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Rice And Corn: Effects Of Non-Price Factors On Production

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Abstract: The Philippines is known for its rich farmlands and vast natural resources, there is no question as to why the country is most likely known primarily as an agricultural country. The purpose of the paper is to determine the effects of non-price determinants which are the land input, the cost of production of crops, the farmers' wages, and COVID-19 on the production of major crops in the Philippines which are rice and corn. Using the Ordinary Least Squares to summarize and analyze the secondary data gathered from the Philippine Statistics Authority from 2010 - 2021, this proved that for Rice, The variables Land input and Cost of Production have a significant positive relationship while the production level while Farmer's wages have a significant negative impact. COVID-19 on the other hand is insignificant since Rice is an essential to every Filipino household even during the time of the Pandemic. For Corn, The variables Land input and Cost of Production also have a significant positive relationship while the production level while COVID-19 have a significant negative impact.

Index Terms **- crop productivity, land input, cost of production, farmers' wages, COVID-19**

CHAPTER I

Introduction

The Philippines is known for its rich farmlands and vast natural resources, so there is no question as to why the country is most likely known primarily as an agricultural country. As reported by the Philippines Statistics Authority (2022) during the 2020 Census of Population and Housing, Filipinos who lived in rural areas comprised 46.0% of the total population of the Philippines in 2020. Specifically, there are 50.10 million Filipinos living in rural areas out of the total population of 109.03 million Filipinos (Philippine Statistics Authority, 2022). With the number of rural area settlers, it is safe to assume that they rely on agriculture as a livelihood. When people live in rural areas, it is a preconceived notion that their primary means of livelihood is something that is within the agricultural sector given the vast availability of land. The Philippines is one of the few countries in which its citizens are heavily reliant on agricultural production as a means of livelihood. In 2019, about 9.70 million Filipinos were employed in the agricultural sector, making a 22.9% contribution to the total employment of the country (Philippine Statistics Authority, 2020). With a good percentage of people employed in the agricultural sector, it is expected that agricultural production coincides with it; however, that is not the case for the Philippines. Agricultural production in the Philippines remains relatively low given that the country is abundant with the resources for agriculture to prosper. As reported by the Philippine Statistics Authority, the value of crop production contracted during the fourth quarter of 2022. With the production of palay (rice that has not been husked) contracting at -2.5% and corn at -6.9%. Both palay and corn are major agricultural products that are produced in the country. The percentage of the production of these major crops is a clear indication that the agricultural production of the country is at a standstill.

The slow pace of agricultural production in the Philippines can be a result of government mismanagement and the lack of proper resource allocation. It is a well-known occurrence that the Philippine government provides different programs that help the progress of the agricultural sector of the country. The Department of Agriculture (DA) declared in their official website that several government-funded services are meant for the progress and aid of the agricultural sector. They provide several aids to the agricultural sector such as the Sikat Saka Program (SSP), SURE COVID-19, Agri-Negosyo Loan Program (ANYO), and Agrarian Production Credit Program (APCP) to name a few. These government programs aim to support the Philippine agricultural sector, specifically to provide financial aid to farmers so that their agricultural production improves. However, despite several government programs and aid, agricultural production in the Philippines remains relatively low. This is because there are other factors that contribute to agricultural production aside from government subsidies and interventions. Subsidies for the agricultural sector play an important role in agricultural development in general (Bai et al., 2022). However, government intervention is not a primary factor to agricultural production. In fact, New Zealand's agricultural sector was reported to have the lowest subsidies out of all the countries comprising the Organization for Economic Co-operation and Development (OECD Agriculture Policy Monitoring and Evaluation, 2017). New Zealand's success has been commended internationally, and is a concrete example that a country's agricultural sector can be highly-productive even with minimal government intervention and subsidies (World Trade Organization, 2015).

Now that government intervention has been put aside when analyzing agricultural (crop) productivity, it gives way to other factors that somehow have a significant contribution as to why production in that specific sector of the Philippine economy is the way it is. Many researchers have concluded that there are other factors that affect agricultural production in a country. Environmental regulations and market force have a significant influence on total factor production (Liu et al., 2022). Factors that were aforementioned have a contribution to how the agricultural sector produces. Aside from environmental regulations, government subsidies, market forces, and price, there are other (non-price) determinants, in the context of supply, that can contribute to the entire agricultural production, more specifically for the production of major crops.

In the Philippines, crops can be classified into four commodity groupings such as cereals, fruit crops, non-food and industrial crops, and vegetable and root crops. When a farmer plans to plant a certain crop, he takes into consideration how much he needs to spend to purchase everything he needs to plant the crop (cost of production), how much he is paid during the production process (farmers' wages), and the scope of land used in the planting of crops (land input).

In the latter part of 2019, the world was struck with the devastation of the Coronavirus (COVID-19) pandemic. The virus primarily affected a person's respiratory system (World Health Organization, 2020). The pandemic brought upon a standstill in people's day-to-day lives and the economy. People were stuck at home in fear of contracting the virus. In early 2020, the COVID-19 virus was basically a mystery to people. The fear of the unknown led to a government mandated quarantine which put a hold on activities, most especially economic activities. The sectors in the economy were immobile during the peak of the COVID-19, including the agricultural sector. All types of farming, whether small-scale or corporate-scale agricultural production, were affected one way or another by the mandates implemented by the government to withstand the pandemic (Lopez-Ridaura et al., 2021). The COVID-19 pandemic was an occurrence that no one could have predicted; hence the researchers inferred that it is merely a dummy variable to agricultural production.

The study will focus on the cost of production, labor productivity, and farmers' wages as the non-price determinants of supply to determine its impact on the production of major crops in the Philippines. The researchers will assess data collected from the Philippine Statistics Authority and World Bank, and use various econometric tools to identify which of the non-price determinants has the greatest impact on production of major crops in the Philippines. When the non-price determinant with the greatest influence is identified, it can help both policymakers and the Filipinos understand as to why the agricultural productivity remains low despite being rich in natural resources. The non-price determinants of supply's effects on the production of major crops in the Philippines currently have limited empirical studies, most especially studies that include the occurrence of the COVID-19 pandemic. Hence, the study can address the following: the effect non-price determinants like land inputs, cost of production, and farmers' wages have on crop production, and the repercussions brought upon by the COVID-19 pandemic on crop production despite it being an external factor.

CHAPTER II: Literature Review

2.1. Non-Price Determinants on Production of Major Crops in the Philippines

2.1.1. Land Input

Many researchers have discussed the relationship between land and labor, and their importance to the overall agricultural production (Li et al., 2022)(Su et al., 2018). Adaption and development of land and yield improvement techniques have played important roles in sustainable development, specifically in agriculture (Abdallah et al., 2020)(Jayne & Sanchez, 2021). When farmers have secured land access, it promotes access to land improvement techniques which can further increase productivity, as stated in a study by Domeher et al. (2016). Through the process of land transfer, farmers gain more rights and enable the modernization of agriculture (Li et al., 2020). In a study made by Koirala et al. (2016), rice farmers in the Philippines experience a 4% rise in rice output if farmsize is increased by 1%. However, a study by Adesina et al. (2023) shows that farm productivity decreases as farm size increases, which is also in contrast to a study by Mondal et al. (2020), which states farm size and farm productivity has a positive relationship with each other. A study by Olarinre et al. (2021) argued that productivity of farmers is dependent on their adaptation of land management practices. Management and monitoring of agricultural land plays an important part in the sustainability and guaranteed quality of agricultural output (Turaev et al, 2023). The implementation of agricultural land management and relaying of information to farmers is important for agricultural production from the agricultural land (Faye et al., 2023).

