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STATISTICAL MODEL FOR SOME CONSTRAINTS AFFECTING THE LEVEL OF RICE FARMERS' INCOME

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Abstract

Rice farming is one of the main sources of income in many rural areas in the Philippines. The purpose of this study is to model the different constraints that influence the level of rice farmers' income in Albuera, Leyte, Philippines. Survey data from an available sample of participants were gathered through a face-to-face interview consisting of the rice farmers' income and its determining constraints. Some descriptive measures were calculated to summarize the gathered variables and ordinary least square (OLS) regression analysis was employed to predict the significant constraints of farmers' monthly income. Results revealed that the rice farmers' monthly income is below the poverty line as the Philippine poverty threshold is concerned, that is, rice farmers in rural areas are considered "poor". The farmers have said that their rice production and income level are "affected" by the following constraints: "high prices of agricultural inputs", "inadequate capital", and "pest and diseases". Additionally, their rice production and income are moderately affected by "lack of credit facilities", "lack of technical services", and "weeds". Moreover, the two constructed statistical models showed that the following constraints are significant factors affecting the income level of rice farmers: "high prices of agricultural inputs", "lack of credit facilities", "high cost of transportation", "low educational attainment", and "land rent". Conclusively, farmers are in need of assistance from the local government concerning access to credit for capital, adoption of new technologies in farming, and other facilities that might improve their production. Furthermore, farmers must undergo some seminars and training to strengthen their knowledge of rice farming and improve their practices to increase their level of production, well-being, and monthly income.

***Key words*:** *Rice farmers, level of income, constraints in rice production, statistical modeling, Philippines*

INTRODUCTION

In the Philippines, rice farming is one of the major contributors to the gross domestic product (GDP) in the country [2]. In the study of Casinillo [8], it is stated that rice is the main crop produced in the country and is considered one of the government focuses concerning laws and policies. In fact, rice production in the Philippines is the main source of income for many Filipino farmers in rural areas, especially for small-scale farm areas [7] [9]. Income is very important for every individual since it provides food security, basic needs, comforts, and other benefits. According to Ojo and Baiyegunhi [18], income in rice farming has a lot of influencing factors that need to be addressed especially the constraints that they are facing. Apparently, rice farming is a risky source of income due to the different problems encountered in the production such as pests and diseases, low soil fertility, bad weather, and inadequate capital for agricultural inputs, among other problems [4], [11], [22], [23]. In that case, to find a solution to the low economic income in rice farming, it is necessary to investigate the root cause and problems in the rice production process.

Farming in the rural areas in the Philippines has mostly been cultivated and managed by aging farmers with low educational attainment [7]. In fact, these rural farmers are in need of support from the local government in regard to knowledge in farming, innovative, latest, and advanced technologies that are suitable nowadays, agricultural inputs, and other vital needs in rice production [1], [22], [27]. Apparently, educational programs in agriculture are vital for farmers' knowledge,

attitudes in farming, and practices towards newly discovered technologies since they influence them to adopt better rice production and profitability [22]. Hence, it is very crucial to investigate the determinants that influence their production process so that some policy-makers might formulate suggestions that may turn into laws that will help farmers and address their agricultural needs. The study of Nueva et al. [17] stated that investigating the farmers' point of view will provide empirical evidence that helps determine the issues and problems that they are facing in their farming activities due to existing laws in the country. Moreover, a survey concerning the income and constraints of rice farmers might provide necessary information that serves as a criterion to improve their way of earning and solve the poverty in the country [7], [19], [28].

Although many studies have been published in the literature concerning rice farmers' income, developing a statistical model for some constraints in the level of income in rice farming is scarce. In fact, it has never been done in rural areas and small-scale farmers in the Philippines, hence, this study was realized. To obtain the goal of this article, the study accomplished the following specific objectives: to describe the socio-demographic profile of rice farmers; to tabulate the different income levels of rice farmers; to characterize the different constraints in rice farming; to document the significant constraints in rice farming using a statistical model. The results of this survey article might help government agencies to improve the promulgated laws and policies concerning the well-being of rural farmers and rice production in the Philippines. Moreover, findings might serve as a piece of baseline information for agricultural extension agents and economics researchers.

