INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 23, No. 4, p. 59-77, 2023
http://www.innspub.net

RESEARCH PAPER | OPEN ACCESS

Situationer and forecast of corn production in the Philippines: A time series approach

Sheila C. Poonon*

Department of Agribusiness Management, College of Agriculture, Central Mindanao University, Bukidnon, Philippines

Article published on October 10, 2023

Key words: Agricultural productivity, Variance inflation, High-volume corn

Abstract

Corn holds the distinction of being the third most significant crop in the Philippines in terms of both productivity and land area. It is frequently utilized for either human consumption or as food for animals. Thus, the production of this commodity carries significant implications for food security. The Philippines Statistics Authority (PSA) published statistical reports from which the data used were derived. This study examines the patterns of production trends, pricing, fertilizer costs, and cultivated land area. It aims to assess the impact of these identified factors and provide a projection for the country from 2021 to 2040. The use of a time-series methodology establishes the estimation of volume. Descriptive statistics were included in the econometric model to illustrate the trends and patterns. The Ordinary Least Squares (OLS) were employed to estimate the parameters. A theoretical framework was constructed employing the designated dependent and independent variables. The estimating and forecasting procedures were conducted through regression coefficient estimates obtained from the most optimal models. The model's correctness was assessed by the utilization of three metrics: mean absolute deviation, mean square error and mean absolute percent error. The analysis indicates a consistent upward trajectory in both output and fertilizer prices over the last four decades, accompanied by a notable rise in production volume. A noticeable decline in production was also seen in certain regions. In conclusion, it is anticipated that the time series plot of corn output will exhibit a discernible rising trend over the following two decades.

***Corresponding Author:** Sheila C. Poonon ✉ f.sheila.poonon@cmu.edu.ph

Introduction

Corn is a significant agricultural commodity in the Philippines, playing a crucial role in ensuring the nation's food security and contributing significantly to its economic stability. The Philippines is recognized as one of the leading corn-producing nations in Southeast Asia, with a consistent upward trend in corn output seen throughout the years. Based on data from the Philippine Statistics Authority (PSA), corn ranked as the third most significant crop in both production and land area. In the year 2020, the nation's corn production exceeded 7.6 million metric tons, therefore making a substantial contribution to the country's overall food security. Nevertheless, despite this significant contribution, the nation continues to have obstacles in fulfilling the grain demand. The global population is seeing a steady increase, leading to a corresponding rise in the demand for grain. In addition, the nation encounters a multitude of obstacles that impact the cultivation of corn, including fluctuations in weather patterns, the presence of pests and diseases, and the conversion of land for other purposes, and the implementation of agricultural development programs. There is no denying the significance of climate change's impact on agricultural productivity. The nation has been encountering severe climatic phenomena, including typhoons and drought, resulting in substantial repercussions on agricultural productivity. In addition, the impact of governmental policies and initiatives on agricultural growth extends to the realm of corn production. The government's emphasis on the promotion of alternative crops, such as rice and high-value crops, has led to the conversion of agricultural areas previously dedicated to corn cultivation.

The study of the current state and future projections of corn output in the Philippines has considerable importance for several reasons. Corn plays a pivotal role as a crucial crop in the agricultural landscape of the Philippines, making substantial contributions to the nation's food security. The Philippines, being a prominent corn-producing nation in Southeast Asia, has the need to establish sustainable and resilient corn production systems capable of withstanding many obstacles, including fluctuations in weather patterns, insect and disease outbreaks, land conversion, and agricultural development policies. Furthermore, this study has the potential to provide valuable insights and benefits to policymakers and government bodies tasked with overseeing agricultural growth inside the nation. The results of this study have the potential to provide valuable insights to policymakers on the many obstacles encountered in corn production and the potential techniques that may be employed to improve its productivity. The study can yield valuable insights into the correlation between weather fluctuations and corn output, as well as the potential policy measures that can be adopted to alleviate the adverse consequences of climate change. Additionally, this data can provide policymakers with valuable insights into the impacts of land conversion on corn output, as well as potential policy measures that can be adopted to promote the long-term viability and sustainability of corn production within the nation. Furthermore, this study has the potential to yield benefits for corn farmers and several other stakeholders involved in the corn production value chain. The outcomes of this study have the potential to assist farmers and other relevant parties in making well-informed judgments on their investments in the cultivation of corn. The study can offer insights into the projected future demand for corn and the corresponding market pricing that farmers might anticipate for their agricultural yield. Furthermore, stakeholders may be informed about the optimal methods in corn production, including the utilization of suitable technology, effective control of pests and diseases, and the preservation of soil. The study on the present and projection of corn production in the Philippines might provide valuable insights for future scholars. The results of this study can be utilized as a point of reference for future investigations pertaining to corn output throughout the nation. The study's approach and conclusions can serve as a foundation for future researchers to undertake more comprehensive and targeted investigations on distinct facets of corn farming in the Philippines.

Material and methods

The current study was carried out to examine the current state and future projections of corn output in the Philippines. To do this, secondary data obtained from the Philippine Statistics Authority (PSA) was employed. The dataset included in this research encompasses the historical span ranging from 1982 to 2020. The Philippine Statistics Authority (PSA) is the governmental entity tasked with the collection, aggregation, and distribution of statistical data pertaining to the economy, population, and society of the Philippines.

The dataset included in this research comprises data pertaining to corn production, yield, area harvested, and other pertinent characteristics. The data utilized in this study were sourced from a variety of reports and publications published by the Philippine Statistics Authority (PSA), such as the Corn Situation and the Annual Corn Statistics Bulletin. The utilization of secondary data has several benefits, including cost-effectiveness and time efficiency. Additionally, it facilitates the examination of extended-term trends and patterns that may not be discernible within a limited timeframe. The data obtained by the Philippine Statistics Authority (PSA) is deemed to be both credible and authoritative, offering a thorough overview of the present state of corn production in the Philippines. Conducting a detailed analysis of the present and prediction of corn output in the Philippines is of utmost importance. The objective of this study is to offer a comprehensive analysis of the present condition of corn production in the nation and to project its forthcoming production patterns. The primary aim is to provide an overview of the trend of the corn sector in the Philippines from the year 1982 to 2040. The primary objectives of this study are as follows: (a) to analyze the patterns of corn production, its corresponding price, fertilizer price, and cultivated land area; (b) to assess the extent to which these identified factors influence corn production; and (c) to project the anticipated corn production in the country for the period spanning from 2021 to 2040.

The theory of supply is a fundamental economic concept that provides insights into the prediction of corn output in the Philippines. The theory of supply posits that several factors, including the price of a product, production costs, and resource availability, exert an influence on the quantity of goods or services that a producer is willing and able to supply. When analyzing corn production in the Philippines, it is crucial to investigate the application of the supply theory to three key factors: the land area allocated for corn cultivation, the cost of fertilizer, and the price of corn.

