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Predicting the cassava economy in Lampung province: An ARIMA-based forecast of supply, demand, and price

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Abstract: Cassava productivity in Lampung Province experienced a decline from 2015 to 2019. This indicates that there are problems in cassava farming in Lampung Province. Apart from that, the tapioca industry in Lampung Province does not meet its need for fresh cassava as a raw material to produce around 9 million tons per year, so it can only produce around 7 million tons per year. This affects the price of cassava in Lampung Province. This research aims to predict the supply, demand, and price of cassava in Lampung Province, Indonesia. The utilized data type is secondary data with a time series of 14 years, from 2006 to 2019. The employed analytical technique is the forecasting method utilizing the ARIMA model. The research results obtained were that forecasting the supply of cassava in Lampung Province and forecasting demand for cassava for the gaplek industry and tapioca in Lampung Province experienced a decline in 2020-2025, while forecasting the price of cassava at the farmer level experienced an increase in 2020-2025. The government can anticipate this by investing in education, counseling, and infrastructure related to the cassava commodity, which currently provides very little outreach of counseling. Meanwhile, what the government can anticipate if there is a decline in cassava prices in the future is to increase the performance of cassava farmer groups so that they can sell their harvests collectively, giving farmers a higher bargaining power position in selling their production to industry.

Keywords: *ARIMA, Cassava, Demand, Forecasting, Supply.*

1. Introduction

The COVID-19 outbreak that hit Indonesia in early 2020 harmed global economic growth [1]. The agricultural sector in Indonesia is the main focus of policymakers both nationally and internationally because it is a very central sector in providing domestic food. Minister of Agriculture, in facing current conditions, food security is also important. The Ministry of Agriculture is implementing three initiatives to address COVID-19 while also developing a program to enhance food availability in the new normal period [2].

The Ministry of Agriculture's primary agendas during the COVID-19 pandemic include the emergency/short-term agenda as the first priority. They encompass food price stability, which includes price regulation, financial support for farmers, and the intensity of agricultural labour. The second agenda focusses on the temporary to medium-term strategy of local food diversification, addressing deficit regions and preparing for drought. The third agenda pertains to the permanent, long-term strategy, which includes the extensification of food crops, enhancement of annual production, establishment of farmer cooperatives, and the cultivation of millennial farmers [2].

The food crop subsector provides added value as measured by the contribution of gross domestic product (GDP) from the agricultural sector is significant in sustaining trade equilibrium. Produce staple

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and national strategic food commodities and products (such as rice, corn, soybeans, and cassava), provide business opportunities and sources of income for farming households, and support the rural economy.

Every quarter, Indonesia's economic growth decreased by 4.19% in the second quarter of 2020. When compared year to year, economic growth decreased by -5.32% [3] so the decline was even more pronounced. In Lampung Province, especially as a center for cassava production in Indonesia, the decline in economic growth has caused a decline in farmers' income as a result of a decline in food production and consumption. In Asia, cassava (Manihot esculenta) is cultivated by about 8 million farmers, stimulating rural economies in numerous countries [4].

Cassava production in Lampung Province fell during 2015 and 2019. This shows that Lampung Province has problems with cassava cultivation. Land area decreased from 256,632 hectares in 2018 to 199,385 ha in 2019 [5], while the price of cassava fluctuated and tended to decline, thus contributing to the decline in production. Cassava breeding in Asia is driven by a combination of food and market needs with technological innovation to increase productivity [4]. Root crops like cassava serve as a safeguard against climate disturbances, seasonal crop failures, and food insecurity during periods of scarcity. The harvest time for cassava is relatively long and usually in small quantities [6]. In addition, cassava, an important food and energy crop, is relatively more resistant to drought stress compared to other crops [7].

According to Kristian and Surono [8] the decline in cassava production was caused by the price of cassava, the cassava harvest area, and the price of urea fertilizer. the quantities of NPK fertiliser, urea fertiliser, SP-36 fertiliser, and the age at harvest, while [9] found that weather variables (rainfall) affected cassava production and harvest area in Thailand. Findings show that climate change has negatively impacted food security in Nigeria [10]. Because of these things, farmers' interest in growing cassava continues to decrease, and many choose to cultivate alternative crops. Cassava production differs by location due to inadequate soil fertility, ineffective weed management, and the absence of improved types [11]. In Africa, Latin America and Asia cassava is essential for maintaining the food security of more than one billion people [12]. Findings show that cassava and sweet potato, two root and tuber crops can contribute to household resilience capacity due to their resistance to climate shocks [13].

The factor of domestic consumption of cassava and its derivative products will have an impact on the price and availability of cassava and its derivative products. Food consumption is closely related to social welfare [14]. Cassava which is first processed into snacks or flour will have an impact on increasing demand for cassava.

The Lampung Provincial government's policy on food diversification is increasingly being intensified. In 2020, the Governor of Lampung Province initiated food diversification and highlighted local food micro, small and medium enterprises (MSMEs). This activity was carried out in anticipation of the global food crisis and the possibility of drought; providing alternative carbohydrate sources; as well as driving the community's economy through MSMEs [15]. Obtaining accurate production and yield predictions for root crops, such as cassava, will continue to be the basis not only for evaluating any policies that encourage the cultivation of these crops to address food insecurity and climate risks and increase farmer incomes but also for evaluating plant research and development activities, both at the international and national levels, which aim to develop and disseminate superior varieties that have high yields and are resistant to pests and diseases [6].

Cassava consumption is separated into two categories: food consumption and industrial consumption. Cassava is consumed directly by the community as food, while cassava is consumed as raw material to be processed into derivative products such as tapioca flour for food, cassava for animal feed [16, 17] cassava flour, and others [18]. The results of research La Fuente, et al. [19] show that DHT added to cassava starch has proven to be an attractive alternative for producing biodegradable plastic with potential use in various industries. Cassava pulp is a potential raw material for future bioenergy production [20].

According to Kristian and Surono [8] Indonesia's diverse population has a significant impact on cassava consumption. Likewise, consumption of cassava derivative products, especially consumption of cassava, remains stable, while consumption of tapioca flour increased drastically between 2016 and 2017. As a result, demand for tapioca flour increases from year to year and must be balanced with production. from cassava derivatives. Consumption of cassava derivative goods will affect the price of cassava. Meanwhile, the market price of tapioca flour is more constant than the basic raw material, namely cassava, at the farmer level. Increasing sensitivity to community needs, providing price subsidies, and ensuring the availability of basic food ingredients that have been enriched with additional nutrients (biofortification), will help increase the acceptance and use of these food ingredients among households in rural areas. These steps aim to make more nutritious foodstuffs more accessible and acceptable to rural communities, thereby improving their well-being and health [21].

