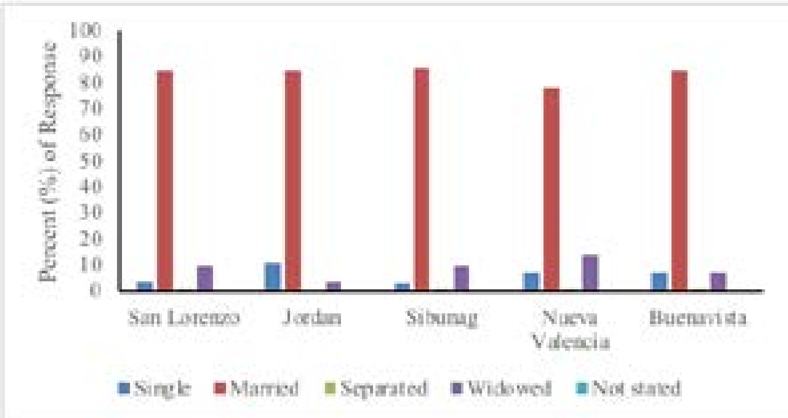

Figure 3. Civil Status

As to educational attainment (Figure 3), it was observed that most respondents in San Lorenzo, Jordan, and Buenavista were elementary graduates with 38%, 30%, and 28%, respectively. On the other hand, most respondents in Sibunag (33%) and Nueva Valencia (40%) were high graduates. This indicates that most of the respondents were not able to reach even vocational or college level. This is probably because the respondents, being sons and daughters of farmers themselves, already consider agriculture as an adequate source of income and subsistence. Therefore, education is not considered a priority as land and work are passed on from parents to offspring (Lu, 2007).

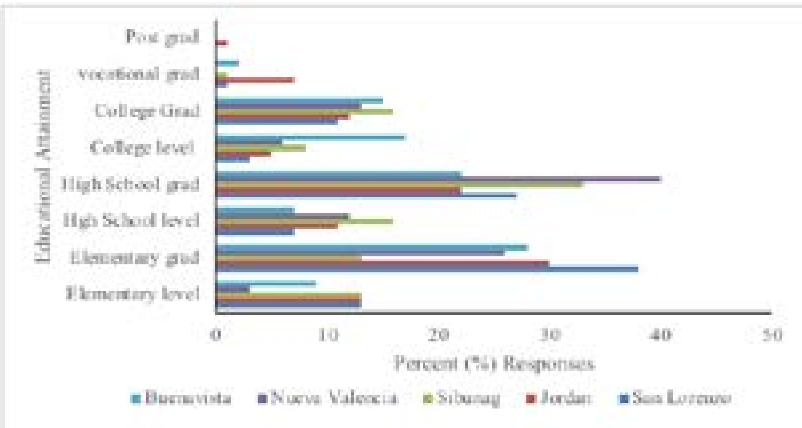

Figure 4. Educational Attainment

As to the number of dependents, most of the respondents in San Lorenzo have 0-1 dependents (39%), and 4-5 dependents in Jordan (32%). While in Sibunag, Nueva Valencia, and Buenavista, most dependents in the household were 4-5 heads with 52%, 37%, and 43%, respectively.

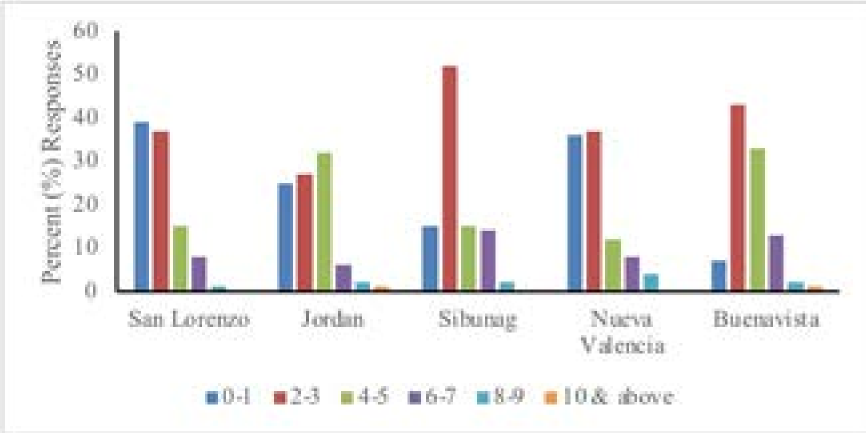

Figure 5. Number of Dependents

In terms of farm ownership, the majority of the respondents in all five (5) municipalities owned the farm (Figure 6). Very few of the respondents managed a farm by inheritance and under a memorandum of agreement. This shows that the majority of the respondents owned their farm as most households owned agricultural land acquired through the Comprehensive Agrarian Reform Program (CARP) or were Agrarian Reform Beneficiaries (ARB).

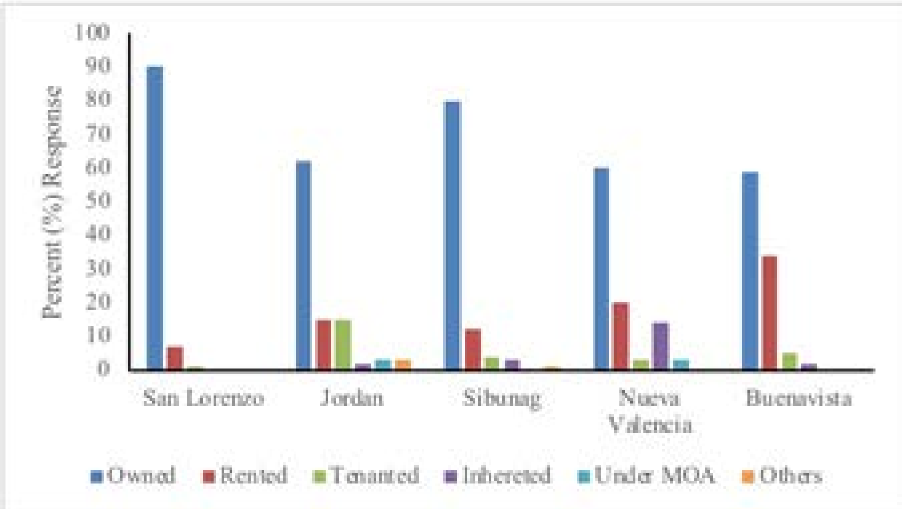

Figure 6. Farm Ownership

As to farm size, the majority of the respondents across five (5) municipalities managed a farm with a total area of 0-1 hectare (Figure 7). Likewise, the results also show that most respondents in all municipalities devoted 1 ha and above of their farms for rice production (Figure 8). This only shows that most farmers allocate most of their farms for rice production.