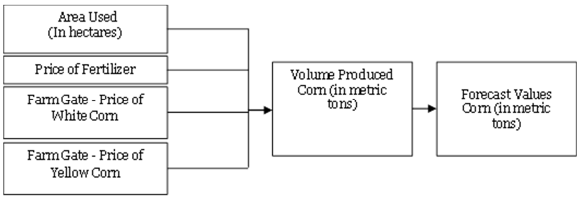

Fig. 1. Variables that may affect demand

Shown in Fig. 1, the first variable pertains to the land area designated for the cultivation of corn. According to the theory of supply, there exists a direct relationship between the quantity of corn supplied by producers and the extent of land allocated to corn cultivation. Consequently, an expansion in the cultivated land dedicated to corn production would result in a corresponding augmentation in the overall supply of corn within the market. On the other hand, a reduction in the land allocated for corn cultivation would result in a corresponding decline in the corn supply within the market. The second variable pertains to the cost of fertilizer. Fertilizers play a crucial role as inputs in the production of corn, with the cost of these fertilizers exerting a notable impact on the quantity of corn produced by growers. In instances when the cost of fertilizer is elevated, farmers may opt to curtail their use of fertilizer, potentially leading to diminished crop yields and a subsequent contraction in the corn supply within the market. Conversely, in instances when the cost of fertilizer is reduced, agricultural producers may opt to augment their utilization of fertilizer, hence potentially leading to increased crop yields and a subsequent augmentation in the overall supply of corn within the market. The third variable pertains to the cost of grain. Based on the tenets of supply theory, there exists an inverse relationship between the price of corn and the quantity of corn supplied by farmers. When the price of corn exhibits an upward trend, producers are motivated to augment their corn production, thereby resulting in a growth of the corn supply within the market. On the other hand, in situations when the price of corn is comparatively low, producers may opt to curtail their corn output, resulting in a decline in the overall supply of corn within the market.

In the Philippine setting, an analysis may be conducted to explore the impact of three factors on the supply of corn across a certain period. As seen by statistics obtained from the Philippine Statistics Authority, there has been a consistent upward trend in the allocation of land for corn cultivation across the nation during the course of the last twenty years (Philippine Statistics Authority, 2021). In recent times, the prices of fertilizer and corn have seen volatility owing to a range of variables, including global market dynamics and regional policies. Through the examination of patterns and interconnections among these factors, it is possible to construct a projection of corn output in the Philippines that incorporates the fundamental concepts of supply theory.

Econometric model

Descriptive statistics were utilized to present the trends and patterns of the variables in the research. In this section, the software application Microsoft Excel was utilized to present the graphical visualizations. The present study employed multiple regression analysis to examine the factors influencing the volume of corn output in the Philippines, utilizing data obtained from the Philippine Statistics Authority.

The research employed the Ordinary Least Squares (OLS) technique for parameter estimation. This approach aims to reduce the total sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear approximation. It effectively minimizes the sum of squared deviations from the regression line that is arbitrarily chosen. In order for the estimates of the parameters to be considered as the Best Linear Unbiased Estimator (BLUE), it is necessary for the following assumptions to be met:

a) $E(\varepsilon_t) = 0$, this implies that the mean of the error terms is zero.
b) $E(\varepsilon_t^2) = var(\varepsilon_t) = \sigma^2$, this is the property of homoscedasticity, i.e., that the errors have a common variance.
c) $Cov(\varepsilon_i, \varepsilon_j) = 0$ where $i \neq j$, this is the property of no autocorrelation, i.e., no two errors are serially correlated.

This investigation did not encounter any violations of the assumptions underlying Ordinary Least Squares. Therefore, it is reasonable to proceed with Ordinary Least Squares (OLS) analysis.

Empirical model

The empirical model for the corn production in the Philippines is expressed as: $corn_t=\beta_0+\beta_1 Area_t+\beta_2 PYC_t+\beta_3 priceWC_t+\beta_4 priceFert_t+\varepsilon_I$,

where,

$corn_t$, volume of corn produced in the Philippines at time t (in metric ton);

$Area_t$, area devoted for corn production in the Philippines at time t (in ha.);

PYC_t, price of yellow corn in the Philippines at time t (in pesos);

PWC_t, price of white corn in the Philippines at time t (in pesos);

$PFert_t$, price of fertilizer for corn in the Philippines at time t (in pesos);

β_0, aggregate level of corn production at time t when all explanatory variables are equal to zero. In many cases, β_0 has no clear economic interpretation, but it is almost always included in the model because it helps in the overall estimation of the model and in prediction;

β_t, parameters which measure the change in value of dependent variable (volume of corn production) given a unit change in an explanatory variable granting other variables constant; and

ε_i, random error term associated with corn production at time t, assumed to be normally distributed with mean 0 and constant variance σ^2.

Forecasting

The regression coefficient estimations from the most accurate model were utilized in order to arrive at an estimated and forecast of the corn production. Since, the supply function is untransformed; hence the samples data are clustered over a limited range of the predictors were employed in the study. To generate its prediction values, a dual technique of forecasting was utilized (increase and decrease in the values of the predictors of the model by 20 percent). The statistical significance of the parameter estimates was evaluated using t-tests, just as it would be in any other type of regression analysis. Additionally, the p-values have been examined. The accuracy of the prediction was calculated thru the mean absolute deviation (MAD), the mean square error (MSE), and the mean absolute percent error (MAPE) so that the model that was forecasted would be as near to accurate as possible.

Data source

The data that were utilized in this investigation included information on corn production, yield, area harvested, and other characteristics that were considered to be important. The Corn Situationer and the Annual Corn Statistics Bulletin were two of the PSA reports and publications that were utilized in the collection and compilation of these statistics.

Results and discussion

Trend of corn production

The production output had reached its highest point of 4.9 million metric tons in 1990. It is the Philippines' second-most productive crop, which is grown on 2.61 million hectares and produced 7,770 metric tons of grain in 2014 after practically steady productivity growth since 2003 (Fig. 2A) (Bureau of Agricultural Statistics, 2008, 2011; Gerpacio, Labios, Labios, & Diangkinay, 2004; Philippine Statistics Authority, 2015). This crop was grown on 2.61 million hectares and produced 7,770 metric tons of grain in 2014. This increase in productivity was also observed in the province of Bukidnon, which was the second-most productive in 2014 after Isabela (Fig. 2B), accounting for more than ten percent and fifteen percent of the nation's total production, respectively (Bureau of Agricultural Research, 2011). Isabela was the most productive province in the Philippines in 2014. El Niño was responsible for the dramatic decline in output that occurred in 1998 (Gonzales and Lapia, 2003).

