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THE INTERACTION OF DISASTER, THE AGRICULTURAL SECTOR AND FOOD SECURITY

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Abstract

This research explores the Interaction of Disasters and the Agricultural Sector on Food Security utilizing the Structural Equation Modeling (SEM-PLS) approach. Food security is crucial for human survival and well-being, making it a priority in any country. Indonesia has been one of the countries prone to disasters over the past decade, impacting the prevalence of food insecurity. The aim of this study is to investigate the effects of disasters on food security mediated by the agricultural sector. Sample selection involved a saturated sampling technique comprising 23 regencies/cities in the Province of Aceh. Data analysis in this research utilized SEM-PLS. The findings indicate that disasters do not influence food security, but they do affect the agricultural sector. Conversely, the research results demonstrate that the agricultural sector does not influence food security. Another significant finding in this study is that the agricultural sector does not significantly mediate the impact of disasters on food security.

Keywords: ***Disasters, The Agricultural Sector, Food Security.***

1. PENDAHULUAN

Food security is one of the main priorities of all countries worldwide (Tirivangasi, 2018) because it is essential for human survival and well-being. Concern for food security and adequate nutrition in an economy is based on the role of human resources in economic development. At the national level, food has economic and political significance, particularly in issues related to national security, maintaining political stability, and ensuring peace and stability among the population (Omonona & Agoi, 2007). National and regional food security is a mandatory requirement but insufficient to fulfill household and individual food security. The condition for adequate national food security is achieving household and individual food security. However, national or regional food sufficiency does not guarantee household food security (Akbar et al., 2023). The level of food security in Indonesia varies by region and depends on regional resources and wealth. More prosperous regions will not face food security issues. If they cannot achieve food self-sufficiency, they can import food from other regions. Meanwhile, poorer regions with limited resources will struggle to meet the food needs of their communities (Rozaki, 2021).

According to the Center for Agricultural Data and Information Systems (2022), 70 districts or 16.83% of the 416 districts in Indonesia have low Food Security Index (IKP) scores, with the distribution as follows: 28 priority 1 districts; 17 priority 2 districts; and 25 priority 3 districts. Priority 1 districts (very vulnerable) are spread across Papua Province (19 districts), West Papua (6 districts), Maluku, Riau, and West Sumatra, each with one district. Meanwhile, there are 4 cities (4%) out of 98 cities with low IKP scores, including Subulussalam City in Aceh Province (priority 1); Gunung Sitoli City in North Sumatra Province; Pagar Alam City in South Sumatra Province; and Tual City in Maluku Province. One of the challenges in maintaining food security in Indonesia is disasters. Over the past decade, Indonesia has been known as a disaster-prone country, experiencing natural disasters that have caused many casualties, direct losses, and infrastructure damage (Pascapurnama et al., 2017). Natural disasters have affected people and their livelihoods throughout human history, causing numerous casualties, material

damage, and poverty, which in turn increases the prevalence of food insecurity and malnutrition, posing a significant threat to food security (Tirivangasi, 2018; Haen & Hemrich, 2007).

