The contribution of agricultural crop production towards the economic growth of Indonesia's agricultural sector

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Abstract. The agricultural sector is annually included in the top three after the manufacturing sector and wholesale and retail trade sectors as Indonesia's largest contributor to gross domestic product (GDP). The average contribution of the agricultural sector to the country's income is around 11–13% of total GDP. The GRDP of the agricultural sector (AgriGRDP) is an indicator of the economic growth of Indonesia's agricultural sector. This study aims to examine the contribution of plantation crop production (PPC), food crop production (PFC), horticultural crop production (PHC), and farmer terms of trade (FTT) to the AgriGRDP. This study uses secondary data sourced from BPS-Statistics Indonesia. This research method uses panel data regression analysis with time series data for 2018–2021 and cross-sectional data from 33 provinces in Indonesia, resulting in 132 observations. The results of this study found that the best econometric model to answer the research objectives is the random effect model (REM). The findings of this study indicate that simultaneously and partially, the variables PPC, PFC, PHC, and FTT have a significant positive effect on AgriGRDP. An increase in PPC, PFC, PHC, and FTT will increase Indonesia's AgriGRDP.

1 Introduction

Indonesia is an agrarian country where people make their living in the agricultural sector. This condition is based on Indonesia's geographical conditions, which are on the equator and have a tropical environment [1]. Therefore, there is a strong potential for developing natural resources in the agricultural sector. It is a sector that utilizes natural resources carried out by farmers and farm laborers to produce agricultural crop products (food, plantations, livestock, and more) so that basic or primary human needs can be fulfilled. The agricultural sector's role in Indonesia has increased every year and is expected to reduce poverty, provide jobs,

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increase export earnings and foreign exchange reserves, increase national income, and realize equitable development in the regions.

The agricultural sector is included in Indonesia’s top three contributors to gross domestic product (GDP) by industry origin [2]. The agricultural sector accounts for approximately 11-13% of total national GDP yearly [3]. Based on data from BPS-Statistics Indonesia [2], the agricultural sector's GRDP in 2018 was 27.92 trillion IDR, increasing yearly; in 2021, it was 30.14 trillion IDR, an increase of 1.10% from the previous year. This condition has a positive impact on Indonesia's economic growth. According to Ruslan and Prasetyo [4], the agricultural sector contributes to the national economy and generates foreign exchange. Cheng [5–7] emphasized that the agriculture sector is essential and contributes to economic development.

The GRDP of the agricultural sector (AgriGRDP) is a proxy for the economic growth of the agricultural sector in Indonesia. The agricultural sector's GDP (AgriGRDP) is an important metric for gauging a country's primary sector for people, especially since the agricultural sector offers a source of income for all households [8]. East Java, North Sumatra, Central Java, Riau, and West Java have the largest agricultural GRDP in Indonesia, with superior agricultural products in each region (Fig. 2). On the other hand, several provinces are still quite low in contributing to the AgriGRDP.

