International Journal of
Economics Development Research, Volume 5(6), 2024
pp. 4907-4918

Ecological Impact on Grain Prices Mediated by Rice Production in Pinrang Regency

Sulaiman[1], Sudirman[2], Muhardi[3]

Abstract:

This study aims to analyze the influence of climate change and irrigation intensity on rice production and grain prices both directly and indirectly. The data analysis method used is Two Stage Least Square (2SLS) with 100 farmer samples. The results of the study showed that climate change had a negative and insignificant effect on rice production, while irrigation intensity had a positive and insignificant effect on rice production, other tests showed that climate change had a significant negative effect on grain prices, while irrigation intensity had a significant positive effect on grain prices. In indirect testing, climate change and irrigation intensity have no effect on grain prices through rice production. The government's role is important in strengthening irrigation systems, making climate change mitigation policies to protect farmers from the impact of extreme weather changes, and formulating policies to maintain grain price stability. Farmers are also expected to optimize irrigation management and use the right rice varieties that are resistant to climate change to increase production productivity.

Keywords: *Climate; Irrigation; Production; Price Grain.*

Sumbitted: 12 November 2024, Accepted: 12 December 2024, Published: 30 December 2024

1. Introduction

Indonesia is an agricultural country where the majority of the population works in the agricultural sector, with rice farming being one of the key industries. According to the Central Statistics Agency (BPS, 2018), the total area of rice fields in Indonesia is 8,087,393 hectares. Pinrang Regency, located in one of Indonesia's regions, has approximately 108,302 hectares of rice fields. The regency consists of 12 sub-districts, all of which have rice fields (BPS, 2023). In terms of Indonesia's economy, the agricultural sector is the second-largest contributor to the GDP, following the processing industry (Badan Pusat Statistik, 2024).

Working as a farmer is not without its challenges. One of the main challenges farmers face today is the ecological impact caused by an unpredictable climate and irrigation systems that are not functioning optimally. Ecology, as a scientific discipline, studies the reciprocal relationships between living organisms and their environment (Ramadhani, Okta, and Maulidian, 2020). Uncertain climate change has already had a significant impact on agricultural productivity (Herlina and Prasetyorini, 2020), and

[1] *STKIP Darud Da wah Wal Irsyad Pinrang, Indonesia, sulaimanridhian@gmail.com.*
[2] *Institut Bisnis dan Keuangan Nitro, Indonesia*
[3] *STKIP Darud Da wah Wal Irsyad Pinrang, Indonesia,*

it is suspected that global warming is contributing to these unpredictable changes. To support increased production, farmers must implement strategies that can eventually enhance sales (Kausar and Sudirman, 2022).

In several regions of Indonesia, the symptoms of climate change are increasingly felt, especially during the dry and rainy seasons. The cause of Indonesia's climate change and the extreme weather conditions occurring every few years is attributed to the 'El Niño-Southern Oscillation' phenomenon (Herlina and Prasetyorini, 2020). One of the agricultural commodities most affected by these uncertain climate conditions is rice. Research by Sun et al. (2023) shows that climate change is expected to reduce the productivity of rice farming in the coming years. Additionally, other studies explain that seasonal floods and nutrient depletion are expected to affect farmers' incomes and decrease productivity, which is also influenced by the excessive use of fertilizers (Van Aalst et al., 2023). Further, Nuraisah, Andriani, and Kusumo (2019) state that climate change results in lower crop yields, increased pest attacks, greater risk of crop failure, and decreased farmer incomes.

The impact of climate change is one of the key issues that need to be addressed in agricultural activities, as it can significantly interfere with agricultural productivity. Several prior studies, including those by Nuraisah et al. (2019), Hidayat (2023), and Estiningtyas and Syakir (2018), have focused on the effects of climate and irrigation on crop productivity. These studies have concluded that low rainfall intensity can increase rice crop productivity, while excessive rainfall can reduce it. However, this study aims to explore more in-depth ecological variables, including both weather conditions and the intensity of irrigation, and their impact on rice production. The subsequent phase of the research will examine the effects on rice grain prices, both directly and indirectly.