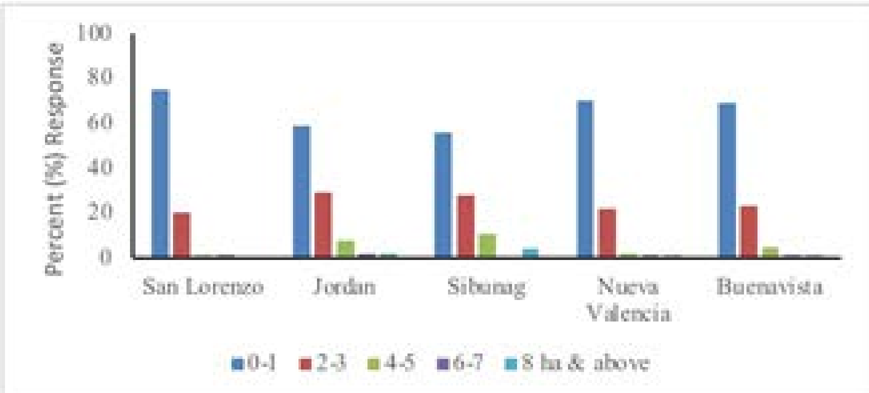

Figure 7. Size of the Whole Farm

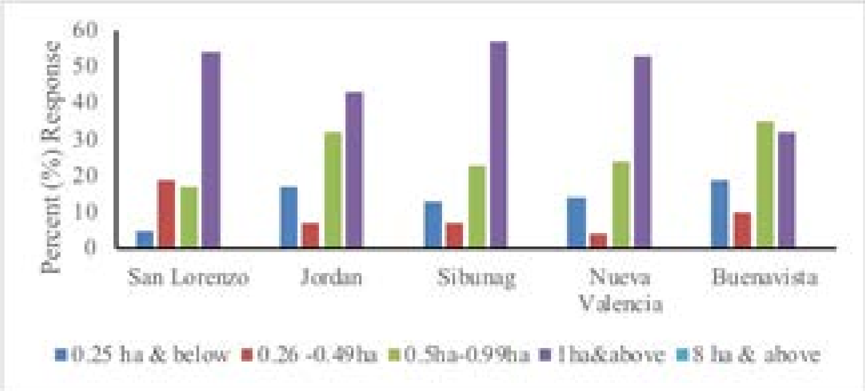

Figure 8. Farm size devoted to rice

As to distance from household to farm, almost all of the respondents in five (5) municipalities were living within or close to their farms (Figure 9). This indicates that most farmers have easy access and monitoring in their farms due to the proximity of their households to the farm.

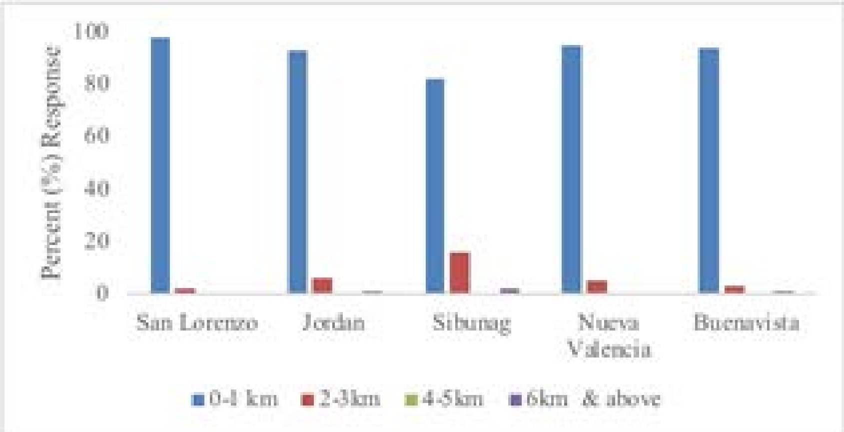

Figure 9. Distance of household from the farm

When the respondents were asked about the number of years they had been in the community, most of them across all municipalities responded that they had been in the community for 26 years and above (Figure 10). This only indicates that most of the respondents were natives of the Province of Guimaras.

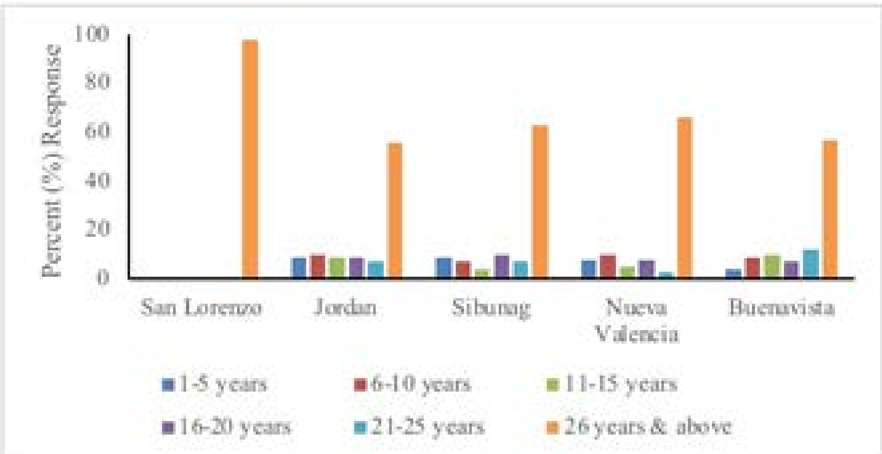

Figure 10. Number of years in the community

Figure 11 reflects that the majority of the respondents rely on farming as their main source of income. The result shows that almost all of the respondents solely rely on farming to generate income. Only very few have other income sources. This is probably because, despite the challenges in rice production, the respondents still viewed farming as a promising enterprise.