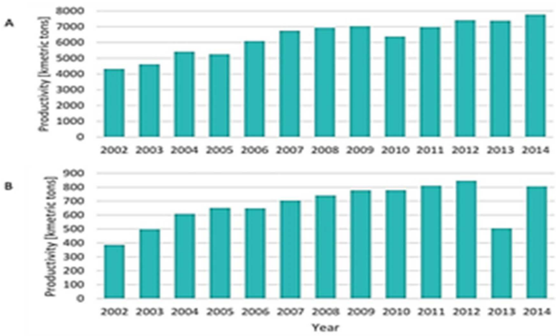

Fig. 2. Corn production between 2002 and 2014 (A) in the Philippines and (B) in Bukidnon (Bureau of Agricultural Statistics, 2008, 2011; Philippine Statistics Authority, 2015)

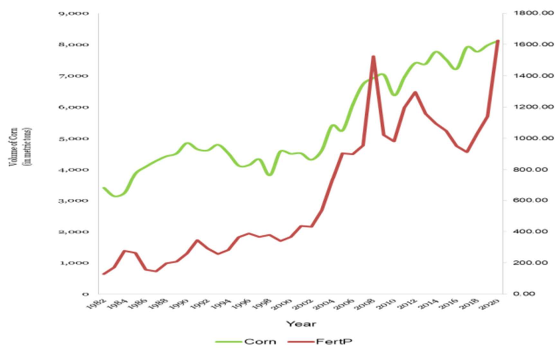

Fig. 3. Trend of corn production and price of fertilizer Source: Philippine Statistics Authority

Fig. 3 depicts the discernible patterns in the output of corn and the price of fertilizer across the years. The data pertaining to corn output indicates a general upward trajectory over the course of several years, but with intermittent periods of decline in some years. The year 2020 marked the attainment of the highest known output, amounting to 8,118.50 metric tons. Conversely, the lowest recorded production was observed in 1998, with a mere 3,823.20 metric tons being produced. In general, an upward trajectory is evident, as indicated by Gonzales and Lapiña's (2003) findings, which report a 1.7% rise in overall yearly production. Between the years 1996 and 2000, the provinces of Bukidnon, Isabela, South Cotabato, and Cotabato emerged as the leading corn-producing regions in the Philippines. Collectively, these provinces accounted for 41% of the overall national corn production. Notably, yellow corn constituted a minimum of 57% of the total corn output, encompassing approximately 46% of the total corn cultivation area within these aforementioned provinces. According to Gerpacio *et al.* (2004), Isabela obtained the highest average corn yield of 2.8 t/ha, while Bukidnon and South Cotabato achieved yields of 2.6 t/ha and 2.3 t/ha, respectively. The production of goods or services can be influenced by several factors, including weather patterns, genotype (variety), and environmental conditions (Salazar *et al.*, 2021).

The Foreign Agricultural Service (FAS) Manila predictions indicate enhanced Marketing Year (MY) 2022/23 corn output as a result of the increased subsidy (such as hybrid seeds) to the industry. It is anticipated that this would improve national yields by at least 2 percent. The funding for the DA Corn Program would grow to PhP5.02 billion ($91.3 million) in 2023, up from PhP1.4 billion ($25.4 million) in 2022. The corn area in the Davao Region and the Caraga Region is expanding, according to contacts from both the industry and the government.

Table 1. Production: Philippine Corn (FAS, 2023)

Region	MY 2021/22	MY 2021/22 S1	MY 2022/23 S1	%Δ
Yellow Corn				
Philippines	6,094,838	2,959,922	2,953,989	0%
Cagayan Valley	1,919,679	880,645	904,235	3%
SOCCSKSARGEN	848,916	579,860	584,634	1%
Northern Mindanao	943,656	672,169	690,773	3%
BARMM	534,361	227,045	224,909	-1%
Ilocos Region	537,158	10,388	11,965	13%
Central Luzon	262,950	25,587	30,818	17%
CAR	201,985	112,937	85,271	-32%
Western Visayas	277,890	162,225	146,396	-11%
Bicol Region	220,798	101,145	101,433	0%
MIMAROPA	105,467	26,648	36,657	27%
Caraga	81,997	73,176	61,291	-19%
Davao Region	71,182	35,116	34,358	-2%
CALABARZON	41,231	23,505	21,103	-11%
Zamboanga Peninsula	34,934	20,614	13,050	-58%
Eastern Visayas	6,143	3,367	3,310	-2%
Central Visayas	6,491	5,495	3,787	-45%
White Corn				
Philippines	2,249,178	1,458,062	1,375,589	-6%
Northern Mindanao	511,561	379,187	382,567	1%
BARMM	613,752	372,748	369,059	-1%
SOCCSKSARGEN	219,131	147,658	127,048	-16%
Davao Region	207,210	118,791	115,546	-3%
Zamboanga Peninsula	174,745	118,848	97,366	-22%
Central Visayas	95,585	79,432	76,221	-4%
Western Visayas	85,012	56,575	53,963	-5%
Bicol Region	70,560	39,715	36,489	-9%
Eastern Visayas	57,389	33,287	28,673	-16%
Caraga	55,401	46,280	30,280	-53%
Ilocos Region	46,439	8,898	9,480	6%
CAR	18,441	15,802	13,833	-14%
Central Luzon	38,471	9,242	8,611	-7%
CALABARZON	24,645	16,674	14,052	-19%
Cagayan Valley	18,177	7,977	6,638	-20%
MIMAROPA	12,660	6,949	5,764	-21%

According to sources in the business, this would raise the overall national area of corn for MY 2022/23 by at least 70,000 hectares when combined with conversions from banana plantations (Foreign Agricultural Service, 2023). In addition, as can be seen in Table 1, FAS Manila anticipates a rise in corn feed consumption in MY 2023/24 as a result of the prolongation of reduced tariffs until the 31st of December, 2023.

Corn is often considered to be the best component for use in animal feed, particularly for broilers and layer chickens. Corn is the source of the yellow pigment seen in eggs. In keeping with the rise in the city's population, FAS Manila boosted their use of FSI products during the MY 2023/24 compared to the previous year of USDA Official. In order to account for new information provided by PSA, FAS Manila revised its estimates of FSI consumption for MY 2021 and 2022 (Foreign Agricultural Service, 2023).

Price of fertilizer

The fluctuation in fertilizer prices exhibits a more unpredictable pattern. Based on the available data, it is evident that the cost of fertilizer has exhibited a general upward trend throughout the years, but with occasional instances of decline in some years. The peak price for fertilizer was documented in 2008, reaching 1,524.70 pesos, and the nadir price was seen in 1982, at 128.80 pesos. The aforementioned observation suggests a prevailing upward trajectory in fertilizer prices over an extended period, but subject to yearly swings that may be influenced by many sources. The upward trajectory of the six primary fertilizer grades started in March 2021. According to Roldan *et al.* (2021), the prices of 50 kg/bag of various fertilizers have experienced a notable increase as of October 2021. The percentage increases range from 18% to as high as 38%. Specifically, Muriate of Potash (MOP) has seen a price increase from Php 1,195.43 to Php 1,412.98, representing an 18% increase. Di-ammonium phosphate (DAP) has witnessed a 20% increase, with prices rising from Php 1,602.86 to Php 1,927.57. Complete fertilizers (T14) have experienced a 24% increase, with prices escalating from Php 1,112.70 to Php 1,378.17. Ammonium phosphate (Ammophos) has undergone a 31% increase, with prices surging from Php 976.34 to Php 1,275.60. Nitrogen (Urea) has seen a 32% increase, with prices rising from Php 1,166.14 in January 2021 to Php 1,540.17. Lastly, Ammonium sulfate (Ammosul) has witnessed a substantial 38% increase, with prices escalating from Php 612.44 to Php 842.86.