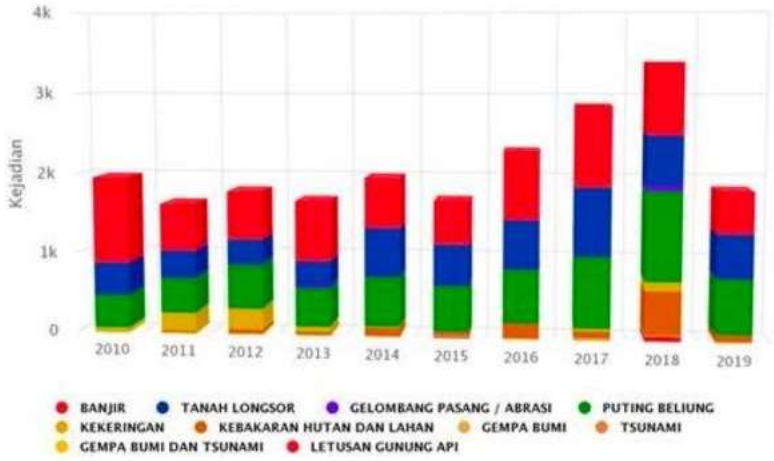

Figure 1: Disaster Event Trends

The trend of disaster events over the past decade shows that Indonesia, and West Aceh in particular, often experiences simultaneous disasters, such as floods followed by landslides, earthquakes followed by tsunamis, and others. This trend tends to increase. This situation certainly has an adverse economic and social impact, both directly and indirectly, as well as positively or negatively on a business, especially if the business is affected by pure risk or natural disasters (Khan, 2008; Young, 2010; Israel & Briones, 2012). These impacts include loss of sales/production, damage to business premises, loss of inventory and equipment, reduced profits, increased costs, disrupted access to business locations, and others (Auzzir, Haigh, Amaratunga, 2018). The agricultural sector is highly vulnerable to natural disasters due to climate change, particularly progressive climate change that refers to long-term changes in the baseline climate over several decades, presenting comprehensive challenges for agricultural and food systems in terms of policy and science (Vermeulen et al., 2012). As we know, the main impact of natural disasters is negative. This is also stated by Sivakumar (2005), who explains that the main impact of natural disasters on agriculture is negative. A review study on the relationship between COVID-19, agriculture, and food security conducted by Rozaki (2020) shows that disasters caused by COVID-19 have affected the agricultural sector and food security.

The agricultural sector plays a strategic role in increasing food availability (Pawlak & Kołodziejczak, 2020). Research results (Pawlak & Kołodziejczak, 2020) show that the strict national agriculture characteristic of the national economy in these countries adds to the problems in providing sufficient nutrition for the population. The very low level of capital resources, including the lack of irrigation systems, affects the level and rate of growth of agricultural production that is insufficient to meet the population's needs, resulting in the need for food imports and a food trade deficit. Pirani & Arafat (2016) explain that water scarcity affects the amount of agricultural land. The scarcity of renewable water resources puts great pressure on the agricultural sector and the sector's ability to reduce the gap between food production and demand. Research conducted by Pirani & Arafat (2016) suggests that food security can generally be improved when considering various self-sufficiency ratios from various Gulf Cooperation Council (GCC) countries, namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. In addition, investing in the agricultural sector in more advanced countries (while not buying land there) can also help ensure food security.

Some previous research results show inconsistent outcomes, so further research is needed to strengthen the theory. Previous research has focused more on the direct relationship between natural disasters and the agricultural sector or between the agricultural sector and food security. Meanwhile, the role of the agricultural sector in mediating the impact of disasters on food security is still limited. Therefore, this study will fill the gap in previous research by investigating the effects of disasters on food security mediated by the agricultural sector. This research was conducted during the crisis caused by the spread of the COVID-19 virus, which is categorized as a non-natural disaster. The objectives of this study are to directly test the effect of disasters on the agricultural sector, test the direct effect of disasters on food security, and test the effect of disasters on food security mediated by the agricultural sector. This research can contribute theoretically to the development of economic and agricultural sciences and local government governance in realizing sustainable food security management. Practically, this research contributes to providing input or recommendations that can be used by the government, society, and stakeholders in efforts to improve food security in the region by managing the agricultural sector supported by budget priorities that are responsive to disaster risks.

2. RESEARCH METHOD

The population in this study includes all local governments in Aceh Province, totaling 23 regencies/cities. In this study, the population size used is relatively small, so the entire population is used as a sample. This sampling method uses saturated sampling techniques. According to Sugiyono (2018), saturated sampling (census) is a sampling technique in which all members of the population are used as samples. Secondary data is used in this study, collected using documentation techniques. According to McCulloch (2004), documents can be briefly defined as records of an event or process. Sources of information used to answer research questions are obtained by collecting documents in the form of archives. The documents collected include disaster reports, agricultural statistics, and food security reports during the budget refocusing policy period from 2020-2021.

This study uses latent variables (latent constructs) consisting of dependent variables, independent variables, and intervening (mediation) variables. The dependent variable in this study is food security. Food security is defined as the condition of being able to fulfill food needs for the country down to individuals, reflected in the availability of sufficient food, both in quantity and quality, safe, diverse, nutritious, equitable, and affordable, not in conflict with religion, beliefs, and culture, to live healthy, active, and productive lives sustainably (Law No. 18 of 2012). The latent variable of food security is measured by the Food Security Index. The measurement of food security indicators uses formative indicators. The next variable is the independent variable. The independent variable in this study is disasters, defined as serious disruptions to the functioning of a community or society causing widespread human, material, or environmental losses that exceed the ability of the affected community to cope using its own resources (Rucińska, 2019). Disasters use formative indicators measured by the Disaster Risk Index. The intervening variable in this study is the agricultural sector, defined as the direct contribution made by agriculture by increasing added value to the Gross Domestic Product (GDP)/Regional Gross Domestic Product and the amount of agricultural production (Awokuse & Xie, 2015). The agricultural sector uses reflective indicators measured by the GDP contribution of the agricultural sector and the amount of rice production.Data analysis in this study uses Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach. SEM-PLS is one of the variance-based SEM statistical techniques designed to handle multiple variables, enabling the analysis of complex relationships and statistical models, even with small sample sizes (Hair et al., 2017). The SEM-PLS measurement model aims to test the validity and reliability of the indicators of latent variables by connecting them. In this study, data were analyzed using the WarpPLS software package.