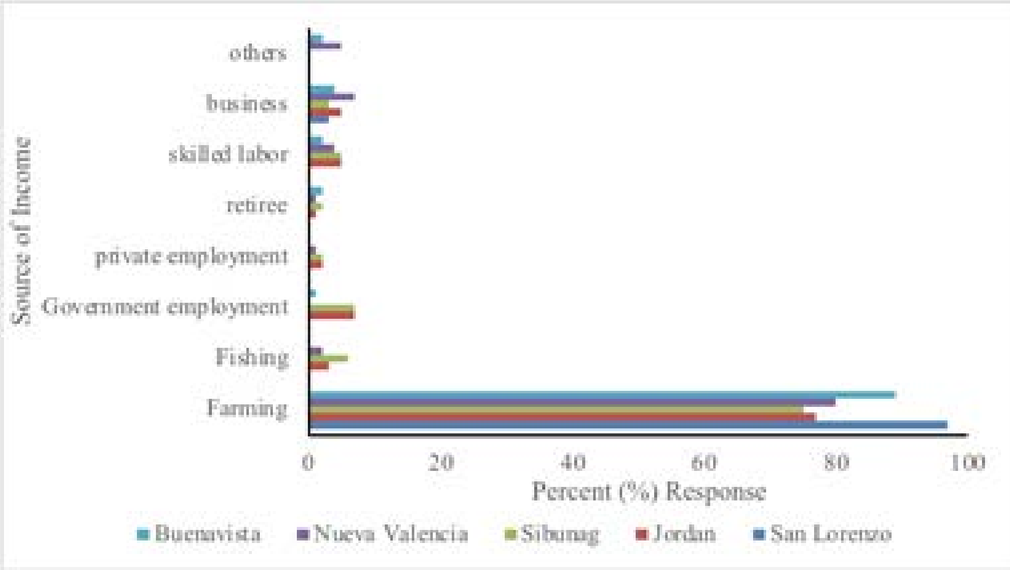

Figure 11. The main source of income

When asked about their monthly income per month, the majority of the respondents from the five (5) municipalities said that they were earning PhP5,000 and below from their main source of income (Figure 12). Most of the respondents earn an income of less than PhP10,000.00. This indicates that the respondents with generally 1-5 dependents were mostly poor as they could not suffice even the basic needs of the family considering the escalating prices of basic commodities. This is supported by the Philippine Statistics Authority (2016b) which set a monthly poverty threshold income of PhP 9,064.00. For a family of five, the family needed at least PhP 9,064.00 to meet basic food and non-food needs. That was only in 2015 when the price hikes for basic commodities is not so much. This means, these recent years, the respondents may hardly meet their basic needs.

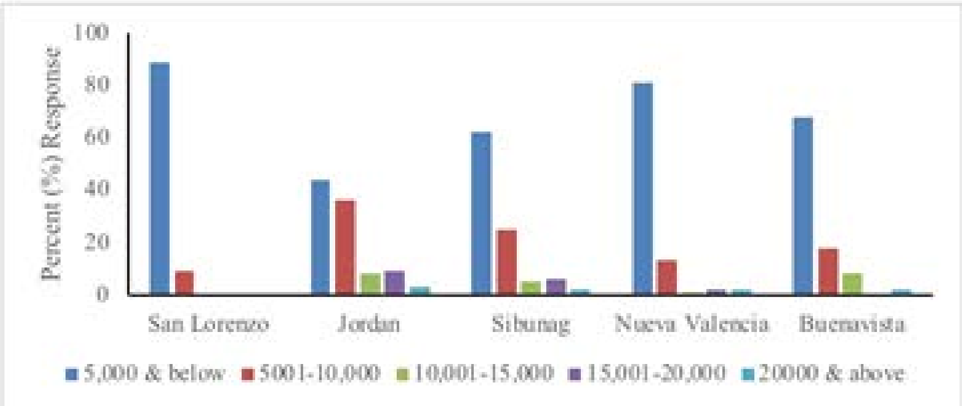

Figure 12. Monthly Income

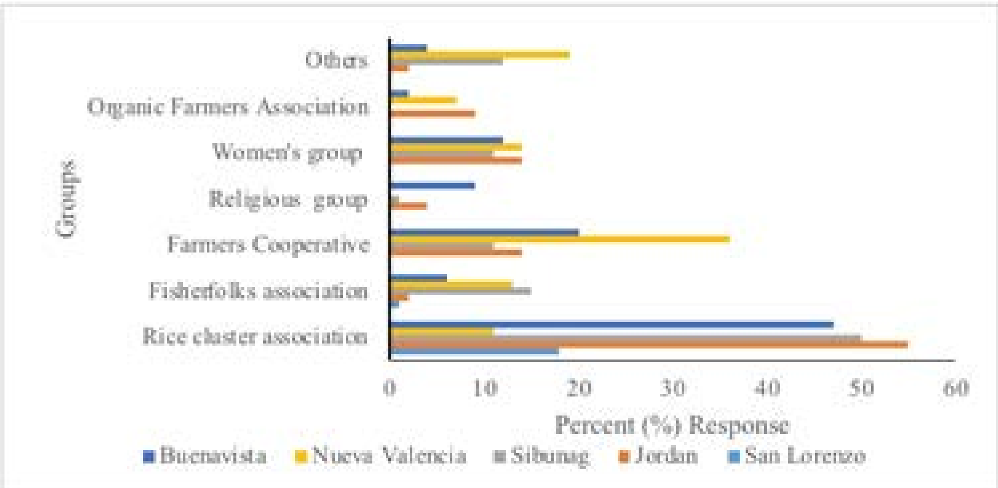

Figure 13. Group Affiliation

Relative to group affiliation, it was noted that most of the respondents from four (4) municipalities namely San Lorenzo, Jordan, Sibunag, and Buenavista were members of the rice cluster associations of their respective municipalities with 18%, 55%, 50%, and 47% responses respectively (Figure 13). Only in Nueva Valencia, the majority of the respondents were affiliated with a cooperative. The membership of most of the respondents to the cluster associations is indicative of the successful drive of the Department of Agriculture to form rice farmers into an association. All projects of the Department of Agriculture are channeled to the associations. Non-membership to any rice cluster association will deprive the farmers to avail of the benefits that the members of the association enjoy from the association. Therefore, the farmers are encouraged to join the association.

In terms of religion, the majority of the respondents in all municipalities were Roman Catholics (Figure 14). Very few percentages were distributed across various religious organizations. This is understandable as 75% of the people in the Province are Roman Catholics (NSO, 2000).