The overall tapioca industry in Lampung Province is 51 units, with an industrial milling capacity of 9,576,000 tons of cassava/per year, according to data from the Department of Industry of Lampung Province. Lampung Province is only able to supply 6.5-7 million tons of raw materials per year, making the tapioca industry sensitive to raw material shortages. This issue arose due to inconsistent cassava harvesting, causing the tapioca sector to run at a lower capacity than it should. Irregular cassava planting cycles result in excess supplies of raw materials in some months and scarcity of raw materials in other months. Nationally, the average producer price of cassava rises every year, but this is not the case in Lampung Province where the price fell from IDR 1,402/kg in 2018 to IDR 1,177/kg in 2019. Compared to another Province as the central cassava producer in Indonesia, Lampung Province still lags behind the average of other provinces. The price of cassava in Indonesia is greatly influenced by variables such as cassava harvest area, cassava consumption, and road length. Consequently, researchers in Lampung Province are keen to investigate and project the supply, demand, and pricing of cassava.

2. Literature Review

The Cassava (Manihot esculenta) plays a crucial role in food security, particularly in Asia, Africa, and Latin America [12]. Its drought-resistant nature makes it essential in climate-vulnerable regions [7]. In Indonesia, cassava production has declined due to fluctuating prices, reduced land area, and climate change [10]. Similarly, in Thailand, weather conditions significantly impact cassava yield [9]. Cassava is widely processed into tapioca flour, gaplek, animal feed, and biofuels [16]. The tapioca industry in Lampung requires approximately 9 million tons of cassava annually but only secures around 7 million tons by Department of Industry, Lampung Province. The projected decline in cassava demand within the tapioca sector creates supply chain imbalances, necessitating efficient supply chain management and government interventions to stabilize raw material availability [22, 23].

Cassava prices in Indonesia fluctuate due to production levels, input costs, and market demand [6]. In Lampung, prices fell from IDR 1,402/kg in 2018 to IDR 1,177/kg in 2019. ARIMA forecasting models are widely used to predict price volatility and inform policy decisions [24]. Strengthening farmer cooperatives can enhance bargaining power and contribute to price stabilization [25]. ARIMA is extensively utilized to forecast agricultural production, demand, and prices. It has been successfully applied to rice, maize, and cassava forecasting [26]. Studies conducted in Thailand and Indonesia affirm ARIMA's reliability in short-term agricultural predictions, though integrating machine learning techniques could further improve forecasting accuracy [9, 27].

To mitigate declining production, governments must invest in agricultural education, infrastructure, and farmer support programs [28]. Public-private partnerships, as successfully implemented in Ghana, could significantly enhance cassava sector productivity [29]. Further research should explore the adoption of high-yield cassava varieties and mechanized farming techniques [30]. Cassava remains a critical agricultural commodity in Lampung; however, declining supply and fluctuating prices pose challenges. While ARIMA forecasts help anticipate trends, additional research and policy interventions are necessary to ensure the long-term sustainability of the cassava sector.

3. Methodology

The data utilized is secondary, comprising a time series spanning 14 years, specifically from 2006 to 2019, taken from central BPS, BPS Lampung Province, Ministry of Agriculture, Lampung Province, and a database of exports and imports of food commodities in Indonesia based on the Ministry of Agriculture, Regulations of the Indonesian Minister of Finance, Indonesian Ministry of Energy and Mineral Resources, Food Security Agency, Indonesian Data, and Information Center, Food Materials Balance (NBM), FAO, and Department of Industry and Trade of Lampung Province.

The data used includes the demand for cassava for tapioca in Lampung Province, the national demand for cassava for tapioca, the price of cassava at the farmer level in Lampung Province, Indonesia, the cost of cassava at the level of industrial producers in Lampung Province, in Indonesia, cassava harvest area in Lampung Province, cassava productivity in Lampung Province, tapioca consumption in Lampung Province, national tapioca availability, national tapioca imports, national tapioca exports, population of Lampung Province, length of roads in Lampung Province, rainfall in Lampung Province, KUR interest rate, Consumer price index, basic price of grain in Lampung Province, basic price of diesel, daily labor wages, Lampung beef price, Lampung consumer corn price, Lampung producer corn price, Lampung consumer rice price (IR II), Lampung cattle population, Lampung imported cattle population, Lampung pig population, HET for urea fertilizer, GRDP per capita at constant prices, industrial tapioca prices and industrial gaplek prices.

The forecasting process uses the time series analysis method using the ARIMA model. The ARIMA model is a model that utilizes past and current data to produce accurate short-term forecasts (Sugiarto, 2000). This method consists of three stages, namely, the initial identification stage for entering time series data, the second stage of parameter estimation, and the third stage of forecasting.

3.1. Initial Identification

The initial identification process carried out was to look at data patterns by carrying out data stationarity tests on each data, which were production, price, and consumption of cassava in Lampung Province. The data stationary test was carried out using the root test. Data that has been tested using the root test is stationary if the Fisher Chi-square PP - Fisher Chi-square probability value is smaller than α 5%.

Stationary tests were conducted on cassava production data in Lampung Province at the level. If the initial stationary test shows that the cassava production data is not stationary, then continue with the condition of 1st and 2nd difference. The same test was also carried out on data on prices and consumption of cassava in Lampung Province. Once the data is stationary, it can be used to estimate the parameters (estimates) of the best forecasting model.

3.2. Parameter Estimation

The estimation process is carried out by entering various models. The estimation of production, price, and consumption data parameters is entered into several possible models with parameters p, d, and q to find the best model to use for forecasting. p shows the order or degree of autoregressive (AR), d is the level of the differencing process seen in the stationary data test process, if the process is stationary at the 1st or 2nd differencing then the order d is written with the number 1 or 2, and q shows the degree of the moving average (MA), so the model can be written ARIMA (p,d,q).

3.3. Forecasting

After getting the best model, the next step is forecasting. Forecasting of production, price, and consumption of cassava in Lampung Province is carried out for the next 5 years. From the forecasting results obtained, it can be seen the rate of development in each aspect of forecasting, which is the rate of development of supply, demand, and prices in Lampung Province.