The purpose of this study is to assess the ecological impact on rice production and grain prices. Agriculture is inherently linked to socio-economic factors, as these are closely tied to policy-making to address the social and economic issues faced by communities (Sarjito, 2023). The solution to agricultural challenges does not solely rest with farmers. The government, as a regulator, must play a crucial role in assisting farmers throughout all stages, from pre-planting to post-harvest. Solutions to agricultural problems can be provided in the form of training, counseling, and direct support for farmers (Parawangi, 2016). This model can be developed when the government is provided with accurate information regarding the challenges farmers face at each stage.

2. Theoretical Background

Ecological System: Ecological change is one of the most pressing concerns for farmers in ensuring the long-term sustainability of their farming operations (Tanjung and Sobari, 2023). Ecology is a concept that examines the complex relationships between living organisms and their environment. In agriculture, these environmental factors—ranging from climate change to water availability—play a critical role in

determining the success of crop production. For crops like rice, the stability and predictability of environmental conditions are essential for optimal growth. Unpredictable weather patterns, such as prolonged droughts or excessive rainfall, can significantly affect crop yield and, by extension, farmers' livelihoods. In addition to climate change, water availability and quality are key factors in agricultural productivity, especially for rice farming, which relies heavily on consistent irrigation (Ramadhani et al., 2020). Farmers must therefore adapt to these environmental challenges by implementing strategies that ensure environmental sustainability, such as optimizing water use and adopting climate-resilient agricultural practices.

Agricultural Economics: Agricultural economics is an important field of study that explores the economic aspects related to production, distribution, consumption, and human resource management in agriculture (Hanani et al., 2023). This discipline is crucial in understanding how economic factors influence farming decisions, the allocation of resources, and the overall welfare of farming communities. In particular, agricultural economics provides valuable insights into the costs and benefits of farming practices, the efficiency of resource use, and the dynamics of the agricultural market. It also plays a significant role in formulating policies that affect income distribution, market stability, and the economic viability of agricultural businesses. As agricultural production is closely linked to the wider economy, fluctuations in crop prices, input costs, and consumer demand directly impact farmers' incomes and economic well-being.

Improving agricultural production requires the collaboration of multiple stakeholders, including not only the farmers themselves but also government agencies, agricultural experts, and the private sector. A key focus should be placed on enhancing the agricultural production system, which directly affects the quality and quantity of agricultural products. This, in turn, influences farmers' bargaining power in the market and their ability to maintain stable income levels. The concept of supply and demand plays a critical role in this process: by ensuring that production meets market demand, farmers can achieve fair prices for their products and stabilize the distribution and prices of agricultural commodities (Titu et al., 2023). Governments can contribute by creating favorable policies that support agricultural development, such as subsidies, market access, and infrastructure improvement, which can lead to increased productivity and economic growth in rural areas.

3. Methodology

It is known that there are 2,822 Farmer Groups in Pinrang Regency that are populations, after calculating using the Slovin formula with an error rate of 10%, a total of 100 samples of farmers who are members of farmer groups are obtained. The type of data used in this study is primary data, This research is a quantitative research with data analysis techniques used in this study, namely the two-stage least square method (2SLS), the 2SLS method is one of the regression methods that is included in the structural equation analysis group (Misno and Sulistianingsih 2019). The hypotheses of this study are:

H1. Climate change has a significant effect on rice production;
H2. Irrigation intensity has a significant effect on rice production;
H3. Climate change has a significant effect on grain prices;
H4. Irrigation intensity has a significant effect on grain prices;
H5. Rice production has a significant effect on grain prices;
H6. Climate change has a significant effect on grain prices mediated by rice production;
H7. Irrigation intensity has a significant effect on the price of grain mediated by rice production.