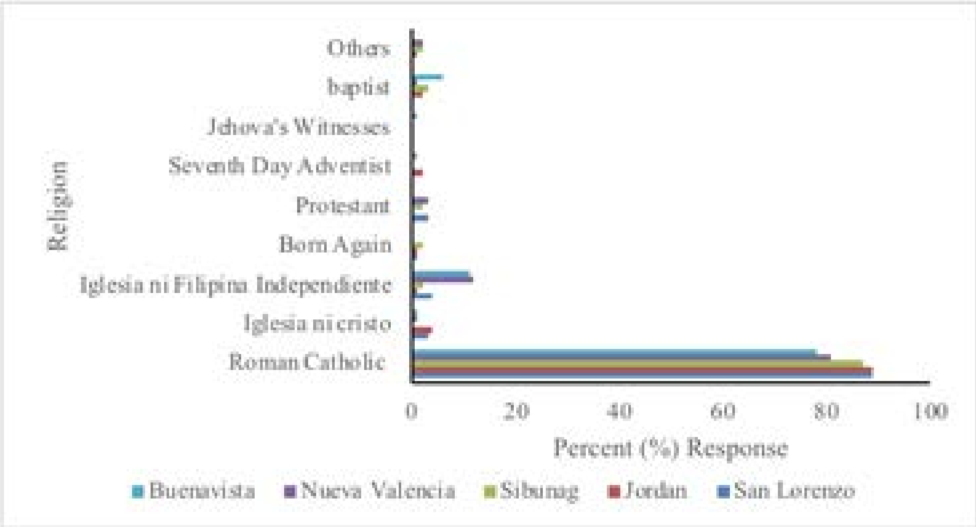

Figure 14. Religious Affiliation

Rice Production Management Practices

Rice production management practices were categorized according to rice ecosystem, rice varieties, land preparation, fertilizer management, crop establishment, water management, weed management, pest and disease management, harvesting, production, residue management, and cropping pattern.

Rice ecosystem

Figure 15 shows the distribution of respondents according to the rice ecosystem. It was noted that most of the respondents in all municipalities managed their farms under rainfed conditions. Among the five municipalities, Sibunag has the highest number of respondents with farms under rainfed conditions with 97%. Jordan had the lowest number of responses as to farming under rainfed conditions.

Rice varieties

As to rice varieties used, the majority of the respondents from all municipalities used inbred rice varieties for production (Figure 16). Only very few of the respondents used traditional varieties and hybrids. Despite the promotion of the Department of Agriculture to use hybrid rice, still respondents opted to use inbred rice varieties even if the farm is irrigated. This is probably because hybrid rice is much more expensive than inbred and can be planted only once. The variety also requires intensive management. According to Casiwan, et al. (2003) labor in seedbed preparation and crop establishment was found to be higher for hybrids than for inbreds. Further, early hybrid varieties were deemed inferior in terms of grain quality compared with best inbreds. The low adoption of hybrid over inbred is that high yield is not always the main consideration of farmers in choosing a variety to grow (Laborte et al., 2015).

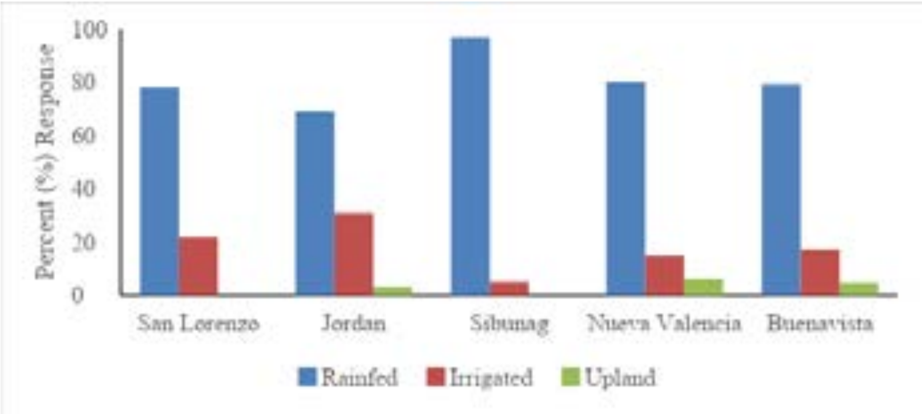

Figure 15. Rice Ecosystem

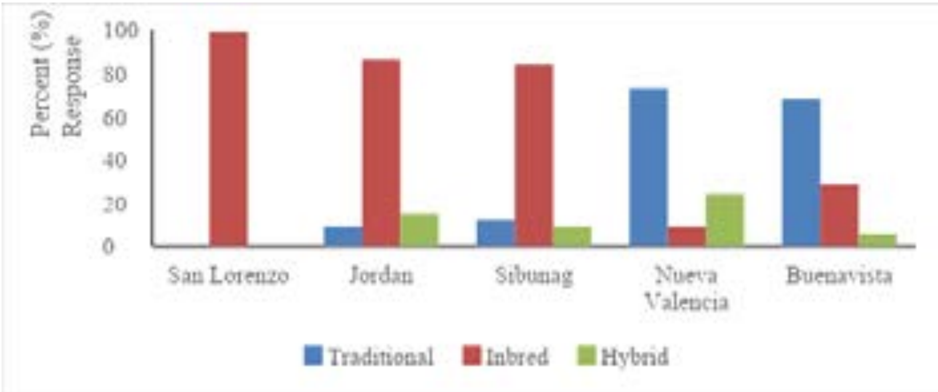

Figure 16. Rice varieties used

Types of Seeds

The majority of the respondents in three (3) municipalities used certified seeds that including San Lorenzo being the highest certified seed user with 99% responses, Jordan with 57% responses, and Sibunag with 74% responses. The other two (2) municipalities like Nueva Valencia and Buenavista mostly rely on good seeds with 67% and 87% responses, respectively (Figure 17). For the three municipalities, this is an excellent indication that the Department of Agriculture through the Municipal Agriculture Office as its counterpart was successful in the promotion of the utilization of certified seeds. This implies that respondents were well-informed of the benefits of using certified seeds. Further, the presence of the Rice Seed Growers in the Municipality of San Lorenzo contributed to encouraging the farmers on utilizing certified seeds.