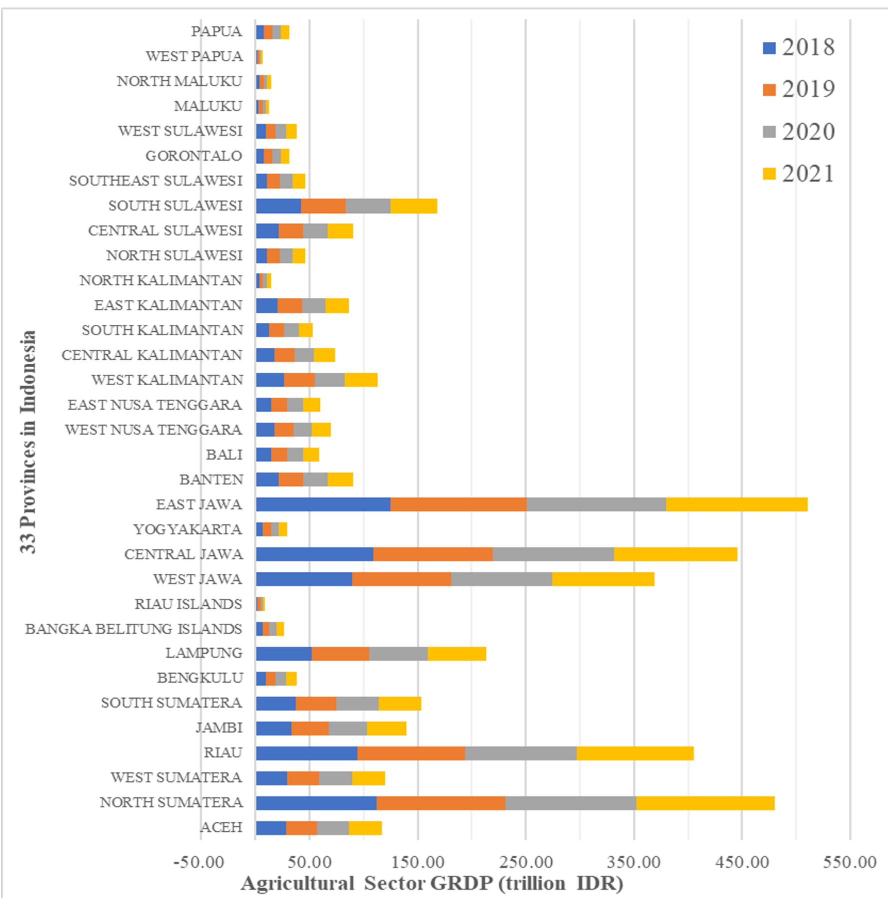

Fig. 1. GRDP of the agricultural sector at constant market prices in 33 provinces
Source: BPS-Statistics Indonesia [3]

Various factors influence AgriGRDP; in this study, the influencing factors or indicators are plantation crops production (PPC), food crops production (PFC), horticultural crops production (PHC), and farmer terms of trade (FTT). According to BPS-Statistics Indonesia [9], PPC was 57,980.7 tonnes in 2020 and 56,479.4 tonnes in 2021 or a decrease of 2.59%. PFC in 2021 decreased from the previous year, by 0.43%, or 54,415,294.22 tonnes [10]. Hence, PHC and FTT experienced fluctuating values from 2018 to 2021. The PHC and FTT values in 2021 grew from the previous year by 4.53% and 2.94%, respectively [11,12].

These conditions do not necessarily affect the growth of AgriGRDP. AgriGRDP is significantly influenced by plantation crop production (PPC) [4,6,13–15]. Food crop production (PFC), which includes rice, corn, soybeans, and other crops, significantly affects AgriGRDP [5,6,15–17]. Furthermore, horticulture crop production (PHC) significantly affects the agricultural sector's economic growth [5,6,15]. At the same time, FTT significantly affects AgriGRDP growth [18–21].

The results of previous research and the theory described above show differences in statistical data from BPS-Statistics Indonesia (gap research), which reports that agricultural crop production and FTT have fluctuating values from 2018–2021 [9–12]. This study differs from past studies in terms of research variables, research methodologies, data collection period, and research themes. Hence, this research aims to learn about the general description of GRDP in the agricultural sector, production of plantation crops, food crops, horticultural crops, and farmer terms of trade, as well as to conduct research that comprehensively analyzes the effect of agricultural crop production (PPC, PFC, and PHC) and FTT on the economic growth of the agricultural sector (AgriGRDP) in Indonesia.

2 Research methods

2.1 Types of data and research models

This study uses secondary data obtained from BPS-Statistics Indonesia [3,9–12]. AgriGRDP is a proxy for economic growth in the agricultural sector. The GRDP value of the agricultural sector used is the GRDP in the Agriculture, Livestock, Hunting and Agriculture Services sub-sectors, while the Forestry, Logging, and Fishery sub-sectors are not included in this study. In order to answer the first research objective, this research uses descriptive statistical methods. This method is used to get an overview of the various characteristics of the research variables, as seen from the mean, maximum, minimum, and standard deviation value [22].

$$logAgriGRDP_{it} = \beta_0 + \beta_1 logPPC_{it} + \beta_2 logPFC_{it} + \beta_3 logPHC_{it} + \beta_4 FTT_{it} + \varepsilon_{it} \quad (1)$$

Where:

AgriGRDP	: GRDP of the agricultural sector (IDR)
$\beta 0$	: Constant
$\beta_1 - \beta_4$	: Regression coefficient
PPC	: Plantation crops production (tonnes)
PFC	: Food crops production (tonnes)
PHC	: Horticultural crops production (tonnes)
FTT	: Farmer terms of trade (index)
ε	: Error term
i	: 33 Provinces in Indonesia
t	: Year (2018 – 2021)
log	: Logarithm

In addition, this study also conducted panel data regression analysis, with time series data for 2018–2021 and cross-sectional data, namely from 33 provinces in Indonesia. DKI Jakarta

Province was not included because it does not have plantation crop production value. This method is used to answer the question of the second objective, namely, to determine the correlation between independent variables (PPC, PFC, PHC, and FTT) and the dependent variable (AgriGRDP) on certain data from an item during the analysis period in order to obtain good statistical estimations [22,23]. Based on the above explanation, the regression model used in this study is as Equation 1.