Land as an agricultural asset is also in correlation with labor productivity (Syverson, 2011), and is an essential factor in the production of agricultural commodities (Koirala et al., 2016). According to Diagne et al. (2012), land had a positive effect on the production of crops, specifically rice. The USAID (2011) stated that only 70% of Filipino farmers own their own land. As mentioned in the study by Daymard (2022), land reforms bring improvement to agricultural production. In achieving agricultural productivity, proper land ownership is vital (Tenaw et al., 2009). Securing land tenure is also considered by a number of lawmakers, since as stated by studies by Ali et al., (2017), Ali et al., (2014), Ali et al., (2021), and (Lawry et al., 2016), land tenure ensures and develops more productive agriculture.

Land availability also has a significant relationship in maintaining food security, since land is used to grow corn and other crops (Mamat & Husen, 2021). The value of land used for agriculture can be measured through its physical condition (e.g., fertility and soil productivity) (Somantri et al., 2021). Land can also be more accessible to farmers through credit, however, a study done by Sant'Anna et al. (2021) explained that the more credit can put upward pressure on land value, making it harder for farmers to have access to land. A study done by Widyanto & Subanu (2023) discussed that in order to reduce farmers' poverty, a variable that should be put into consideration is land ownership area. 17

2.1.2. Cost of Production of Crops

Cost of production are the expenses incurred in carrying out the production process (Muzari, 2022). According to the Philippine Statistics Authority (2022), cost of production of crops consists of cash cost, non-cash costs, imputed costs, and total costs. Fertilizers, known to be one of the factors needed for the production of crops (PSA, 2022). However, farmers face cash constraints which make them unable to purchase a crucial factor to the production (Duflo et al., 2011). Fertilizers are not the only inputs that face cash constraints in agricultural production, hence why there are input subsidies. Input subsidies provide assistance to farmers who are least able to purchase input at market prices (Chirwa & Dorward, 2013), so they invest more in their farming (Akber et al., 2022). In a publication by Baffes & Koh, (2021), fertilizer prices increase due to the high-demand of crop-producing areas. Factors of production such as fertilizers, influence grain production as stated in studies conducted by Lu et al., (2019) and Bagnall et al., (2021). In an article by Mula & Coronado (2022), the increase in fuel could have a significant effect on the crop production of the Philippines. In which farmers could lessen their use of fertilizers or decrease the area in which they are supposed to plant. Small-scale farmers have limited access to formal financial institutions (Sarfo et al., 2021), which hinders these farmers to access financial aid to purchase fertilizers.

In addition to agricultural costs are the water frameworks and irrigation systems used by farmers especially in the Philippines where the temperature rises severely. Water is one of the inputs that can help produce crops and nowadays, scarcity in water is one of the major challenges the world is facing (Veisi, et. al., 2022). The continued growth in the world population will also increase the demand for food production and water supplies (Zhong, et. al., 2023). This is where irrigation systems are most useful. From the traditional way of pumping water into the fields, systems have been developed and some are now solar powered. photovoltaic or solar powered pumping systems are useful for irrigation (Cervera-Gascó, et.al., 2023). This development will not only cover the irrigation needs of farmers but it also provides environmental benefits such as minimizing energy costs in the long run and this is supplemental to the environmental preservation since this decreases carbon footprints (Hilali, et. al., 2022). Cost of application of solar powered pumps has decreased by 80% during 2003-2013, while the alternative price of fossil fuels has increased over the same period of time by almost 250% (Foster & Cota, 2014).

When increasing agricultural (crop) production, effective use of new and existing technology must be utilized (Berhanu et al., 2021). When the use of agricultural machinery increases, harvest cost decreases (Parvin et al., 2022). However, increasing the use in machinery also gives more room for externalities to arise as explained by Parvin et al. (2022). Continuous use of machinery leads to soil degradation which can cause added direct costs to farmers and to the society as a whole (Graves et al., 2015). The Philippine agricultural sector consists of small-scale farmers (farmer-peasant) whose income falls below the poverty threshold (PSA, 2022). Despite the Philippines having a significant number of small-scale farmers, mechanization can still be attainable through government subsidies. As reported by the Philippine Statistics Authority (2019), Php 414.99 was the budget allocated for agricultural production loans. Majority of agricultural subsidies went to the establishment and growth of crops (Barnedo, 2021), which lowers the costs of farmers. According to a study by Liao et al. (2022), the application of agricultural machinery reduces the cost of production which speeds up the production, and eventually leads to an increase in yields that increases small-scale farmers' income. 17

2.1.3. Farmers' Wages

In exchange for the labor contributed by farmers in the agricultural industry, they are compensated through wages and salaries. As stated by a study done by Saha & Roy (2022), many factors can be attributed to the change in rural agricultural wages over the years. The wages of these farmers are measured through the Agricultural Wage Rate. Defined by the Philippine Statistics Authority, the Agricultural Wage Rate is an Indicator of the progress of farm workers that refers to the amount paid to them in accordance with the agreed basis of payment. When determining agricultural wage rates, the supply of agricultural labor is essential (Kumar & Anwer, 2020).

Farming is more labor intensive therefore, an increase in the wages of farm workers will increase the cost of production of agricultural commodities (Gulati, et. al.,2014). Rising agricultural wage rates help decrease poverty in rural areas (Lanjouw and Shariff 2004) but in contrast with other countries, farmers residing in rural areas here in the Philippines tend to be poor despite the improvement in wages. According to Gulati, et. al. (2014), farm labor is generally at the bottom of the economic pyramid. Compared to other earnings of labor in other sectors, Agricultural wages tend to be quite lower. The migration of labor from rural areas creates a shortage in agricultural labor that will increase the workload of other farmers. This scenario increases the wages of agricultural labor and potentially increases the costs of production as well. (Das et al., 2020).

Due to increasing circumstances of risks when it comes to agriculture such as the COVID-19 pandemic and climate change, farmers are rallying to increase agricultural wages because of these circumstances that they are facing. During the unexpected pandemic and lockdown that happened, some farmers "left the crop lying in the field" just to protect themselves from the virus being faced (Quandt, et. al. 2022). Because of this, many agricultural farmers and even the government, invested in technology just to limit the exposure of physical labor for their own safety, therefore there is only minimal cost of labor spent during the pandemic. Studies conducted by Zhang et. al. in 2017 show that most farmers tend to invest in agricultural machinery to save labor costs. Despite farming being labor intensive, innovations in technology are also a great help in improving agricultural production.