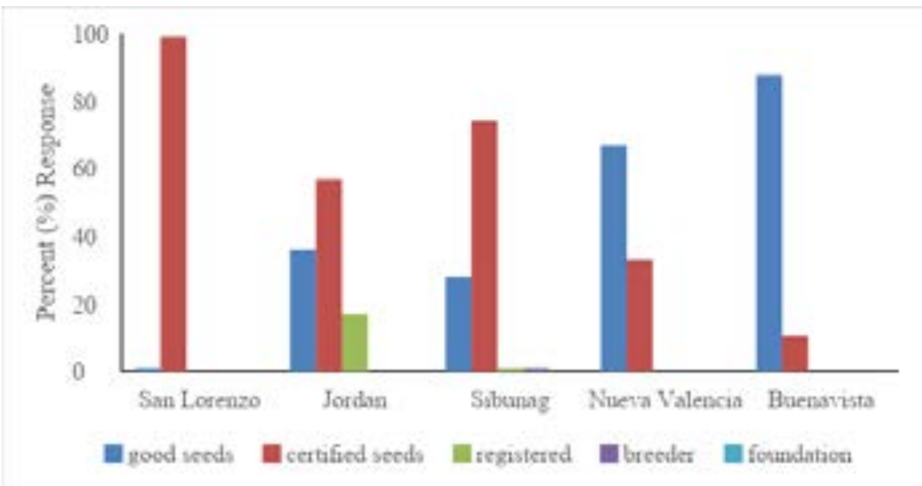

Figure 17. Types of seeds

Land preparation

Inland preparation, some farmers used both mechanical and manual methods. Due to the availability of farm machinery, it can be noted in the three municipalities that include San Lorenzo, Sibunag, and Nueva Valencia, where most of the respondents employ mechanical hand tractors in land preparation with 73%, 78%, and 95% responses, respectively. However, for Jordan and Buenavista, most of the respondents still rely on the manual method of land preparation with 90% and 73% responses, respectively. Only 10% in San Lorenzo and 1% in Sibunag use a 4-wheeled tractor (Figure 18). Respondents are now gradually relying on mechanical hand tractors than the animal-drawn plow. This is probably because tractors (4-wheel or hand tractors) can do plowing, harrowing, leveling, and even hauling of farm inputs and outputs. Likewise, farmers appear to consider machines as these work faster than manual and reduce production costs (Baustista, Kim, Kim& Panganiban, 2017).

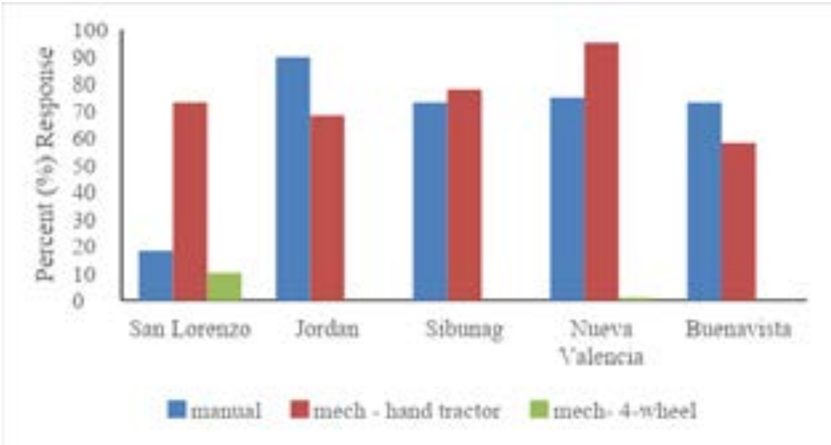

Figure 18. Method of land preparation

In terms of the frequency of plowing and harrowing, the majority of the respondents from four (4) municipalities such as Jordan, Sibunag, Nueva Valencia, and Buenavista practice plowing and harrowing their field twice with 60%, 65%, 90%, and 60% responses, respectively. While almost all respondents in San Lorenzo only plow and harrow their field once with 96% responses (Figure 19). The result indicates that the respondents were not following the recommended frequency of plowing and harrowing in rice production. Farmers generally employed the practice as they wanted to catch up with the rain, particularly those farming under rainfed conditions. Their practice is not in consonance with PhilRice (2016) recommending plowing and harrowing once a week for three times before final leveling to prevent weeds and seeds from germinating.

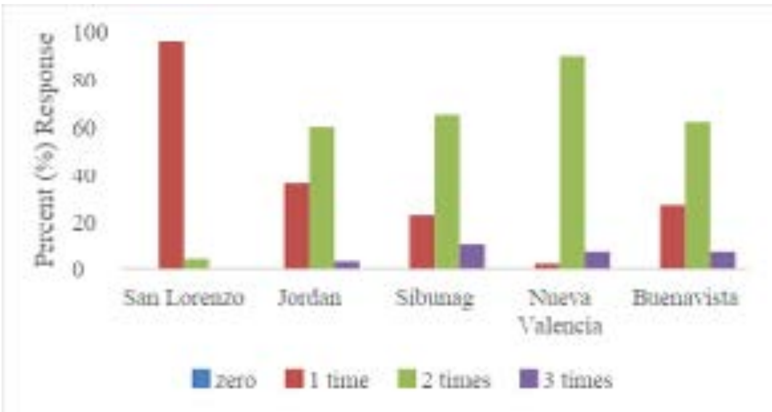

Figure 19. Frequency of plowing

As to following, the five municipalities practices different periods for the activity. It was noted that respondents from San Lorenzo and Buenavista practice a fallow period of 3-4 months with 100% and 81% responses, respectively. On the other hand, respondents from Sibunag and Jordan said they practice a 1-2 months fallow period with 54% and 69% responses, respectively. Further, most of the respondents from Nueva Valencia employ a fallow period of 6 months and above with 49% responses (Figure 20).

Figure 20. Fallow period

Fertilizer application

The respondents from five (5) municipalities have varying responses to their fertilizer application bases. All respondents from San Lorenzo (100% responses) and 95% of the respondents in Nueva Valencia said that they have no basis for fertilizer application. For Jordan and Sibunag, most of the respondents said that they base their fertilizer application on the result of the rice crop manager with 51% and 83% responses, respectively. However, in Buenavista, 96% of its respondents based their fertilizer application on soil analysis (Figure 21). The result implies that respondents from San Lorenzo and Nueva Valencia are applying fertilizers without any basis. Despite the free soil analysis offered by the Regional Soil Laboratory in Iloilo City, the respondents were not yet able to send their soil for analysis. This may be because the soils laboratory is far from their respective places. Others were able to utilize rice crop manager probably because of the assistance from their Municipal Agricultural Technologists/ Technicians, particularly in Jordan and Sibunag, Buenavista respondents probably have their soil analyzed because, according to the farmers, they used the recommended fertilizer application by the Bureau of Soils and Water Management.

