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EVALUATING FOOD SECURITY: THE INTERPLAY OF INCOME SOURCES FOR PEPPER FARMERS IN WEST KALIMANTAN

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ABSTRACT

Food security remains an essential world challenge, with agriculture having an important part in ensuring food availability, accessibility, and stability. Agricultural families, particularly those living in rural border areas, frequently suffer from poverty and inadequate nutritional needs, making them vulnerable to food insecurity. Insufficient facilities and high food prices enhance the circumstances in these areas. Pepper production is a vital source of income for farmers in the border areas of West Kalimantan. This study analyzes the revenue generated by pepper farming and its impact on food security using descriptive and logistic regression analysis. This study aims to analyze the income structure of pepper farmers and its relationship with food security by employing descriptive statistics and logistic regression methods. Findings reveal that pepper farmers derive income from three primary sources: on-farm, off-farm, and non-farm activities, with an average annual farming income of IDR 48,331,800. The study classified most pepper farmers as "food secured," emphasizing that income from farming and off-farm work significantly influences their food security status. These results underscore the importance of income diversification and agricultural development in mitigating food insecurity, particularly in rural and border communities.

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INTRODUCTION

Food security in border areas is important because border areas often have limited access to food supplies. Limited access to food distribution can be caused by poor infrastructure conditions or long distances from distribution centers. Border areas also have a high dependence on food imports. If there is a problem with importing supplies, it could affect food availability in border areas. Economic inequality is also often found in border areas, which affects border communities' access to food. If there is large economic inequality, it can affect the food security of

border communities. Border areas often have difficult natural conditions, such as steep terrain or extreme weather. This can affect food production in border areas.

Food security is Indonesia's commitment to the food development sector. This commitment is stated in several policies, namely in Law Number 7 of 1996 concerning food and Indonesian Government Regulation Number 68 of 2002 concerning food security. According to Law Number 7 of 1996 and the Republic of Indonesia Government Regulation Number 68 of 2002 concerning food, food security is defined as a condition of fulfilling food for households, which is reflected in the availability of food that is sufficient in quantity and quality, safe, equitable and affordable.

Agriculture plays a key role in maintaining and improving global food security. Agriculture's contribution includes production, innovation and sustainable management, and all of these have a significant impact on achieving food security goals. Farmers as elements of human resources in the agricultural sector play a central role in the context of food security, because they are directly involved in all stages of food production. Food security has a close relationship, both directly and indirectly, with agricultural productivity. Food security has a crucial role in the context of individual security and sustainable development efforts. Addressing sufficient dietary requirements can mitigate the likelihood of food insecurity within the community (Desker et al., 2013; Khusna et al., 2019; Mbow et al., 2019; Riesgo et al., 2016).

The situation of farmers in border regions highlights the challenges they face, especially in responding to modernization in agriculture. Farming families, especially in rural border areas, primarily consist of persons living in poverty with unfulfilled nutritional needs, making them vulnerable to food insecurity. The condition of the farmer's family is the principal criterion for assessing food security, requiring considerable focus (Atem & Niko, 2020; Riesgo et al., 2016).

In border regions, where access to resources and infrastructure is often limited, farming operations significantly impact farmer welfare and local food security. Pepper (Piper nigrum L.) is a commodity of economic and strategic importance in border areas. Pepper plants hold considerable economic importance, acting as a principal source of income for many farmers in the area, and have the potential to improve food security in adjacent nations. Pepper may be cultivated in several agro-ecological zones, making it an attractive option for small-scale farmers in border areas. Furthermore, peppers has a prolonged shelf life, allowing cultivators to retain and sell their products when prices rise. The current high prices of pepper commodities motivate farmers to continue planting pepper.

The earnings of pepper producers can significantly impact food security at both local and national tiers. Local pepper production may generate income for farmers and their families, allowing them to secure food and other necessities. This revenue can further enhance the local economy and support other businesses in the area. Furthermore, local sales of pepper can serve as a supply of fresh produce for communities, so enhancing food security by improving access to nutritious food. Pepper planting can enhance food security nationally by supplying a frequently utilized spice. The exportation of pepper can yield foreign cash for the nation and bolster the advancement of the agriculture sector. The income can be utilized to

invest in infrastructure, education, and other initiatives that have the potential to enhance food security for the entire population.

The area of pepper plantation in West Kalimantan reaches 13,203 Ha (West Kalimantan Provincial Plantation and Livestock Agency, 2022). The largest area of pepper plants is in Bengkayang Regency, with an area of pepper plants reaching 3,067 Ha, followed by Sanggau, Sintang and Landak. The potential of the agricultural sector in the Bengkayang Regency area can be optimized according to the resources available, where agricultural land is available quite widely, but productivity is still low. However, agriculture remains the leading sector in Bengkayang Regency because this sector is cultivated in all sub-districts in Bengkayang Regency on large areas of land and continues to be developed into a superior commodity (Kurniadi et al., 2017). Pepper stands as one of the primary commodities that can contribute to the sustenance and enhancement of the economy for the people in Bengkayang Regency. (BAPPEDA-Bengkayang, 2020).

