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The Effect Of Agricultural Sector Labor, Agricultural Sector Exports, And Agricultural Sector Investment On Economic Growth With Technology As A Moderating Variable

Muhamad Yufa Ariefqi¹, Diyah Ariyani²

¹ Faculty of Economics and Islamic Business, Salatiga State Islamic University, Salatiga

² Faculty of Economics and Islamic Business, Salatiga State Islamic University, Salatiga

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Abstract

The role of the agricultural sector on economic growth is the main focus of this study. This study aims to analyze the effect of labor, exports, and investment in the agricultural sector on economic growth in Indonesia with technology as a moderating variable. This type of research is quantitative using time series data covering the period 2012-2023. The analysis method used is Panel Data Regression Analysis and Moderation Regression Analysis (MRA) using the STATA application. The results showed that agricultural sector labor had a positive and significant effect, and technology was unable to moderate its relationship to economic growth. While agricultural sector exports have a negative and insignificant effect, and technology is able to moderate its relationship to economic growth, agricultural sector investment has a significant negative effect and technology is able to moderate its relationship to economic growth. In the F test, it was found that the independent variables together had a significant effect on economic growth.

Kata kunci:

Pertumbuhan Ekonomi

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Abstrak

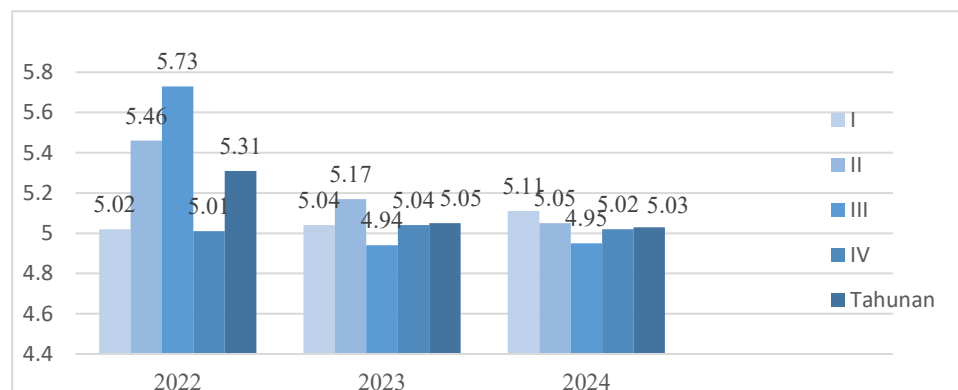
Peranan sektor pertanian terhadap pertumbuhan ekonomi menjadi fokus utama penelitian ini. Penelitian ini bertujuan untuk menganalisis pengaruh tenaga kerja, ekspor, dan investasi sektor pertanian terhadap pertumbuhan ekonomi di Indonesia dengan teknologi sebagai variabel moderating. Jenis Penelitian ini adalah kuantitatif dengan menggunakan data time series yang mencakup periode 2012-2023. Metode analisis yang digunakan adalah Analisis Regresi Data Panel dan Analisis Regresi Moderasi (MRA) dengan menggunakan aplikasi STATA. Hasil penelitian menunjukkan bahwa tenaga kerja sektor pertanian berpengaruh positif dan signifikan, dan teknologi tidak mampu memoderasi hubungannya terhadap pertumbuhan ekonomi. Sedangkan ekspor sektor pertanian berpengaruh negatif tidak signifikan, dan teknologi mampu memoderasi hubungannya terhadap pertumbuhan ekonomi, investasi sektor pertanian berpengaruh negatif signifikan dan teknologi mampu memoderasi hubungannya terhadap pertumbuhan ekonomi. Hasil Uji F, ditemukan variabel independen secara bersama-sama mempunyai pengaruh terhadap pertumbuhan ekonomi.

1. Introduction

Development is a multidimensional process that involves changes in social structures, changes in people's attitudes to life, and changes in state institutions. Furthermore, development also includes changes in economic growth, reduction of national income inequality, and eradication of poverty. The achievement of development goals is highly desirable. Therefore, the focus of development is directed at three important aspects: first, increasing the availability and distribution of basic needs for the community; second, improving people's welfare; and third, strengthening people's ability to access economic and social activities in their daily lives (Jefry, 2019).