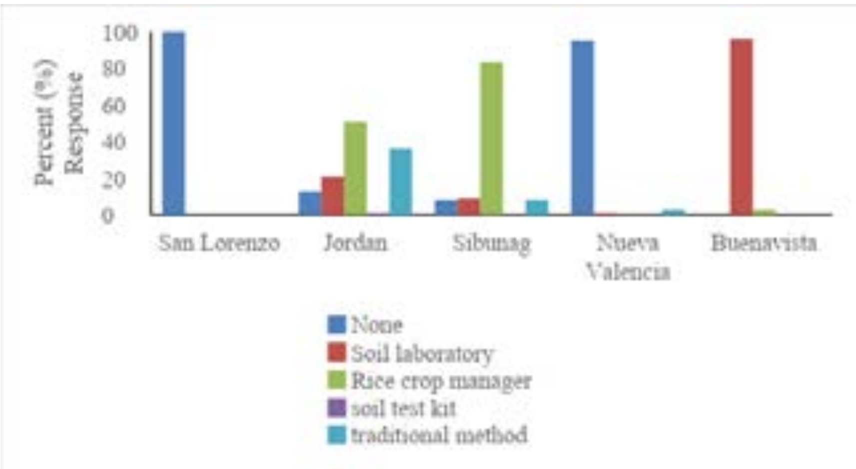

Figure 21. Bases for fertilizer application

Generally, the respondents from four (4) municipalities (Jordan, Sibunag, Nueva Valencia, and Buenavista) used combinations of organic and inorganic fertilizers in their farms. The majority of the fertilizers across all municipalities used inorganic fertilizers. No respondents in San Lorenzo use organic and commercial organic fertilizers. Jordan got the highest number of respondents combining organic fertilizers with inorganic fertilizers with 45% responses (Figure 22). This implies that the majority of the respondents solely supply their farms with chemical fertilizers as these fertilizers are easily acquired from the market. Likewise, they probably lack knowledge on the importance of organic fertilizers or composts in improving soil fertility

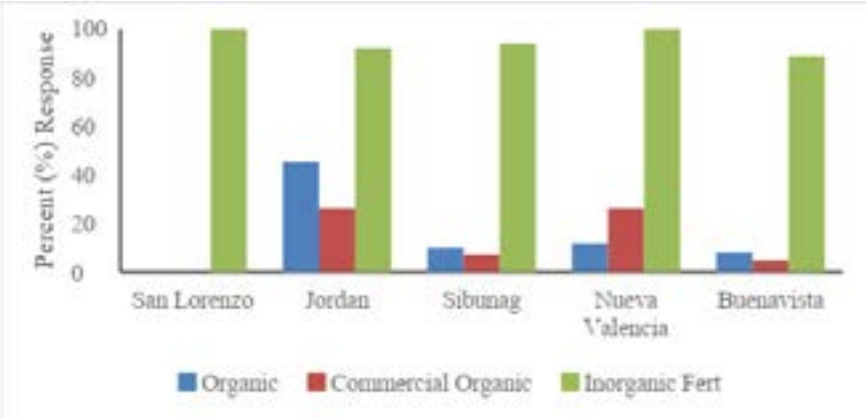

Figure 22. Types of fertilizers used

Crop establishment

When respondents were asked about their practice in terms of the interval between harrowing and crop establishment, most of the respondents from all municipalities replied that they establish crops within 7 days after harrowing (Figure 23). The interval indicated that farmers prepare the field for a very short period considering that they only prepare their land for only a maximum of 14 days. PhilRice (2016) recommends that land should be prepared for 21 days to prevent weeds and dropped seeds from germinating. This period also allows weeds and crop residues to decompose and the soil to be exposed under the sun to kill weed seeds and soil-borne pathogens (Fajardo et al. 2000).

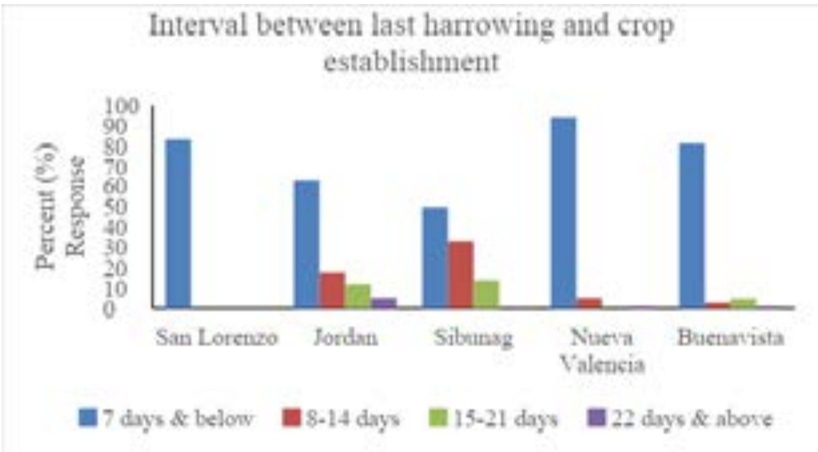

Figure 23. The interval between last harrowing and crop establishment

Water management

In four (4) municipalities, water management relies on rainfall for irrigation, including San Lorenzo, Sibunag, Nueva Valencia, and Buenavista with 79%, 27%, 78%, and 39% responses respectively (Figure 24). Only the majority of the respondents in Jordan rely on rivers and streams for irrigation. This is true as Guimaras generally had ricefields operated under rainfed conditions.

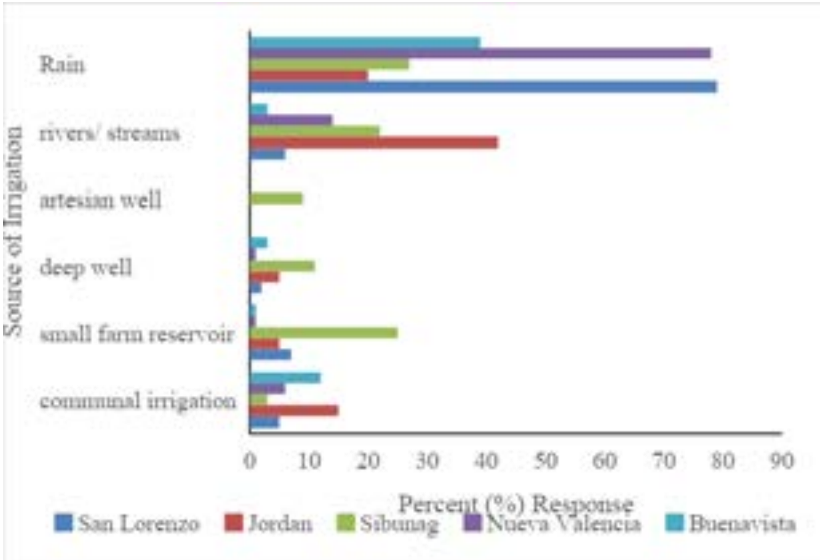

Figure 24. Source of Irrigation

Weed management, and pest and disease management

As to weed management and pests and diseases, the majority of the respondents from all municipalities rely on chemical inputs to control weeds (Figures 25 and 26). Only a few respondents employ manual weeding and combinations of manual and chemical control of weeds. This implies that all respondents solely rely on chemicals to control weeds, pests, and diseases as these materials are easily acquired from the market. The rampant use of chemicals could be due to their effectiveness in the speedy removal of weeds and controlling pests and diseases on the field.