Large Scale Agricultural Investments (LSAIs) can also be referred to as Large Scale Land Acquisition is notably on the rise in developing countries like in Africa. Communities near LSAIs often receive higher wages (Edafe, et. al., 2023). Studies show that agricultural workers supply fewer hours of labor compared to workers in other sectors within a year due to the wage gap expressed on a per-hour basis (McCullough, 2017). This only shows that higher piece rate wages do induce increases in labor productivity that can potentially improve the production of goods as well (Stevens, 2017). 10

2.1.4. COVID-19 Pandemic

In the latter part of 2019, the world was struck with the devastating COVID-19 Pandemic. Several countermeasures such as lockdowns, widespread stay-at-home orders, limited in-person contact, etc., have been adopted globally to further avoid the spread of the virus (Wang et. at., 2020). These restrictions have disrupted domestic and global agricultural production and the value chain system (Barrett, 2020). Food supply chains were disrupted by these restrictions which generated panic buying and hoarding among consumers in the early stages of the pandemic and raised demand for necessary agricultural and food commodities (Prentice et al., 2020; Vercammen, 2020; Hobbs, 2020; Benton, 2020). On the production side, the epidemic has caused shortages of inputs including manpower, insecticides, and fertilizers. The COVID-19 pandemic can also be seen as affecting agricultural labor productivity (Pu & Zhong, 2020)(Gregorioa & Ancog, 2020). The non-availability of labor has affected harvest in other countries, specifically in North-west India, when COVID-19 struck (Dev, 2020), and the shortage of laborers brought about by the lockdown has jeopardized the agricultural production of crops (Balwinder-Singh et al., 2020). COVID-19 affected labor productivity due to the risk of contracting the virus not only in the workplace but also during family/friend gatherings, shopping, dining out, etc. (Haqiqi & Bahalou Horeh, 2021). Transport of agricultural products both locally and internationally has also been hampered by it. As a result, certain nations have seen a fall in agricultural productivity. Due to the pandemic, consumer expenditure on food has decreased due to individuals being obliged to stay at home and eat at home less. As a result, demand for In the midst of the COVID-19 pandemic, the fuel industry went through a sttural decline (OECD, 2020), which made the importation of fertilizer difficult or more costly for Filipino farmers. The Philippines relies heavily on the importation of fertilizers, with 95% of its fertilizer coming from imports (Department of Agriculture, 2021). With the increase in prices of agricultural inputs like fertilizers due to the pandemic, agricultural production has been affected (Kumar et al., 2021). 12

2.2. Synthesis

2.2.1. Aims and Objectives

This study aims to understand the effects of non-price determinants on the production of major crops in the Philippines. Furthermore, this study aims to:

1. Identify the relationship of land input on the production of major crops.
2. Identify the relationship of the cost of production on the production of major crops.
3. Identify the relationship of the farmers' wages on the production of major crops.
4. Identify the relationship of the COVID-19 pandemic on the production of major crops.

2.2.2. Theoretical Framework

The Cobb-Douglas Function is a production function that describes the maximum amount of output that can be produced in a fixed period of time as a function of factors of production that are available (Beer, 1980). To calculate productivity growth rates for agriculture, service and industry, a production function was used (Lewis et al., 1988). Felipe and Adams (2005) suggested that the Cobb-Douglas production function is an overall form of analysis of growth and productivity and growth. To analyze the relationship between agricultural output and input factors of production, Yuan (2011) used the Cobb-Douglas production function. The Cobb-Douglas production function answers the questions regarding production levels. Land input, cost of production of crops, farmers' wages, and COVID-19 have been considered non-price determinants of the production of major crops.

The researchers will be using the model proposed by Sinha (2023) that was derived from the Cobb-Douglas Production Function:

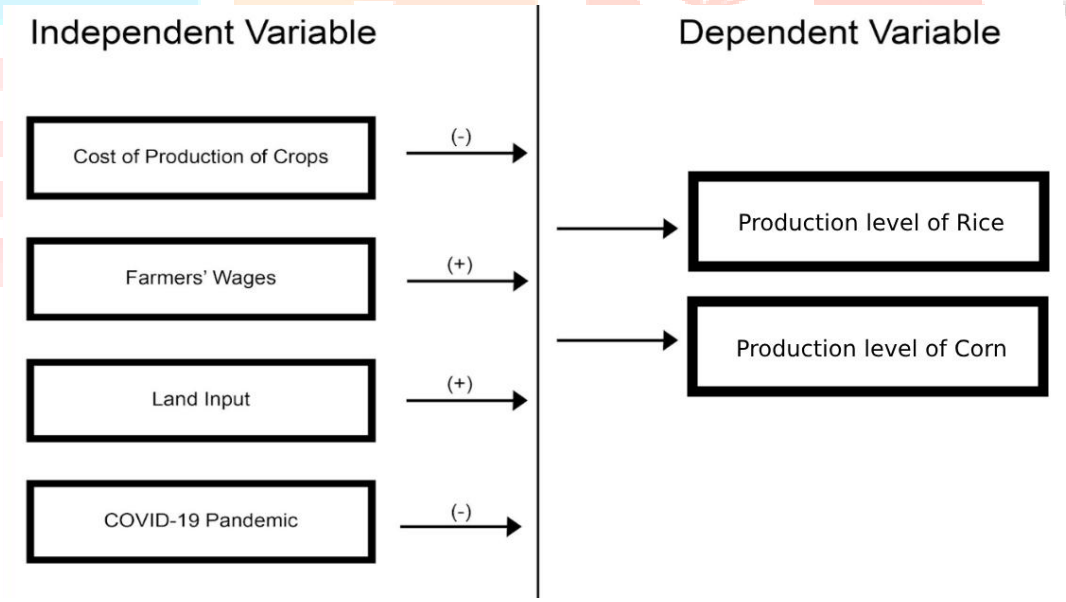
$y=AL^{\beta1} D^{\beta2} C^{\beta3} F^{\beta4} I^{\beta5}$

y - crop production (output)
A - factor productivity
L - area of cultivated land as input
D - labor input
C - household consumption input
F - fertilizer
I - Irrigation
β1 - share of land for output
β2 - share of labor for output
β3 - share of household consumption for output
β4 - share of fertilizer for output
β5 - share of irrigation for output

Sinha (2023) states the Ordinary Least Squares (OLS) regression is applied in order to estimate the model of a linear regression, by linearizing this equation by taking the natural logarithms of the equation for both sides, the equation now becomes:

$$\ln Y = \ln A + \beta1 \ln L + \beta2 \ln D + \beta3 \ln C + \beta4 \ln F + \beta5 \ln I$$

2.2.3. Simulacrum (Conceptual Framework)



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2.2.4. Hypothesis For Production of Rice

Hypothesis 1:

Ho: Land input has no significant effect on the production of Rice.
Ha: Land input has a significant effect on the production of Rice.

Hypothesis 2:

Ho: The Cost of Production has no significant effect on the production of Rice.
Ha: The Cost of Production has a significant effect on the production of Rice.

Hypothesis 3:

Ho: The Farmers' Wages have no significant effect on the production of Rice.
Ha: The Farmers' Wages have a significant effect on the production of Rice.

Hypothesis 4:

Ho: The COVID-19 pandemic has no significant effect on the production of Rice.