The main factor in assessing the effectiveness of a country's development is through economic growth. Economic growth is also closely related to people's income. According to Diar (2018), indicators of the success of a country's economy can be seen from high economic growth. This shows that positive economic growth is expected to improve people's welfare, so that they can live more prosperously.

Figure 1: Indonesia's GDP Data for 2022-2024

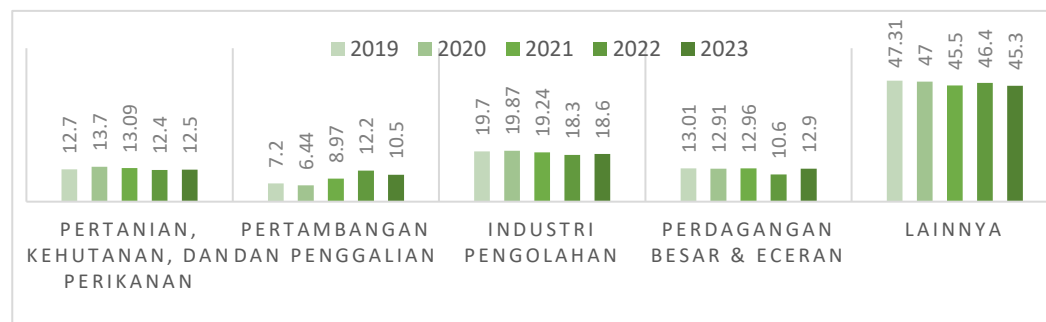


Source : BPS (processed, 2025)

Based on Figure 1.1, it can be explained that the data shows that in 2022 GDP touched a figure of up to 5.73 percent in the third quarter, but in the third quarter of 2023 it experienced a downward trend even at 4.94 percent. In contrast to the previous years, in 2024 it did not experience significant changes and even tended to decline at the end and when viewed on an annual basis it actually fell from the previous year (Central Bureau of Statistics, 2024). said that this stagnation occurred because Indonesia could not compete in the production of labor-intensive goods due to relatively high wages, while the productivity required to compete in high value-added activities was still lacking. Meanwhile, the Indonesian government's target needs to achieve economic growth of at least around 8% by 2029.

In Indonesia, several sectors of the economy that contribute to GDP by business sector do not change significantly over the period 2019 - 2023. The three business sectors that have the largest average contribution during the period are the manufacturing industry followed by agriculture, forestry and fisheries and wholesale and retail trade. As can be seen in figure 1.2 below.

Figure 2: Distribution of GDP by Business Sector 2019-2023



Source : BPS (processed, 2025)

Figure 1.2 shows that the sector with the largest contribution during this period was the manufacturing sector, with an average contribution of 19.14 percent. Agriculture became the second sector after the processing industry with an average contribution of 12.8 percent, followed by the trade and mining sectors at 12.3 percent and 9.06 percent respectively. When viewed by specific sectors, the agricultural sector is the second largest contributor to GDP, which shows that this sector remains one of the important pillars in the national economy. Although the manufacturing sector dominates with a contribution of 19.14 percent, agriculture here serves as an important provider of raw materials and human resources for other sectors (Central Bureau of Statistics, 2023).

Agriculture is a very important sector to support economic growth, especially in developing countries. Agriculture not only serves as a provider of food needs, but also contributes significantly to job creation and increasing people's income. The contribution of the agricultural sector to economic growth becomes more impactful with the adoption of sustainable agricultural technology and innovation. Milligan (2022) in his research said that increased investment in agricultural innovation can significantly boost economic growth and reduce poverty, especially in rural areas. Thus, the development of an innovative and sustainable agricultural sector is a solution to achieve inclusive and sustainable economic growth.

The agricultural sector not only provides employment for millions of people, but also plays an important role in its contribution to national GDP. Research by Djamaluddin & Sari (2021) revealed that the high number of workers in the agricultural sector is in line with the increase in exports, which in turn drives economic growth and improves farmers' welfare. Increased productivity and quality of agricultural products, as well as a skilled workforce will be able to meet international market demand, thus creating a positive cycle between exports, economic growth, and human resource development in the sector. This confirms the importance of policy support and investment in the agricultural sector to maximize its economic potential. The development of exports of agricultural commodities has been positive, which shows the positive value of investment in the agricultural sector. This can make the agricultural sector to continue to compete with other sectors in increasing value in the global market (Ministry of Trade, 2024).