4. Empirical Results

4.1. Forecasting Cassava Supply in Lampung Province

The data stationary test is carried out before determining the best model using the AR, MA, or ARIMA methods. Data that is stationary means that the mean, variance, or auto variance (at various lags) of the data remains the same, meaning that the data does not vary over time [31]. The stationary test results of cassava production data are presented in Table 1.

Table 1.
Stationary test results of cassava supply in Lampung Province.

Method	Statistic	Prob.**
PP - Fisher Chi-square	305.102	0.0000
PP - Choi Z-stat	-299.991	0.0014

The probability value of the PP-Fisher Chi-Square is 0.0000, which indicates that the value is less than 0.05, so it can be concluded that the cassava production data is stationary at the 1st difference condition. Table 2's R-squared value of 61.15 percent indicates that AR(1) and MA(2) can account for 61.15 percent of the cassava supply. The computed p-value is 0.0302 and the F-statistic is 4.7238, indicating that simultaneously AR(1) and MA(2) have a real effect of 95 percent on the supply of cassava in Lampung Province. The Probability AR(1) and MA(2) values also show a significant value of 99 percent. Based on this description, the best model for offering cassava in Lampung Province is ARIMA (1,1,2).

The stationary test shows that the condition of the data is stationary at the time of the 1st difference which in writing in the model is marked D=1. Testing the best model on the cassava supply equation model in Lampung Province obtained the AR (1) and MA (2) equation models. The ARIMA equation model symbol (p,d,q) can be expressed as ARIMA (1,1,2). The results of testing the best AR, MA, and Table 2 present ARIMA models for cassava production in Lampung Province.

According to Figure 1, the supply of cassava in Lampung Province is estimated in 2020-2025 will decrease from 10,579,141.01 tons/year in 2020 to 7,822,102.11 tons/year in 2025. This value is lower compared to Colombia with the highest cassava production coming from semi-arid areas on the Atlantic Coast with relatively low yields for fresh consumption (≤11 t/ha) [32]. Based on the data obtained, the supply of cassava in 2018-2019 has decreased, so the projected supply of cassava has also decreased. This is following research by Puteri [33] that the projected supply of cassava in Indonesia will decline in 2025 and Pipitpukdee, et al. [9] obtained results that cassava production in Thailand will experience a decline, but the projection obtained by Kristian and Surono [8] get different results, which is increased cassava production. The variation in findings is due to the choice of various base years for cassava production, as well as varying cassava production trends. According to Boansi [34] The climate will considerably influence cassava yield forecasts in the medium and long term.

Table 2.
Test results of the best AR, MA, and ARIMA models for cassava supply in Lampung Province.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.9999***	0.2409	-4.1501	0,0025
MA(2)	-0.9984***	0.0173	-5.7631	0,0000
R-squared	0.6115			
F-statistic	4.7238**			
Probability of the(F-statistic)	0.0302			

Note: Description :
* = Level α = 0.10
** = Level α = 0.05
*** = Level α = 0.01.

The government can use this forecast data to develop plans to increase the supply of cassava in

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Lampung Province. According to Boansi [34] higher yields from cassava cultivation require government incentives or assistance. In Cambodia, cassava is an obligatory crop for farmers, but the cassava market is unstable and the harvest is uneven [35]. Accurately predicting production and yields for cassava crops can improve food security and address climate risks. These predictions can increase farmers' income and develop plant research to create superior varieties that are resistant to pests and diseases [6].

Increasing cassava production can be achieved by grouping farmers who have small-scale businesses into groups, this can increase productivity because these groups can easily find labor and access the production facilities needed for cassava farming. Cassava farmers will have a higher bargaining power position in selling their products to the industry [25]. The government of Ghana implemented a similar thing, which implemented an institutional approach to increase the productivity and income of cassava farmers by involving the role of NGOs, financial institutions, and counselors in a comprehensive manner so that they could implement partnerships perfectly [29]. Investments in education, counseling, and infrastructure have been suggested as policy options to improve the cassava farming sector in Nigeria [36]. The counseling program and financial assistance provided by the government have had a major influence in making agriculture and cassava processing the main focus or important activity in society. This program helps strengthen the important role of agriculture and cassava processing in people's lives and the economy [37]. Apart from that, the optimal level of cassava production is greatly influenced by land cultivation which provides adequate soil physical conditions [30]. According to studies Reichert, et al. [30] the most profitable no-till system approach in terms of fertilizing nutrients in the soil for optimal results can be adopted to optimize cassava farming land. ideal, but the supply of cassava may be less than land management but can improve the physical condition of the soil in the long term, which can have an impact on more stable yields.

According to Ivans, et al. [38] increasing the production of lowland rice farming businesses in the short term can be done by using production facilities that are by proposals for the medium term include expanding the cultivation area and using critical production elements, while the long term entails developing cultivation technology. which can also be used in cassava cultivation. This is in line with research by Rahman and Awerije [28] that the increase in cassava productivity in Nigeria from 9.8 tons per hectare to 10 tons per hectare was due to the use of superior varieties that were developed, namely the TMS superior variety. Several previous studies conducted related to the income of cassava farming showed that cassava farming was profitable [39, 40]. A cassava farming business that is already profitable does not mean that the agricultural enterprise carried out is technically proficient, this was found in research Amri [41] that cassava cultivation lacks technical efficiency, the same results were also obtained in Rahman and Awerije [28] that the scale of medium and large cassava farming in Nigeria is technically and economically inefficient. Technical efficiency is related to the use of production factors and the resulting production, so if the cassava farming business is not technically efficient then it can be concluded that the production of the cassava farming business has not reached the optimum point in terms of the use of the production factors used. Based on the forecasting results and descriptions, For the sake of the viability of the cassava farming enterprises in Lampung Province, the strategy to expand their supply must be implemented. The cassava sector is hindered by insufficient market infrastructure, processing facilities, information deficits, and volatile local prices. It is recommended to disseminate improved tropical cassava selection technology and invest in market infrastructure, processing technology, irrigation systems, and information dissemination to enhance the cassava sector's capacity to support agricultural growth in Nigeria [28].

The results of rice production forecasting carried out by Zamahzari and Anugerah [26] show that rice production in East Java Province in 2022-2027 will experience a decline. Rice consumption in East Java Province is predicted to decline in 2022. This aligns with the research that the projected outcomes of other food crops have decreased following the COVID-19 pandemic. Figure 1 shows the results of predicting Lampung Province's cassava supply statistics.

