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Dynamics of the Agricultural Sector and Food Security in the Border Areas East Nusa Tenggara Province – Timor Leste

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ABSTRACT: East Nusa Tenggara (NTT) Province is a strategic area bordering Timor-Leste, with significant potential in agriculture and trade. However, NTT faces food insecurity issues, reflected in high poverty rates and malnutrition prevalence, making it the province with the highest malnutrition rate in Indonesia. This study uses Multiple Linear Regression Method to analyze the impact of climate change, accessibility, education, agricultural diversification programs, and community participation on food security. A sample of 150 farmers from Kupang, South Central Timor, North Central Timor, Belu, and Malaka districts was randomly selected. The results show that these five variables significantly affect food security in NTT, both partially and simultaneously. Strategic recommendations include adopting climate change adaptation programs, improving accessibility, education, agricultural diversification, and strengthening community participation in decision-making processes.

Keywords*:* Accessibility, Agricultural Diversification, Community Participation, Dynamics of Climate Change, Food Security

ABSTRAK: *Provinsi Nusa Tenggara Timur (NTT) adalah wilayah strategis yang berbatasan dengan Timor Leste dan memiliki potensi besar dalam pertanian dan perdagangan. Namun, NTT menghadapi masalah kerawanan pangan, terlihat dari tingginya kemiskinan dan prevalensi gizi buruk, menjadikannya provinsi dengan kekurangan gizi tertinggi di Indonesia. Penelitian ini menggunakan Metode Regresi Linear Berganda untuk menganalisis dampak perubahan iklim, aksesibilitas, pendidikan, program diversifikasi pertanian, dan partisipasi masyarakat terhadap ketahanan pangan. Sampel sebanyak 150 petani dari Kabupaten Kupang, Timor Tengah Selatan, Timor Tengah Utara, Belu, dan Malaka dipilih secara acak. Hasilnya menunjukkan kelima variabel tersebut berpengaruh signifikan terhadap ketahanan pangan di NTT, baik secara parsial maupun simultan. Rekomendasi strategis meliputi adopsi program adaptasi perubahan iklim, peningkatan aksesibilitas, pendidikan, diversifikasi hasil pertanian, serta penguatan partisipasi masyarakat dalam pengambilan keputusan. .*

Kata Kunci: *Aksebilitas, Dinamika Perubahan Iklim, Diversifikasi Pertanian, Partisipasi Masyarakat, Ketahanan Pangan*

INTRODUCTION

The border region of East Nusa Tenggara (NTT) Province and Timor Leste has a unique history and economic dynamics, especially in the context of agriculture and food security. As the border between the two countries is close to each other, the geographical and socio-economic conditions in this area are crucial for an in-depth understanding of the potential and challenges faced by the agricultural sector and food security. Agriculture as the backbone of the economy in many border communities not only reflects the way of life of local communities but is also a major factor in determining the level of food security in this region.

The geographical conditions of the NTT-Timor Leste border, which is an area with a unique history and economic dynamics, have a significant influence on agricultural patterns and food security in this region Lourdes (2016) explains that economic dynamics in this region are not only influenced by internal factors but also by historical events that shape the unique characteristics of the agricultural system and food security in border areas. In the history of the development of Timor Island, there has been a shifting pattern in the consumption patterns of the people. In the beginning, taro and other tubers were the staple food in the area. However, in the early 1970s, a significant change occurred when rice replaced taro as the staple food. This shift was related to the implementation of the New Order government program at that time.

During the New Order period, the Indonesian government encouraged a shift in people's consumption patterns from taro to rice. This change was aimed at increasing rice production as a national food strategy. The policy involved various incentives, campaigns, and agricultural programs to encourage the growth and consumption of rice in various regions including Timor Island. This shift not only covers food aspects, but also has economic and social impacts. These changes in consumption patterns impact the sustainability of local resources and also affect people's traditional ways of life. In turn, this creates new dynamics in the food structure and daily lives of Timor Islanders, reflecting the complexity of interactions between government policies, local agriculture, and local culture (Dako et al., 2019).

Data from Statistics of Nusa Tenggara Timur Province (2023) shows that the agricultural sector in NTT Province has a significant contribution to the Gross Regional Domestic Product (GRDP) and the livelihoods of some people in this region. It can be identified that the agricultural sector contributes 30.32 percent with the total population working in this sector being 2,725,000 people. The data presented by the Central Bureau of Statistics above is in line with previous research by Nalle et al. (2022) which highlighted the central role of the agricultural sector in meeting local food needs and the economic welfare of border communities. Ironically, the high contribution of the agricultural sector in the employment and GRDP of NTT Province turns out to have a variety of problems marked by a high poverty rate of 19.96 percent, even though this figure is categorized as the third highest in Indonesia after Papua and West Papua Provinces.

The journey of East Nusa Tenggara (NTT) Province in facing food security challenges opens a new chapter in understanding the complex dynamics involved in the sustainability of food resources and community welfare. In this context, several symptoms have emerged that reflect an imbalance, highlighting the need for in-depth attention to these issues. Through further exploration, these phenomena can be identified as signaling the need to adopt integrated solutions, paving the way for the restoration and improvement of food security in East Nusa Tenggara Province. Some of these phenomena include fluctuations in agricultural production, climate change that may affect planting and harvesting patterns, unequal access to agricultural resources, and challenges in supporting the economic sustainability of local farmers. Identifying and deeply understanding these symptoms is the first step in designing sustainable and effective solutions (Hamakonda et al., 2023).

The poor food security in NTT Province is clearly illustrated by several symptoms that reflect serious challenges in meeting food needs and community welfare. Previous research reported by Rachmawati & Pusponegoro (2021) shows that one of the main indicators of food security is the high level of hunger and malnutrition among the population. Research conducted by Nubatonis et al (2022) also explained that the prevalence of stunting affects children under five years old, NTT Province has the highest percentage in Indonesia with a figure reaching 40.03 percent.