Ha: The COVID-19 pandemic has a significant effect on the production of Rice.

2.2.5. Hypothesis For Production of Corn

Hypothesis 1:

Ho: Land input has no significant effect on the production of Corn.

Ha: Land input has a significant effect on the production of Corn.

Hypothesis 2:

Ho: The Cost of Production has no significant effect on the production of Corn.

Ha: The Cost of Production has a significant effect on the production of Corn.

Hypothesis 3:

Ho: The Farmers' Wages have no significant effect on the production of Corn..

Ha: The Farmers' Wages have a significant effect on the production of Corn.

Hypothesis 4:

Ho: The COVID-19 pandemic has no significant effect on the production of Corn.

Ha: The COVID-19 pandemic has a significant effect on the production of Corn.

CHAPTER III: Research Method

3.1. Research Design

This research used a quantitative method in determining the relationship and effect of the independent variables which in this case are the non-price determinants: land input, cost of production of crops, farmers' wages, and COVID-19 on the dependent variable which is the production of major crops in the Philippines. This research is mainly focused at a national level in the Philippines with a time series data ranging from the year 1961 - 2021. In order to validate and test the data, Microsoft Excel and GRETL applications will be utilized. Ordinary Least Squares (OLS) regression analysis will be used for analyzing the relationship between the dependent and independent variables (Sinha, 2023). In addition to the OLS regression analysis test for Unit Roots, Autocorrelation, Normality of Residuals, Specification Error, Multicollinearity, Heteroskedasticity, and Stability, in order to have valid and correct data to be interpreted.

3.2. Data Collection Procedure

This research is based on secondary data from the Philippine Statistics Authority (PSA). The following are the variables and their respective measurements. (1) Land Input was measured through the area harvested by crop per year in hectares. (2) Cost of Production was measured through the total cost of production in Pesos per Hectare. The Formula for the total cost of production is the sum of the cash costs, non-cash costs, and imputed costs. (3) Farmers' wages were measured through the average daily pay of agricultural workers in Pesos. (4) COVID-19 will be a dummy variable wherein years with COVID have a value of 1 and years without has a value of 0. Lastly, (5) The Production of Rice and Corn is measured through the production volume of major crops in metric tons. The major crops of the Philippines used in this research are Palay and Corn.

3.3 Data Analysis

3.3.1 Econometric Model

The objective of this paper is to identify the effects of non-price factors such as land input, cost of production, farmers' wages, and COVID-19 on the production of major crops Sinha (2023), provided similar research showing the impact of economic factors on the production of crops using a function derived from the cobb-douglas production function then turned into a linear model by implementing natural logarithms on both sides of the equation. The researchers used time series data regression in order to measure the results of the analysis.

The econometric model used in this research was derived from the cobb-douglas function used by Sinha (2023) and was modified by the researchers to fit the variables used in this study:

$$Y=L^{\beta 1} C^{\beta 2} F^{\beta 3} [\![D1]\!]^{\beta 4}$$

Where:
Y - Production of Major Crops (Rice/Corn)
L - Land Input
C - Production Costs
F - Farmers' Wages
D1 - COVID-19
β1 - Share of land input to output
β2 - Share of production cost to output
β3 - Share of farmers' wages to output
β4 - Share of COVID-19 to output

As stated by Sinha (2023), the OLS regression is applied in order to estimate the model of a linear regression, by linearizing this equation by taking the natural logarithms of the equation for both sides, the equation now becomes

$$\ln Y = \beta 1 \ln L + \beta 2 \ln P + \beta 3 \ln F + \beta 4 D1$$

3.3.2. Diagnostic Tests

Data gathered through the PSA will be cleaned and analyzed using Microsoft Excel and GRETL. The Ordinary Least Squares (OLS) has been used for data analysis of the relationship between the dependent and independent variables. Furthermore, the following tests have been performed:

(1) Test for Unit Root

In order to avoid false results, the Augmented Dickey-Fuller (ADF) test is an important part to take in the regression. The ADF test is a common statistical tool to examine whether the data is stationary or not.

(2) Test for Autocorrelation

To examine if a serial correlation is present in the output, the Breusch-Godfrey test is used (Wooldridge, 2016). Breusch and Godfrey have developed a test of autocorrelation that is general in the sense that it allows for non-stochastic regressors, such as the lagged values of the regressand; higher-order autoregressive schemes, such as AR(1), AR(2), etc.; and simple or higher-order moving averages of white noise error terms (Gujarati, 2004)

(3) Test for Normality of Residuals

For the Normality of Residuals, the statistical tool used by the researchers was the Jarque-Bera test. This aims to determine the regression model's normal distribution of residual variables regarding its kurtosis and skewness (Runtunuwu, et. al., 2022).

(4) Test for Specification Error

The Ramsey's Regression Equation Specification Error Test (RESET) is usually a specification test for linear regression. This tests whether specification errors such as incorrect functional form, and redundant and omitted variables exist in the OLS regression data. (Gujarati, 2004).

(5) Test for Multicollinearity

The test for multicollinearity was conducted in order to test whether the regression model finds a correlation among the independent variables, furthermore, if the correlation is present, there will be a multicollinearity error. According to Runtunuwu, et. al. (2022), A good regression model has no correlation between the independent variables.

(6) Test for Heteroskedasticity

To identify whether the estimated variance from the regression is dependent on the values of the individual variables, the Breusch-Pagan-Godfrey and White Heteroskedasticity Tests were applied. Additionally, the tests were applied to identify if the regression residuals have unequal variances. Based on the result, accept the null hypothesis that there is no heteroskedasticity, which shows that the p-value of the f-stat on both tests is greater than the 0.05 level of significance.