The form of the simultaneous equation is then written below:

$Z = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + e1$ …… Equation (1)
$Y = \pi 0 + \pi\ 1\ X1 + \pi\ 2\ X2 + \pi\ 3\ Z + e2$ …… Equation (2)
Equation 1 in substitution to Equation 2 then:
$Y = \pi 0 + \pi\ 1\ X1 + \pi\ 2\ X2 + \pi\ 3\ (\beta 0 + \beta 1\ X1 + \beta 2\ X2 + e1) + e2$
$Y = (\pi 0 + \pi\ 3\ \beta 0) + (\pi\ 1\ X1 - \pi\ 3\ \beta 1\ X1) + (\pi\ 2\ X2 + \pi\ 3\ \beta 2\ X2) + \pi\ 3\ e1 + e2$
$Y2 = \Sigma 0 + \Sigma 1\ X1 + \Sigma 2\ X2 + E$ …… Equation (3)

Where:
Y……. Yn; Z.....Zn : n Endogenous variables, or variables that are not free together
X1, X2…….. Xn : n Exogenous variables, or bound variables
β and π : Endogenous variable coefficients
e1 and e2 : Stochastic disorders

4. Empirical Findings/Result

Validity and Reliability Test
Testing the validity of the data was carried out using SmartPLS3 Software. The test results showed an AVE value of > 0.5 which means that the data used in this study was valid, then to test the reliability of the data can be seen in the value of Crobach's Alpha must be > 0.7 (Sholihin and Ratmono 2021), The tests carried out in this study showed Crobach's Alpha values of 1,000 for all variables tested, this means that the data used in this study is reliable.

Table 1. Validity and Reliability Test

	Cronbach's Alpha	rho A	Composite Reliability	Average Variance Extracted (AVE)
Grain Price (Y)	1,000	1,000	1,000	1,000
Irrigation Intensity (X2)	1,000	1,000	1,000	1,000
Climate Change (X1)	1,000	1,000	1,000	1,000
Rice Production (Z)	1,000	1,000	1,000	1,000

Source: Data Processed, by SmartPLS3

Two Stage Least Square Method – 2SLS

The analysis of the equation data of this study uses the 2SLS Method and is explained below:

Table 2. Uji Regresi (Regression Weights)

			Estimate	S.E.	C.R.	P	Label
Z	<---	X1	-,098	,190	-,515	,606	par_1
Z	<---	X2	,059	,069	,859	,390	par_2
Z	<---	E1	,439	,031	14,071	***	par_6
Y	<---	Z	,010	,007	1,561	,118	par_3
Y	<---	X1	-,027	,013	-2,127	,033	par_4
Y	<---	X2	,012	,005	2,545	,011	par_5
Y	<---	E2	,029	,002	14,071	***	par_7

Source: Data Processed, by AMOS26

The modeling results in the equation are shown below:

$Z = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + e1$

$\beta 0 - 0.098\ X1 + 0.059\ X2 + e1$

$Y = \pi 0 + \pi\ 1\ X1 + \pi\ 2\ X2 + \pi\ 3\ Z + e2$

$\pi 0 - 0.027\ X1 + 0.012\ X2 + 0.010\ Z + e2$

$Y = \pi 0 + \pi\ 1\ X1 + \pi\ 2\ X2 + \pi\ 3\ (\beta 0 + \beta 1\ X1 + \beta 2\ X2 + e1) + e2$

$\pi 0 - 0.027\ X1 + 0.012\ X2 + 0.010\ (\beta 0 - 0.098\ X1 + 0.059\ X2 + e1) + e2$

$Y = (\pi 0 + \pi\ 3\ \beta 0) + (\pi\ 1\ X1 - \pi\ 3\ \beta 1\ X1) + (\pi\ 2\ X2 + \pi\ 3\ \beta 2\ X2) + \pi\ 3\ e1 + e2$

$(\pi 0 + \pi\ 3\ \beta 0) + (-0.027\ X1 - 0.088\ X1) + (0.012\ X2 + 0.069\ X2) + 0.010\ e1 + e2$