With great potential, agricultural exports in Indonesia must be encouraged through appropriate policies and sustainable investment. Improving the competitiveness of agricultural products in the global market will determine the direction of national economic growth Djamaluddin & Sari (2021). In addition, synergies between the government, farmers, and the private sector need to be improved to create an ecosystem that supports the growth of the agricultural sector and its exports. With these measures, the agricultural sector will not only continue to contribute to economic growth, but also help create a more prosperous and well-off society.

Having highlighted that agricultural labor contributes to economic growth, and that agricultural exports can spur economic growth, it is important to underline how agricultural investment has a synergistic effect in driving Indonesia's economic growth.

Furthermore, investment in the agricultural sector can provide a multiplier effect and linkage effect on the economy, namely on increasing GDP, community income, employment, and encouraging the growth of other sectors or industries Djamaluddin & Sari (2021). It can be observed that this sector has not escaped attention in order to support its contribution to economic development.

The agricultural sector in Indonesia is not only influenced by the number of workers, the level of exports, and agricultural sector investment, but is also increasingly influenced by technology. Technology plays an important role in improving the efficiency and productivity of the agricultural sector by facilitating better access to information for farmers. Halim (2021) said that through digitization of the agricultural sector, farmers can obtain up-to-date data on weather, market prices, and optimal cultivation techniques, so that they can make more informed and quicker decisions.

In addition, digital platforms allow farmers to connect directly with buyers, reducing the middlemen that often work against them. Thus, the application of technology not only supports the improvement of farmers' welfare through better market access, but also contributes to more effective land management and investment (Halim & Prabowo, 2022). With better access to market information, production technologies, and government policies, farmers can increase their yields and income, which in turn contributes to regional and national economic growth.

2. Literature Review

2.1 Economic Growth

Economic growth is the transformation of a country's economy towards better conditions in a specific period of time. Sukirno (2020), states that economic growth is an activity that causes an increase in the production of goods and services by the community so that welfare increases. Therefore, economic growth can also be explained as a step to increase the ability of economic production, which is realized in an increase in state income. An increase in the economy is a sign of success in developing the economy (Sinaga Anita & Nurhayati, 2019).

In this study, the neo-classical theory of Robert Solow and Trevor Swan is used to underlie the variables of labor, exports, investment, and technology. There is a positive signal if capital accumulation is accompanied by labor so that it has an impact on future economic growth, as well as how technology affects this contribution.

Not only that, the underlying contribution of the agricultural sector is to see how from an Islamic perspective, Agriculture in an Islamic perspective has a very important and noble position. The Prophet Muhammad SAW. encouraged his people to farm and garden, the Apostle Muhammad SAW. emphasized that these activities not only meet individual food needs but also contribute to the welfare of society.

Agriculture Sector Labor

Labor refers to the people employed in a production process. All efforts made by the mind and limbs to obtain appropriate rewards. In production activities, each worker will get a wage, namely the income received by workers as a form of reward for their work. Therefore, labor demand can be interpreted as potential human resources needed by employers at various levels of wages (Boediono, 2018).

From the search results, research by Sari and Prabowo (2020) found that an increase in the number of workers in the agricultural sector is positively related to economic growth in rural areas. However, on the other hand, research by Rahman and Sari (2021) shows that an increase in the number of workers that is not matched by an increase in productivity can actually reduce efficiency and potentially hamper economic growth. This shows that there is a gap in the understanding of how the number of workers in the agricultural sector can optimally contribute to economic growth.

2.2 Agriculture Sector Exports

According to Samuelson & Nordhaus (2019) exports are all goods and services produced domestically which are then purchased by foreigners or in other words consumers from abroad. In the understanding of BPS (2019) Export is the delivery of goods and services sold by residents of a country to residents of other countries to obtain foreign currency from the buyer's country.

In previous research related to agricultural sector exports. Research by Hidayat and Lestari (2019) shows that exports of agricultural products have a significant positive impact on economic growth, especially in increasing foreign exchange. However, research by Setiawan (2022) found that high dependence on exports of certain agricultural products can lead to economic vulnerability, especially when there are price fluctuations in the international market.