Furthermore, dependence on food imports is another indication of poor food security in this region (Ngongo et al., 2021). For example, the report from The Central Statistics Agency of East Nusa Tenggara Province (2023), recorded that in 2022, rice production capacity in this region was 442,842 tons, while the food demand from rice consumption reached 523,112 tons. This figure indicates a food production deficit of 80,270 tons, or it can be said that the food production capacity in this region is only 84.65 percent of the community's consumption. To address this food shortage, the alternative solution taken is to implement import policies from outside the region. If most of the food needs are met through imports, then the region becomes vulnerable to global price fluctuations and logistical challenges (Hamilton et al., 2020). The high level of dependence on certain agricultural sectors is also a significant risk indicator. If the community relies on a single type of crop or specific agricultural activity, natural disasters or climate change can quickly destroy the main food resources and threaten local food security (Fahad & Wang, 2020).

Agricultural dynamics and food security in the border areas of NTT Province and Timor Leste are an important part of research in facing the challenges of climate change and economic dynamics. Research conducted by Taek et al. (2022) highlights the escalation of the impact of climate change on the agricultural sector, providing an essential basis for understanding that extreme weather fluctuations and uncertainty in rainfall patterns are the main focus for understanding how climate dynamics can influence agricultural productivity and its impact on food security. Furthermore, Kennedy et al. (2022) Research conducted revealed that one of the causes of the low level of food security in NTT Province in general, especially in Malacca Regency, is caused by erratic fluctuations in climate change such as short rainy seasons and long dry seasons, floods and landslides, which have an impact on crop failure. and low productivity (Taek et al., 2022).

The border area of East Nusa Tenggara Province and Timor Leste faces several factors that influence the level of food security, with accessibility being one of the key factors. According to research by Rachmaningsih & Priyarsono (2012), the eastern region of Indonesia, including NTT Province, shows a high level of vulnerability to food security challenges. This vulnerability is caused by three main pillars, namely accessibility, availability, and utilization of food which has not been optimal in its management. The main focus in the accessibility aspect is infrastructure, especially road infrastructure. According view Rachman (2010), the existence of good infrastructure, especially adequate roads, has a positive impact on the mobility of goods and services. This positive impact directly encourages local economic growth, so it has significant implications for the level of community welfare in the region.

Siegner et al. (2018) further emphasized that one of the important keys to increasing food security is increasing access to food services. These steps involve various strategies, including increasing production, and availability, improving food quality and safety, as well as special attention to the smooth distribution and stability of food procurement. Thus, the accessibility aspect does not only include the physical ease of reaching food resources but also involves comprehensive improvements in the food value chain, from production to distribution. All of this is an integral part and joint effort to achieve optimal results in increasing food security in the NTT-Timor Leste border region.

Future research focuses on agricultural diversification program variables, exploring the implications of limited crop and livestock variation in local agricultural contexts. Within this framework, Waha et al. (2018) emphasize the urgency of diversification as a key strategy to reduce production risks and increase food security. Their research suggests that agricultural diversification not only creates diversity in production but also provides a solid foundation for overcoming market fluctuations and the impacts of climate change. In this context, Hooks & Johnson (2003), highlight the significance of diversification as a form of protection against production risks. They emphasize that by integrating different types of crops and livestock, farmers can reduce the risk of losses due to failure to harvest one particular type of crop or from pest attacks. In addition, variations in plant types can increase land productivity and maintain the balance of the agricultural ecosystem, which in turn supports agricultural sustainability (Hooks & Johnson., 2003).

Recognizing that diversification is not just a risk strategy, Chavas et al. (2022), also highlight the positive impact on food security. Agricultural diversification can increase food availability throughout the year, provide a wider range of nutritional options, and strengthen household food security. Therefore, in designing agricultural policies or strategies in the border region of East Nusa Tenggara and Timor Leste, it is important to understand the central role of agricultural diversification as a holistic solution in increasing food security and the welfare of local communities.

In addition to agricultural diversification, education also plays a crucial role in enhancing food security in the border regions of NTT and Timor-Leste. The study by Mutisya et al. (2016) highlights that the level of education has a critical role in shaping the public's understanding of modern agricultural practices and adaptation to climate change. The Central Statistics Agency of East Nusa Tenggara Province (2023), notes that the average length of schooling for residents in NTT Province is 7.8 years. This fact is reinforced by the research findings of Suek et al. (2021), which revealed that 53 percent of farmers in NTT have an education level equivalent to elementary school. This low level of education is one of the factors causing low productivity and vulnerability to food insecurity. With higher education, awareness of the latest agricultural technologies can be increased, providing greater opportunities for communities to adopt more efficient and sustainable agricultural practices (Nalle., 2018).

According to Thoai et al. (2018), Education also shapes the capacity to adapt to climate change. With a higher level of education, society will be able to better respond and adapt to changing climate conditions which have the potential to influence agricultural production patterns. Education provides the foundation of knowledge and skills needed to face environmental challenges while increasing agricultural productivity. Furthermore, this research will explore the impact of education levels in the border areas of NTT and Timor Leste on policies, practices, and community awareness in the context of food security. With a deeper understanding of the relationship between education levels and food security, it is hoped that policy solutions can be identified that support increasing education levels as an integral strategy in building sustainable food security in this region.

Furthermore, community involvement and participation also play an important role in enhancing food security in the border regions of Timor Island. Active community involvement in decision-making and the implementation of agricultural programs can significantly shape the sustainability and effectiveness of food security initiatives. For instance, a study conducted by Limnirankul et al. (2015), revealed that community participation in decision-making and the implementation of agricultural programs can improve the sustainability and effectiveness of food security initiatives. Community participation not only includes understanding and approving agricultural policies but also directly involves the community in the implementation and monitoring of agriculture-related programs (Sulandjari et al., 2023). By actively involving the community, food security initiatives can be more targeted and aligned with the needs and conditions of local communities. This aligns with the research findings by Nagoda & Nightingale (2017), which state that community participation in decision-making processes can increase the acceptability and sustainability of agricultural programs.