MATERIALS AND METHODS

A complex correlational design was applied in this study to capture the association between several variables. In addition, it utilized some descriptive statistical techniques and statistical modeling in the form of econometrics. The survey study site is one of the Barangaysin Albuera, Leyte, Philippines that is considered rice producers. The name of the barangay is Poblacion where most of the farmers in this area are considered small-scale workers where they cultivate a paddy farm of at most 2 hectares or an average of 0.77 hectare. The area was chosen because of the existing problems and constraints that hindered the rice production level in the said barangay. Hence, the researcher has the desire to investigate and suggest a solution to improve the low production level in rice farming. Map 1 presents the study's research location, that is, Barangay Poblacion, Albuera, Leyte, Philippines using Google Maps.

Map 1. Location of Barangay Poblacion, Albuera, Leyte, Philippines
Source: [12].

The participants of this study were farmers who cultivate a paddy farm of at most two hectares and who experience some constraints during their production process. In addition, the dominant (60%) of these farmers were a tenant. And the researchers use primary data through a face-to-face interview with the activity of availability sampling. This means that the study considered only the rice farmers who are available during the time of the survey. Before the study has been conducted, it involves an ethical process such as a permission letter sent to the Municipal Agriculture Office (MAO) of the town of Albuera, Leyte to have prior consent in conducting the said survey. After the go signal

of the head of MAO, the survey was immediately implemented. The farmers were informed that the said survey was voluntary and the information gathered was solely used for research only and treated confidentially.

The researchers developed a structured questionnaire that contains the following parts: (1) demographic profile; (2) level of income; (3) constraints in rice production. For the demographic profile, farmers were asked about their age (actual years), sex (0-female, 1-male), and educational attainment (0-no college degree, 1-with college degree). Secondly, farmers' actual monthly income was determined by the following formula:

$$Monthly\ income = \frac{total\ revenue - total\ cost}{4\ months} \quad \text{.....(1)}$$

The above formula (1) is a calculation of the monthly income of rice production in one cropping season with a duration of about 4 months from soil preparation to harvesting [25]. Lastly, the farmers were asked to rate the following constraints in rice farming: land rent; inadequate capital; inaccessibility to farmland; pests and diseases; weeds; high inputs; lack of post-harvest facilities; lack of credit facilities; lack of technical services; high cost of transportation; and low soil fertility. The rating scale is from 1 to 4 with the following verbal description: 1-Not affected (1.00-1.75); 2-Moderately affected (1.76-2.50); 3-Affected (2.51-3.25); and 4-Severely affected (3.26-4.00).

After the data is collected, it is encoded in excel and undergoes clearing to remove or exclude the participants who have missing and extreme (outlier) response/s. Hence, the total number of participants is 63 rice farmers. Now, in summarizing the variables, descriptive statistics such as mean, standard deviation, minimum, maximum, counts, and percentages were used. In determining the significant constraints of rice farmers' income, a statistical model was constructed in the form of an ordinary least square (OLS) econometric regression analysis. The monthly income was the dependent variable, and the demographic and constraints in farming were the independent variable in the regression. The model equation is given by

$$I_j = c_0 + c_1 X_{j1} + c_2 X_{j2} + \cdots + c_p X_{jp} + e_j \quad \text{.....(2)}$$

where I_j is the farmers' monthly income, $j = 1, \ldots, m$ and m is the number of rice farmers involved in the study, $c_t (\forall t \in \{0, 1, \ldots, p\})$ are the parameters of the model (2), X_{jt} $(\forall t \in \{1, \ldots, p\})$ refers to the independent variables and e_j refer to the random error. Diagnostic tests such as the heteroscedastic test, omitted variable test, multicollinearity problem test, and normality test for residuals were also employed to ensure the validation of the results of the regression. The said tests were subject to a 5% level of significance. Finally, STATA version 14.0 was used for all the calculations involved in this study.