2.3 Agriculture Sector Investment

Investment is an expenditure made by investors related to the use of resources or supplies that are expected to generate certain benefits for the investment made. Interest rates and tax policies are the most important economic forces in determining the amount of investment (Samuelson & Nordhaus, 2019). According to Neo-Classical Theory, investment plays an important role in economic growth, especially regarding the dual nature of investment, namely investment creates income and investment increases the amount of economic production by increasing the capital stock (Arsyad, 2018).

Furthermore, previous research on investment in the agricultural sector Wijaya and Utami (2020) stated that investment in the agricultural sector can increase productivity and innovation which will have an impact on economic growth. However, research by Anwar and Hidayah (2021) shows that untargeted investment or lack of infrastructure support can lead to negative results, and can even worsen economic conditions in certain regions. This suggests the need for further research to understand how effective investments can be implemented to support economic growth in the agricultural sector.

H1: Agricultural labor has a positive and significant effect on economic growth

H2: Agricultural exports have a positive and significant effect on economic growth

H3: Agricultural investment has a positive and significant effect on economic growth

Technology

Technology is defined as the utilization of knowledge to carry out certain tasks or activities more efficiently. According to Kaunang (2021), technology is a means that supports human work in managing, conveying, and storing information or messages, so that the process takes place faster and is stored well for a long time. Information technology is the application of computer equipment, both hardware and software, which facilitates the task of using existing technology to process and manage information data which can be text, sound, or video. (Maukutuhu, 2021).

Technology has the potential to increase the efficiency and productivity of the agricultural sector by providing better access to information to farmers (Setiawan, 2021). However, research that integrates technology in analyzing the influence of these factors on economic growth in Indonesia is still limited. This shows that there is a research gap that needs to be studied, especially in the context of how technology can strengthen the relationship between the number of workers, exports, and investment in the agricultural sector with economic growth.

H4: Technology is able to moderate agricultural labor in influencing economic growth

H5: Technology is able to moderate agricultural exports in influencing economic growth

H6: Technology is able to moderate agricultural sector investment in influencing economic growth

3. Data and Research Methods

3.1 Research Type and Data Source

The object of this research is in Indonesia. Referring to the literature review, this research is about how the influence of agricultural sector labor, agricultural sector exports, agricultural sector investment on economic growth with technology as a moderating variable. The type of research used is quantitative research. This study uses secondary data with annual data (time series) for 2012-2023. Data obtained from various sources, namely the National Statistics Agency and the Ministry of Agriculture.

3.2 Operational Definition of Variables

Tabel 1: Operational Defition of Variables

Variables	Measurement	Data Source
Dependent Variable		
Economic Growth (Y)	Gross Domestic Product (Constant Prices)	BPS
Independendet Variable		
Agricultural Labor (X1)	TKP = (Number of Agricultural Workers / Total Working Population) x 100%	BPS
Agricultural Exports (X2)	ESP = $\sum(\text{Commodity Export Volume} \times \text{Commodity Price})$ $\sum(\text{FDI in Agriculture} + \text{FDI in Agriculture})$	Kementerian Perdagangan
Agricultural Investment (X3)		Kementerian Perdagangan
Moderating Variable		
Technology (Z)	Technology index	BPS

3.3 Analisis Data

The data analysis model used in this study is to use descriptive statistics, stationarity test, correlation coefficient test, multiple regression test, MRA test, and classical assumption test (normality test, hetorskedasticity test, multicollinearity test, and autocorrelation test). This descriptive statistical approach

is used to interpret data or numbers into a form of reading so that readers better understand the meaning of the data or numbers displayed. The analytical tool used in this research is Stata 17.