(7) Test for Stability

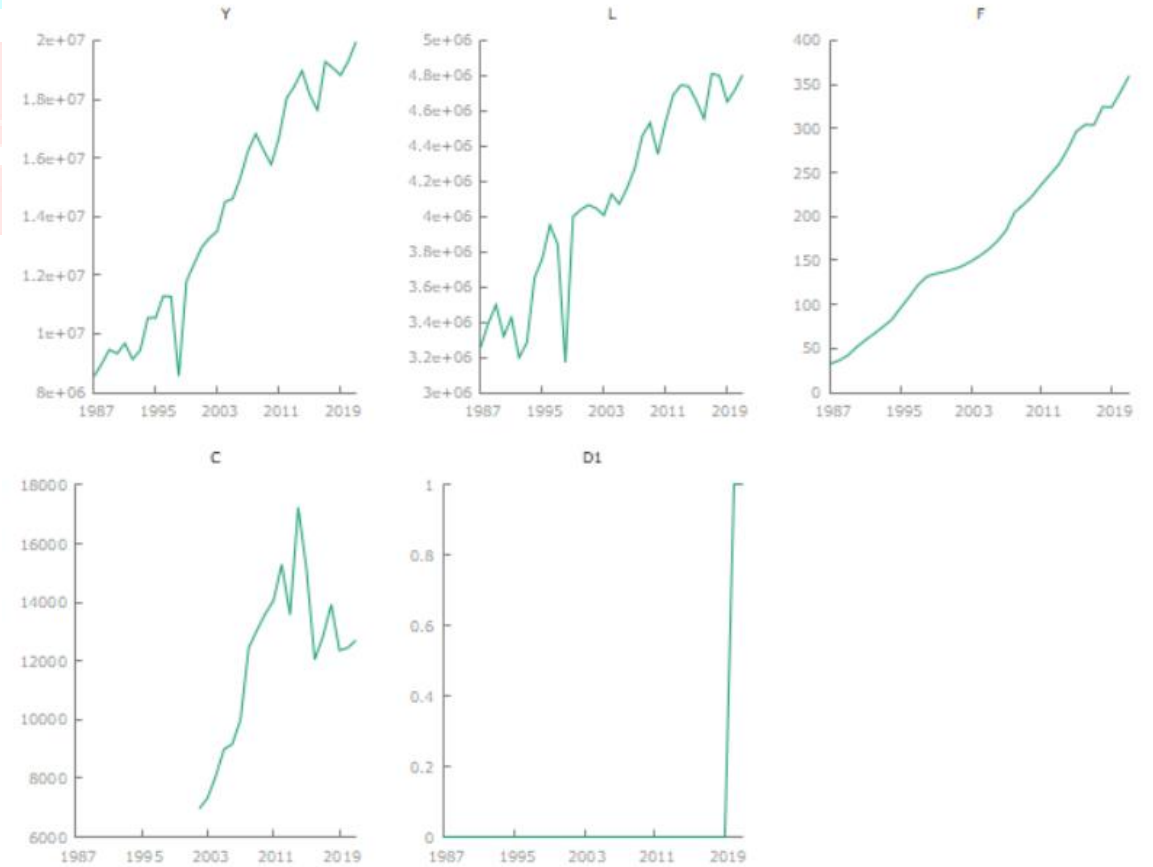
For the test of stability, the Chow breakpoint test was utilized. The Chow Test was used to select the common effect or fixed-effect models (Runtunuwu, et. al., 2022). This test can be easily generalized to handle cases of more than one structural break (Gujarati, 2004). The procedure of this test involves splitting the data into 2 sub parts. If the resulting f-ratio is greater than the critical value, the null hypothesis structural stability can be ruled out, on the other hand, if the f-ratio is less than the critical value, the null hypothesis is accepted (Calicdan et al., 2020).

CHAPTER IV: Results and Discussion

4.1. Descriptive Results

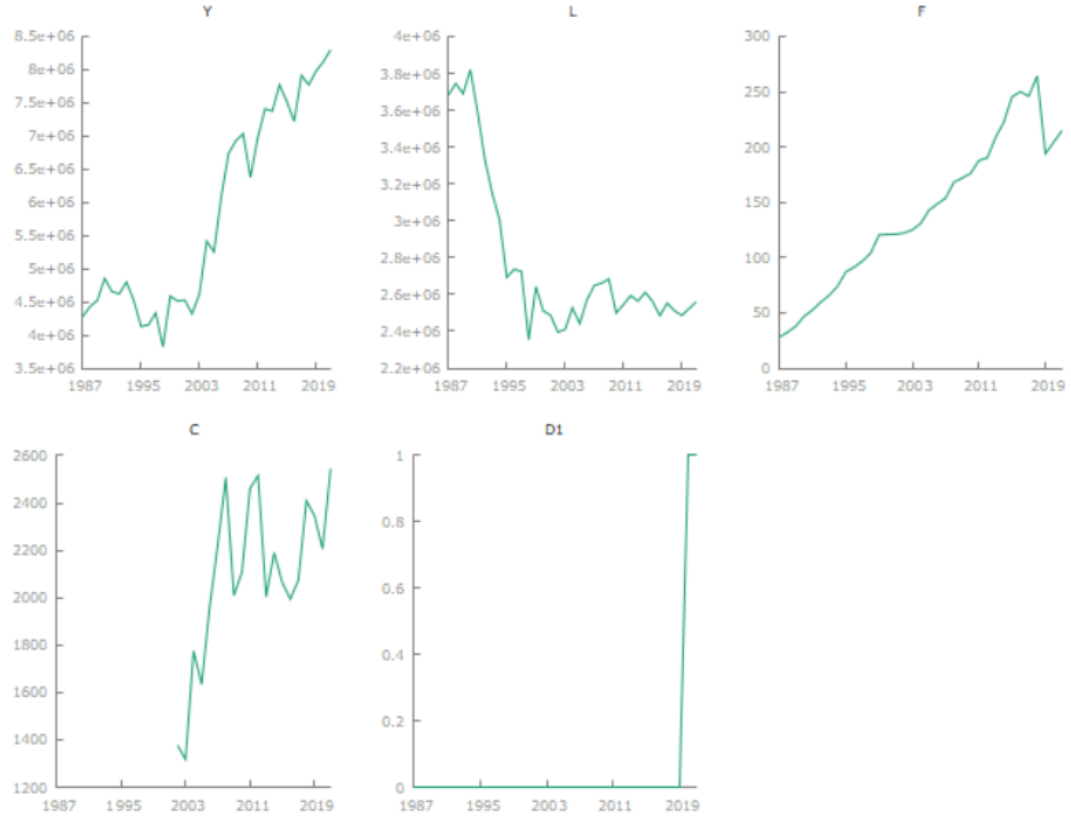
The graph below shows the trend of the variables used in this study from 2002-2021 of both rice and corn. For the variables on rice,the production level (Y)was constantly increasing but from 2006 to 2010 there was a downward movement but later rose back in the latter year. Land area input (L), and Cost of production (C), are all moving upward but fluctuating while luckily for farmers, their wages (F) is steadily rising. For Covid-19 (D1), the graph shows no movement from 2002-2019 since it was only present from 2020 onwards.

GRAPH 1.1. Time Series Graphs of All Rice Variables



For the variables on corn,the production level (Y) was fluctuating upwards but there was a gap of 657,237 metric tons (mt) in 2009-2010 as well as 8070541.91 mt in 2014-2016. Land area input (L) is also moving upward but fluctuating, and Cost of production (C) is rising but peaked at 2014 amounting to 2611431.8 pesos/hectare. The farmers' wages(F) is also steadily rising and for Covid-19 (D1), the graph also shows no movement from 2002-2019 since it was only present from 2020 onwards.