It is noteworthy to mention that alongside the rising trend in corn output, there is a concurrent upward trend in fertilizer prices. The potential escalation in fertilizer costs might potentially have adverse effects on farmers' financial returns and operational efficiency, as they may encounter difficulties in procuring the necessary inputs, such as fertilizer, due to the higher prices. Therefore, it is crucial to implement policies and programs that facilitate farmers' access to cost-effective inputs and advanced technologies, along with providing them with market and pricing information. These measures play a significant role in ensuring the long-term viability and enhancement of the agricultural sector in the Philippines. An example of this is the Tariff Reform and Import Liberalization Program which was consistently implemented in 1986. This program resulted in the liberalization of fertilizer importation and other agricultural products. Consequently, the government ceased the imposition of import quotas for fertilizer and decreased the associated import duties and tariffs on fertilizer imports (Briones, 2020).

Whereas, Corn (*Zea mays*), which is a high-input crop, needs a significant amount of nutrients and is also prone to nutrient imbalance (Aliyu *et al.* , 2021; Mullins *et al.* , 1998; Kaiser *et al.* , 2016). According to Karlen *et al.* (1988), an imbalance in the supply of nutrients has an effect on the absorption and use of nutrients, as well as the total productivity of corn. The majority of Filipino farmers implement GAP on their corn fields not only for their personal benefit but also to comply with RA 10068 (Mojica *et al.*, 2013). This is because Good Agricultural Practices (GAP) was created in the Philippines in order to boost corn output (Banzon *et al.*, 2013). In order to prevent losses in good quality, the Department of Agriculture (DA) developed the Code of Good Agricultural Practices for Corn (GAP Corn) has set comprehensive quality and safety requirements for corn production, harvesting, and on-farm postharvest handling and storage which includes organic inputs and practices (Philippine National Standard 2016), hence, many Filipino farmers apply organic inputs to their corn farms (Gerpacio *et al.*, 2004; Guerrero, 2010; Maghirang *et al.*, 2011), the country's enormous organic farming resources positively respond to the implementation of GAP and also the RA 10068 (Rey, 2012).

As one of the primary organic crops produced in the Philippines, and according to Willer and Lernoud (2015), the Philippines has 0.1 million hectares of agricultural land that is grown organically. According to the findings of the Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura (MASIPAG) survey, which was carried out in 2004 by the Philippine Partnership for the Development of Human Resources in Rural Areas (PhilDHRRA), 1,897 farmers (with 1,754 hectares) were fully implementing organic corn farming, whereas 11,052 farmers (with 15,411 hectares) adopted low-chemical and pesticide practices. These methods focus on the fertility of the local soil as the primary factor in successful production since doing so drastically minimizes the amount of external inputs required by eliminating the application of chemo-synthetic fertilizers, medications, and pesticides. Instead, it permits the powerful laws of nature to improve agricultural productivity while simultaneously increasing pest resistance (Carating *et al.*, 2010).

The amount of nutrition that corn needs is dependent on the desired and prospective volume yield; consequently, the demand for nutrients will be higher for new hybrids and high-yielding corn cultivars. Nevertheless, applying the right fertilizers at the right rate and at the right time is crucial for a successful crop (Volha, 2021). For instance, in order to yield around 14.5 tons/ha of new hybrid corn, the crop requires the following nutrient rates in kilograms per hectare (Table 2).

Table 2. Required nutrient rates (kgha-1) in corn

Nutrients	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B
Nutrients needed (kgha-1) of corn	247	192	194	80	75	23	2.6	0.45	0.5	0.125	0.32

The Department of Agriculture acknowledged the research findings in 2020 that the average yield for yellow and white corn is only 4.18 MT/ha and 1.89 MT/ha (PSA), respectively. This demonstrated that many corn areas did not reach their optimum yield of more than 5 MT/ha for both yellow and white corn. Therefore, in order to enhance the yield, the optimal fertilizer rate needs to be administered, and this ought to be done in accordance with the findings of the Site-Specific Nutrient Management (SSNM) experiments (DA, 2021). This was done through the Department of Agriculture's Memorandum Order No. 36, Series of 2021.

According to the results of the SSNM trials conducted in the various areas, increasing the amount of fertilizer applied by 21 kg/ha for nitrogen, 14 kg/ha for phosphorus, and 29 kg/ha for potassium on SSNM-treated farms in Isabela, Nueva Ecija, and Bukidnon resulted in a yield increase of 1.00 t/ha when compared to the Farmer's Fertilizer Practice (FFP). In addition, there is a corresponding rise in production costs and an increase in profit by 1.5 times following the suggestion of the SSNM due to a greater yield (Ocampo *et al.*, 2015). This is in spite of the fact that there is an increase in the application of fertilizer. Although the approach was first created for irrigated rice in Asia (Dobermann *et al.,* 2002; Witt *et al.,* 2007; IRRI 2007), the ideas behind it are universal and may be applied to a variety of crops. In order to bridge the gap between the nutrient requirements of a high-yielding crop and the nutrient supply from naturally occurring indigenous sources, such as soil, crop residues, manures, and irrigation water, it provides a method for the timely application of fertilizers at optimal rates. As a result, it is an approach to nutrient management that combines effective methods for crop management with a set of nutrient management principles in order to assist producers in increasing profitability and production.

The study by Ocampo *et al.* (2015), which became the benchmark for trials, revealed that despite higher fertilizer application rates in the SSNM, which substantially increased fertilizer costs (+Php 3,681) across sites, the profit using the SSNM recommendation still increased by about 1.5 times (the additional investment in fertilizer), as compared with the FFP, and ultimately came to the conclusion that the former has great economic and agronomic potential to increase the yield of the crop.

Fig. 4. Trend of corn production and area used.
Source: Philippine Statistics Authority

Area used

According to the data presented in Fig. 4, there has been a consistent upward trend in the amount of corn output during the examined period. Specifically, the volume has exhibited a notable growth from 3,404.1 metric tons in 1982 to 8,118.5 metric tons in 2020. Nevertheless, the trajectory in the field of manufacturing exhibits a lack of uniformity. The production area saw a notable growth trajectory, rising from 3,382.9 thousand hectares in 1982 to its zenith at 3,819.6 thousand hectares in 1990. However, it then experienced a decline, reaching a nadir of 2,484.5 thousand hectares in 2016, before rebounding to 2,553.8 thousand hectares in 2020.

According to Gerpacio *et al.* (2004), the production of corn in the Philippines may be broken down into three distinct agroecological zones based on the elevation of the land. These zones are the lowlands, the middlelands, and the uplands. Rice fields and corn harvests in these regions traditionally alternated between being grown on lowland lands, which are defined as having just a little inclination, and a high likelihood of becoming flooded during periods of heavy precipitation (Gerpacio *et al.*, 2004). Corn, a crop that is less susceptible to water shortages, was produced during the dry season and rice was planted during the rainy season. However, since the introduction of genetically modified organisms (GMOs) and their widespread use across the country, corn crops are now primarily grown on slopes, while rice fields grow year-round in the bottom of valleys.