RESULTS AND DISCUSSIONS

Farmers' Profile

In [9], it is stated that most of the rice farmers in rural areas are elderly since the young ones are sent to school for better educational attainment and later find decent work with higher income. A parallel finding was found in Table 1 where rice farmers are mostly older individuals (M=57.49, SD=9.59). The youngest is 36 years old and the oldest is 79 years old. Dominant (65%) of these farmers are male and about 35% of them are females (Table 1). It is worth noting that rice farming requires a masculine nature of work, hence, male individuals are more capable of doing the heavy part in the rice production. However, the easy and light part of rice production is mostly done by females, hence, women's participation in farming is also certain and essential [10]. Only 11% of these rice farmers are college level and the dominant (89%) of them are high school level and below (Table 1). This result is parallel to the findings in [8] and [9], wherein small-scale rice farmers are mostly with low educational backgrounds, that is, on average, they are only high school level.

Table 1. Rice farmers' profile.

Variables	M	SD	min	max
Age	57.49	9.59	36	79
Male[a]	0.65	0.48	0	1
Educational Attainment[a]	0.11	0.32	0	1

Note: a-dummy variable
Source: Own calculation (2022).

Farmers' Income Level

Table 2 shows that about 41.27% of the rice farmers' income fell in the interval 4,000 (₱) and below. About half (50.79%) of these farmers are having a monthly income in the interval 4,001 (₱) - 7,000 (₱) and only 7.93% of them are having an income of 7,001 (₱) and above. This shows a small percentage of farmers with a good monthly income in rice farming. In fact, the average monthly income is close to 4,652.28 ($\pm$ 2,102.35)(₱). This implies that these rice farmers are living below the poverty threshold in the country Philippines [3]. In that case, it is sufficient to say that these farmers are in need of support concerning their agricultural inputs to somehow progress their production and increase their economic income in rice farming [7], [13].

Table 2. Rice farmers' monthly income.

Monthly income[b]	Frequency	Percentage (%)
4,000 and below	26	41.27
4,001 - 7,000	32	50.79
7,001 and above	5	7.93
M ($\pm$SD)	4,652.28 ($\pm$2,102.35)	

Note: b-in Philippine Peso (₱)
Source: Own calculation (2022).

Constraints in Rice Farming

Farmers said that their income in rice production is "affected" by "high prices of agricultural inputs" (M=2.51, SD=0.62) (Table 3). This result is in consonant with the findings in [7] and [9] that rice farmers' profitability is affected by the higher expense of farming inputs, especially for fertilizer, herbicides, and pesticides, among others. Farmers' rice production is also affected due to inadequate capital (M=3.19, SD=0.84) (Table 3). This implies that small-scale farmers are having difficulty acquiring capital for agricultural inputs and other requirements in production [7].

Another constraint that adversely affects production is the pest and diseases that destroy the rice crop (Table 3). It is worth noting that these farmers are having problems buying pesticides and fertilizer due to high prices and inadequate capital, hence, their yield is relatively decreasing [16]. Additionally, rice production is moderately affected by a lack of credit facilities (M=2.33, SD=0.84), and a lack of technical services (M=2.22, SD=0.99) (Table 3). Hence, these farmers must be supported by the Philippine government concerning their needs in agricultural inputs to continue and progress their production and income level [1], [6], [9]. Moreover, rice production is also moderately affected by weeds (M=2.44, SD=0.64) that adversely affects the nutrient consumption of rice crop due to competition (Table 3). In that case, farmers must adopt new technologies and techniques to naturally diminish the presence of weeds in the rice fields [22]. Overall, farmers' rice production and income level are moderately affected (M=2.10, SD=0.76) by the constraints mentioned in Table 3.