GRAPH 1.2. Time Series Graphs of All Corn Variables



4.2.Numerical Results

Figure 1.1. Rice Ordinary Least Squares Regression
Dependent variable: Production level (Y) of Rice

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Model 1: OLS, using observations 2010-2021 (T = 12)
Dependent variable: d_Y

             coefficient     std. error     t-ratio   p-value
  ---------------------------------------------------------------
  const       578686          112531           5.142    0.0013   ***
  d_L              4.45022         0.453615    9.811    2.43e-05 ***
  d_F         -33297.5          8560.64       -3.890    0.0060   ***
  d_C            130.904          33.8785       3.864    0.0062   ***
  D1          223753          156456           1.430    0.1958

Mean dependent var   307812.8   S.D. dependent var   777157.5
Sum squared resid    2.32e+11   S.E. of regression   181999.5
R-squared            0.965100   Adjusted R-squared   0.945157
F(4, 7)              48.39301   P-value(F)           0.000035
Log-likelihood      -159.1344   Akaike criterion     328.2688
Schwarz criterion    330.6933   Hannan-Quinn         327.3711
rho                  0.262128   Durbin-Watson        1.466057

Excluding the constant, p-value was highest for variable 5 (D1)
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Figure 1.1 shows the ordinary least squares regression results of the effects of the independent variables : Land input (L), Farmers' wages (F), Cost of production (C), and dummy variable, Covid-19 (D1), on the production levels of rice ranging from 2010 - 2021 for a total of 12 observations. The P-Value (F) is statistically significant with a value of 0.000035 which is less than alpha 5%. The land input (L), farmers' wages (F) and the cost of production (C) is statistically significant at alpha 5% however, Covid-19 (D1) is statistically insignificant since its p-value is higher than alpha 5%. Since the land input, farmers' wages and the cost of production significant,are this leads us to accept the alternative hypothesis that these variables have a significant impact on the production of rice.

Based on the OLS regression, the econometric model for rice with the coefficients of each variable now becomes:

$$Y=4.45022L+〖130.904C〗^{-33297.5F^{+223753D1+Ɛ}}$$

This suggests that if all the independent variables are zero, the dependent variable, production level of rice, is 578,686. Also, for every 1 unit increase on the independent variables, land input, farmers' wages, cost of production and covid-19, the Production level will increase by 4.45022, 130.904 and -33297.5 respectively.

Figure 1.2. Corn Ordinary Least Squares Regression
Dependent variable: Production level (Y)

```
Model 2: OLS, using observations 2010-2021 (T = 12)
Dependent variable: d_Y

              coefficient     std. error    t-ratio   p-value
  ------------------------------------------------------------
  const       201739         36577.6         5.515    0.0009   ***
    L              5.35997       0.483817   11.08     1.08e-05 ***
    F          -2776.85        1365.88       -2.033    0.0815   *
    C            146.107        135.800        1.076    0.3177
    D1        -224746          89926.6       -2.499    0.0410   **

Mean dependent var   105524.1   S.D. dependent var   398973.4
Sum squared resid    8.42e+10   S.E. of regression   109668.9
R-squared            0.951918   Adjusted R-squared   0.924442
F(4, 7)              34.64598   P-value(F)           0.000106
Log-likelihood      -153.0559   Akaike criterion     316.1119
Schwarz criterion    318.5364   Hannan-Quinn         315.2142
rho                  0.059392   Durbin-Watson        1.682376
```

Figure 1.2 shows the ordinary least squares regression results of the effects of the independent variables : Land input (L), Farmers' wages (F), Cost of production (C), and dummy variable, Covid-19 (D1), on the production levels of corn ranging from 2010 - 2021 for a total of 12 observations. The P-Value (F) is statistically significant with a value of 0.00106 which is less than alpha 5%. The land input (L) and Covid-19 (D1) are statistically significant at alpha 5% which also leads us to accept the alternative hypothesis that land input and Covid-19 have a significant impact on the production of corn. However, farmers' wages (F) and cost of production (C) are statistically insignificant since their p-values are higher than alpha 5%.

Based on the OLS regression, the econometric model for corn with the coefficients of each variable now becomes:

$$Y=5.35997L+〖146.107C〗^{-2776.85F^{-224746D1+Ɛ}}$$

This suggests that if all the independent variables are zero, the dependent variable, production level of corn, is 201,739. Also, for every 1 unit increase on the independent variables, land input, farmers' wages, cost of production and covid-19, the Production level will increase by 5.3997, 146.107, -2776.85 and 224746 respectively.

Table 1.1. Diagnostic Tests for Rice Variables

DIAGNOSTIC TESTS	RESULTS
UNIT ROOT (Augmented Dickey-Fuller)	Unit Root Test (PALAY)

VARIABLE	Level	1st difference	2nd difference
Level of Production (Y)	0.03014		
Land Area (L)	0.4279	3.88E-04	
Farmers' Wages (F)	0.05398	0.6551	1.01E-06
Production Cost (C)	0.7658	2.50E-06	

AUTOCORRELATION (Breusch-Godfrey Serial Correlation LM Test)	0.516
NORMALITY OF RESIDUALS (Jarque-Bera)	0.398872
SPECIFICATION ERROR (Ramsey's RESET)	squares and cubes: 0.244
MULTICOLLINEARITY (Variance Inflation Factors)	d_L 1.256 d_F 1.286 d_C 1.272 D1 1.232
HETEROSKEDASTICITY (Breusch-Pagan-Godfrey)	0.284554
STABILITY (Chow Breakpoint)	0.6208

1. Test for Unit Root

The results for the unit root tests show that the variable Production Level (Y) is stationary at base level, Land input (L) and Cost of production (C) are stationary at first difference, and Farmers' wages (F) is stationary at second difference.

2. Test for Autocorrelation

The results of the Autocorrelation test shows that the p-value of f-stat 0.516 is greater than 0.05 level of significance which means there is no autocorrelation error.

3. Test for Normality of Residuals

Based on the result of the Test for Normality of Residuals, the p-value of f-stat 0.398872 is greater than the 0.05 level of significance; this means that the residuals are normally distributed.

4. Test for Specification Error

Based on the results, the p-value of f-stat 0.244 is greater than the 0.05 level of significance which means that there is no specification error.

5. Test for Multicollinearity

Based on the result, each independent variable's Variance Inflation Factors (VIF):

d_L 1.256
d_F 1.286
d_C 1.272
D1 1.232

is significantly less than 10; therefore, accept the null hypothesis that there is no multicollinearity error.

6. Test for Heteroskedasticity

Based on the result, the p-value of the f-stat 0.284554 is greater than 0.05 level of significance; therefore, accept the null hypothesis that there is no heteroskedasticity error.

7. Test for Stability

Based on the result,the p-value of the f-stat 0.6208 is greater than 0.05 level of significance; therefore, accept the null hypothesis, which determines there is no structural breakpoint.

Table 1.2. Diagnostic Tests for Corn Variables

DIAGNOSTIC TESTS	RESULTS
UNIT ROOT (Augmented Dickey-Fuller)	Unit Root Test (CORN) VARIABLE / Level / 1st difference Level of Production (Y): 0.564 / 2.54E-02 Land Area (L): 0.01929 Farmers' Wages (F): 0.01018 Production Cost (C): 0.6149 / 1.00E-04
AUTOCORRELATION (Breusch-Godfrey Serial Correlation LM Test)	0.822438
NORMALITY OF RESIDUALS (Jarque-Bera)	1.20894
SPECIFICATION ERROR (Ramsey's RESET)	squares and cubes: 0.0954
MULTICOLLINEARITY (Variance Inflation Factors)	L 1.144 F 1.023 C 1.054 D1 1.121
HETEROSKEDASTICITY (Breusch-Pagan-Godfrey)	0.340338
STABILITY (Chow Breakpoint)	0.257267

1. Test for Unit Root

The results for the unit root tests show that the variables Production Level (Y) and Cost of production (C) are stationary at first difference. On the other hand, Land input (L) and Farmers' wages (F), are stationary at base level.