$Y = \Sigma 0 + \Sigma 1\ X1 + \Sigma 2\ X2 + E$

$\Sigma 0 - 0.115\ X1 + 0.081\ X2 + E$

Hypothesis Test

This hypothesis testing aims to answer previously made research hypotheses. Where to find out whether there is an influence (significant) or no influence (not significant) on the variables that are tested for relationships. This test uses AMOS Software where the significance value in this study when seen at the P (P-Value) value < 0.05 (Malkanthie 2019), The test results can be seen in the Wight Regression table at the P (P-Value) value, as well as to find out:

Direct Effect

Table 3. Direct Effect Test

Hypothesis	Pathway	β *(Estimate)*	S.E.	C.R.	*P Value*	Conclusion
H1	X1 ⟶ Z	-.098	.190	-.515	.606	Negative, insignificant
H2	X2 ⟶ Z	.059	.069	.859	.859	Positive, insignificant
H3	Z ⟶ Y	.010	.007	1.561	.118	Positive, insignificant
H4	X1 ⟶ Y	-.027	.013	-2.127	.033	Negative, Significant
H5	X2 ⟶ Y	.012	.005	2.545	.011	Positive, Significant

Source: Data Processed, by AMOS26

Indirect Effect

Table 4. Indirect Effect Test

Hypothesis	Pathway	β *(Estimate)*	*P Value*	Conclusion
H6	X1 ⟶ Z ⟶ Y	-0.088	0.072	Negative, insignificant
H7	X2 ⟶ Z ⟶ Y	0.069	0.101	Positive, insignificant

Source: Data Processed, by AMOS26

5. Discussion

Climate change has a direct effect on rice production

Based on the hypothesis testing conducted regarding the direct influence of climate change on rice production, it is concluded that climate change (X1) has an insignificant negative effect on rice production (Z) in Pinrang Regency. This can be observed from the β value (Estimate) of -0.098, which indicates a negative direction of influence from the climate change variable on rice production. This means that a 1-point increase in the climate change variable is interpreted as reducing rice production by 0.098. The P-value of 0.606 further indicates that the effect is not significant (not influential). From this information, it can be concluded that the negative impact of climate change is not a significant factor in the decline of rice production. Other more significant variables are likely contributing to the decrease in rice production.

This finding aligns with the research conducted by Salsabila, Rohmah, and Arisandi (2024), in which the researchers explained that extreme and erratic weather changes can lead to a decrease in rice production. While the influence in this study is not statistically significant, it may still be valuable information for farmers, encouraging them to use rice seed varieties that are more resistant to extreme weather conditions. Although the effect is not substantial, it could potentially become more significant if extreme weather persists over a longer period, as suggested by Malau et al. (2023).

Irrigation intensity has a direct effect on rice production

Based on the hypothesis testing conducted regarding the direct influence of irrigation intensity on rice production, it is concluded that irrigation (X2) has a non-significant positive effect on rice production (Z) in Pinrang Regency. This is reflected in the β value (Estimate) of 0.059, which indicates a positive influence of the irrigation intensity variable on rice production. This means that a 1-point increase in irrigation intensity is interpreted as increasing rice production by 0.059. However, the P-value of 0.859 indicates that the effect is not significant (not influential). From this information, it can be concluded that the positive influence of irrigation intensity is not a variable that significantly affects the increase in rice production, suggesting that other more significant variables may be influencing rice production.

The results of this study show that the intensity of irrigation, which refers to the irrigation applied to farmers' paddy fields during each planting season, does not have a significant influence on rice production. This can be explained by research

conducted by Sasqia (2019), which found that irrigation treatments did not have a significant effect on plant physiology or production outcomes. While the intensity of irrigation may differ among farmers, the yield tends to remain similar across areas of land with the same conditions. Communication with farmers reveals that the most crucial aspect of the irrigation system is not the frequency of irrigation but how well farmers understand the growth phases of rice plants and know when the plants require water. Proper knowledge of the irrigation system can help increase the number of productive seedlings (Wahyudin and Marina 2024). This knowledge includes understanding the critical growth stages of rice and the water requirements at each stage. Improper management of irrigation intensity and timing may explain why irrigation's impact was not significant in this study. The key focus should now be on how the government can ensure the reliability and functionality of the existing irrigation systems. The availability of irrigation directly impacts rice production (Novizal 2022), and the amount of water supplied through the irrigation system can also influence rice production (Murtala 2021). Therefore, it is crucial that water is available whenever farmers need it for irrigation.