Middle-lands are areas that have a major slope that ranges from 16 to 32%, and as a result of the terrain, landslides are a concern in these types of locations, as stated by Gerpacio *et al.* (2004). Furthermore, the problem of landslides is rendered much more severe in these hilly regions where corn is largely cultivated since there is a significant amount of exposed soil in these areas. Farmers in upland areas continue to cultivate the first open-pollinated variety (OPV) of corn planted for domestic consumption. These regions have a terrain that is hilly and undulating and is referred to as upland areas. Corn is the primary crop produced in highland areas. According to Gerpacio *et al.* (2004), corn productivity is at its highest during the months of July and September on highland slopes that are steeper than 15%.

Corn is grown on the most acreage and yields the most in the highland parts of Mindanao. This is true across the whole of the Philippine archipelago. Corn is also produced in the lowlands that are irrigated by rain, and in these regions, it is often planted in the dry season after the rice crop has been harvested. The cultivation of corn after rice not only boosts the efficiency of irrigation systems during the dry season but also provides much-needed grain during a time of year when supplies would otherwise be scarce. Corn farmers who have modest landholdings might boost their revenue by raising animals as part of their operation (FSSRI, 2000; Eusebio and Labios, 2001). This is because livestock production results in high-value goods.

This observation indicates that although the production sector has seen fluctuations, advancements in technology, agricultural practices, and seed diversity have resulted in enhanced productivity per unit of land. The observed phenomenon might potentially be attributed to several variables, including the implementation of enhanced irrigation techniques, advancements in fertilizers and insecticides, and the cultivation of corn types that exhibit resistance to dry conditions.

Technology adoption and constraints

According to Gerpacio *et al.* (2004), the incapacity of government extension agencies to deliver enough and up-to-date knowledge on agricultural technology was the primary factor contributing to low farm production. It is difficult to pinpoint the specific factors that influence a farmer's decision to use a particular technique or not (Reyes *et al.*, 2009). It is thought that using technology will increase a farmer's crop output. However, it is still difficult to pinpoint the specific factors that influence a farmer's decision to use technology. The choice to adopt a new concept or set of technologies is typically the result of a number of forces acting over time. Both Quimpo (1987) and Palaje (2012) mentioned the cost of adoption as the key argument for not utilizing or embracing certain technologies.

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Climate conditions such as floods during the rainy season, the impact of drought, and rapid climate change also limit high-volume corn production, which is why it is regarded as the primary issue facing corn growers; pests and illnesses are another major factor in the annual production losses experienced by corn producers in the Philippines. Climate conditions such as floods during the rainy season, the impact of drought, and rapid climate change also limit high-volume corn production. The production of corn presents a number of challenges, one of the most significant of which is the presence of weeds, which can lead to a reduction in yield of one hundred percent if neither manual weeding nor pesticides are utilized. According to Signabon *et al.* (2017), the corn-growing regions of the nation are also significantly harmed by restrictions on the fertility of the soil.

According to Gerpacio *et al.* (2004), in order to boost corn output, considerable simultaneous expenditures need to be made in infrastructure, agricultural extension, input production and distribution networks, grain harvest and post-harvest facilities, and grain marketing.

The average corn yield in the provinces of Bukidnon, Isabela, South Cotabato, and Cotabato exhibited positive growth as a result of the increased adoption of higher-yielding corn varieties by farmers, particularly hybrids (Gerpacio *et al.*, 2004). Hybrid corn has superior yields in comparison to local, traditional, and enhanced open-pollinated varieties (OPVs). Notably, rain-fed lowland habitats demonstrate much higher yields when contrasted with upland plains and rolling-to-hilly terrain. Hybrids frequently exhibit a production range of 1.6 to 6.0 metric tons per hectare (t/ha) across various agro-ecozones. According to the source mentioned, the rainfed lowland areas of Mindoro Occidental have the greatest hybrid yields, with peak values ranging from 5.5 to 9.0 t/ha (ibid., p. 21).

Prices

Fig. 5 illustrates the seasonal variation in the crop's volume, wherein certain years exhibit an upward trend and others display a decline. In the meantime, the pricing of white corn and yellow corn has exhibited fluctuations throughout the years, wherein certain years have witnessed an upward trend in prices while others have experienced a decline. However, when examining the correlation between the quantity of corn produced and the prices of white corn and yellow corn, some noteworthy discoveries may be made. To begin with, it is important to note that there exists no consistent correlation between the quantity of corn produced and the market price of either white or yellow corn. In the year 1982, there was a notable increase in the quantity of corn produced, accompanied by a comparatively low market value for both white and yellow corn.

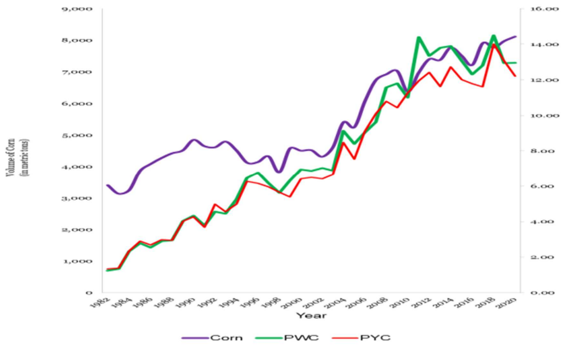

Fig. 5. Trend of corn production and prices of white and yellow corn
Source: Philippine Statistics Authority

In contrast, the year 1989 had a comparable level of corn output but was accompanied by somewhat elevated prices for both white and yellow corn. The absence of consistency in this context implies that there are more elements, beyond the mere quantity of output, that exert influence on the price of corn. Furthermore, there seems to exist a potential association between the pricing of white corn and yellow corn. Upon examining the data, it is evident that some years exhibited a parallel movement in the prices of white corn and yellow corn. Notably, in 2002 and 2003, both commodities had an upward trend in their respective prices.

In previous years, namely 2008 and 2018, there was a rise in prices for both yellow and white corn. However, the magnitude of the price increase was notably higher for yellow corn compared to white corn. This link implies the presence of common elements that can influence both prices, such as weather patterns, global demand, or shifts in government policy. It is noteworthy that there are certain patterns and correlations within the data under consideration. The complexity and multifarious nature of corn production, as well as the pricing dynamics of white and yellow corn, are evident. Therefore, it is difficult to establish definitive conclusions on the relationship between the amount of production and the price of white corn and yellow corn without conducting a comprehensive analysis of additional elements that might potentially influence these patterns.

Table 3. Monthly Average Farmgate Prices for Yellow Corn, (Php/kg)

Item	January - March		% Change
	2021	2022	
Farmgate			
Jan.-Mar. Average	12.47	16.11	29.1
January	12.20	15.95	30.7
February	12.67	16.05	26.7
March	12.55	16.32	30.0

Source: Philippine Statistics Authority, Farm Prices Survey.