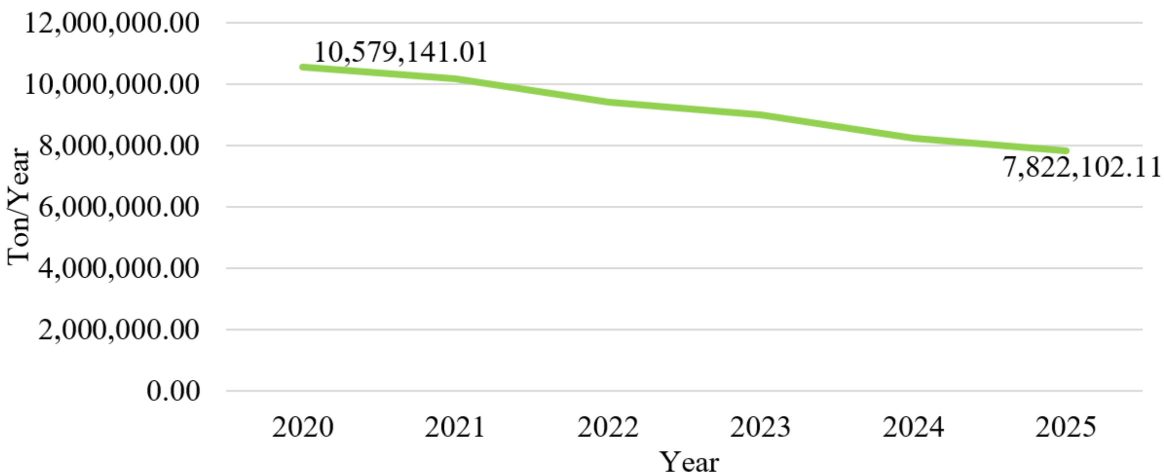

Figure 1.
Shows the outcomes of Lampung Province's cassava supply prediction for 2020–2025.

The decline in cassava production can be caused by pest attacks and plant diseases, weather, and the cultivation process. There is limited information regarding farmer behavior related to moving planting material, and farmers' perceptions and awareness of cassava diseases mean that many farmers do not know the source of diseases that attack cassava plants [42]. Cassava bacterial blight (CBB) is a severe disease caused by the bacterial pathogen Xantho-monas axonopodis pv. manihotis (Xam), which causes significant crop yield losses worldwide [12]. Leaf diseases have attacked in recent years due to climate change, increased growth of outdoor air pollutants, and global warming. These diseases can damage crop yields, leading to detrimental effects on global food security. Therefore, timely and appropriate detection of leaf diseases is essential to prevent their spread and ensure the sustainability of agricultural production [43]. Cassava is the main source of carbohydrates for more than 70% of people in Nigeria, which is the largest producer and consumer in the world. However, cassava yields in Nigeria are relatively low, largely due to pest and disease infections that significantly cause inconsistencies in cassava productivity across various environmental conditions [44]. Empirically shows how biological control can overcome the threat of invasive pests in various agricultural commodities, one of which is cassava, ensuring annual benefits (on-farm) of US$ 14.6-19.5 billion per year [45]. One of the models obtained to be able to diagnose plant diseases and pests is Nuru. Nuru was developed by PlantVillage (Penn State University), FAO, IITA, CIMMYT, and others as a public resource for detecting plant pests and diseases quickly and cost-effectively so that it can be used by researchers, agricultural counseling workers, and farmers so they can manage their farming businesses efficiently better [46]. Land-saving technologies facilitate the substitution of other inputs for land while agricultural mechanization saves labor, chemical and biological technologies are land-saving. Several countries that implemented land-saving biological control experienced rapid agricultural productivity growth [45].

Cultivation factors are also one of the factors that can reduce cassava production. Higher yields of fresh cassava roots were obtained on no-till land [49]. In Nigeria and Vietnam, cassava processors incur the majority of losses, whereas in Thailand, most losses transpire during the cassava harvest [47]. And weather is a factor causing the decline in cassava production. The results showed that monthly, seasonal, and annual minimum and maximum temperatures were significantly related to cassava harvest at $p \leq 0.05$ [48].

The predicting outcomes of this study indicate that cassava production in Lampung Province will diminish post-COVID-19. These results are in line with Kementerian Pertanian [49] which has published the performance of cassava in Indonesia during 2019-2023. There has been a significant decrease in cassava harvest area and productivity has also decreased quite significantly, especially in

2022-2023.

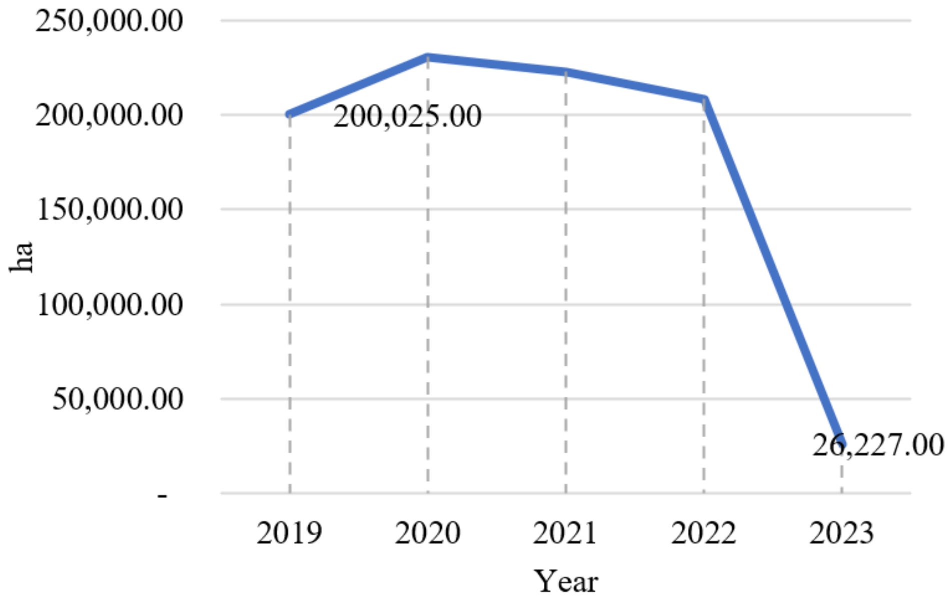

Figure 2.
Cassava Harvest Area in Lampung Province.