Climate change has a direct effect on grain prices

Based on the hypothesis testing that has been carried out related to the testing of the direct influence of climate change on grain prices, it is concluded that Climate Change (X1) has a significant negative effect on grain prices (Y) in Pinrang Regency. This can be seen in the β value (Estimate) of - 0.027 which shows the direction of the negative influence of climate change variables on grain prices. This means that if there is an increase of 1 point in the climate change variable, it is interpreted to reduce the price of grain by 0.027, and the P-Value of 0.033 which means that the influence is significant (influential), this means that with a confidence level of 95%, it can be believed that climate change has a real influence on changes in grain prices.

As it is known that the reference price of grain is determined by the government, it can be interpreted that due to climate change, the government takes policies to protect farmers from the possibility of a decrease in farmers' income due to crop failures caused by climate change. In this context, the government has made mitigation and adaptation policies to climate change to maintain the stability of agricultural commodity prices, including grain, and maintain food security stability (Sujarwo 2023).

Irrigation intensity affects grain prices

Based on the hypothesis testing that has been carried out related to testing the direct influence of irrigation intensity on grain prices, it is concluded that Irrigation (X2) has a significant positive effect on the price of Grain (Y) in Pinrang Regency. This can be seen in the β value (Estimate) of 0.012 which shows the direction of the positive influence of the irrigation intensity variable on the price of grain. This means that if there is an increase of 1 point in the variable of irrigation intensity, it is interpreted to increase the price of grain by 0.012, and the P-Value of 0.011 which means that the influence is significant (influential), this means that with a confidence level of 95%,

it can be believed that the intensity of irrigation has a real influence on the change in grain prices.

The important to carry out the right irrigation system because, good irrigation skills, can increase the growth of rice plants know when the seeds need water because understanding the right irrigation system can increase the number of productive saplings (Wahyudin and Marina 2024). Proper irrigation also affects the weight of the plant (Sasqia 2019). Good and quality crops due to the ability of farmers to utilize the existing irrigation system will give farmers a strong bargaining position to maintain their grain prices at the highest reference price level.

Rice production has a direct effect on grain prices

Based on the hypothesis testing that has been carried out related to the testing of the direct influence of irrigation on rice production, it is concluded that Rice Production (Z) has a not significant positive effect on the Price of Grain (Y) in Pinrang Regency. This can be seen in the β value (Estimate) of 0.010 which shows the direction of the positive influence of the variable change in rice production on grain prices. This means that if there is an increase of 1 point in the variable of rice production, it is interpreted to increase the price of grain by 0.010, and the P-value value of 0.118 which means that the effect is not significant (not influential), and from this information it can be concluded that the positive influence of rice production is not a variable that has a significant effect on the increase in grain prices, there are other variables that are more significant that affect the increase in prices Grain.

Talking about price, one of the things that affects price changes is demand and supply, where price changes depend on consumer preferences and the availability of goods (Mankiw 2019). In this study, the availability of goods, in this case rice production, does not have a significant influence on grain prices, in Pinrang Regency itself, according to the results of interviews with farmers grain prices sometimes increase when production is abundant, and sometimes grain prices also increase when production is reduced. On the other hand, farmers also did not have the power to control grain prices, the grain prices that prevailed at that time depended on government policies in determining the reference price, both the minimum price and the base price. Given that rice production does not have a significant effect on grain prices, both central and regional governments, as well as related parties managing the agricultural sector need to pay attention to distribution channels that can increase the efficiency of grain distribution from farmers as producers to mills as consumers. This aims to avoid unscrupulous games that can extend distribution channels and carry out market interventions that benefit companies and harm farmers (de Brauw and Bulte 2021). One way that can be done to break the long chain of distribution channels is through agricultural contracts, where contracts offer several benefits including high-value market access, reduced risks related to price fluctuations, and farmers can receive technical support and input forces such as seeds that have been provided by companies or the government (Wang, Wang, and Delgado 2014).