3. RESULT AND DISCUSSION

The initial stage in SEM-PLS analysis begins with model specification. This stage involves creating a path model that connects variables and constructs based on theory and logic. When creating the path model, it is important to distinguish the types of constructs and the relationships between them. Constructs can be considered exogenous or endogenous. Exogenous constructs act as independent variables and do not have arrows pointing towards them, while endogenous constructs are explained by other constructs. Although often considered dependent variables in relationships, endogenous constructs can also act as independent variables when placed between two constructs. Variables placed between two paths are also referred to as intervening (mediation) variables.

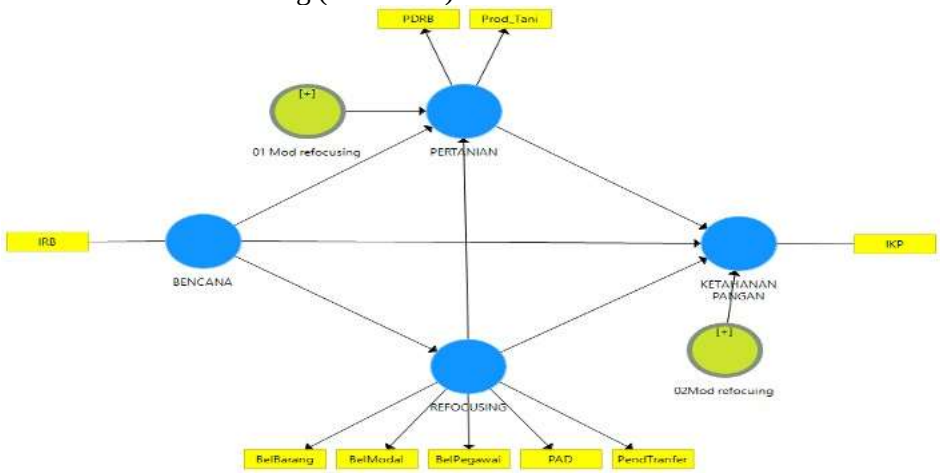

Figure 2. Path Model Specification
Source: Data Processed by SmartPLS

The next stage in SEM-PLS analysis is the outer model (measurement model). At this stage, the measurement model is concerned with examining the measurement models that differ for reflective and formative constructs (J F Hair et al., 2019), with each approach relying on a different set of criteria (Joseph F. Hair et al., 2012). The first step in assessing the reflective measurement model involves examining the indicator loadings. A loading above 0.708 is recommended as it indicates that the construct explains more than 50 percent of the indicator's variance, thus providing acceptable item reliability. The second step is to assess internal consistency reliability, most often using composite reliability (J F Hair et al., 2019). Composite reliability varies between 0 and 1, with higher values indicating higher reliability levels. It is generally interpreted similarly to Cronbach's alpha. Specifically, composite reliability values of 0.60 to 0.70 are acceptable in exploratory research, whereas in more advanced research, values between 0.70 and 0.90 can be considered satisfactory (J. F. Hair et al., 2017). The third step is to assess the convergent validity of each construct measure. Convergent validity is the extent to which a construct converges to explain the variance of its items. The metric used to evaluate the convergent validity of a construct is the average variance extracted (AVE) for all items on each construct. The minimum acceptable AVE is 0.50 or higher. This indicates that the construct explains 50 percent or more of the variance of the items that form the construct. The results of the examination of the agricultural sector variables using reflective measurement are presented in Table 1 below:

Table 1. Reflective Measurement Model Evaluation

Variabel dan Indikator	*Loading factor*	*Composite reliability*	*convergent validity* (AVE)
Sektor pertanian		0,785	0,648
Ln_PDRB	0,888		