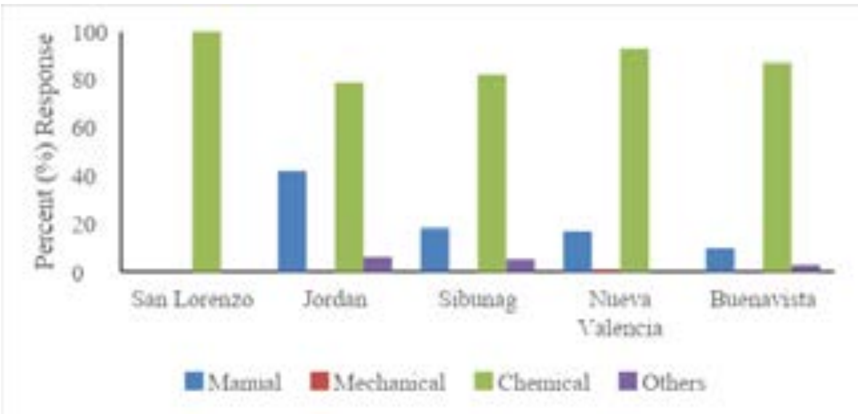

Figure 25. Weed management

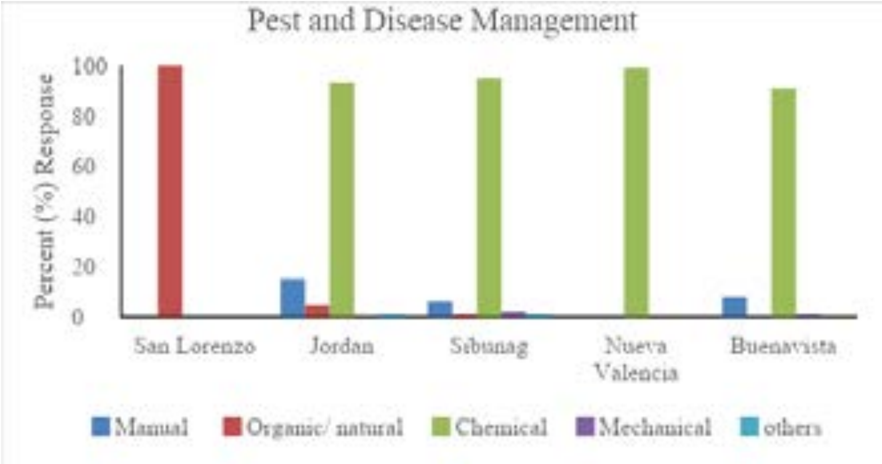

Figure 26. Pests and Disease management

Residue management

Most of the respondents in the Municipalities of San Lorenzo, Jordan, and Sibunag composted their residue while Nueva Valencia and in Buenavista, most of the respondents rely on soil incorporation and composting (Figure 27). The result indicates that almost all respondents turned their rice straw residues into composts. They probably learned the importance of rice straws for fertilizer. However, going back to fertilizer application, it was noted there that farmers were not applying organic fertilizers to include composts. The respondents probably apply their composted materials to other crops. In terms of rice stubbles, it is understandable that most rice stubbles are normally incorporated in the field.

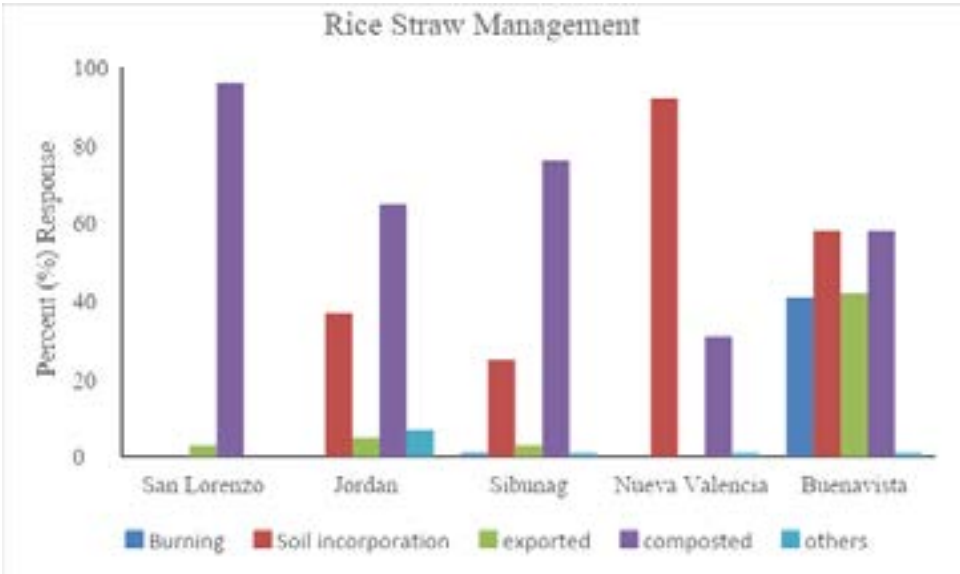

Figure 27. Rice straw management

Soil Nutrient Status

Based on the soil analysis provided by the Bureau of Agriculture and Water Management (BSWM), nitrogen status in the whole five municipalities is low, P is generally low, and K is moderately low (Figure 28). The result implies that the lowland rice soils are generally poor as to nutrient status. Poor soil nutrient conditions might be due to fertilizer application, and pest and disease management. Most farmers applied fertilizers without soil analysis, which means that fertilizers were not appropriately supplied. Likewise, the majority of the farmers applied synthetic fertilizers on the farm. According to Tripathi et al., 2020 excessive fertilizer and pesticide applications in crop production negatively affect the environment including soil degradation, enhanced greenhouse gas emissions, accumulation of pesticides, and decline in the availability and quality of water. Synthetic fertilizer application destroys soil biodiversity by suppressing the role of nitrogen-fixing bacteria and enhancing the role of everything that feeds on nitrogen. These feeders then amplify organic matter and humus decomposition, thereby reducing soil fertility. The indiscriminate use of synthetic fertilizers affects the soil properties and also causes water pollution through runoff in the rainy season. The inappropriate use of chemical fertilizers, especially in paddy fields may affect the growth-inhibiting microorganisms. The extensive applications of synthetic fertilizers from the last several years have caused soil degradation and pollution of soil and water with health implications in population. In agriculture, chemical fertilizers are used extensively, but they are costly and also have various adverse effects on soils, i.e., depletes water holding capacity, soil fertility, and disparity in soil nutrients. Insufficient uptake of these fertilizers by plants results in the leaching away from soil (Rai and Shukla, 2020).