Climate change affects grain prices mediated by rice production
Based on the hypothesis testing that has been carried out related to the testing of the indirect influence of climate change on grain prices through rice production as a mediating variable, it is concluded that Climate Change (X1) has a negative effect on grain prices (Y) through rice production (Z) in Pinrang Regency. This can be seen in the β value (Estimate) of - 0.088 which shows the direction of the negative influence of climate change variables on grain prices mediated by rice production. This means that if there is an increase of 1 point in the climate change variable, it is interpreted to reduce rice production by 0.098, the decline in rice production will have an impact on the decrease in grain prices, but the P-Value value is 0.072 which means that the effect is not significant (not influential), and from this information it can be concluded that the negative influence of climate change is not a variable that has a significant effect on the decrease in rice production that can Affecting the decline in grain prices, there are other more significant variables that affect the decline in rice production and grain prices.

This research is in line with the research conducted Salsabila et al., (2024) where it is explained that extreme, erratic weather changes can result in a decrease in rice production. Rachman et al. (2022) In his research, he corroborated the results of this study which stated that although rice production increased, its impact on prices was often dominated by economic factors and government policies, which resulted in grain prices not always increasing. The government in taking policies related to price determination often pays attention to the climate aspect, this is because climate change can reduce farmers' production if climate change occurs for a long time. Therefore, farmers need to have a mitigation strategy against the potential for climate change so that the decline in rice production due to extreme weather can be overcome (Tan et al. 2021).

Irrigation intensity affects the price of grain mediated by rice production
Based on the hypothesis testing conducted regarding the indirect influence of irrigation intensity on grain prices through rice production as a mediating variable, it is concluded that irrigation (X2) has a non-significant positive effect on grain prices (Y) through rice production (Z) in Pinrang Regency. This is reflected in the β value (Estimate) of 0.069, which indicates a positive influence of the irrigation intensity variable on grain prices, mediated by rice production. This means that a 1-point increase in irrigation intensity is interpreted as increasing rice production by 0.069. The increased rice production would, in turn, impact the rise in grain prices. However, the P-value of 0.101 suggests that the effect is not significant (not influential). From this, it can be concluded that the positive influence of irrigation intensity is not a variable with a significant effect on increasing production and grain prices. Other more significant variables likely contribute to the increase in rice production and grain prices.

This research aligns with previous findings that indicate irrigation intensity plays an important role in increasing production yields, but other factors, such as water quality, efficiency, and soil conditions, are more influential (Ahmad et al., 2024). In addition to irrigation intensity, the ability of farmers to implement the correct irrigation system

affects the plant's weight (Sasqia, 2019). Quality crops, resulting from the farmers' ability to utilize the existing irrigation system effectively, give farmers a stronger bargaining position, enabling them to maintain their grain prices at the highest reference level. This is consistent with the findings from the direct influence of irrigation variables, where a significant positive effect on grain prices was observed.

6. Conclusions

The results of the tests in this study show that climate change has a negative effect on rice production is not significant, while the intensity of irrigation has a positive effect is not significant. Other tests showed that climate change had a significant negative effect on grain prices, and irrigation intensity had a significant positive effect. Meanwhile, although rice production has a positive effect on grain prices, the effect is not significant, as well as the indirect influence of climate change and irrigation intensity on grain prices through rice production is also insignificant.

Based on the findings of this study, it is hoped that the government can pay attention to the irrigation system by improving the efficiency and quality of water and irrigation, as well as providing training to farmers regarding proper irrigation management. In addition, the government is expected to make policies related to climate change mitigation to protect farmers from the negative impact of climate change on both rice production and grain prices. For farmers, it is hoped that they will be able to understand the phases of rice growth so that the irrigation carried out can be right on target, and can choose rice varieties that are resistant to climate change.