Prod_Tani	0,713

Source: Data Processed by SmartPLS

The loading factor values of the agricultural sector indicators in Table 1 are all above 0.708 and the composite reliability value is 0.7. This shows that each research construct is reliable and all loading factor values are above 0.6. While the AVE value is greater than 0.50. This indicates that the construct has good discriminant validity. Based on these examination results, the validity and reliability requirements of the constructs are met. The fourth step is to assess discriminant validity, which is the extent to which a construct is distinct from other constructs. In research, discriminant validity is assessed through HTMT. HTMT is defined as the average value of item correlations between constructs (i.e., heterotrait-heteromethod correlations) relative to the average (geometric) value of item correlations for items measuring the same construct (i.e., monotrait-heteromethod correlations). Discriminant validity issues arise when the HTMT value is high (J F Hair et al., 2019). An HTMT value above 0.90 indicates a lack of discriminant validity. However, when constructs are conceptually more distinct, a lower and more conservative threshold value, such as 0.85, is recommended (J F Hair et al., 2019). The results of the examination of each construct differ and are below 0.9, which meets the discriminant validity criteria (Table 2).

Table 3. Heterotrait-Monotrait Ratio (HTMT)

Variabel	BCN	KP	SPT
BCN			
KP	0,146		
SPT	0,690	0,74	

Source: Data Processed by SmartPLS

The next measurement of constructs is for variables using formative indicators. To evaluate formative constructs using indicator collinearity, the Variance Inflation Factor (VIF) is used to measure collinearity. A value of 5 or more indicates collinearity issues between predictor constructs. Table 4 presents the results of the formative indicator measurement, where the VIF values are below 5. This indicates that there is no multicollinearity between constructs. Thus, the formative measurement criteria are met.

Table 4. Formative Indicator Measurement (VIF)

Indikator	VIF
IKH	1,000
Prod_Tani	1,107
ln_PDRB	1,107
IB	1,000

Source: Data Processed by SmartPLS

The stage after the outer model is the structural model. In this model, collinearity is first examined. Collinearity must be evaluated before assessing the structural model to ensure that the regression results are not biased (Hair et al., 2019). To test collinearity, ideally, the variance inflation factor (VIF) is below 5. The VIF values in Table 4 for all indicators are below 5. This condition means that no collinearity issues are found. Thus, the structural model meets the criteria for being accountable. Next, the quality of the model in this study needs to be examined first before testing the hypotheses. Path coefficients are evaluated using the Bootstrapping procedure with 5,000 subsamples (Chin et al., 2008). The criteria to be evaluated are the coefficient of determination (R2) and effect size (f2) (J F Hair et al., 2019). An R^2 value of 0.75 is considered substantial, 0.50 is moderate, and 0.25 is weak (Hair et al., 2019). The R^2 for food security is 0.031, and the R^2 for the agricultural sector is 0.241 (see Table 5). This indicates that food security is influenced by exogenous constructs with small criteria, while the agricultural sector is influenced by

exogenous constructs with moderate criteria. Finally, f^2 testing is conducted to assess the effect size of each path model with criteria: 0.02 low, 0.15 moderate, and 0.35 high. The f^2 test results show that exogenous constructs have effect sizes in the low and moderate criteria for endogenous constructs.

Table 5. Hasil Pemeriksaan Kualitas Model

	R2	R Square Adjusted	*f^2 effect size*
KP	0,031	-0,014	
SPT	0,241	0,223	
BCA = > KP			0,032
BCA = > SPT			0,317
SPT = >			0.010

Sumber : Data di olah SmartPLS

At the end, hypothesis testing is carried out using the bootstrapping procedure. The results of hypothesis testing are presented in Table 6 below:

Table 6. Hypothesis Testing Results

Hipotesis	**Original Sample (O)**	**T Statistics (|O/STDEV|)**	**P Values**
Bencana -> Ketahanan Pangan	0,019	0,114	**0,910**
Bencana -> Pertanian	0,479	2,905	**0,004**
Bencana -> Ketahanan Pangan	-0,073	0,428	**0,669**
Bencana -> Pertanian -> Ketahanan Pangan	-0,035	0,420	**0,675**

Source: Data Processed by SmartPLS

The hypothesis test results show that disasters do not significantly affect food security (see Table 6, 0.910 > 0.05). This insignificant effect is because during the disaster caused by Covid-19, the Indonesian government issued budget refocusing policies to reduce disaster risks. Based on these policies, local governments can allocate social assistance to reduce food insecurity issues. There are six social safety net programs to mitigate the impact of Covid-19, including PKH policies, Sembako Cards, Pre-Employment Cards, electricity tariffs, anticipation of basic needs, and credit payment relief for informal workers, both online motorcycle taxi drivers, tax drivers, and MSME actors (Basri et al., 2021). Although the first hypothesis result could not prove the effect of disasters on food security, the second hypothesis proves that disasters affect the agricultural sector (see Table 6, 0.004 < 0.05).