This research has significant relevance in the context of food security in the border areas of NTT and Timor Leste. Previously, research conducted by Be (2022) focused on the North Central Timor District, with the variables of rice production, availability and price as the main focus in measuring food security. However, this study tries to fill the knowledge gap by involving the entire mainland area of Timor Island bordering Timor Leste. In addition, this study involves external variables that include climate change dynamics, accessibility, education, agricultural diversification programs, and community participation. In this way, the investigation can provide a more comprehensive understanding of the factors affecting food security in the region.

Empirical facts show that, so far, no specific research has explored food security in the border areas of NTT and Timor Leste Province as a whole. By involving a wider range of external variables, this research is expected to provide deeper insights and more holistic solutions to improve food security in a geographically and socially challenged region. This research not only creates a significant contribution to the scientific literature but can also provide a basis for government and stakeholder decision-making in designing more effective and sustainable policies in the field of food security.

The significance of this research lies in its contribution to forming the basis of a sustainable and results-oriented policy. The goal is not only limited to in-depth understanding but also to the implementation of concrete solutions that can improve food security, farmers' welfare, and agricultural sustainability in the border area of NTT-Timor Leste Province. The results of this research are expected to provide strategic guidance for relevant parties, including the government, development agencies, and community organizations, in designing effective and measurable intervention programs. In addition, this research is also expected to provide a solid scientific foundation to optimize agricultural potential in the border region, creating a real positive impact to improve food security sustainably.

METHODS

This research is experimental research with a quantitative approach or inferential analysis method, which aims to evaluate the partial or simultaneous influence of independent variables (dynamics of climate change, accessibility, education, agricultural diversification programs, and community participation) on the dependent variable represented by food security. Apart from that, this research also utilizes qualitative methods to explore it, to explore various indicators that can explain the presence or absence of influence of each independent variable on the dependent variable. This approach is expected to provide a holistic and in-depth understanding of the problems faced by farming communities. By integrating quantitative and qualitative findings, this research aims to make a significant contribution. It is hoped that the in-depth findings will provide a strong basis for formulating policy recommendations that are appropriate to the real challenges faced by farming communities in the region. Apart from that, it is also hoped that this recommendation can be an alternative solution for the Regional Government in designing effective and efficient policies for overcoming food security problems in the NTT-Timor Leste border area.

This research was carried out over approximately 5 months, starting from July to December 2023. The focus of the research was on farming business actors spread across five districts on the mainland of Timor Island, an area that geographically borders directly on the State of Timor Leste. The five districts that were the research subjects included Kupang District, South Central Timor, North Central Timor, Belu, and Malaka District.

The population of this study refers to publication data provided by Statistics of Nusa Tenggara Timur Province (2023). This population includes farming business actors in the five districts mentioned previously, with a total of 288,882 people. Considering the homogeneity of population characteristics, the sample determination method applied used Simple Random Sampling, with calculations based on the Slovin formula (Nalle & Pangastuti, 2023). The number of samples taken was 150 people. To minimize the potential for data bias, the sample selection criteria involved farmers aged 25-55 years, who had consistency in carrying out farming activities for at least the last 10 years, and were active or members of assisted farmer groups.

The size of the population and determination of the research sample can be seen in Table 1 below;

Table 1. Determining the Number of Research Samples

No	Location	Population	Samples
1	Kupang Regency	66,168	15
2	South Central Timor Regency	106.414	15
3	North Central Timor Regency	49,674	25
4	Belu Regency	29,744	25
5	Malacca Regency	36,882	70
	Total	288,882	150

This research will focus specifically on Malacca Regency, with a significant number of samples taken from the area. The selection of Malacca Regency as the main focus of research was based on in-depth considerations. This region has cultural and historical riches that are closely related to the State of Timor Leste. Apart from that, the Regional Government of Malacca Regency is intensively

implementing the “Agricultural Revolution Program” as part of efforts to increase the productivity of the agricultural sector (Seran et al., 2019). This decision was taken with the consideration that Malacca Regency provides a rich and relevant context for understanding the dynamics of agriculture and food security in the East Nusa Tenggara-Timor Leste border region. Local Government actions through the Agricultural Revolution program provide an important background for investigating the impact of these policies on agricultural practices and food security at the local level.

To provide a more visual and clear picture of the research location, it can be seen in the accompanying picture.

Source: Map Design Results with the ArcGIS Application in 2023

Figure 1. Map of Malacca Regency and Research Locations

This research employs two types of data, namely primary data and secondary data. Primary data is directly obtained from respondents or research samples, who are members of the farming business community. Meanwhile, secondary data consists of information acquired from government institutions, particularly data publication documents closely related to the research objectives. The collection of primary data involves active participation from the farming business community, who serve as respondents in this research, providing direct information on agricultural practices, challenges faced, and various aspects related to food security. On the other hand, secondary data is obtained from government institutions, particularly from the Central Statistics Agency for East Nusa Tenggara Province (NTT). This data includes information on the number of farmers in the five districts focused on in the research, the contribution of the agricultural sector to Gross Regional Domestic Product (GRDP), as well as statistics on rice production and consumption in the community.

The primary data collection methods in this study include questionnaires, interviews, documentation, and direct observation. Each indicator related to research variables, such as Climate Change Dynamics, Accessibility, Education, Low Agricultural Diversification, Community Participation, and Food Security, is presented as a positive statement to facilitate respondents in providing answers. These statements are crafted based on theoretical studies and previous research relevant to the research objectives. The questionnaire provided to respondents offers guided alternative answers, utilizing a Likert scale with four category levels: strongly agree, agree, disagree, and strongly disagree (Suárez-Alvarez et al., 2018). This approach enables the assessment of the respondent's level of agreement or disagreement with each statement, providing a structured framework for evaluating the research variables (Mircioiu & Atkinson, 2017).