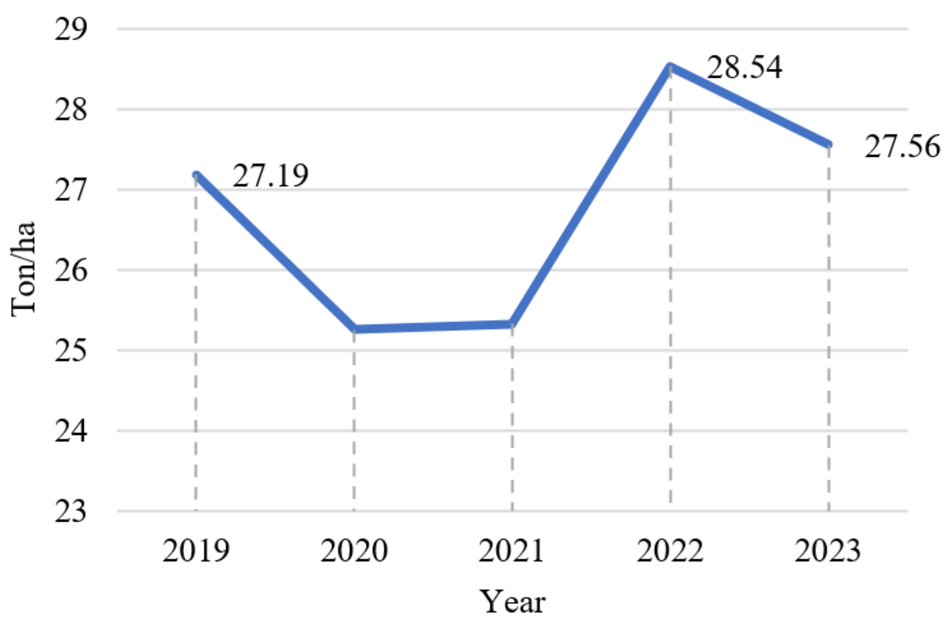

Figure 3.
Cassava productivity in Lampung Province.

4.2. Forecasting Demand for Cassava in Lampung Province

One type of cassava that is widely used as raw material for the food processing industry, restaurants, cafes, or hotels is jarak towo cassava [50]. Moreover, biofortified varieties of yellow cassava have been evaluated as a cost-effective strategy to address vitamin A deficiency in low- and

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middle-income nations with significant cassava consumption, such as Nigeria [51, 52]. In Thailand, local fresh cassava can replace imported potatoes in chip production. However, chips made from local cassava are not widely available on the market. This difficulty in market access could be due to a lack of information about consumer preferences [53]. Cassava produces cyanide which is a neurotoxin and requires processing to be safe for consumption. Consuming cassava that is not properly processed, combined with a diet that is low in protein, can have neurodegenerative effects. This problem is further exacerbated by drought conditions which increase these toxins in the plant [54]. Micronutrient deficiencies are a major public health problem in Nigeria and correlate with levels of cassava consumption [55].

Cassava leaves have the potential to support human nutrition and prevent metabolic diseases accompanied by low-grade inflammation [56]. Cassava leaves can also be an alternative source as a protein supplement and for the extraction of carotenoids and chlorophyll and pave the way for the valorization of this abundant agricultural by-product [57]. Conversion of cassava roots (Manihot esculenta) into processed products such as gari and fufu before consumption for detoxification, extending shelf life, or for profit [58]. So that the results of the disposal of cassava waste can increase the production of lactic acid thereby producing economic value [59]. So based on this explanation, every part of the cassava plant can be used to make products that have economic value.

4.3. Forecasting Demand for Cassava in the Tapioca Industry

Table 3 shows the results of the stationary test for demand for cassava for the tapioca industry in Lampung Province which is stationary at the 1st difference condition. The probability value on the PP-Fisher Chi-square is 0.0000, indicating it is less than 0.05 and the data is stationary in this condition. The best model testing is carried out after obtaining stationary conditions for the data used. The stationary 1st difference condition shows that the forecasting equation model uses the ARIMA model with the writing in the model given the sign D=1. Testing the best model on the cassava demand equation model for the tapioca industry in Lampung Province obtained the AR (1) and MA (2) equation models. The ARIMA equation model symbol (p,d,q) can be expressed as ARIMA (1,1,2). The resulting R-squared value of 54.52 percent in Table 4 shows that 54.52 percent of the variation in forecasting cassava consumption can be explained by AR(1) and MA(2). The prob value in the F-statistic is 0.0590, which means that AR(1) and MA(2) simultaneously influence the demand for cassava for the tapioca industry in Lampung Province. The R-squared value, probability of each variable, and probability F-statistic are indicators for assessing the best model in forecasting using the ARIMA method. Based on this description, the best model for cassava demand for the tapioca industry in Lampung Province is ARIMA (1,1,2). The stationary test results for cassava demand in the tapioca industry of Lampung Province are displayed in Table 3, while the optimal AR, MA, and ARIMA model findings for cassava demand in the same industry are shown in Table 4.

Table 3.
Results of stationary test demand for cassava in the tapioca industry in Lampung Province.

Method	Statistic	Prob.**
PP - Fisher Chi-square	600.594	0.0000
PP - Choi Z-stat	-586.223	0.0000

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Table 4.
Test results of the best AR, MA, and ARIMA models for demand for cassava in the tapioca industry in Lampung Province

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.9998***	0.0095	-1.0499	0.0000
MA(2)	-0.9928***	0.3001	-3.3076	0.0091
R-squared	0.5452			
F-statistic	3.5974*			
Prob(F-statistic)	0.0590			

Note: Description :
* = Level α = 0.10
** = Level α = 0.05
*** = Level α = 0.01.

Demand for cassava for the tapioca sector is expected to fall from 6,476,395 tonnes/year in 2020 to 4,257,008 tonnes/year in 2025. The decline in demand for cassava in the tapioca sector is undoubtedly related to the decline in production of cassava in Lampung Province. It can be seen that demand for cassava for the tapioca business increased from 7,029,000 tons/year in 2018 to 7,120,400 tons/year in 2018, even though demand for cassava for the tapioca industry has decreased over the last five years. Different conditions occur in Sub-Saharan Africa, which is projected to experience an increase in food demand of 55% in 2035, where cassava (Manihot esculenta) is the predominant crop and serves as the primary source of calories [22].