Several hypotheses have been developed and statistically examined as temporary answers to the research problems based on the framework. The research hypotheses are: 1) HPPC: PPC has a significant positive effect on AgriGRDP, 2) H_{PFC}: PFC has a significant positive effect on AgriGRDP, 3) H_{PHC}: PHC has a significant positive effect on AgriGRDP, dan 4) H_{FTT}: FTT has a significant positive effect on AgriGRDP.

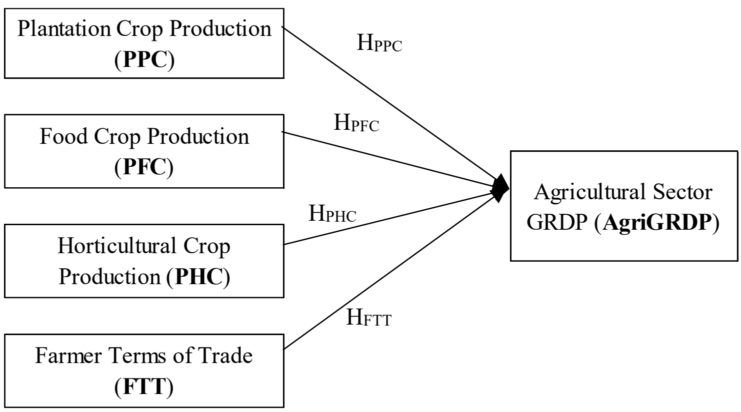

Fig. 2. Research framework

2.2 Research model selection

The best research model that satisfies statistical requirements is selected using the econometric model selection process. The three models are the common effect model (CEM), fixed effect model (FEM), and random effect model (REM) [22,23]. The CEM model, also known as partial least squares, which combines all panel data with each analysis subject, is assumed to have the same intercept and slope [22,23]. FEM is known as the Least Squares Dummy Variable since it is estimated with a dummy variable to represent changes in intercepts between study variables, assuming different intercepts between subjects and the same slope between subjects [22,23]. Meanwhile, REM has the advantage of overcoming uncertainty in the FEM model, and REM also has the advantage of eliminating heteroscedasticity [22,23].

$$Chow = \frac{[RRS-URRS]/(n-1)}{URRS/(nT-n-K)} \tag{2}$$

Where:

n : Data cross section
T : Time series data
K : Number of explanatory variables
RSS : Residual sum of squares from CEM estimation results
URRS : Residual sum of squares from FEM estimation results

The process of selecting the optimal regression model for these three models was then carried out. The regression model was tested for the first time using the Chow, Hausman, and

LM tests. The Chow test compares two models, CEM and FEM, using the cross-sectional Chi-square value at the 5% level of significance [22,23]. Chow Test Statistics as Equation 2.

Hausman test is used to choose between the FEM and REM models by looking at random cross-section values at the 5% significance level [22,23]. Hausman Test Statistics:

$$X^2(K) = (b-\beta)'[var(b-\beta)^{-1}(b-\beta) \quad (3)$$

Where:
b : REM coefficient
β : FEM coefficient

The LM test is used to identify between the CEM and REM models, by looking at the Breusch-Pagan value at the 5% level of significance [22,23]. LM Test Statistics:

$$LM = \frac{nT}{2(T-1)}\left[\frac{\Sigma_{i=1}^{n}[Te]^2}{\Sigma_{i=1}^{n}\Sigma_{i=1}^{T}e_{it}^2} - 1\right]^2 \quad (4)$$

Where:
T : Number of time series units
n : Number of cross-sectional units
e_{it} : Residual at the i^{th} unit and t^{th} time

2.3 Classic assumption test

The selected research model was subjected to a series of classical assumption tests to ensure the results fulfilled the best linear unbiased criteria [22,23]. To determine whether the distribution of research data in the panel data is normally distributed, the test comprises a normality test. To ascertain whether there was a linear relationship between the variables that explained the selected model, a multicollinearity test was used. The heteroscedasticity test explains various residuals that are either constant or changing. The autocorrelation test is used to determine the link between variables in the model and time periods.