References:

Ahmad, M. I., Shen, Q., Zhang, Y., Rehman, A., Song, C., & Ma, H. (2024). Do agricultural credit, wheat, and rice production impact environmental quality? Novel evidence from China's mega agricultural regions. *Frontiers in Sustainable Food Systems, 8*(August), 1–24. https://doi.org/10.3389/fsufs.2024.1424173

Badan Pusat Statistik. (2024). *Ekonomi Indonesia Triwulan IV-2023 tumbuh 5,04 persen (y-on-Y)*. Badan Pusat Statistik (BPS - Statistics Indonesia). Retrieved from https://www.bps.go.id

BPS. (2018). *Luas lahan sawah (hektar), 2015*. Badan Pusat Statistik (BPS - Statistics Indonesia). Retrieved from https://www.bps.go.id

BPS. (2023). *Luas panen (hektar), 2015-2020*. Badan Pusat Statistik Kabupaten Pinrang.

de Brauw, A., & Bulte, E. (2021). Interventions for inclusive and efficient value chains: Insights from CGIAR research. *International Food Policy Research Institute* (2021), 0–13. Retrieved from https://www.ifpri.org

Estiningtyas, W., & Syakir, M. (2018). Impact of climate change on rice production in rainfed areas. *Jurnal Meteorologi dan Geofisika, 2*(18).

Hanani, N., Syafrial, S., Suhartini, S., Toiba, H., Asmara, R., Sujarwo, S., Nugroho, T. W., Fahriyah, F., Andajani, T. K., Nugroho, C. P., Mutisari, R.,

Andriatmoko, N. D., Widyawati, W., Meitasari, D., 'Ula, M. L., Rahman, M. S., & Andrianto, B. (2023). *Pengantar ekonomi pertanian*.

Herlina, N., & Prasetyorini, A. (2020). Pengaruh perubahan iklim pada musim tanam dan produktivitas jagung (Zea Mays L.) di Kabupaten Malang. *Jurnal Ilmu Pertanian Indonesia, 25*(1), 118–128. https://doi.org/10.18343/jipi.25.1.118

Hidayat, A. (2023). Dampak perubahan iklim terhadap pertanian dan strategi adaptasi yang diterapkan oleh petani.

Kausar, A., & Sudirman, S. (2022). Dampak penerapan manajemen strategi terhadap perkembangan usaha mikro di Sulawesi Selatan. *Jurnal Manajemen Perbankan Keuangan Nitro, 5*(1), 20–32.

Malau, L. R. E., Rambe, K. R., Ulya, N. A., & Purba, A. G. (2023). Dampak perubahan iklim terhadap produksi tanaman pangan di Indonesia. *Jurnal Penelitian Pertanian Terapan*.

Malkanthie, A. (2019). Chapter-1: The basic concepts of structural equation modeling 1.1. *Introduction*. https://doi.org/10.13140/RG.2.1.1960.4647

Mankiw, N. G. (2019). *Principles of economics*.

Misno, & Sulistianingsih, E. (2019). Estimasi model persamaan simultan dengan metode two stage least square (2SLS). *Buletin Ilmiah Math. Stat. dan Terapan (Bimaster), 8*(4), 653–658.

Murtala, M. (2021). Pengaruh irigasi air tanah, luas lahan, dan penggunaan pupuk terhadap produksi padi sawah di Provinsi Aceh. *Jurnal Ekonomi dan Pembangunan*.

Novizal, R. (2022). Pengaruh pembangunan irigasi terhadap produksi padi dan pendapatan petani di Kota Langsa. *Jurnal Akuntansi, Manajemen dan Ilmu Ekonomi (Jasmien)*.

Nuraisah, G., Andriani, R., & Kusumo, B. (2019). Dampak perubahan iklim terhadap usaha tani padi di Desa Wanguk Kecamatan Anjatan Kabupaten Indramayu, *Vol. 5*.