The results of theoretical exploration and indicator settings related to each research variable are arranged in the following summary table

Table 2. Summary of Variables, Indicators, and Previous Research

Variable	Indicator	Previous Research
Dynamics of Climate Change (X1)	● The number of changes in annual average temperature.	Wollenberg et al., (2016),Gits, (2016),Medina et al., (2017).

Variable	Indicator	Previous Research
Accessibility (X2)	● Annual rainfall change patterns. ● Frequency of climate-related natural disasters. ● Average travel distance to major food resources. ● Availability of transportation infrastructure. ● Access to key markets.	O'Hara & Toussaint, (2021), Westengen & Banik, (2016), Gani & Prasad, (2007), Khan et al., (2012).
Education (X3)	● Average years of schooling of the population. ● Percentage of the population with a certain level of education. ● Access agricultural education and sustainable practices.	De Muro & Burchi, (2007), Kaiser et al., (2015), Alvi & Gupta, (2020).
Agricultural Diversification Program (X4)	● Diversity Index of Plants Planted ● Percentage of superior crops to total agricultural production ● The degree of variation in annual agricultural production.	Mango et al., (2018),Adem et al., (2018),Tamburini et al., (2020),Dedehouanou & McPeak, (2020).
Community Participation (X5)	● Level of participation in farmer groups or agricultural cooperatives. ● Level of participation in agricultural development programs. ● Percentage of people involved in local decisions related to agriculture.	Carney et al., (2012),I et al., (2019),Windiasih et al., (2020)
Food Security (Y)	● Household Food Security Index (HKI) ● Food Availability Per Capita. ● Level of vulnerability to food security.	Izraelov & Silber, (2019),Thomas & Hombres, (2017),Chen et al., (2019)

Source: Google Scholar Search, 2024

After all respondents complete the questionnaire, the next step involves data collection and tabulation to serve as the basis for analysis. Descriptive statistical analysis is employed to provide an overview of respondent characteristics and describe factual conditions based on research variables. Additionally, inferential analysis, utilizing multiple linear regression analysis methods, is conducted to assess the partial and simultaneous influence of dynamic variables such as climate change, accessibility, education, low agricultural diversification, and community participation on food security. This analytical approach follows the framework proposed by Núñez et al. (2011).

$$Y_{FS} = \alpha + \beta_{Dyn\_Climate\_Change} + \beta_{Access} + \beta_{Educ} + \beta_{ADP} + \beta_{Community\_Particip} + \varepsilon$$

Where:

Y_{FS} = Border Area Food Security
A = Constant

$ß_{Dyn\ Climate\ Change}$ = Regression Coefficient of Climate Change Dynamics Variables
$ß_{Access}$ = Accessibility Variable Regression Coefficient
$ß_{Educ}$ = Education Variable Regression Coefficient
$ß_{ADP}$ = Agricultural Diversification Program Variable Regression Coefficient
$ß_{Community\ Particip}$ = Regression Coefficient of Community Participation Variable
E = Epsilon

The data analysis process was carried out using the Eviews 12 software application. Before starting the analysis, an important first step was to test the quality of the data collection instruments through validity and reliability. This stage is considered absolute to ensure that the data analyzed can produce accurate research output. Furthermore, classical assumption tests were also carried out, which included normality tests, autocorrelation tests, multicollinearity tests, and heteroscedasticity tests. All these tests aim to meet the required statistical standards and ensure the integrity of the data analysis performed (Pangastuti, 2022).

RESULTS AND DISCUSSIONS

Respondent Characteristics

In this research, the respondents who constitute the research sample come from the population of farming business actors in the border areas of NTT and Timor Leste Provinces. These respondents have different characteristics including age, educational background, length of business activity, and gender. More detailed information can be found in Table 3 below.

Table 3. Respondent Characteristics

Characteristics	Amount	Percentage (%)
Gender:		
▪ Man	107	71.33
▪ Woman	43	28.67
Respondent Age:		
▪ 25-35 Years	19	12.67
▪ 36-45 Years	47	31.33
▪ 46-55 Years	84	56.00
Level of education		
▪ Elementary School	73	48.67
▪ Junior High School	35	23.33
▪ Senior High School	24	16.00
▪ Diploma	11	7.33
▪ Bachelor	7	4.67
Length of Business:		
▪ 1-5 Years	16	10.67
▪ 6-10 Years	52	34.67
▪ ≥ 11 Years	87	58.00

Source: Processed Primary Data 2024

The characteristics of the respondents shown in the results of this study can provide a picture that helps explain how agricultural productivity is produced and the level of food security in the border area of NTT and Timor Leste. From a total of 150 respondents, farmers in this region are still dominated by men, reaching 71.33 percent. Likewise, most farm business actors are vulnerable, especially in the non-productive vulnerable category with an age range of 46-55 years, reaching 56 percent. The high proportion in this age group can hurt the productivity of agricultural products, given the potential for productivity to decline with age. Furthermore, it should be noted that most farming business actors in the border area of NTT-Timor Leste Province have a low level of education,

equivalent to elementary school, reaching 48.67 percent. This low level of education is a constraint in terms of innovation, mastery of technology, managerial skills, and transformation of agricultural diversification. Field findings also show that the average respondent who works as a farmer has been in this business for more than eleven years, reaching 58 percent. However, all of the above illustrates the challenges farmers face in adopting more modern agricultural technologies and practices and adapting to the latest developments in the agricultural sector.