Table 4. Monthly Average Farmgate Prices for White Corn, (Php/kg)

Item	January - March		% Change
	2021	2022	
Farmgate			
Jan.-Mar. Average	13.85	16.69	20.6
January	13.00	16.14	24.2
February	14.43	16.39	13.6
March	14.11	17.55	24.4

Source: Philippine Statistics Authority, Farm Prices Survey

According to the results of PSA's farm pricing survey, the average farmgate price of yellow corn was recorded at Php 16.11 per kilogram for the period of January to March 2022 (Table 3). This is a 29.1 percent increase when compared to the Php 12.47 per kilogram recorded during the same time period in 2021. Yellow corn prices at the farmgate in 2022 were consistently higher than the records that were set from January to March 2021. According to the same study, the average farmgate price of white corn was recorded at Php 16.69 per kilogram (Table 4). This is an increase of 20.6 percent from the Php 13.85 per kilogram recorded during the period of January to March 2021.

The demand for and production of white corn as a food source exhibit a relatively stable trend, in contrast to the increasing demand and productivity of yellow corn. The growth in demand for yellow corn might be attributed to the rising consumption of meat products. In order to fulfil its raw material needs and enhance operating efficiency, the feed milling industry has utilized both domestically produced yellow corn and imported supplies. The imports under consideration encompass yellow corn as well as its primary alternative, feed wheat, in terms of quantity (Salazar *et al.*, 2021). The primary recipients of yellow corn in the market are feed mills, strategically located in proximity to hog and poultry-producing regions such as Central Luzon, Southern Tagalog, Central Visayas, and Southern Mindanao (PSA, 2019).

The disparity in the overall market conditions between white and yellow corn is typically manifested in the average yield discrepancy, with white corn yielding only half as much as yellow corn. Furthermore, there is a possibility for increased demand for white corn in the future, potentially positioning it as a prominent dietary staple. This is primarily due to its nutritional advantage in mitigating and managing diabetes. Based on the findings of PSA (2015), the annual per capita consumption of corn in 2006 was recorded at a mere 14 kg, which subsequently experienced a rise to 22 kg by 2014. The percentage of the subject under consideration, as reported by Salazar *et al.* (2021), is just 20%, in contrast to the weight of rice which amounted to 114 kg in the year 2014.

In contrast to other nations like Mexico, where yellow corn is mostly utilized for human consumption, the Philippines predominantly employ yellow corn as a feed grain. The utilization of the entire corn plant as a fodder crop, namely for cattle feed, is a prevalent practice in the agricultural industry. This market is mostly controlled by prominent feed producers, both domestic and international, who are predominantly situated in the proximity of Metro Manila, specifically in the regions of Central Luzon and Southern Tagalog (Salazar *et al.*, 2021).

According to Briones (2020), the use of enhanced technological advancements in the cultivation of yellow corn has yielded substantial gains in output. Specifically, yellow corn's share of the overall corn production escalated from 23% in 1985 to 58% in 2001.

Descriptive statistics of variables

The analysis involved examining data obtained from the Philippine Statistics Authority (PSA) about the volume of corn output (CORN), the area of land dedicated to corn cultivation (AREA), the prices of white corn (PWC), the prices of yellow corn (PYC), and the prices of fertilizer (FERTP) for the years spanning from 1982 to 2020. The relevant information is presented in Table 1. Descriptive statistics for five variables pertaining to corn production in the Philippines, namely corn production volume (CORN), corn area (AREA), pricing for white corn (PWC), prices of yellow corn (PYC), and prices of fertilizer (FERTP), are presented in Table 5. The dataset encompasses a period of time span ranging from 1982 to 2020.

Table 5. Descriptive statistics of corn production, area planted and prices

Name	Mean	S. Dev.	Min	Max
Corn	5468.7	1556.5	3134.1	8118.5
Area	2854.8	459.13	2354.2	3819.6
PWC	7.8544	4.1875	1.2500	14.510
PYC	7.4290	3.7899	1.3400	14.010
FERTP	642.81	429.18	128.80	1626.1

The average annual corn output volume in metric tons is represented by the mean value of CORN, which are 5468.7. The observed standard deviation of 1556.5 suggests a substantial variability in output volume over different years, with certain years yielding quantities exceeding 8118.5 metric tons, while others yielding as low as 3134.1 metric tons.

The mean value of AREA is 2854.8, indicating the average land area dedicated to the production of corn in hectares. The presence of a standard deviation of 459.13 suggests a substantial variability in the extent of corn cultivation over different years, wherein certain years witness a greater allocation of land for corn cultivation compared to others. The pricing for white and yellow corn are denoted as PWC and PYC, respectively. Both variables have mean values of around 7.8, suggesting that the average price of corn has demonstrated a generally consistent level of stability across the observed time period. Nevertheless, the calculated standard deviations of 4.1875 for PWC and 3.7899 for PYC suggest the presence of price variations across the observed time period. These fluctuations have resulted in certain years exhibiting significantly higher or lower costs compared to the average.

The variable denoted as FERTP represents the price of fertilizer, with a mean value of 642.81. The observed standard deviation of 429.18 implies a substantial variability in the price of fertilizer over different years, with certain years exhibiting significantly higher or lower costs.

Table 6. Analysis of Variance - From Mean

	SS	DF	MS	F
Reg.	0.89013E+08	4.	0.22253E+08	248.220
Error	0.30481E+07	34.	89651.	p-value
Total	0.92061E+08	38.	0.24227E+07	0.000

Test of OLS assumptions

Analysis of variance from mean

The regression model exhibits a substantial degree of explanatory power, as evidenced by the significant F-value (248.220) and the highly negligible p-value (0.000) presented in Table 6. These statistical indicators indicate that a considerable proportion of the variability in the data can be accounted for by the regression model. This implies that the likelihood of attaining an F-value of such magnitude just due to random chance is quite small. Hence, it may be inferred that the regression model well corresponds to the data. Furthermore, it can be shown that the overall sum of squares (0.92061E+08) is equivalent to the sum of the sum of squares for regression (0.89013E+08) and the sum of squares for error (0.30481E+07). This finding indicates that the model and the error term have effectively explained all the variability present in the data.

The statistical study of variance demonstrates a substantial model, indicating its suitability for forecasting purposes.