Parawangi, A. (2016). Peran pemerintah dalam pemberdayaan petani padi di Desa Parumpanai Kecamatan Wasuponda Kabupaten Luwu Timur. *Jurnal Administrasi Publik, 2*(2).

Rachman, B., Ariningsih, E., Sudaryanto, T., Ariani, M., Septanti, K. S., Adawiyah, C. R., Ashari, Agustian, A., Purwati Saliem, H., Tarigan, H., Syahyuti, & Yuniarti, E. (2022). Sustainability status, sensitive and key factors for increasing rice production: A case study in West Java, Indonesia. *PLoS ONE, 17*(12), 1–19. https://doi.org/10.1371/journal.pone.0274689

Ramadhani, M. T., Okta, M., & Maulidian, R. (2020). Persepsi masyarakat terhadap perkebunan kelapa sawit ditinjau dari aspek ekologi dan ekonomi di Gampong Cot Girek, Kecamatan Cot Girek, Kabupaten Aceh Utara. *Jurnal Pendidikan Geosfer, 5*(2).

Salsabila, Z., Rohmah, F., & Arisandi, D. (2024). Dampak perubahan iklim terhadap usahatani dan keberlanjutan pangan di Desa Reban Kecamatan Reban Kabupaten Batang. *Jurnal Sahmiyya, 3*(1), 74–83.

Sarjito, A. (2023). Efektivitas kebijakan sosial dalam mengurangi ketimpangan pendapatan dan angka kemiskinan. *Jurnal Ilmu Sosial Potik dan Humaniora, 6*(2), 2023. https://doi.org/10.36624/jisora.v6i2.90

Sasqia, S. L. (2019). Tinjauan fisiologi berbagai varietas padi dan macam pengairan pada system of rice intensification dan konvensional.

Sholihin, M., & Ratmono, D. (2021). *Analisis SEM-PLS dengan WarpPLS 7.0 untuk hubungan nonlinier dalam penelitian sosial dan bisnis* (C. Mitak, Ed.). CV Andi Offset.

Sujarwo, B. (2023). Mitigasi dampak perubahan iklim pada bidang pertanian guna mendukung ketahanan pangan nasional.

Sun, J., Chen, L., Ogle, S., Cheng, K., Xu, X., Li, Y., & Pan, G. (2023). Future climate change may pose pressures on greenhouse gas emission reduction in China's rice production. *Geoderma, 440*. https://doi.org/10.1016/j.geoderma.2023.116732

Tan, B. T., Fam, P. S., Radin Firdaus, R. B., Tan, M. L., & Gunaratne, M. S. (2021). Impact of climate change on rice yield in Malaysia: A panel data analysis. *Agriculture, 11*(6). https://doi.org/10.3390/agriculture11060569

Tanjung, M., & Sobari, R. (2023). Faktor-faktor yang mempengaruhi keputusan petani dalam memilih varietas ubi Cilembu. *Tabela Jurnal Pertanian Berkelanjutan*.

Titu, M. A., Darsana, I. M., Rahmadona, L., Triyono, A., Ramayanti Sinaga, H., Sastradinata, B. L. N., & Hartono, M. (2023). *Pengantar ilmu ekonomi*. CV Intelektual Manifes Media.

Van Aalst, M. A., Koomen, E., Tran, D. D., Hoang, H. M., Nguyen, H. Q., & de Groot, H. L. F. (2023). The economic sustainability of rice farming and its influence on farmer decision-making in the Upper Mekong Delta, Vietnam. *Agricultural Water Management, 276*. https://doi.org/10.1016/j.agwat.2023.107911

Wahyudin, S., & Marina, I. (2024). Pengaruh jarak tanam dan sistem pengairan terhadap produksi padi varietas Ciherang dan Sintanur di lahan tadah hujan. *Journal of Innovation and Research in Agriculture*.

Wang, H. H., Wang, Y., & Delgado, M. S. (2014). The transition to modern agriculture: Contract farming in developing economies. *American Journal of Agricultural Economics, 96*(5), 1257–1271. https://doi.org/10.1093/ajae/aau036