The forecasted decline in cassava production until 2025 will cause demand for cassava for the industry to decline, however, demand for fresh cassava for the tapioca industry will remain the same or even increase due to the increase in the number of tapioca factories in Lampung Province. According to the Lampung Province Department of Industry and Trade [60] the need for fresh cassava for the tapioca industry in Lampung Province is 9,576,000 tons per year, because the need this raw material cannot be supplied from cassava production Lampung Province, tapioca industry must buy fresh cassava from outside Lampung Province. As a result of industrial demand not being met, this condition could affect the price of cassava in Lampung Province.

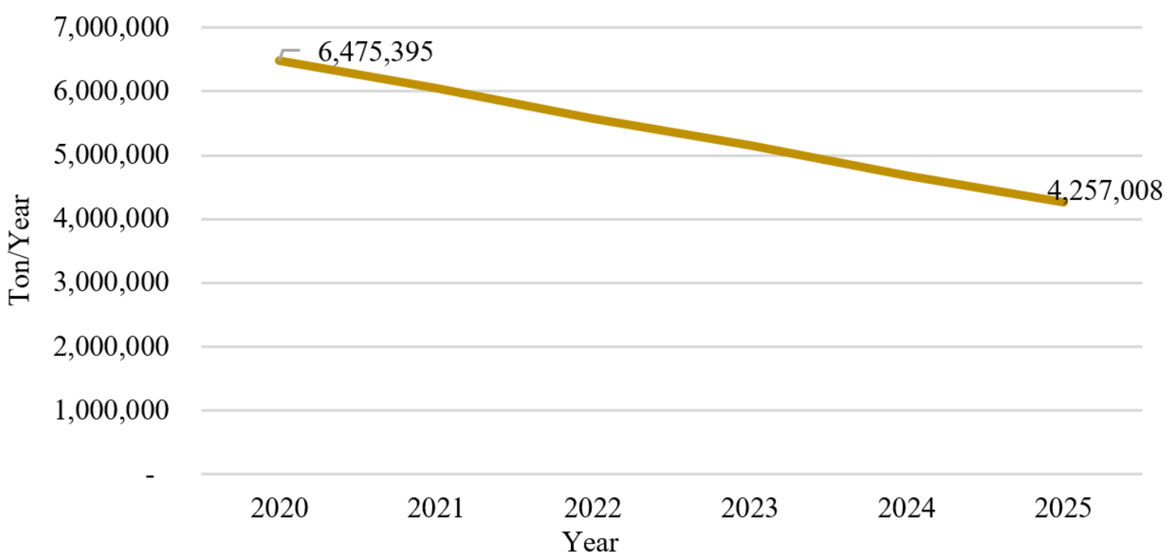

Figure 4.
Results of forecasting demand for cassava in the tapioca industry in Lampung Province in 2020-2025.

Tapioca production in industry is very dependent on the supply of cassava, therefore demand for cassava for industry and cassava production must be balanced [61]. According to the findings of

Iskandarin and Simbolon [23] the availability of raw materials for the cassava processing sector is an internal factor that influences demand for cassava. Cassava farmers in Lampung Province are experiencing problems in meeting the demand for fresh cassava raw materials in the tapioca sector. Government involvement is also needed in increasing cassava production in Lampung Province, where government policy is considered an external variable that can influence demand for cassava [23]. Cassava production that is sufficient for industrial needs will have an impact on stable cassava prices at the farmer level. When cassava reaches its maximum harvest age (18 months), profits are maximized because the amount of harvest is much greater. However, at this age, cassava roots contain a lower percentage of starch so pricing based on starch content provides a much lower average monthly profit compared to pricing based on weight. Cassava roots at such an old age are only suitable for processing into cassava chips or pellets, but not for making tapioca flour [62].

4.4. Forecasting Demand for Gaplek Industry

The results of stationary testing data on demand for cassava for the gaplek industry in Lampung Province are stationary at the 1st difference condition. The probability value of each variable used in the cassava demand equation for the gaplek industry can also indicate a stationary condition. Based on these results, the appropriate forecasting model for the cassava demand equation for the gaplek industry in Lampung Province uses the ARIMA method. The outcomes of the stationary test regarding cassava demand for the gaplek industry in Lampung Province are displayed in Table 5.

Table 5.
Results of the stationary test for cassava demand in the Gaplek industry of Lampung Province.

Method	Statistic	Prob.**
PP - Fisher Chi-square	604.879	0.0000
PP - Choi Z-stat	-561.770	0.0000

The R-squared value obtained was 42.04 percent (Table 6). This value means that variations in forecasting demand for cassava for the cassava industry can be explained by AR(1) and MA(2). The probability F-statistic value obtained has no real effect because it is more than 0.1 percent. The best ARIMA model testing results for forecasting demand for cassava for the gaplek industry in Lampung Province are AR(1) and MA(2). Table 6 presents the outcomes of evaluating the optimal AR, MA, and ARIMA models for cassava demand within the gaplek industry in Lampung Province.

Table 6.
Test results of the best AR, MA, and ARIMA models for cassava demand for the cassava industry in Lampung Province

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.7887	0.5716	1.3797	0.2010
MA(2)	-0.9999	3.5638	-0.0002	0.9998
R-squared	0.4204			
F-statistic	2.1763			
Prob(F-statistic)	0.1605			

Figure 3 depicts the results of estimating the demand for cassava in the Lampung Province cassava sector from 2020 to 2025, which is 58,727.77 tons/year in 2020 to 52,448.92 tons/year in 2025. Forecasting demand for cassava for the cassava industry also experienced a decline, comparable to the predicted tapioca consumption for the cassava sector. In the last three years, demand for cassava in the cassava business has fallen so it is predicted that it will also decline. The number of industries and production capacity of the gaplek industry is not as big as the tapioca industry, but with the existence of the gaplek industry, at least cassava farmers are not fixated on just one industry, which is the tapioca industry. The increasing number of cassava processing industries will have an impact on the price of cassava which cannot be monopsony by the tapioca industry. According to the analysis of factors affecting the price of cassava at the farmer level, the results obtained are that the cassava price variable at the gaplek industry level influences cassava price at the farmer level.