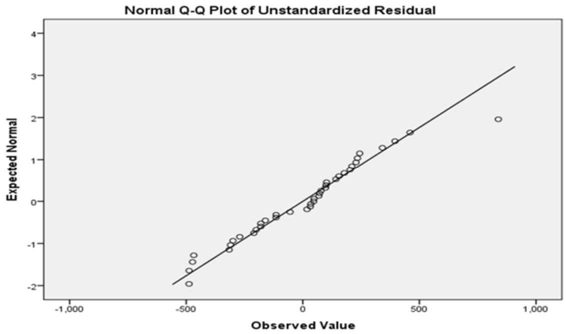

Fig. 6. Q-Q plot for unstandardized residuals

Normality of residuals

The residuals of the model exhibit normality as shown by the Kolmogorov-Smirnov and Shapiro-Wilk tests. In addition, the normality test is confirmed by Q-Q plots depicting unstandardized residuals. Two statistical methods commonly used to assess normality are the Kolmogorov-Smirnov test and the Shapiro-Wilk test. Both tests are employed to assess whether a given sample of data conforms to a normal distribution. The statistical test's results include the test statistic and degrees of freedom (df), along with the significance level (Sig.). The significance level determines if the observed data substantially deviates from a normal distribution. The findings from both tests indicate that the residuals of the model have a normal distribution. The test statistic for the Kolmogorov-Smirnov test is calculated to be 0.115, based on a sample size of 39 degrees of freedom. The significance level for this test is determined to be 0.200, which above the conventional threshold of 0.05. The Shapiro-Wilk test statistic is seen to be 0.963, with corresponding degrees of freedom of 39 (Table 7). The obtained significance level is determined to be 0.219, which exceeds the conventional threshold of 0.05. Furthermore, the Q-Q plot of unstandardized residuals serves to confirm the normality test as shown in Fig. 6. The Q-Q plot is a graphical technique used to evaluate the normality of data by comparing the actual distribution to the predicted distribution of a normal distribution. If the data points on the plot exhibit proximity to the diagonal line, it is indicative of a probable normal distribution of the data. It is important to acknowledge that the quoted significance levels are accompanied by a footnote indicating that they represent a minimum threshold for actual significance, incorporating a correction for Lilliefors Significance. This adjustment accounts for the fact that the normality tests were performed on the residuals instead of the raw data. In conclusion, according to the available information, it appears that the residuals of the model exhibit normality. This is supported by the outcomes of the normality tests conducted as well as the visual inspection of the Q-Q plot. This implies that the statistical model employed is suitable for the dataset and may be utilized for subsequent research.

Table 7. Tests of normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig	Statistic	df	Sig
Unstandardized Residual	.115	39	.200*	.963	39	.219
Standardized Residual	.115	39	.200*	.963	39	.219

Table 8. Autocorrelation assumption

Durbin-Watson Statistic		1.73817
Durbin-Watson positive autocorrelation test	p-value	0.102827
Negative autocorrelation test	p-value	0.897173

Autocorrelation

The Durbin-Watson statistic result is presented in Table 8. The purpose of the test was to assess the presence of autocorrelation and determine the extent to which the observations within a time series exhibit correlation with one another. The presence of autocorrelation in statistical models is a challenge as it contradicts the assumption of independent observations. This violation might result in erroneous and inefficient estimations of the parameters of the model. The Durbin-Watson statistic is a measure that falls between the range of 0 to 4. When the statistic is near to 2, it suggests the absence of autocorrelation. A number below 2 signifies the presence of positive autocorrelation, which implies that adjacent residuals are positively associated. Conversely, a value over 2 shows the existence of negative autocorrelation, meaning that adjacent residuals are negatively connected.

In the present scenario, the Durbin-Watson statistic is calculated to be 1.73817, exhibiting a proximity to the value of 2. This observation implies a lack of substantial evidence supporting the presence of autocorrelation in the dataset. The Durbin-Watson test also yields p-values for assessing positive and negative autocorrelation. The null hypothesis for each test posits the absence of any positive or negative autocorrelation, respectively. When the p-value is lower than the predetermined significance level, often set at 0.05, it signifies compelling evidence that contradicts the null hypothesis and implies the existence of autocorrelation.

In contrast, the p-value for the positive autocorrelation test is 0.102827, whereas the p-value for the negative autocorrelation test is 0.897173. Both p-values above the conventional threshold of 0.05, suggesting a lack of substantial evidence supporting the presence of positive or negative autocorrelation in the dataset. Hence, based on the Durbin-Watson statistic and p-values, it may be inferred that the data does not exhibit any violation of the autocorrelation assumption. This implies that the dataset in question exhibits a high likelihood of satisfying the assumption of independence of observations. Consequently, statistical models that rely on this assumption can be employed without apprehension over the presence of autocorrelation bias.

Heteroscedasticity tests

The variance inflation factor (VIF) test is employed to assess the presence of homoscedasticity, a statistical assumption that posits the constancy of error or residual variance across all levels of predictor variables inside a given model. The presence of violations in homoscedasticity can result in estimations of model parameters that are both biased and inefficient, hence impacting the integrity of statistical inference. The Variance Inflation Factor (VIF) test computes the ratio between the variance of the residuals and the variance of the projected values (Y-hat) inside the model.

Assuming that the ratio approaches unity, it may be inferred that homoscedasticity is upheld. If the ratio exceeds a value significantly larger than 1, it indicates the presence of heteroscedasticity. In this particular scenario, the VIF test is conducted by employing several metrics of the residuals. The test statistic that is presented is the chi-square statistic, which is employed to assess if there is a significant deviation from the expected ratio of the residuals' variance to the predicted values' variance, denoted as 1.

Table 9. Result for variance inflation factor

	Chi-square test statistics	DF	p-value
E**2 ON YHAT:	2.216	1	0.13656
E**2 ON YHAT**2:	2.186	1	0.13930
E**2 ON LOG(YHAT**2):	2.147	1	0.14282
E**2 ON LAG(E**2) ARCH TEST:	0.228	1	0.63312

The findings of the Variance Inflation Factor (VIF) are presented in Table 9. The findings indicate that there is no evidence of a violation of the homoscedasticity assumption in the dataset. The chi-square test statistics for all measures of the residuals, namely E2 ON YHAT, E2 ON YHAT2, E2 ON LOG (YHAT2), and E2 ON LAG (E**2) ARCH TEST, exhibit significantly small values and possess p-values beyond the conventional significance level of 0.05. This finding suggests that there is little evidence to support the presence of heteroscedasticity in the dataset, indicating that the assumption of constant variance of the residuals across all levels of the predictor variables is likely to hold true for this particular dataset. Hence, the outcomes of the Variance Inflation Factor (VIF) examination indicate that the assumption of homoscedasticity remains unviolated inside the dataset. This implies that statistical models that make the assumption of constant variance of the residuals can be employed without concern over the presence of heteroscedasticity bias.

OLS estimates

The regression study used ordinary least squares (OLS) estimation to examine the association between corn output and several predictor variables, such as the prices of yellow and white corn, the price of fertilizer, and the production area. The findings are displayed in Table 10. The consideration of the signs and magnitudes of the coefficients is crucial in the interpretation of the results. The presence of a positive sign in the coefficient suggests that there is a positive relationship between the variable connected with the coefficient and the rise in corn output. In the case of a negative sign, it may be inferred that a rise in the independent variable corresponds to a drop or fall in corn production.

Table 10. OLS estimates

Variable	Estimated Coefficient	T-Ratio	Elasticity
Price of Yellow Corn	371.35** (100.7)	3.687	0.41
Price of White Corn	48.183^{ns} (91.69)	0.526	-0.09
Price of Fertilizer	0.65343** (0.3004)	2.175	0.23
Area	1.1792** (0.1544)	7.637	0.82
Constant	-1454.9** (554.6)	-2.623	
R-Square	0.9669		

** Significant at 5% level ^{ns} not significant

The price of yellow corn: The price of yellow corn has a positive coefficient of 371.35, accompanied by a t-ratio of 3.687. This suggests that a rise in the price of yellow corn is associated with a corresponding increase in corn output. According to the given information, there is a positive relationship between the price of yellow corn and corn output, holding all other factors constant. Specifically, for each 1 peso rise in the price of yellow corn, there is an observed increase of 371.35 kg in corn production. The calculated elasticity of 0.41 indicates a rather modest impact; however it remains statistically significant at the 5% significance level.