2. Test for Autocorrelation

The results of the Autocorrelation test shows that the p-value of f-stat 0.822438 is greater than 0.05 level of significance which means there is no autocorrelation error.

3. Test for Normality of Residuals

Based on the result of the Test for Normality of Residuals, the p-value of f-stat 1.20894 is greater than the 0.05 level of significance; this means that the residuals are normally distributed.

4. Test for Specification Error

Based on the results, the p-value of f-stat 0.0954 is greater than the 0.05 level of significance which means that there is no specification error.

5. Test for Multicollinearity

Based on the result, each independent variable's Variance Inflation Factors (VIF):

L 1.144
F 1.023
C 1.054
D1 1.121

is significantly less than 10 and 30; therefore, accept the null hypothesis that there is no multicollinearity error.

6. Test for Heteroskedasticity

Based on the result, the p-value of the f-stat 0.340338 is greater than 0.05 level of significance; therefore, accept the null hypothesis that there is no heteroskedasticity error.

7. Test for Stability

Based on the result,the p-value of the f-stat 0.257267 is greater than 0.05 level of significance; therefore, accept the null hypothesis, which determines there is no structural breakpoint.

4.3.Hypothesis Testing and Results of the Objective

4.3.1.A. Hypothesis Testing for Rice

Hypothesis 1:

Ho: Land input has no significant effect on the production of Rice.
Ha: Land input has a significant effect on the production of Rice.
CONCLUSION: ACCEPT ALTERNATIVE HYPOTHESIS

Hypothesis 2:

Ho: The Cost of Production has no significant effect on the production of Rice.
Ha: The Cost of Production has a significant effect on the production of Rice.
CONCLUSION: ACCEPT ALTERNATIVE HYPOTHESIS

Hypothesis 3:

Ho: The Farmers' Wages have no significant effect on the production of Rice.
Ha: The Farmers' Wages have a significant effect on the production of Rice.

CONCLUSION: ACCEPT ALTERNATIVE HYPOTHESIS

Hypothesis 4:

Ho: The COVID-19 pandemic has no significant effect on the production of Rice.

Ha: The COVID-19 pandemic has a significant effect on the production of Rice.

CONCLUSION: ACCEPT NULL HYPOTHESIS

4.3.1.B. Hypothesis Testing for Corn

Hypothesis 1:

Ho: Land input has no significant effect on the production of Corn.

Ha: Land input has a significant effect on the production of Corn.

CONCLUSION: ACCEPT ALTERNATIVE HYPOTHESIS

Hypothesis 2:

Ho: The Cost of Production has no significant effect on the production of Corn.

Ha: The Cost of Production has a significant effect on the production of Corn.

CONCLUSION: ACCEPT NULL HYPOTHESIS

Hypothesis 3:

Ho: The Farmers' Wages have no significant effect on the production of Corn..

Ha: The Farmers' Wages have a significant effect on the production of Corn.

CONCLUSION: ACCEPT NULL HYPOTHESIS

Hypothesis 4:

Ho: The COVID-19 pandemic has no significant effect on the production of Corn.

Ha: The COVID-19 pandemic has a significant effect on the production of Corn.

CONCLUSION: ACCEPT ALTERNATIVE HYPOTHESIS

4.3.2. Results of the Objective

Based on the Chapter 1 of this study, The objective of this was to identify whether the independent variables Land input, Cost of production, Farmers' wages and Covid-19, have a significant effect on the dependent variable, Production of rice and corn. Based on the regression results of this study, the researchers concluded that:

For Rice:

1. Land Input and the Production levels of Rice have a significant positive relationship.
2. Farmers' Wages and Production levels of Rice have a significant negative relationship
3. Cost of Production and the Production levels of Rice have a significant positive relationship.
4. COVID-19 and Production levels of Rice have a positive relationship. However, it is statistically insignificant.

For Corn:

1. Land Input and the Production levels of Corn have a significant positive relationship.
2. Farmers' Wages and Production levels of Corn have a negative relationship, however, it is statistically insignificant.
3. Cost of Production and the Production levels of Corn have a significant positive relationship.
4. COVID-19 and Production levels of Corn have a significant negative relationship

5. Conclusion

The paper focused on the effect of certain non-price factors on the production of rice and corn in the Philippines. The independent variables land input (L), cost of production of crops (C), farmer's wages (F), and COVID-19 (D1) were studied and assessed whether or not they had a significant effect on the dependent variable which is the production of rice and corn. The researchers gathered secondary data from the Philippine Statistics Authority (PSA), and have drawn inferences from 12 observations. The researchers applied a quantitative approach which also included a bit of descriptive approach in achieving the objective of this study. The effect of the independent variables L, C, F, and D1 on production of rice and corn were estimated through multiple time-series regression. Some diagnostics tests came out statistically insignificant, however, there were significant issues encountered in the regression model. This paper, specifically hypothesis testing for rice accepts the alternative hypothesis of H1, H2, and H3 and the null hypothesis of H4. For the hypothesis testing of corn, it accepts the alternative hypothesis of H1 and H4 and the null hypothesis H2 and H3.

5.2 Land Input to Production of Rice and Corn

Land is essential for the production of rice and corn. The access to land makes or breaks the amount of output that a farmer makes. Based on the result of the OLS regression of the study, it showed that land input has a direct relationship with the production of rice and corn. As mentioned by several authors in chapter 2, the access to land input has a direct correlation with the amount of crop produced. As emphasized by Li et al. (2020) and Su et al. (2018), both land and labor hold great relevance to overall agricultural production. When agricultural land is developed and improved, it increases the land's productivity in producing the crops as mentioned by Abdallah et al. and Jayne & Sanchez (2021). Other authors also share the same sentiment regarding the relationship between land input and the production of rice and corn.

Land input and the amount of rice and corn production shows a positive relationship with each other. How a farmer handles land has a domino effect on how much rice and corn he can produce from that land. If a farmer has little to no access to land, he produces less output than what he could have produced. On the other hand, if a farmer has access to more land and invests in inputs that could improve the land, his production of rice and corn will increase. However, given the situation that most Filipino farmers are in, it can be difficult for them to have access to land and at the same time acquire inputs that yield land improvements. There are instances when a farmer does have access to land, but their income does not cover the amount that is needed to maintain that land which could affect their productivity. The rice and corn production in the Philippines remains at a stand still despite the country being abundant with land that is suited for the growth of these crops. These assertions support the positive relationship between land and production of rice and corn which was portrayed in the results of the study.

5.3 Cost of Production to Production of Rice and Corn

The amount that a farmer uses when producing crops is a significant sign of how much crop he produces. Based on the results of the OLS regression done in the study, it showed that the cost of production has a positive relationship with the production of rice and corn. Several studies mentioned in Chapter 2 further support the results of this study. Subsidies provided to farmers who are not able to purchase agricultural inputs to encourage them to invest more in agricultural production as mentioned by Akber et al. (2022). According to Lu et al. (2019) and Bagnall et al. (2021), when farmers have access to finances that cover the cost of production, it influences the production of grain.