Model I:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e \quad (1)$$

Model II:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_1 Z + \beta_5 X_2 Z + \beta_6 X_3 Z + e \quad (2)$$

Description:

Y	: Economic Growth
α	: Constant
$\beta_{1,2,3}$	: Regression Coefficient
X1	: Agricultural Labor
X2	: Agricultural Exports
X3	: Agricultural Investment
Z	: Technology
e	: Standard error

4. Results and Discussion

Tabel 2: Results of Descriptive Statistical Analysis

	GDP (Y)	Agricultural Labour (X1)	Export Agriculture (X2)	Investment Agriculture (X3)	Technology (Z)
Mean	1823083	37.4675	6.30e+07	2.31e+10	5.081667
Minimum	2617690	39.45	8.03e+07	2.97e+10	5.9
Maximum	1039441	34.58	5.54e+07	1.34e+10	4.24
Std. Dev.	499138.1	1.266578	7736849	5.64e+09	0.5989208

Referring to table 1.2 of the observations it can be seen that the value of the variables used, namely, economic growth as measured by GDP obtained a mean of 1823083 with a maximum value of 2617690 and a minimum of 1039441 while for the standard deviation of 499138.1. The agricultural sector labor variable according to the test results has an average value of 37.4675 with the lowest value of 34.58, the highest is 39.45 and the standard deviation is 1.266578. For the next, namely the agricultural sector export variable with an average result of 6.30e+07, a maximum value of 8.03e+07, a minimum value of 5.54e+07 with a standard deviation of 7736849.

The agricultural sector investment variable obtained a result of 2.31e+10 for the mean value with the maximum, minimum and standard deviation values of 2.97e+10, 1.34e+10, and 5.64e+09. Technology as a moderating variable obtained a mean, maximum minimum and standard deviation values, namely, 5.081667, 5.9, 4.24, and 0.5989208.

Tabel 3: Pearson Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) y(PDB)	1.000						
(2) x1(tenaga kerja)	-0.221	1.000					
(3) x2 (investasi)	0.712***	-0.034	1.000				
(4) x3(ekspor)	-0.300	0.501*	0.025	1.000			

(5) x1z (tenagakerja / teknologi)	0.878***	0.124	0.813***	-0.138	1.000		
(6) x2z (ekspor/ teknologi)	0.298	-0.089	0.328	-0.523*	0.387	1.000	
(7) x3z (investasi/ teknologi)	0.185	0.414	0.431	0.875***	0.335	-0.360	1.000

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Pearson correlation test results based on table 4.5 show that the agricultural sector export variable (x2) has a strong and positive relationship with economic growth (GDP), with a correlation coefficient of 0.712 and significant at the 1% level, while agricultural sector labor (x1) and agricultural sector investment (x3) show a negative relationship with GDP of -0.221 and -0.300, respectively, but not significant. The interaction between labor and the moderating variable (x1z) shows a very strong and positive correlation to GDP of 0.878 and is significant at the 1% level, while the export interaction (x2z) and investment interaction (x3z) show a positive correlation of 0.298 and 0.185, respectively, but both are not significant. These results indicate that agricultural exports and labor interaction with moderating variables are the most strongly and significantly correlated factors with economic growth compared to other variables.

4.1 Multiple Linear Regression Analysis

Tabel 4: Multiple Linear Regression Analysis Results

Variable	Coefficient	Std. Error	Prob.
C	5389692	1.07E+07	0.629
Agricultural Labour (X1)	-56409.19	292419.3	0.852
Agricultural Exports (X2)	0.1342906	0.0414364	0.012**
Agricultural Investment (X3)	-0.0000752	0.0000657	0.285

Note: t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results of the t -statistical test are in Table 4. The constant value of 5389692 indicates that when the independent variable is equal to zero or constant, it indicates that economic growth is worth 5389692. Agricultural sector labor obtained a value of - 56409.19, which means that if agricultural sector labor increases by 1%, economic growth will decrease by - 56409.19. The agricultural sector export variable obtained a negative coefficient value of 0.1342906, so it can be concluded that when agricultural sector exports increase by 1%, economic growth will increase by 0.1342906. Furthermore, agricultural sector investment with a value of - 0.0000752 indicates that when agricultural sector investment increases by 1%, it illustrates a decrease in economic growth by - 0.0000752.