Table 3. Rice farmers' constraints in rice production

Constraints[c]	M	SD	Description
1. High Inputs	2.51	0.62	Affected
2. Lack of Post-harvest Facility	1.68	0.84	Not affected
3. Land Rent	1.48	0.64	Not affected
4. Lack of Credit Facilities	2.33	0.84	Moderately affected
5. Lack of Technical Services	2.22	0.99	Moderately affected
6. High Cost of Transportation	1.62	0.87	Not affected
7. Inadequate Capital	3.19	0.84	Affected
8. Inaccessibility to Land	1.46	0.69	Not affected
9. Pest and Diseases	2.60	0.83	Affected
10. Weeds	2.44	0.64	Moderately affected
11. Low Soil Fertility	1.59	0.59	Not affected
Overall	**2.10**	**0.76**	**Moderately affected**

Note: c-Scale of 1 to 4.
Source: Own calculation (2022).

Hence, their income from rice farming is somehow diminished due to the said constraints.

Statistical Models

The statistical model I in Table 4 is heteroscedastic concerning its variances (X^2=9.21; p-value=0.002). In that case, the model was corrected by robust standard errors command in STATA which is suggested in [14]. The model has omitted variables (F=3.02; p-value=0.038), however, no problem of multicollinearity (VIF=1.31) was found between predictors. Moreover, it is shown that the residuals are normally distributed (Z=1.102; p-value=0.135). On the face of it, it suffices to say that the model has no problem interpreting the findings.

Table 4 shows that model (I) is significant at a 5% level (F=2.47; p-value=0.023) and has a coefficient of determination of 0.226. This means that there are significant factors (constraints) that influence the income of rice farmers.

Firstly, the evident predictor of income level in model I is high inputs (p-value=0.058) and it is significant at a 10% level (Table 4).

Table 4. Statistical model (I) for constraints in rice income[d].

Predictors (Constraints)	Model I		
	Coefficient	*Std. Error*	*p-value*
Age of farmers	-0.0036[ns]	0.0027	0.191
Male[a]	-0.0411[ns]	0.0327	0.214
High Inputs[c]	-0.0518*	0.0267	0.058
Lack of Post-harvest Facility[c]	-0.0001[ns]	0.0276	0.996
Lack of Credit Facilities[c]	-0.0342*	0.0242	0.100
Lack of Technical Services[c]	0.0133[ns]	0.0184	0.474
High Cost of Transportation[c]	0.0601**	0.0250	0.020
Low Soil Fertility[c]	0.0429[ns]	0.0281	0.134
Constant	3.9142***	0.1964	<0.001
No. of Participants	63		
F-test	2.47**		
p-value (two-tailed)	0.023		
R^2	0.226		

Note: a-dummy variable; c-Scale of 1 to 4; d-one cropping season; ns- not significant; * - significant at 10%α level; ** - highly significant at 5%α level; *** - highly significant at 1%α level

Source: Own calculation (2022).

This means that farmers are struggling to acquire good agricultural inputs due to their expensive prices.

It is worth noting that quality inputs in rice production are necessary for the outcome of a good harvest that correspondingly increases farmers' economic income. On the face of it, rice farmers' productivity and satisfaction are affected because of the difficulty of buying essential inputs in farming [5], [7], [8], [9], [21], [29].

Secondly, it is significant at the 10% level that lack of credit facilities is a constraint in rice production. This means that farmers are having difficulty acquiring a budget for their expenses in rice production. In that case, farmers are encouraged to join an association of farmers or cooperatives where they can borrow a budget for inputs and other costs in rice farming [30]. The model revealed an inverse effect of the high cost of transportation and it is significant at a 5% level. This means to say that if the transportation is high, farmers are looking for an alternative to transporting their heavy equipment and rice outputs. Hence, farmers do need not to pay the high costs of transferring their heavy loads. Instead, farmers are finding some ways to lessen their costs concerning the transportation process in rice production.

Again, the statistical model II is considered heteroscedastic concerning the nature of variances (X^2=9.84; p-value=0.001) (Table 5), hence, the model was corrected by robust standard errors [14]. No omitted variables (F=0.67; p-value=0.577) and no problem of multicollinearity (VIF=1.34) between predictors were found in model II. Additionally, it is found that the residuals are normal (Z=0.418; p-value=0.338). Hence, the model has no trouble interpreting its results. Apparently, model II is highly significant at a 1% level (F=4.96; p-value<0.001) and possesses a coefficient of determination of 0.359. This implies that there are significant predictors (constraints) that influence the income level of rice farmers.