2.4 Parameter significance test

The F-test, t-test, and coefficient of determination are required to assess the feasibility of the research model [22,23]. Simultaneously, an F-test was employed to determine whether any independent variable had significant effects on the dependent variable. The t-test determines the partial impact of the four independent variables on the dependent variable in the selected econometric model. The coefficient of determination determines how well the four independent factors describe a dependent variable.

3 Result and discussion

3.1 Research result

Indonesia is one of the world's leading producers of agricultural crops. In 2018, Indonesia's agricultural sector had the world's fifth-greatest GDP [24]. The number of observations, mean, maximum, minimum, and standard deviations value are calculated using descriptive statistical analysis (Table 1). There are 132 observations for each research variable. The agricultural sector's economic growth (AgriGRDP) in Indonesia from 2018 to 2021 was 31,498.80 billion IDR, with a maximum value of 130,377.00 billion IDR in East Java

Province (2021) and a minimum value of 1,582.00 billion IDR in West Papua Province (2018). Oil palm dominates plantation crop production (PPC) in Indonesia. Production of oil palm plants reached 46.22 million tonnes in 2021 [9]. The mean PPC value from 2018 to 2021 was 1,706.22 thousand tonnes, with the maximum and minimum PPC values being 10,679.60 thousand tonnes (Riau Province in 2020) and 48.40 thousand tonnes (Riau Islands Province in 2021).

Rice, corn, cassava, sweet potatoes, soybeans, and long beans are the main food crops of Indonesia [10]. In 2022, Indonesia's rice production will reach 54.75 million metric tonnes [10] and rank third globally [25]. The statistical summary in this study illustrates that the mean value of food crops production (PFC) is 1.69 million tonnes, the maximum value gained by Central Java Province in 2018 is 10.50 million tonnes, and the minimum value gained by Riau Islands Province is 852.54 tonnes in 2020. Horticultural crop production in 2018-2021 had a mean value of 1.37 million tonnes, with West Java Province achieving the maximum value in 2018 and West Papua Province obtaining the minimum value in 2018 (Table 1). FTT is a proxy for farmer welfare in Indonesia [12]; during the research year, the mean value was 102.55, the maximum value was 138.72 in Riau Province (2021), and the minimum value was 86.89 in Bangka Belitung Islands Province (2018).

Table 1. Results of research descriptive statistics

Variables	AgriGRDP (Billion IDR)	PPC (Thousand tonnes)	PFC (tonnes)	PHC (tonnes)	FTT (index)
Mean	31,498.80	1,706.22	1,688,280.39	1,370,876.38	102.55
Maximum	130,377.00	10,679.60	10,499,588.23	22,192,717.00	138.72
Minimum	1,582.00	48.40	852.54	11,488.00	86.89
Std. Dev	35,881.71	2,466.56	2,724,175.53	2,920,265.80	8.01

In this study, the most effective research model was chosen using a statistical test method. The Chow Test yields a probability value of 0.000 and H_1 is accepted, and the second test can be continued. If the probability value of the Hausman Test is greater than 0.051 (>0,05), H_1 is accepted, and the LM Test is performed. The results of this final test obtained a probability value of 0.000, then H_1 was accepted. As a result, the REM model was chosen as the regression model to evaluate the hypothesis of this study model. Table 2 presents the results of the selection of models and the classic assumptions of the research.

Table 2. Research model selection results

Selection of Research Model		
Test	**Probability Value**	**Decision**
Chow Test	0.000*	FEM
Hausman Test	0.051*	REM
LM Test	0.000*	REM
Classic assumption test		
Normality Test	0.393*	
Multicollinearity Test	Independent Variable < 0.80**	

` Note: Significant level 5% (*), multicollinearity level 0.80 (**)

With a value of 0.393, the selected research model is free of deviations from normality, and the multicollinearity test for the four independent variables is less than 0.80. Because the REM model is weighted by cross-section weight, it lacks heteroscedasticity and autocorrelation violations [22,23]. The AgriGRDP model is free of the problem of divergence from classical assumptions (BLUE). Table 3 displays the REM model output estimation results.