4.2 Interaction Test (Moderated Regression Analysis)

Tabel 5: Moderated Regression Analysis (MRA) Test Results

Variable	Coefficient	Std. Error	Prob.
C	1.43e+07	2566632	0.003**
Agricultural Labor (X1)	536868.1	164357.6	0.022**
Agricultural Exports (X2)	-0.0014033	0.0182586	0.135
Agricultural Investment (X3)	-108542.3	0.0002198	0.001***
labor/technology (X1Z)	-108542.3	28482.51	0.012**
Export/technology (X2Z)	0.0002178	0.0001057	0.094
Investment/technology (X3Z)	0.000262	0.0000412	0.001***

Note: t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Looking at table 4.6, the results of the MRA test show that, the interaction of the agricultural sector labor variable with technology gets the result - 1.08542.3 indicating that when the value of agricultural sector labor with technology increases by 1% it will have an effect on a decrease in economic growth by 1.08542.3. Agricultural sector exports interacted with technology get a result of 0.0002178 showing that when the interaction of agricultural sector exports with technology rises by 1% it has an impact on increasing economic growth by 0.0002178. The interaction between the agricultural sector investment variable and technology results in 0.000262, indicating that when the interaction of agricultural sector investment with technology increases by 1%, it has an impact on increasing economic growth by 0.000262.

5. Analysis of Estimation Results

The second (H1) hypotheses can explain the significant positive effect of the relationship between the influence of agricultural sector labor, agricultural sector exports, and agricultural sector investment on economic growth. This is in line with the Solow production function model which allows substitution between capital and labor, so that an increase in labor will increase output and ultimately encourage overall economic growth (Arief et al., 2020). This conclusion is in line with the research of Masdawia & Novia Nengsih (2024) and Arinil 'ula fil izza (2024) that agricultural sector labor has a significant positive effect on economic growth.

In the context of this research, an increase in the number of workers in the agricultural sector means an increase in the production factor of labor (labor) which can directly increase the sector's output. Simply put, agricultural sector labor affects economic growth. Agricultural sector labor is clearly able to contribute to economic growth, with Indonesia as an agrarian country where the labor sector is dominated by the agricultural sector.

Government effectiveness as a moderating variable is a crucial reason for researchers. Because an effective government can play a significant role in influencing agricultural sector investment on economic growth. The results in hypotheses (H4 and H6) show that agricultural sector investment moderated by technology is able to play a role in economic growth and also with agricultural sector exports although the results are not significant, but have an effect.

Research shows that investment in the agricultural sector supported by digital technology and innovation can significantly increase agricultural yields, strengthen food security, and create greater market opportunities for export products. In addition, digitization in the agricultural sector also attracts

investment as investors feel more confident with transparency and fund management based on advanced technology (CIPS, 2022).

In the Solow theoretical framework, technology acts as a catalyst that can increase labor productivity and production efficiency of agricultural exports, thereby promoting sustainable economic growth. According to Mahendra Fathur Nugroho (2020), the trend of agricultural sector exports in Indonesia has fluctuated, and although technology can improve production efficiency, its impact on economic growth still requires time and continuous policy support.

However, this insignificant result may indicate that technology adoption in Indonesia's agricultural sector still faces constraints such as limited access to appropriate technology, lack of labor training, and dependence on raw commodities without added value, as well as an export structure that is not yet diversified, so technology has not been able to fully optimize the contribution of exports to economic growth.

6. Conclusion

After the research process starting from data collection, analysis to interpretation. There are conclusions that can be drawn, namely, agricultural sector labor has a positive and significant effect on economic growth in Indonesia in 2012-2023. In other words, the first hypothesis is accepted. Agricultural exports have a negative and insignificant effect on economic growth in Indonesia in 2012-2023. In other words, the second hypothesis is rejected. Investment in the agricultural sector has a significant negative effect on economic growth in Indonesia in 2012-2023. In other words, the third hypothesis is rejected. Technology is not able to moderate the effect of agricultural labor on economic growth in Indonesia in 2012-2023. In other words, the fourth hypothesis is rejected. Technology is able to moderate the effect of agricultural exports on economic growth in Indonesia in 2012-2023. In other words, the fifth hypothesis is accepted. Technology is able to moderate the effect of agricultural sector investment on economic growth in Indonesia in 2012-2023. In other words, the sixth hypothesis is accepted.

This research has limitations that may affect the research process and results. There are limited reference sources on the role of technology as a moderating variable in influencing the agricultural sector. The use of technology use expertise indicators in the ICT development index has not been able to explain digital literacy as a whole, because in eastern Indonesia access to energy is very limited and exclusive.

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