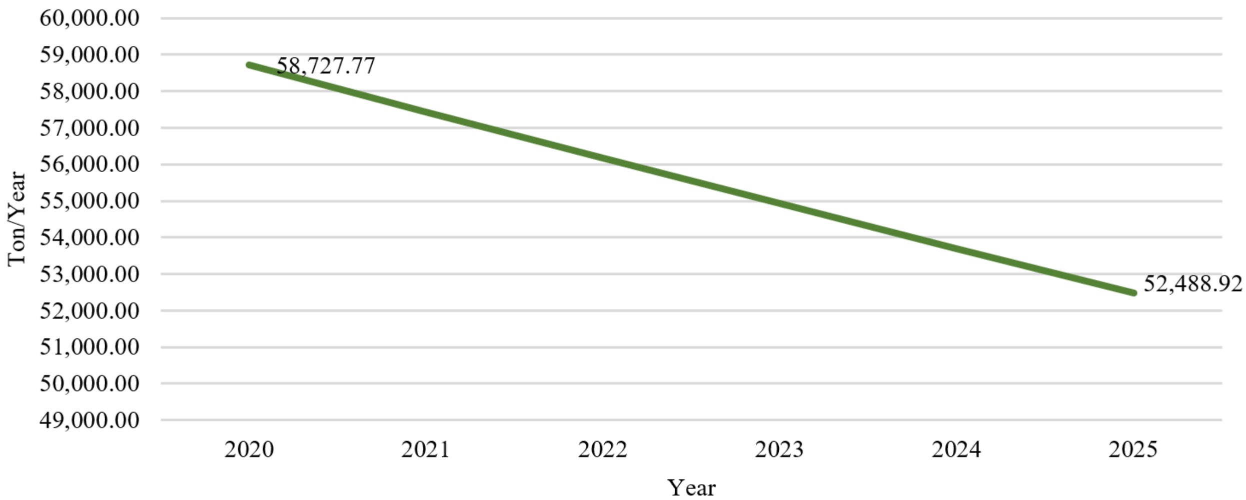

Figure 5.
Results of forecasting demand for cassava for the cassava industry in Lampung Province in 2020-2025.

4.5. Forecasting Cassava Prices for Lampung Province

One of the conditions that must be met so that an equation model can be predicted is that the data is stationary. Table 6 shows that the farm-level price of cassava in Lampung Province is stationary at the 1st difference condition. This condition can be seen in the Probability value of the PP-Fisher Chi-Square below 0.05. Based on these results, the appropriate forecasting model for the farmer-level cassava price equation in Lampung Province uses the ARIMA method.

The best models obtained to predict cassava prices at the farmer level are AR(2) and MA(1) (Table 7). The R-squared value obtained was 49.08 percent. This means that variations in farm-level cassava price forecasting can be explained by the variables AR(2) and MA(1). The prob value in the F-statistic is 0,0945 which means that AR(2) and MA(1) have a simultaneous effect on the price of cassava at the farmer level in Lampung Province. The R-squared value, probability of each variable, and probability F-statistic are indicators for assessing the best model in forecasting using the ARIMA method. Based on this description, the best model for cassava production in Lampung Province is ARIMA (2,1,1). The stationary test results for farmer-level cassava prices in Lampung Province are displayed in Table 6, while the outcomes of the optimal AR, MA, and ARIMA model tests for these prices as presented in Table 7.

Table 6.
Stationary test results of cassava prices at farmer level in Lampung Province.

Method	Statistic	Prob.**
PP - Fisher Chi-square	46.8315	0.0000
PP - Choi Z-stat	-4.23363	0.0000

Table 7.
Results of testing the best AR, MA, and ARIMA models for farm-level cassava prices in Lampung Province.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(2)	-0.6988*	0.3353	-2.0838	0.066
MA(1)	-0.3318	0.4939	-0.6717	0.518
R-squared	0.4908			
F-statistic	2.8916*			
Prob(F-statistic)	0.0945			

Note: Description :
* = Level α = 0.10
** = Level α = 0.05
*** = Level α = 0.01

The forecast price for cassava at the farm level in Lampung Province will increase from IDR 1,138.36/kg to IDR 1,1441.63/kg in 2020-2025. A cassava harvest age of 18 months significantly provides a higher average monthly profit, this is because the longer farmers harvest their cassava, the higher the price [62]. The study reports a significant increase in almost all food commodities during the COVID-19 pandemic when compared to the period before the COVID-19 pandemic [63]. Yams, sweet potatoes, and cassava flour (alagbo) saw their prices double after the COVID-19 lockdown (96.32-117.5%) [63]. The factors that influence Thai farmers' decisions in selling their cassava harvest are market prices. Seasonal differences, cassava weight, and starch content can change with the age of the cassava plant [62]. A more accurate, high-performance, and cost-effective phenotyping approach can accelerate the development of cassava varieties with high starch content to meet growing market demand [27].

The findings are expected to be encouraging for cassava farmers in Lampung Province. These results require government assistance and government initiatives. This is consistent with the findings of [25] that institutions play an important role in ensuring that other cassava marketing actors (farmers, processors, distributors, transporters, and consumers) are well aligned to strengthen horizontal relationships and interactions. vertical. Government institutions are the main institutions in developing and enforcing policies. An institutional approach to cassava farmers can be the focus of the government to maintain cassava price stability. The availability of fresh cassava as an industrial raw material is very important for the industry so that it can continue to produce gaplek or tapioca. The research findings reveal that farmers, processors, transporters, traders, consumers, and institutions are the primary stakeholders. Four types of institutions exist: governmental, non-governmental, community-based groups, and international institutions. These institutions are tasked with policy design and execution, research and development, capacity building, and creating market access networks for cassava and its derivatives. The results demonstrate an absence of identifiable connections and collaboration among farmers, producers, processors, traders, transporters, and consumers. These institutions are efficiently coordinated and fulfil diverse duties across the chain to influence player dynamics. From a policy perspective, it is crucial to develop strong public-private partnerships to improve the insufficient connections among stakeholders (farmers, producers, processors, merchants, transporters, and consumers) and institutions. Strong collaborations are expected to reduce transaction costs among stakeholders [25]. The problem that arises related to prices according to Opata, et al. [24] is the failure of farmers to calculate and estimate transaction costs, if farmers can calculate these costs, then farmers will be able to know what prices farmers should receive when selling their cassava harvest.