Table 3. REM model output estimation results

Variables	Coefficient	Std. Error	t-Statistic	Prob.	Decision
C	3.007	0.153	19.68	0.000	
PPC	0.098	0.025	3.880	0.000*	H_{PPC} Acceptable
PFC	0.121	0.023	5.196	0.000*	H_{PFC} Acceptable
PHC	0.032	0.009	3.348	0.001*	H_{PHC} Acceptable
FTT	0.001	0.000	5.514	0.000*	H_{FTT} Acceptable
Goodness of fit					
R2		0.263	Coefficient of determination: 23.90%		
Adj R2		0.239			
F-statistic		10.991	F-Statistics Test: 0.000		
Prob(F-statistic)		0.000*			

Note: significant level 5% (*)

The F-test findings showed a probability value of 0.000 or less than 5%, indicating that at least one independent variable correlated with the dependent variable, while PPC, PFC, PHC, and FTT had a significant effect on each of the dependent variables (AgriGRDP). The t-test states that the PPC, PFC, PHC, and FTT variables partially have a significant effect on the GRDP of the agricultural sector. The coefficient of determination is 23.90% of the variance of the dependent variable, which can be expressed in terms of the independent variables; the other variables explain the remaining 76.10%. Other variables that have not been analyzed, such as the inflation rate, farmer poverty, selling and buying prices of agricultural commodities, weather conditions, and others. Based on Table 3, the equation of the research model is:

$$logAgriGRDP_{it} = 3.007 + 0.098logPPC_{it} + 0.121logPFC_{it} + 0.032logPHC_{it} + 0.001FTT_{it} \quad (5)$$

3.2 The effect of plantation crop production on the AgriGRDP

The PPC coefficient is 0.098 (Table 3), which suggests that increasing PPC by one percent increases the agricultural sector's GRDP (a proxy for economic growth in the agricultural sector) by 0.098%, assuming cateris paribus. The t significance test yielded a probability value of 0.000, then H_{PPC} is acceptable. The study's findings indicate that PPC significantly increases AgriGRDP in Indonesia. The higher the production of plantation crops, the higher the agricultural sector's economic growth, contributing to Indonesia's income.

The findings of this study are supported by research indicating that plantation crop production has a significant effect on the GRDP of the agricultural sector [4,6,13–15]. Oil palm is the plantation crop that contributes the most to the agriculture sector's GRDP [9]. According to [26,27] oil palm production can increase GRDP in Indonesia, and the most important thing is to increase PAD in each region. Plantation crops are a leading sub-sector and a priority for energy development in the Bangka Belitung Islands Provincev[28].

The plantation sub-sector contributes significantly to the national economy and generates foreign exchange through plantation commodities [4]. Additionally, a good, effective, and efficient supply chain for oil palm crops or fresh fruit bunches can help improve the welfare of oil palm farmers in the region [29]. During the COVID-19 pandemic, the palm oil industry became a mainstay of the performance of the national trade balance, contributing 3.5% of Indonesia's GDP and ranking first in agricultural crop production [30]. The government must continue to increase and maintain plantation crop production capacity by expanding land area and plantation crop productivity.

3.3 The effect of food crop production on the AgriGRDP

PFC has a coefficient value of 0.121, which means that increasing PFC by one percent increases AgriGRDP by 0.121%. The t test's probability value is 0.000, then HPFC is acceptable. The conditions show that PFC has a significant positive influence on AgriGRDP in Indonesia. Increased production of food crops such as rice, corn, soybeans, and others will increase the AgriGRDP in Indonesia.

The findings of this study are consistent with studies from [5,6,15–17], which indicates that the amount of agricultural crop production, especially food crops, impacts the agricultural sector's GRDP. According to [27,31], the agricultural sector contributes significantly to the economy by supporting growth in other sectors, particularly the industrial sector. The agriculture sector's GRDP is affected by expenditures in the food crop, plantation, livestock, and fisheries sub-sectors [15].

On the other hand, food crop production is increasing, and food security will face challenges in the medium term with reduced irrigation infrastructure and logistics chains [32]. Additionally, the role of agricultural technology is needed to increase the production of agricultural crops, especially food crops, and increase the added value of agriculture in the case of Bihar, India [33]. The government needs to create a long-term plan for irrigation infrastructure development in the region so that agricultural crop output is not disrupted and increases year after year. Increased production of food crops is urgently needed because food crops are the people's basic needs in each region that must be met and impact the economy.