It is revealed that the educational attainment of farmers is a highly significant (at a 1% level) predictor of income level in rice

farming (Table 5). This indicates that a farmer with more knowledge is more competitive as opposed to non-educated farmers. In [9], it is stated that the farmers' learned skills from school are very useful in the rice production process since it gives innovative and creative idea to progress their efficiency and sufficiency in the fieldwork. In that case, farmers must be supported by the government through extension agents by educating and facilitating them what are the new technologies and innovative techniques in improving rice yields that are suitable for time being [15], [20]. Apparently, if the farmers are properly informed by the said new advancement technologies, then they are more likely to adopt and practice the new knowledge for the sake of increasing their level of production and income [24], [26].

On the other hand, farmers' income level is adversely affected if the land rent is high and it is highly significant at a 1% level (Table 5). It is worth noting that the dominant (60%) of the farmers are tenants, hence, they have to pay some rent to their cultivated paddy farm which is an additional cost in the production. In the study by Casinillo and Seriño [9], it is said that farmers who owned the land are more likely happy and satisfied in farming since they don't have to pay economic rent.

Table 5. Statistical model (II) for constraints in rice income[d].

Predictors (Constraints)	Model II		
	Coefficient	*Std. Error*	*p-value*
Educational Attainment[a]	0.2407***	0.0787	0.003
Land Rent[c]	-0.0567***	0.0204	0.007
Inadequate Capital[c]	-0.0148[ns]	0.0211	0.486
Inaccessibility to Land[c]	-0.0058[ns]	0.0221	0.793
Pest and Diseases[c]	0.0009[ns]	0.0304	0.997
Weeds[c]	0.0215[ns]	0.0445	0.631
Constant	3.7234***	0.0906	<0.001
No. of Participants	63		
F-test	4.96***		
p-value (two-tailed)	<0.001		
R^2	0.359		

Note: a-dummy variable; c-Scale of 1 to 4; d-one cropping season; ns- not significant;*** - highly significant at 1%α level

Source: Own calculation (2022).

Hence, the Philippine government must take initiative to make a law that lessens the rental fee for borrowing the paddy farm to somehow increase the farmers' economic profit as well as their well-being.

CONCLUSIONS

The paper's main goal is to document the level of income of rice farmers and to predict its constraints. The result has indicated that the income level of rice farmers in Albuera, Leyte, Philippines is relatively low and most of these farmers are living below the poverty threshold in the Philippine standard of economic status. The findings have shown that rice farmers are struggling to have enough budget in acquiring agricultural inputs because they cannot afford them due to high prices. In that case, farmers cannot buy sufficient herbicides, pesticides, and fertilizers, among others, that are suitable for increasing their yield. Additionally, farmers don't have enough capital for their expenses in rice production and don't have access to credit facilities. Hence, these farmers are having difficulty managing their budget plan from soil cultivation and planting to harvesting. Moreover, farmers' income is also affected by land rental fees since these are additional costs. Furthermore, it is revealed that educational attainment is very helpful in progressing their level of production. In other words, farmers with low education levels are more likely to have a low production and income level.

In conclusion, the Philippine government must support small-scale rice farmers to continue and progress their production by providing them subsidies and other benefits that might help them in acquiring agricultural inputs. The local government also must form a rice farmers cooperative that may help poor farmers to access credit with a low-interest rate. Plus, it is suggested that farmers' associations must be initiated to discuss and address the farmers' needs, constraints, and problems, among others. Likewise, the local government must provide training and seminars that educate the farmers on the new development of technologies in agriculture to positively influence their practices in farming. It is recommended that a similar survey study must be conducted in other rural areas in the

Philippines and incorporate variables related to well-being, resilience, and satisfaction to strengthen the current findings.

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