There is a situation in the field where cassava is abundant, causing queues for cassava in the Tapioca industry to last for days. This condition causes the starch content of cassava to be low. Lower cassava prices will result from a continued decline in quality. According to [47] selling fresh cassava crops will cause the greatest losses compared to crops that have been processed first. This can be anticipated by farmers by developing farming strategies for each farmer group in each hamlet. Diverse planting patterns in each cassava plantation will produce an even harvest every month so that the availability of cassava for industry is more guaranteed. A stable supply of cassava will result in a more stable and even higher cassava price. This is in accordance with research by Zakaria [64] which found that institutional recommendations at the farmer level regulate planting patterns for cassava production. By guaranteeing cassava's accessibility as a raw resource for industry, a pattern of cooperation can be formed. This certainty can be used to calculate the agreed price for cassava. Both parties will benefit from this collaboration. Cassava farmers as producers get certainty about the price of cassava at harvest time, and industry as consumers of fresh cassava for industrial raw material needs get certainty about raw materials so that production planning and implementation can be carried out optimally by the cassava processing industry, as well as the development of cassava agribusiness wood in Lampung Province to be realized [64]. The following results of forecasting cassava prices at the farmer level in Lampung Province are presented in Figure 6.

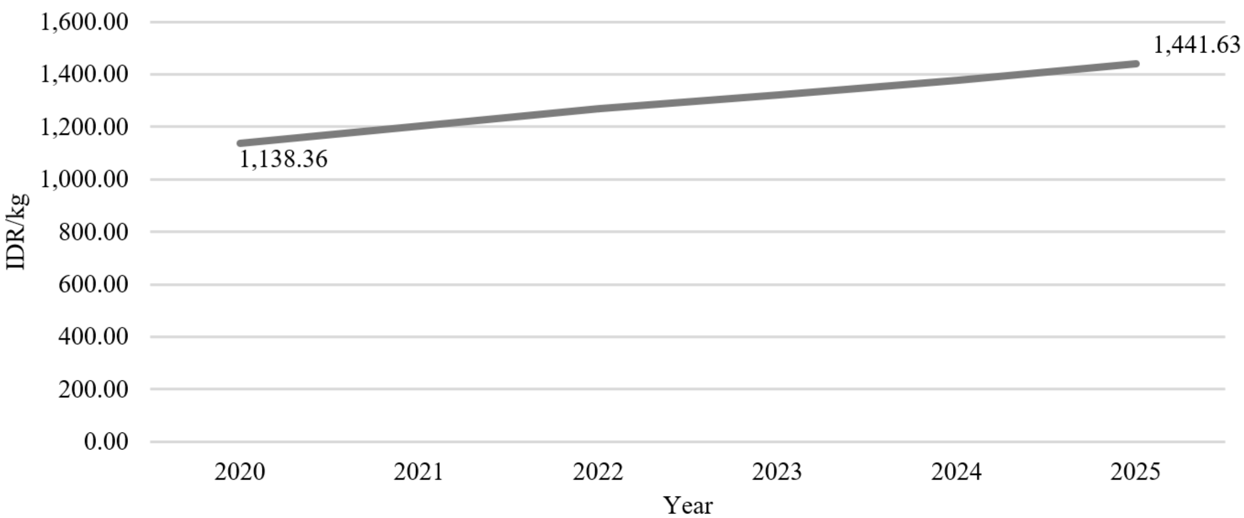

Figure 6.
Results of forecasting cassava prices at farm level in Lampung Province for 2020-2025.

The results of cassava price forecasting in this research show that the price of cassava will increase until 2025. These results are in line with publications from (the Ministry of Agriculture [65]) statistics indicate that in Lampung Province, the cost of cassava at the producer level will rise in 2022. Forecasting analysis which was carried out using the ARIMA method in this research can be adopted by other researchers and can become a recommendation for policy input for the government because the results obtained can represent the real situation.

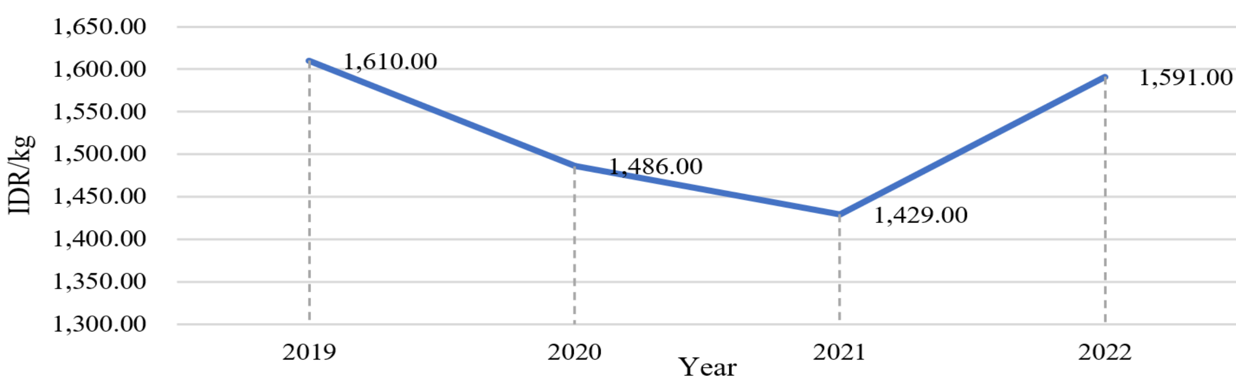

Figure 7.
Average farmer price of cassava in Lampung Province in 2019-2022

5. Conclusion

A The conclusion that can be drawn from this research is that the forecast supply of cassava in Lampung Province and the forecast demand for cassava for the cassava and tapioca industry in Lampung Province will experience a decline in 2020-2025, while the forecast price of cassava will stagnate. Farmers have grown between 2020 and 2025. The government can anticipate a decline in cassava production by investing in education, counseling, and infrastructure related to the cassava commodity, which currently has very little outreach regarding this mainstay commodity of Lampung Province. Counseling programs and financial assistance provided by the government can have a big influence on making agriculture and cassava processing the main focus or important activity in society. This program can strengthen the important role of agriculture and cassava processing, this was adopted by Rahman and Awerije [28] and Roman and Westengen [37]. Meanwhile, the anticipation that can be made by the government if there is a decline in the price of cassava in the future is to increase the performance of the cassava farmer group so that they can sell their harvest collectively so that farmers will have a higher bargaining power position in selling their production to industry. adopted from Mutyaba, et al. [25].

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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