Data Validity and Reliability Test

Testing of data collection instruments is carried out through data validity and reliability tests as an absolute requirement in multivariate statistical tests. The benchmark value in assessing data validity is by conducting the Pearson correlation test, where the calculated r-value must be greater than the r-table with a standard alpha coefficient of 0.05. Furthermore, the data reliability test is carried out to evaluate the level of trust in respondents' answers. The criterion for the success of this test is that the Cronbach's alpha value must be greater than 0.60 (Bannigan & Watson, 2009).

Table 4. Recapitulation of Data Validity and Reliability Test Results

Variables	Items	R count	Table	*Crombach Alpha*	Information
Dynamics of Climate Change (X_1)	X1.1	0.807	0.195	0.803	Valid and Reliable
	X1.2	0.883	0.195		Valid
	X1.3	0.853	0.195		Valid
Accessibility (X_2)	X2.1	0.787	0.195	0.635	Valid and Reliable
	X2.2	0.726	0.195		Valid
	X2.3	0.767	0.195		Valid
Education (X_3)	X3.1	0.753	0.195	0.672	Valid and Reliable
	X3.2	0.767	0.195		Valid
	X3.3	0.812	0.195		Valid
Agricultural Diversification Program (X_4)	X4.1	0.847	0.195	0.700	Valid and Reliable
	X4.2	0.731	0.195		Valid
	X4.3	0.794	0.195		Valid
Community Participation (X5)	X5.1	0.618	0.195	0.663	Valid and Reliable
	X5.2	0.776	0.195		Valid
	X5.3	0.791	0.195		Valid
Food Security (Y)	Y1	0.749	0.195	0.758	Valid and Reliable
	Y2	0.859	0.195		Valid
	Y3	0.850	0.195		Valid

Source: Primary Data Processed Results, 2024

Based on the results of the data analysis listed in Table 3, it can be explained that all indicators contained in each variable construct have met the criteria for data validity and reliability. This can be seen from the Pearson correlation value which is approximated by the calculated r which is greater than the r table, as well as the Cronbach's alpha value which exceeds 0.60 at an alpha significance level of 0.05. This situation shows that the instruments used in this research can be considered valid and reliable for measuring the variables studied. Therefore, research can proceed to the next stage of analysis with the confidence that the data obtained can provide accurate and reliable results.

Classic Assumption Test

Testing of data collection instruments is carried out through data validity and reliability tests as an absolute requirement in multivariate statistical tests. The benchmark value in assessing data validity is by conducting the Pearson correlation test, where the calculated r-value must be greater than the r-table with a standard alpha coefficient of 0.05. Furthermore, the data reliability test is carried out to

evaluate the level of trust in respondents' answers. The criterion for the success of this test is that the Cronbach's alpha value must be greater than 0.60 (Delacre et al., 2020).

Table 5. Recapitulation of Classical Assumption Test Results

Variables	Classic assumption test			
	Jargue-Bera test (P-value)	Prob. Chi-Square (2) (P-value)	Prob. Chi-Square(14) (P-value)	VIF value
Residual	1.741389	0.0704	0.0825	
Dynamics of Climate Change				1.710322
Accessibility				1.453482
Education				1.538404
Agricultural Diversification Program				1.280372
Society Participation				1.280372

Source: Primary Data Processed Results, 2024

Based on the results listed in Table 5, it can be identified that all elements in the classical assumption test have been fulfilled, providing a strong basis for continuing data analysis. The results of the normality test show that the data has a normal distribution, as an indication of the Jarque-Bera value which is greater than alpha (1.741389>0.05). Testing the autocorrelation and heteroscedasticity assumptions shows that the value of Prob. The resulting Chi-Square is greater than alpha (0.0704 and 0.0825>0.05), indicating that there is no equal variance in all research variables. This means that variations in these variables are constant. The multicollinearity test also gave satisfactory results, with the resulting Variance Inflation Factor (VIF) value being smaller than 10. This indicates that there was not a perfect correlation between the independent variables in this study. Thus, the conclusions from the results of this classical assumption test support the continuation of further data analysis, and the results can be relied on for accurate interpretation.

Multiple Linear Regression Analysis

This analysis aims to provide answers to the research objectives, namely to evaluate the partial and simultaneous influence of the dynamic variables of climate change, accessibility, education, agricultural diversification, and community participation on food security in the border area of NTT-Timor Leste Province.

Table 6. Recapitulation of Multiple Linear Regression Analysis Results

Variables	Coefficient	R-Square	t-Statistics	t-Table	F-Statistic	F-Table	P-Value
C	-0.533406	0.526802	-0.66098	1.65543	32.06244	2,27	0.5097
Dyn_Climate_Change	0.087806		1.177310				0.2410
Access	0.138394		1.870408				0.0635
Educ	0.201877		2.704032				0.0077*
Div_Agric	0.187096		2.376691				0.0188*
Soc_Part	0.439127		6.103251				0.0000**

Dependent Variable: Food Security

Note: *) Significant at α = 0.05

**) Significant at α = 0.01

Source: Primary Data Processed Results, 2024

The results of the data analysis, as shown in Table 5, yield the following regression equation:

$$Y_{FS} = -0{,}533406 + 0{,}087806_{Dyn\_Climate\_Change} + 0{,}138394_{Access} + 0{,}201877_{Educ} + 0{,}187096_{Div\_Agric} + 0{,}439127_{Soc\_Part}$$

(0,2410) (0,0635) (0,0077) (0,0188) (0.0000)

In the regression equation above, a constant value of -0.533406 is obtained. This means that if there are no simultaneous changes in the dynamic variables of climate change, accessibility, education, agricultural diversification programs, and community participation, then the level of food security in the border area of NTT-Timor Leste Province will decrease by 0.533406. Furthermore, each independent variable has a partial influence on food security, which is shown by the variation in different regression coefficient values for each variable.