The price of white corn: Based on the calculated coefficient of 48.183 and its associated t-ratio of 0.526, it can be concluded that there is no statistically significant relationship between the price of white corn and corn output. According to the given information, there is a positive relationship between the price of white corn and corn output, holding all other factors constant. Specifically, a 1 peso rise in the price of white corn leads to a corresponding increase of 48.18 kg in corn production. The presence of a negative coefficient suggests that a rise in the price of white corn might potentially result in a decrease in corn output, but with a limited impact.

The price of fertilizer: The coefficient of 0.65343, which has a t-ratio of 2.175, indicates a positive relationship between the price of fertilizer and corn output, suggesting that a rise in fertilizer price results in a corresponding increase in corn yield. According to the observed relationship, a unit increase of 1 peso in the cost of fertilizer leads to a corresponding rise of 0.65 kilos in corn yield, assuming all other factors remain constant. The calculated elasticity value of 0.23 suggests that the observed effect is very modest in magnitude, although it remains statistically significant at the conventional 5% significance level.

Area of production: The observed positive coefficient of 1.1792, accompanied by a t-ratio of 7.637, suggests that there is a statistically significant relationship between the area of production and corn output, indicating that an expansion in the area of production is associated with a corresponding rise in corn production. The calculated elasticity of 0.82 indicates a substantial and statistically significant effect, with a significance level of 5%.

Constant term: The presence of a constant component, shown by the negative coefficient of -1454.9 with a t-ratio of -2.623, suggests the existence of unaccounted elements in the model that exert an influence on corn output. The presence of a non-zero constant factor in the model implies the existence of fixed costs or other non-variable expenditures that are not explicitly incorporated into the analysis of corn production.

R-squared value: The R-squared value of 0.9669 indicates a strong relationship between the model and the observed corn production data, suggesting that the model effectively accounts for a significant percentage of the variability in corn output. This high R-squared number implies that the model is a suitable representation of the data.

In general, the findings indicate that the price of yellow corn, the price of fertilizer, and the area of production exhibit substantial influence on corn productivity. The observed data does not indicate a substantial correlation between the price of white corn and corn output. Additionally, it is plausible that there are unaccounted variables within the model that exert an influence on corn production.

Forecast

Moreover, the outcomes of a regression analysis employed to ascertain the correlation between corn production and the independent variables, namely the price of yellow corn (PYC), the price of white corn (PWC), the price of fertilizer (PF), and the production area, are shown as follows: The equation is estimated and presented as follows, with the standard errors of the estimations shown in parentheses below each coefficient:

Corn	=	-1454.9	+	371.35PYC	+	48.183PWC	+	0.65PF	+	1.18Area
		(554.6)		(100.7)		(91.69)		(0.3004)		(0.1544)
		MAD	=	221.86		MAPE	=	4.18M		
		SE	=	78517.33		Accuracy	=	95.82%		

The accuracy of the model was determined to be 95.82% by the calculation of the mean absolute percentage error (MAPE). Therefore, the approximated equation is suitable for making predictions. Fig. 7 depicts a graphical representation of the comparison between the projected data and the observed data pertaining to corn output spanning the years 1982 to 2020. The provided data also includes an evaluation of the model's accuracy in predicting corn output, as measured by the mean absolute percentage error (MAPE), mean absolute deviation (MAD), and mean squared error (MSE). The Mean Absolute Percentage Error (MAPE) value of 4.18% signifies that, on average, the model's predictions deviate by around 4.18% from the true value. The Mean Absolute Deviation (MAD) result of 221.86

indicates that the average absolute difference between the predicted and observed values is 221.86. The mean squared error (MSE) value of 78517.33 is the average of the squared errors between the predicted and the actual values.

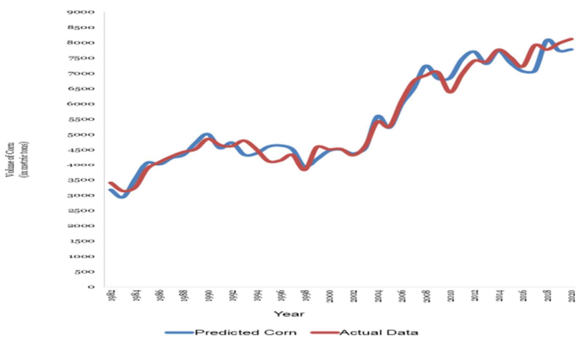

Fig. 7. Graphical presentation of the predicted and the actual corn data

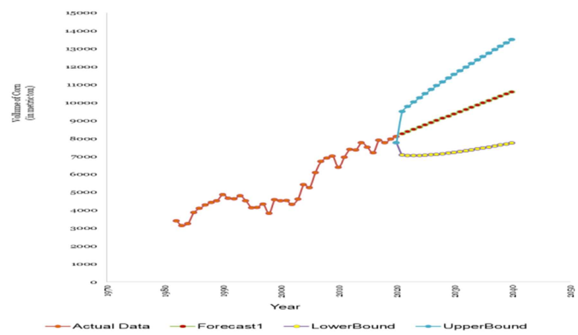

Fig. 8. Graphical representation of the corn production's actual data and the forecasted data with lowerbound and upper bound data

The graphical depiction in Fig. 8 illustrates the empirical data pertaining to corn production, together with the independent variables: the price of yellow corn (PYC), the price of white corn (PWC), the price of fertilizer (PF), and the area of production. The data spans the time period from 1982 to 2020. The line shown by the color red is designated as Forecast 1, derived from an equation used to depict data spanning the years 2021 to 2040. The line colored in blue indicates the projected data's upper bound, while the line colored in yellow shows the lower bound data. The lower and upper bounds of the data are determined by assuming a 20% drop (lower bound) and a 20% rise (upper bound) in the values of the predictor model. Upon examination of the time series plot, it is evident that there exists a clear upward trend.

Conclusion

The present study investigates the patterns of corn production, pricing dynamics, fertilizer expenditures, and cultivated land area in the Philippines throughout the period spanning from 2021 to 2040. The findings demonstrate a persistent rising trend in both output and fertilizer prices during the last four decades, accompanied by a significant increase in production volume. The regression study demonstrates a statistically significant association between corn output and the prices of yellow corn, white corn, fertilizer, and production area. The accuracy of the model is reported to be 95.82%, accompanied by an average deviation of 221.86. The dataset encompasses the time period from 1982 to 2020, with a discernible rising trajectory in the upper limit. The accuracy of the model is assessed by using metrics such as mean absolute percentage error (MAD) and mean squared error (MSE). A discernible upward trend is expected to manifest in the time series representation of corn output throughout the forthcoming two decades.

Acknowledgement

The author is appreciative to the Central Mindanao University (CMU) Department of Agribusiness Management for the assistance they provided.

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