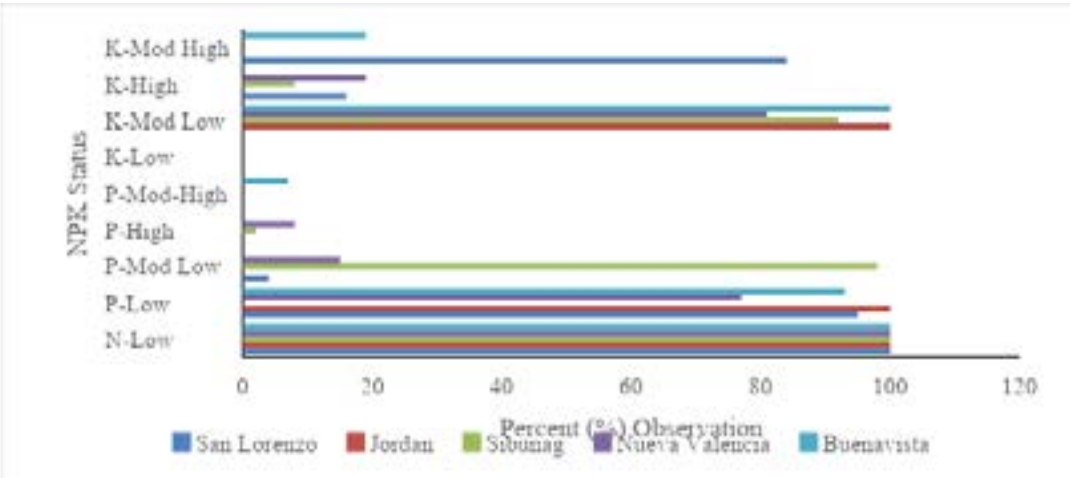

Figure 28. NPK Status

The soil pH is generally high in the five municipalities and the general soil fertility rating of the farms considered in the study was generally moderately low (Figure 29). This implies that the application of synthetic fertilizers and pesticides less likely affected soil pH value but have an overall implication to moderately low soil fertility rating. Synthetic fertilization caused soil acidification and salinization (Zhang et al., 2015). This is supported by Muktamar et al., 2016 who reported that nitrogen fertilizer application for a long time significantly decreased soil pH, exchangeable Ca, Mg, and K, and Cation Exchange Capacity (CEC). Fertilizers and pesticides tend to have long persistence in the soil, so they are bound to affect the soil microflora, thereby disturbing soil health. Fertilizer and pesticide applications strongly influence a range of soil functions and properties. These include rhizodeposition, nutrient content, bulk, rhizospheric soil, soil organic carbon, pH, moisture, soil enzymes, and many others. These factors indirectly affect the changes in the population dynamics of soil microflora along with the direct effects of fertilizers and pesticides (Prashar, and Shah 2016).

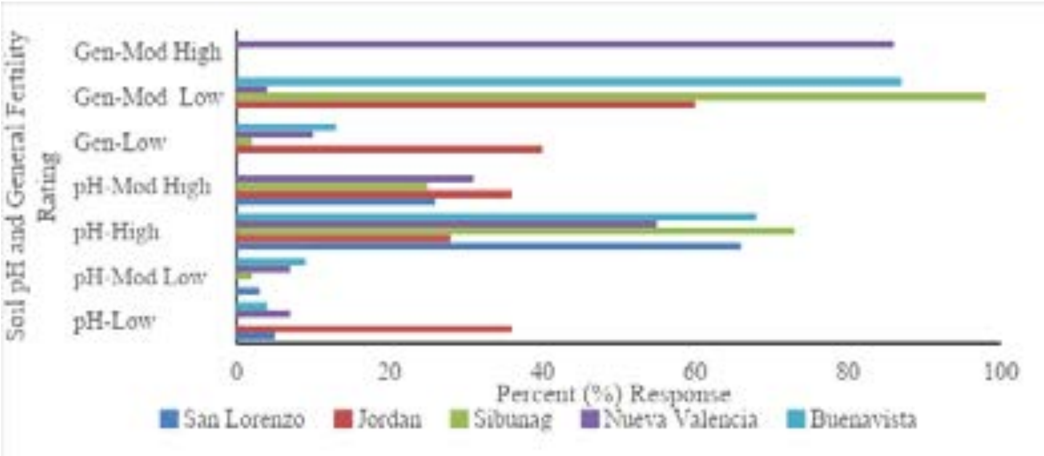

Figure 29. Soil pH and General Fertility Rating

CONCLUSION

Majority of the respondents have ages ranging from 61 years old and above, males, married, elementary graduates, have 0-1 dependents, and owned their farm. The majority of the respondents managed a farm with a total area of 0-1 hectare, with rice farms of 1 hectare, have their farms close to their household (0-1 km), with farming as their main source of income. Majority of the respondents said they have incomes of PhP 5,001 to PhP 10,000. They generally stay in the community for more than 26 years, were members of the rice cluster association, and were Roman Catholics.

Most of them managed their farms under rainfed conditions, inbred rice varieties for planting, used certified seeds, and used handtractor to prepare their farms. They plow their farms twice and observed an last harrowing and crop establishment. Most of the respondents observed a fallow period of 3-4 months. Respondents do not have any bases for fertilizer application other rely on rice crop manager. All respondents responded that they practiced chemical weeding, and chemical application to control pests and diseases. Majority of the respondents said they convert rice straws into composts and other said they incorporate during land preparation. Among the problems identified were pests and diseases, followed by capital and adverse climatic condition. Other problems included high cost of farm inputs and very few responded that they have problems on fertilizer sources. In terms of soil fertility, majority of the respondents' farm were low in nitrogen (N), low in Phosphorus (95 or 95%), moderately high in Potassium (K) (84 o 84%), and high in soil pH (66 or 66%). In terms of general fertility, the 94 of 94% of the farms were moderately low.

In order to make study more comprehensive, researchers may further determine problems on the different crop management practices relating soil fertility depletion. The LGUs may develop organic agriculture policies based on the study results.

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