From the results of simultaneous testing, as seen in Table 6, the F_{count} value was greater than F_{table} (32.06244 > 2.27). In addition, a probability value that is smaller than alpha (0.0000 < 0.05) indicates that simultaneously, the independent variables in this research, namely the dynamics of climate change, accessibility, education, agricultural diversification programs, and community participation, affect the variable dependent, namely food security in the border area of NTT-Timor Leste Province.

The results of the analysis show an Adjusted R-squared value of 0.526802, indicating that the statistical model built in this research can explain the variability in the dynamics of climate change, accessibility, education, agricultural diversification programs, and community participation which have an influence on food security in the region. the NTT-Timor Leste Province border was 52.68 percent. Meanwhile, the remaining 47.32 percent was influenced by other variables not included in this research.

Discussion

The Effect of Climate Change Dynamics on Food Security

The research results show that the variable of climate change dynamics has a non-significant partial effect on food security in the border region of NTT Province and Timor-Leste. This is supported by a probability value greater than the alpha value (0.2410 > 0.05) and a t-statistic value greater than the t-table value (1.97646 > 1.177310). One of the factors why climate change dynamics variables do not show a significant influence on food security in the NTT-Timor Leste border region is that the implementation of climate change adaptation policies or programs has not yet reached an adequate level (Ferdinand et al., 2019). Although there is an understanding of the importance of climate change adaptation, factors such as lack of resources, inadequate infrastructure, or lack of coordination between institutions can hinder the effectiveness of policy implementation. This may hamper efforts to mitigate the impacts of climate change and improve food security in these border regions.

In facing these conditions, regional governments need to take strategic steps related to climate change adaptation to achieve food security in the NTT-Timor Leste border area. ***First***, improving irrigation and drainage systems is a key policy. Fluctuations in rainfall patterns and temperatures due to climate change affect water availability for agriculture. Therefore, the development of irrigation and drainage systems is considered a vital strategy to increase the resilience of the agricultural sector (Levidow et al., 2014). This program can serve several roles, including Stable water supply, where modern irrigation systems can guarantee a consistent water supply throughout the year. This helps farmers overcome water shortages during longer dry seasons or irregular rain intensities. In addition, increasing water use efficiency can also be achieved through the application of advanced irrigation technology, such as drip irrigation or sensor-based smart irrigation, to help farmers use water more efficiently (Rakhimov et al., 2020).

Second, The use of plant varieties that are resistant to climate change has a strategic role in facing the challenges of climate change in the NTT-Timor Leste border region. This program not only focuses on selecting plant varieties that can adapt to increasingly uncertain climatic conditions but also involves farmers in implementing sustainable agricultural practices (Scheben et al., 2016). First of

all, this program includes outreach and training about various plant varieties that are resistant to climate fluctuations. Farmers are provided with in-depth information about the characteristics of each variety, including resistance to drought, pest attacks, and extreme temperature changes. Through this understanding, it is hoped that farmers can make intelligent decisions in choosing varieties that best suit local climate conditions.

Furthermore, this program encourages the use of modern agricultural technology to increase the effectiveness of selecting and planting appropriate crop varieties. Implementation of climate monitoring technologies, such as weather stations and soil sensors, helps farmers understand local climate patterns more accurately. With a better understanding of environmental conditions, farmers can adjust planting schedules and farming methods according to predicted climate changes. The use of plant varieties that are resistant to climate change is also integrated with sustainable agricultural practices. Farmers are empowered to implement crop rotation, polyculture, and organic farming practices to increase the sustainability of agroecosystems. It also includes increasing farmers' capacity in water management and efficient use of fertilizers to support optimal crop growth under varying climatic conditions (Vijayasarathy & Ashok, 2015).

Third, implementing the Agricultural Insurance Program. Agricultural Insurance plays a crucial role in efforts to support food security in the NTT-Timor Leste border region, especially in facing uncertainty and risks that may arise due to climate change. This agricultural insurance program is designed to protect farmers from the negative impacts that can be caused by climate change, such as natural disasters, droughts, floods, and other extreme weather (Meuwissen et al., 2018). Risk management through agricultural insurance is also integrated with sustainable agricultural practices. Farmers are encouraged to apply agricultural methods that are more resilient to climate change and more efficient (Vyas et al., 2021). The importance of agricultural insurance lies not only in financial protection for farmers but also in economic recovery after a disaster or crop failure. With this financial protection, farmers can have more confidence to invest in more sophisticated agricultural technology, increase their capacity to adapt to climate change, and ultimately, support food security in the NTT-Timor Leste border region.

Fourth, Disaster Risk Management. The disaster risk management program is designed to involve farmers in efforts to mitigate, prepare, and recover from the impacts of disasters that may occur due to climate change. First of all, the program includes identifying potential disaster risks in the region. Risk analysis is carried out to assess the types of disasters that may occur, such as floods, landslides, drought, or other extreme weather. A deep understanding of these risks provides the basis for developing appropriate risk reduction strategies. Furthermore, this program focuses on empowering communities in increasing disaster preparedness. Training and counseling are provided to farmers to understand the steps that need to be taken before, during, and after a disaster. This includes preparing emergency response plans, using information technology for weather monitoring, and establishing disaster volunteer groups at the community level (Tirivangasi, 2018).

Disaster risk management also involves building disaster-resistant infrastructure. The local government is working with various parties to ensure there are embankments, good water channels, and an effective early warning system. This infrastructure not only protects agricultural land from damage but also protects the safety and resilience of the surrounding community. The sustainability of this program also depends on the existence of a reliable early warning system. Real-time weather monitoring and fast and accurate early warning systems provide opportunities for farmers to take preventive action before disaster strikes. The involvement of information technology, such as the use of mobile applications or short messages, is key in disseminating information quickly and accurately. The importance of managing disaster risk in the context of food security is not only reducing material losses, but also involves efforts to protect farmers' livelihoods, ensure the sustainability of food production, and support economic recovery after a disaster occurs (Uy et al., 2016).