This research result supports the findings of (Rozaki, 2020), which showed that the disaster caused by Covid-19 affected the agricultural sector and food security. However, this research result differs from the studies by Israel and Briones (2012). Israel & Briones (2012) found that disasters caused by typhoons, floods, and droughts had an insignificant impact on overall agricultural production at the national level, but typhoons had a significant negative impact on rice production at the provincial level. Meanwhile, the disaster variable in this study still maintains a positive effect on the agricultural sector and food security. This aligns with the findings of Loayza & Olaberri (2012), which showed that floods maintain a positive and significant effect on aggregate GDP growth, agriculture, and services. This positive disaster effect is due to efforts to rebuild the agricultural sector destroyed by the disaster. Reconstruction efforts in the agricultural sector require investments allocated to the improvement of agricultural facilities and infrastructure.

However, Hallegatte et al., (2006) highlight that reconstruction investments often take a long time to implement (especially in developing countries), given the limited capacity in the financial sector and government to channel the necessary resources for reconstruction activities and the high demand for reconstruction skills that are in limited supply (e.g., construction workers). Support such as foreign aid is needed to alleviate some of these financial and technical constraints, so reconstruction in the agricultural sector can focus on post-disaster development. Although the positive effects of disasters have increased development in the agricultural sector, the role of the agricultural sector in improving food security remains a major issue when people cannot easily access daily food needs. However, according to this research, the agricultural sector has been proven not to affect food security. This result can occur because the development of the agricultural sector in Aceh Province has not been integrated with sustainable agricultural development, resulting in some districts/cities still being food insecure, although most districts/cities in Aceh Province have reached the Green Food Security Index (IKP) Cut Point based on Keumala et al.'s (2021) research. However, there are two areas with food security indices classified in the red zone, namely Subulussalam City and Aceh Singkil Regency. The impact of the Covid-19 pandemic is believed to be a factor hindering food distribution between regions. This can certainly threaten the food security status in Aceh Province. This condition shows that increasing agricultural production is not a guarantee of food security if food distribution is not evenly distributed in each region. This is also evident in the study by Pawlak & Kołodziejczak (2020), which showed that although agriculture's contribution to Gross Domestic Product (GDP) is very high, poor conditions coupled with inadequate infrastructure in Nepal will hinder agricultural production.

Another significant finding in this study is that the agricultural sector does not significantly mediate the effect of disasters on food security. This means that the agricultural sector has a direct role in achieving food security, as shown in the study by Herrera et al. (2021), which indicates that agricultural practices are a crucial factor in determining food security in agrarian communities in northeastern Madagascar. The size of the land and agricultural productivity are more important than demographics and socioeconomics in rural populations. The larger the land size and agricultural productivity, the lower the likelihood of food insecurity.

Although agriculture is vital for food production, its direct impact on food security is influenced by various factors. Growth in the agricultural sector is indeed important, but this growth does not necessarily guarantee food security. Other elements such as distribution, access, and socio-economic factors play a crucial role. Additionally, external factors such as disasters, armed conflicts, and pandemics can disrupt agricultural systems and jeopardize food security (FAO, 2023). Therefore, efforts to achieve food security require a holistic approach that includes natural resources, agricultural sustainability, and market access. These are necessary to enhance food security and reduce poverty in low-income countries, as suggested by Herrera et al. (2021). Another recommended strategy for developing countries with different agricultural characteristics, based on Pawlak & Kołodziejczak (2020), includes technology transfer, productivity enhancement, irrigation services, and multidimensional growth strategies.

4. CONCLUSION

Disasters and the agricultural sector have complex and multidimensional effects on achieving food security. Poorly managed disasters can pose a threat to the development of the agricultural sector and impact food security. This study demonstrates that disasters do not affect food security. Although the effect of disasters on food security is not significant, other hypotheses prove that disasters affect the agricultural sector. On the other hand, the role of the agricultural sector in enhancing food security remains a major issue when people cannot easily access daily food needs. Based on the results of this study, it is proven that the agricultural sector does not influence food security. Another important finding of this research is that the agricultural sector does not significantly mediate the effect of disasters on food security. This means that the agricultural sector has a direct role in achieving food security.

Therefore, to improve food security in the region, policies must be pursued that are holistic and multidimensional, encompassing efforts to reduce disaster risk through the role of sustainable agriculture.

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