Access to finances that cover the cost of production has a direct impact on the production of rice and corn. Given that the Philippines consist of small-scale farmers who have little access to funds or credit, it affects how much rice and corn is produced in the country. If a farmer has no means to cover the cost of production, the amount of rice and corn in the country decreases which explains why local production of these crops have slowed down over the years. However, when these farmers are given access to credit and subsidies to cover specific costs of production, a significant increase in the number of output may be observed for rice and corn. Given the budget allocation for the agricultural sector, production of these crops may remain low. These indicate that there is a significant relationship between cost of production and the production of rice and corn.

5.4 Farmer's wages to Production of Rice and Corn

Farmers play a big role in producing rice and corn, especially in the Philippines where mechanization is not that evident in the country. Based on the OLS regression, farmer's wages and the production of rice and corn have a negative relationship. However tests for the relationship of farmer's wages and production of corn showed that it was statistically insignificant. Multiple authors from Chapter 2 also mentioned the negative relationship between the two variables. As mentioned by Zhang et al. (2017), agricultural machinery is being invested more to increase production, as opposed to hiring more farmers and spending more for wages. The existence of external factors like COVID-19, gave rise to allocating costs for machinery to increase production and lessen the amount of cost that goes to farmer's wages (Quandt et al., 2022).

Given that mechanization is not something that is largely evident in the Philippines, specifically in the agricultural sector, shows that farmer's wages was a crucial variable in the study. However, there are some reasons why farmer's wages are insignificant to the production of these crops, specifically for the production of corn. Agricultural production is leaning towards mechanized farming, though not fully implemented in the Philippines. This causes farms to invest more in the purchasing of agricultural machineries that replaces manual agricultural work. The negative relationship between the production of rice and corn and farmer's wages can be seen in the way that when a farm pays less for farmer's labor, the cost that could've gone to paying the farmers can now be allocated towards other factors of production that can further improve productivity. These assertions manifest the relationship of farmer's wages and production of rice and corn.

5.5 COVID-19 to Production of Rice and Corn

COVID-19 is an external factor in the production of rice and corn that has recently been taken into consideration. The OLS regression showed that COVID-19 and the production of rice and corn has a negative relationship, and for the production of rice, it is statistically insignificant. Several authors from Chapter 2 have delved into the relationship between COVID-19 and the production of these crops. The emergence of the COVID-19 disrupted the production of several agricultural commodities as what was discussed in a study by Barrett (2020). As mentioned in a study by Kumar et al. (2021), due to several restrictions brought about by the pandemic, importation of several agricultural inputs have been limited which affected the production of crops. The rise of COVID-19 cases caused agricultural manpower to lessen due to the government mandated lockdowns which ultimately decreased the number of agricultural production (Balwinder-Singh, 2020).

The results from the regression analysis of COVID-19 and rice shows that it has a negatively insignificant relationship with each other. This can be explained by the fact that Filipinos are major consumers of rice. Despite the restriction brought about by the pandemic, farmers still continue to produce rice since the demand from the consumer does not stop. This could explain why despite the negative relationship between the variables, it shows to be statistically insignificant.

Corn on the other hand depicts a negatively significant relationship with COVID-19. This can be explained by the fact that farmers will choose to produce rice instead of corn because of the never-ending demand for it. Corn is a crop that is not consumed as much by Filipinos. Instead of allocating resources for the production of corn amidst the pandemic, farmers would choose to not produce as much corn as COVID-19 cases increase for them to focus more on the production of rice. This manifests the negatively significant relationship between the variables that was shown in the results of the study.

6. Policy Implication

Land, Cost of Production, and Farmer's wages are factors in agriculture that play a huge role in agricultural productivity. Because of this, the researchers can address that land inputs, cost of production, and wages to farmers each have a relationship with the production of rice and corn, which are vital crops in Philippine agriculture. The policy implication of this paper suggests that financial assistance to cover costs of production, proper land reform, access to information, and access to technology are crucial in improving the productivity and profitability of rice and corn production.

These are some of the existing Philippines government programs and projects that our study can support: (1) The Rice Farmer Financial Assistance (RFFA) is a program issued on November 21, 2019 through the Department of Agriculture (DA). The program aims to provide cash grants to small-scale rice farmers, facilitate timely funds for the procurement of needed agricultural inputs, and widen the farmers' opportunity to improve their productivity and profitability. This study recommends that this program focus on the rice farmers who are at a decline in their production, give them the opportunity to improve the land they already own through the provision of financial aid to fund agricultural inputs so that their production improves ten fold and improve their efficiency in producing, ultimately increasing their chances of profitability. The program should also broaden the provinces that they implement the program in. This is to ensure that more rice farmers across the country can benefit from the program. (2) The Department of Agriculture also has a program called Sikat Saka Program (SSP) that aims to assist rice and corn farmers in accessing affordable production credit. The program's goal is to improve rice and corn farmers' agricultural production through ensuring that they can get a hold of irrigation services, extension links to markets, and at the same time provide these farmers with a favorable economic environment. The Department of Agriculture also has a project called (3) SURE COVID-19, which tackles the timely effects of the COVID-19 pandemic on small-scale farmers. This project offers emergency production assistance to marginalized small farmers so that they can still continue to produce and make profit amid the restrictions and limitations of the pandemic.

Farmers' access to their own land rights is also a crucial factor for their productivity and efficiency. (4) The World Bank created a program called the Support to Parcelization of Lands for Individual Titling Project (SPLIT). This was created to help the Philippine government distribute landowner documents to over 700,000 beneficiaries with unresolved claims. This was implemented to help farmers who were granted lands under the Philippines' agrarian land reform program but have still not received their individual titles. With farmers possessing their own land titles, this can improve their agricultural productivity leading to increased income. (5) The amendment of the Philippines' Comprehensive Agrarian Reform Program (CARP) called the Comprehensive Agrarian Reform Program Extensions with Reforms (CARPER) aims to provide more time for the government to allocate land equitability to its beneficiaries. It aims to secure more beneficiaries with land ownership which was what the previous CARP failed to achieve.

The introduction to new agricultural technologies is something that the Philippine government is working hard to achieve. (6) The One DA Reform Agenda: Eighteen Key Strategies aims to provide the Philippine Agricultural sector with inclusive approaches to modernization and industrialization that can improve agricultural productivity and efficiency. This program is targeted to provide farmers with education & training for agribusiness management, climate adaptation and mitigation measures, farm mechanization and infrastructure investment, and technology and innovation including digital agriculture Though Filipino farmers are heavily reliant on the traditional methods of farming, this program aims to educate these farmers on the benefits of innovation and technology for their agricultural production, and at the same time provide them with the financial assistance they need to access these technologies. (7) The Philippine Rice Information System (PRiSM) was developed by the International Rice Research Institute (IRRI) in collaboration with the Department of Agriculture, this aims to provide farmers with timely data on seasonal changes, outbreaks of pests and diseases, and other related information that can help small-scale farmers on making informed decisions when planting crops. With the help of this program, farmers can boost their agricultural production since their decisions are backed up with significant scientific data that can assist them in the production process.

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