The Effect of Accessibility on Food Security

In the second variable, the analysis results show that the accessibility variable has a regression coefficient value of 0.138394, with a probability greater than the alpha value (0.0635>0.05). This indicates that partially, the accessibility variable has an insignificant effect on food security in the

Timor Island border region. From the field findings, it can be investigated that some of the factors that cause the accessibility variable to have an insignificant influence on food security are due to the inadequate condition of infrastructure, especially transportation facilities, which are the main obstacles. The results of research conducted by Gunita et al. (2019) found that of the total road length of 2800 km, only 41 percent of the road conditions were categorized as good, while the remaining 59 percent were categorized as severely and lightly damaged. In another review, it was explained that transportation facilities in the form of roads have a significant influence on economic productivity in NTT Province.

In addition, inclusive financial services, such as the availability of credit or banking services, may not have reached adequate levels in these border regions. Lack of access to financial services may hinder farmers' ability to access the capital needed to increase agricultural production or make investments in more sustainable agricultural technologies and practices. Research results revealed by Moata & Bunga (2023), revealed that most farmers stated that of the nine challenges faced by farmers in NTT Province in developing their businesses, the toughest factor in increasing productivity and agricultural businesses was due to limited accessibility of capital, with a percentage of 22 percent.

Accessibility, including transportation and financial services, is critical to supporting food security in the border areas of NTT Province and Timor Leste. It affects food distribution and supply. Good transportation networks are needed, including good roads and connectivity between villages and cities. Investments in this infrastructure will help farmers reach markets more easily and cheaply, improving their economy and food availability in the area.

Along with this, efforts to improve accessibility through transportation infrastructure can also include information and communication technology (ICT). The use of ICT can help farmers obtain market information, commodity prices, and weather forecasts, all of which influence production and distribution decisions. Therefore, a holistic approach to improving accessibility must include an understanding of the needs of modern physical and technological infrastructure (Tende et al., 2018). Concrete steps could include improving and expanding the road network, developing affordable public transportation, utilizing technology for tracking and distribution management, and providing training to farmers on how to optimally use existing transportation facilities. Thus, fulfilling optimal accessibility can play an important role in achieving sustainable and inclusive food security (Torkamani & Bakhshoodeh, 2004).

Another aspect of accessibility involves the availability of financial services and market infrastructure. The presence of easily accessible financial services is a key factor in supporting farmers in increasing agricultural production. With affordable financial services, farmers have better access to the capital needed to invest in modern equipment, seeds, and technology. This provides opportunities for increasing production efficiency and increasing agricultural yields (Koomson et al., 2023).

Apart from that, the availability of an efficient market also has a big impact. Well-functioning markets enable farmers to sell their agricultural products at fair and competitive prices. Having efficient distribution channels helps reduce post-harvest losses, ensure supply chain sustainability, and maximize the value of agricultural products. Apart from supporting farmers' incomes, efficient markets also create incentives for farmers to increase the production and quality of their products. Concrete steps to improve this aspect of accessibility involve an integrated approach (Bozsik et al., 2022). Improved financial services could involve collaboration with microfinance institutions, governments, or private sector partners to provide access to farmers, especially those in remote areas. Empowerment through training and education about the benefits of financial services can also increase farmer participation.

Meanwhile, to optimize market infrastructure, it is necessary to invest in the construction and maintenance of market facilities, including the provision of modern storage and distribution facilities (Zhao & Chen, 2023). These steps are aimed at creating an inclusive, fair, and efficient market environment for all parties involved in the agricultural supply chain. For example, involving various stakeholders, such as farmers, local governments, financial institutions, and the private sector, can

form mutually beneficial partnerships (Kuzmin, 2016). Thus, efforts to increase the accessibility of financial services and markets can significantly support food security and sustainable agricultural development in the NTT-Timor Leste border region.

The Influence of Education on Food Security

The results of the data analysis of the education variable obtained a regression coefficient value of 0.201877 with the resulting probability value smaller than alpha (0.0077 <0.05). This means that the level of food security will grow by 1 percent if the education variable increases its role by 0.201877 percent, while still taking into account the principle of ceteris paribus. This result confirms that education is one of the most important aspects and needs serious attention from the government through programs that favor farmer business actors either through training and mentoring or budget alignments in the form of social safety nets in improving education.

Education has a central role in forming and increasing food security in the border region of East Nusa Tenggara (NTT) and Timor Leste. A serious problem faced by the farming community in NTT Province is the level of education which tends to be low, reaching 53 percent as revealed in research by Suek et al. (2021). This low level of education cannot be separated from the parents' habit of prioritizing children to help in the garden, as expressed by Julyyanti et al. (2022). On the contrary, Suek (2020) said that through formal and non-formal education, farmers' understanding can be improved, helping them act rationally, and reducing the risk of crop failure.

A high level of education not only improves people's quality of life but also has a positive impact on the agricultural sector and overall food security. Education provides the necessary knowledge and skills for farming entrepreneurs. Farmers who have a good level of education tend to be better able to adopt agricultural technology innovations, use more efficient farming methods, and carry out sustainable natural resource management (Adem et al., 2018). Additionally, education provides a deep understanding of climate change and how to deal with it. Educated farmers can be more responsive to changes in erratic weather patterns. They can take adaptation steps such as adjusting cropping patterns, using crop varieties that are more resistant to climate change, and implementing environmentally friendly agricultural practices (Njura et al., 2020).

Education also plays an important role in opening up access to market information and economic opportunities. Educated farming business actors can be smarter in planning production, understanding market dynamics, and looking for new opportunities in the agricultural sector. With adequate education, people in the NTT-Timor Leste border region can develop agricultural diversification. They can understand the added value of various types of crops and livestock, which in turn can improve food security and the household economy (Wulandari et al., 2019).