3.4 The effect of horticultural crop production on the AgriGRDP

PHC is an area's total horticulture crop production. The findings of this study indicate that the PHC coefficient is 0.032, meaning that the more the PHC increases by one percent, the AgriGRDP will increase by 0.032%, assuming ceteris paribus. The t test's probability value is 0.001, then HPHC is acceptable. The conditions of this study explain that PHC significantly affects AgriGRDP in 33 provinces. The higher the horticulture crop production, the higher the economic growth in the agriculture sector.

The results of this study align with studies that report that the production of horticultural crops has a significant effect on the GRDP of the agricultural sector [5,6,15]. Investment in the agricultural sector, namely in the sub-sectors of plantation crops, food crops, and horticulture crops, has the potential to enhance Aceh's economy [34]. Increased horticultural crop production must correspond with increased commodity marketing to generate additional value for horticultural crop farmers. In addition, policies related to agricultural development, especially horticultural crops with "agropolitan" zoning, are needed based on the percentage share of agriculture and the distribution of the road network [35].

3.5 The effect of farmer terms of trade on the AgriGRDP

FTT is a proxy for farmers' well-being in Indonesia. The FTT calculation is done by dividing the price index received by smallholders by the price index paid by smallholders [12]. Table 3 indicates that the FTT coefficient is 0.001, meaning that increasing the FTT value by one percent increases agricultural GRDP by 0.001%, assuming cateris paribus. In the significance test, a probability value of 0.000 was obtained, then HFTT is acceptable. This condition indicates that FTT has a significant positive effect on the economic growth of the agricultural sector in Indonesia. With the increase in the welfare of farmers in various regions of Indonesia, the economic growth of the agricultural sector has also increased and contributed to national income.

This study's findings are strengthened by research that says that the GDP of the food crops sub-sector is significantly influenced by the FTT of food crops [18–20]. Farmers' and farm laborers' income has a considerable positive impact on agricultural sector economic growth and agricultural economic development [21]. The agricultural sector provides a source of income for all farmer households, thereby increasing farmer's social and economic welfare [8].

Government policies must maintain FTT above 100 (surplus) or at least 100 (break-even), so that farmer's welfare increases and impacts the GRDP of the agricultural sector. The government must maintain the cost of goods sold at the farmer's level so that farmers receive a price index above 100. On the other hand, the government must also reduce the price index paid by smallholders in the sector of production costs and additional capital. Providing subsidies for fertilizers, pesticides, and plant seeds to producers will be useful for keeping farmers' purchasing power for these products affordable and reducing the price index smallholders pay.

4 Conclusion

The agricultural sector's GRDP (AgriGRDP) is a proxy for the agriculture sector's economic growth. The results of this study showed that the best econometric model for answering the research objectives was REM. Based on the research results and discussion, it appears simultaneously that the variables PPC, PFC, PHC, and FTT affect AgriGRDP. In the t-test statistics, it can be concluded that PPC, PFC, PHC, and FTT significantly influence the economic growth of Indonesia's agricultural sector (AgriGRDP). PPC, PFC, PHC, and FTT had coefficients of 0.098, 0.121, 0.032, and 0.001, respectively.

Government agricultural policies have been appropriate and on target; increasing plantation crop production (PPC), food crop production (PFC), horticultural crop production (PHC), and farmer exchange rates (FTT) will increase economic growth and national income in Indonesia's agricultural sector. The increased production of agricultural crops corresponds to the employment of more advanced agricultural technologies and increasingly limited agricultural land.

Indonesia's national and local governments have successfully and efficiently executed HPP for agricultural crops, allowing market price stability to be maintained. In addition, the government's provision of retail prices and subsidies for fertilizers, pesticides, and plant seeds that are right on target and evenly distributed can reduce production costs and increase capital so farmers can prosper. The government must also support the infrastructure sector in rural areas through irrigation and roads, as well as improve the skills of farmers. This research has limitations in terms of period, method, and research variables. It is expected that researchers and academics can improvise this research theme based on the period, methods, and research variables (such as the inflation rate, selling and buying prices of agricultural products, and others).

Acknowledgment. The researchers thanked the OR TKPEKM at BRIN, which became a forum for researchers to develop a career as researchers, and Mrs. Rulina (Librarian of BRIN), who facilitated some of this research literature.

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