The government needs to pay special attention to increasing access to education in this region. Training and extension programs that focus on sustainable agriculture and climate change adaptation can be an effective instrument in increasing food security in the border areas of NTT-Timor Leste Province. In this way, education can be a key driver in achieving sustainable and equitable food security throughout the region.

The Effect of Agricultural Diversification Programs on Food Security

The results of further analysis of the variable agricultural diversification program obtained a regression coefficient value of 0.187096 with a probability value smaller than alpha (0.0188 <0.05). This result explains that partially the agricultural diversification variable has a significant positive effect on food security in the border area of NTT-Timor Leste Province. The number 0.187096 implies that any increase in food security growth by one percent will also increase the agricultural diversification variable by 0.187096 percent when other variables are considered constant.

The agricultural diversification program has a significant impact on food security in the border region of NTT-Timor Leste Province. Agricultural diversification is an important strategy to reduce dependence on one type of crop or business activity, thereby increasing overall food security. The need for food is increasing, while on the other hand, it is not balanced with the level of productivity, one program that can be implemented is land optimization accompanied by diversification of agricultural products (Tabenu et al., 2023). One of the positive impacts of the agricultural

diversification program is increasing the diversity of agricultural products. By cultivating various types of crops or livestock, people can reduce the risk of crop failure due to climate fluctuations or attacks by certain pests. Agricultural diversification also provides new economic opportunities and increases farmer incomes (Noriega et al., 2017).

This program also plays an important role in increasing accessibility to food. With a variety of agricultural products, people can have more diverse consumption choices, including various nutrients needed to maintain health. Agricultural diversification also contributes to food security by creating sufficient food reserves to face emergencies or difficult situations (Fahad & Wang, 2020).

Apart from that, agricultural diversification can also have a positive impact on the environment. Diverse agricultural practices can help maintain ecosystem balance, reduce soil erosion, and improve soil health. It is important to ensure that diversification programs are designed taking into account local conditions, community needs, and climatic factors that apply in the border areas of NTT-Timor Leste Province. Community involvement in planning and implementing this program is very important so that agricultural diversification can run effectively and sustainably (Mengistu et al., 2021). The government and related parties need to provide financial, technical, and ongoing monitoring support to ensure the sustainability and success of agricultural diversification programs. Thus, this program can become one of the main pillars in improving food security and community welfare in the border areas of NTT-Timor Leste Province.

The Influence of Community Participation on Food Security

The fifth independent variable, namely community participation, produces a regression coefficient value of 0.439127 with a significance value smaller than alpha (0.0188 <0.05). The results of this analysis also explain that the community participation variable has a positive influence on food security in the border area of NTT-Timor Leste Province. The regression coefficient value of 0.439127 implies that when the growth of food security increases by one percent, this is due to the movement of changes in the role of community participation by 0.439127 percent.

Community participation has a crucial role in increasing food security in the NTT-Timor Leste border area. Active participation of the community in various aspects of agriculture, food policy, and decision-making can have a significant positive impact. First of all, community participation in planning and implementing agricultural programs can help understand the needs and challenges faced by local communities. Involving the community directly in the decision-making process will create policies that are more in line with local realities and needs. Community participation also contributes to increasing accessibility to food. By involving the community in infrastructure development such as transportation networks and markets, we can ensure more efficient distribution of agricultural products, thereby increasing food availability in local markets (Haruna et al., 2019).

In addition, community participation in agricultural activities themselves, such as agricultural extension and skills training, can increase agricultural productivity and diversification. Communities that are actively involved in various agricultural activities have a greater opportunity to create an agricultural system that is sustainable and adaptive to climate change (Nagoda & Nightingale, 2017). Community participation can also form strong social networks among farmers, business actors, and other stakeholders. This network can be a means of sharing knowledge, experience, and support, which is very important in facing food security challenges (Olarinde et al., 2020).

To increase community participation, there needs to be an inclusive and sustainable approach. The government and related parties need to create mechanisms that enable community participation, such as discussion forums, farmer groups, and involvement in decision-making processes (Sulandjari et al., 2023). It is also important to empower women's role in community participation because women often have a key role in agricultural sustainability and family food security (Devi et al., 2023). By increasing community participation, especially involving them in every stage of planning and implementing agricultural programs, we can create a strong foundation for increasing food security in the NTT-Timor Leste border region.

CONCLUSION

From the results of data analysis and descriptions in the previous chapter, several important things were found in this research. First, the results of multiple linear regression analysis show that partially, the dynamic variables of climate change and accessibility have an insignificant positive influence on food security. Meanwhile, education variables, agricultural diversification programs, and community participation have a significant positive influence on food security. Second, from the results of simultaneous testing, it appears that simultaneously the variables of climate change dynamics, accessibility, education, agricultural diversification programs, and community participation have a significant influence on food security in the border area of NTT-Timor Leste Province.

Realizing that NTT Province has a fairly high level of food insecurity, the Regional Government can adopt several policies to support food security programs in border areas. First, it is necessary to aggressively implement the Extreme Climate Change Adaptation Program by improving irrigation and good drainage systems. Apart from that, it is important to use plant varieties that are resistant to climate change and implement the Agricultural Insurance and Disaster Risk Management Program.

To increase accessibility, strategic steps that can be taken include building an adequate transportation infrastructure network, developing an information technology network, and providing inclusive financial services and market infrastructure. Furthermore, the Government needs to pay special attention to increasing access to educational services. Training and extension programs that focus on sustainable agriculture and climate change adaptation can be effective instruments in increasing food security.

In the context of agricultural diversification, efforts are needed to increase the diversity of agricultural products by cultivating various types of plants or livestock. This can help people reduce the risk of crop failure due to climate fluctuations or certain pest attacks. Finally, to increase community participation, an inclusive and sustainable approach is needed. The government and related parties need to create mechanisms that enable community participation, such as discussion forums, farmer groups, and involvement in strategic decision-making processes.

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