The income effect can impact food security by influencing people's ability to afford food, which is particularly challenging in border areas due to various factors such as trade facilitation, conflict, and economic inequalities. Populations residing in border areas are susceptible to food insecurity due to various factors, including poverty, susceptibility to criminal activity, hazardous transit routes, and inadequate access to livelihoods and essential resources (Orjuela-Grimm et al., 2022). Therefore, addressing food security in border communities requires comprehensive strategies that consider the unique challenges posed by violence, limited access, and trade barriers.

Analyzing food security in border regions, especially regarding the income effect, is crucial for various reasons. Border regions often display unique economic and social characteristics that can significantly impact food security. The influence of economic policies on food security is especially pronounced in border regions, since it might disproportionately affect the most underprivileged persons who dedicate a larger share of their income to food expenditures.

Based on the information provided, the study aimed to analyze the income level of pepper farmers, including on-farm, off-farm, and non-farm income, the food security condition of farmers, and how total income affects food security in border areas

RESEARCH METHOD

The research method employed in this study utilized descriptive analytical techniques, with purposive sampling strategies. The study was conducted in Pisak Village, Tujuh Belas District, Bengkayang Regency, in September 2023. The sample was selected purposively, focusing on pepper farmers in border areas who were still actively engaged in pepper farming. The technical definition of food security is that it is the probability of detecting a "secured or non-secured" effect when it exists. Long (1997), suggests that sample sizes of less than 100 should be avoided. As the population of pepper farmers in Pisak Village, Tujuh Belas District, Bengkayang Regency is 225 farmers, the total sample size in this research is 113 respondents, which means half of the population.

Income Analysis

The total revenue is obtained by multiplying total production by the farmer's selling price, or written as follows (Soekartawi, 2002) :

TR = P x Q

Notes: TR = Total Revenue; P = Price Q = Quantity

Income received in farming includes labor income, net income and family income. Net income from farming is obtained by reducing the total income from costs, or is formulated as follows: (Soekartawi, 2002).

Pd = TR – TC

Notes: Pd = Income; TR = Total Revenue; TC = Total Cost

Level of Food Security

Measuring the level of food security of pepper farmers uses the share of food expenditure. The share of food expenditure can be calculated using the formula for dividing food expenditure by the total expenditure of farming households. The results can indicate the level of food security of the household.

PF = (PP t)/(TP t) x 100 %

(Ilham, 2007)

Notes :

PF = Share of food expenditure (%)

PPt = Expenses for food (Rp/month)

TPt = Total expenses (Rp/month)

If the share of food expenditure is less than 60% then the household is food secured, but if the share of food expenditure is more than 60% then the household is food insecure (Maxwell et al., 2000).

Data Analysis

The statistical analysis used to conduct this research is logistic regression analysis. Ghozali (2016) states that logistic regression was used as a regression analysis tool due to the dependent variable being binary (food secured or food insecure). Logistic regression is similar to discriminant analysis; it is utilized to ascertain whether the independent variable can predict the probability of the dependent variable's occurrence. Logistic regression analysis is a statistical method that analyzes the likelihood that an independent variable can predict a dependent variable. Logistic regression analysis does not require a normal distribution of the independent variables. Consequently, logistic regression analysis does not necessitate normality checks, heteroscedasticity tests, or conventional assumption tests for the independent variables.

Logistic regression analysis comprises four tests: Overall Model Fit, Goodness of Fit Test, Nagelkerke's R Square, and Classification Matrix (Ghozali, 2016).

The feasibility of the regression model was evaluated using Hosmer and Lemeshow's metric, quantified by the chi-square statistic. This model aims to evaluate the null hypothesis on the compatibility of empirical data with the model, indicating no discrepancy between them, therefore affirming the model's adequacy (Ghozali, 2016).

Consequently, the equation for logistic regression analysis is as follows:

$$Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \varepsilon$$

Notes:

Y	: Food Security of Farmers (dummy variable, one if food secured, zero if food insecure)
α	: Constant
β1	: On Farm Income Regression Coefficient
X1	: On Farm Income
β2	: Off-Farm Income Regression Coefficient
X2	: Off-Farm Income
β3	: Non-Farm Income Regression Coefficient
X3	: Non-Farm Income
ε	: error

The study used the Wald test and the Omnibus test to evaluate the importance of variables. Ghozali (2016) asserts that the Wald test (t) quantifies the degree to which the independent variables (on-farm income, off-farm income, and non-farm income) individually affect the dependent variable. The significance level for the Wald test (t-test) is set at 5%. Omnibus tests of model coefficients are simultaneous statistical assessments (F-test). This research will examine whether the independent variables simultaneously effect the dependent variables.

RESULT AND DISCUSSION

Characteristics of Farmers

Table 1. illustrates the research findings on the attributes of pepper producers, encompassing age, education, gender, number of dependents, farming area, and farming experience.

The study's findings reveal that the mean age of farmers is 41.36 years, placing them within the productive age range. This allows farmers to function more effectively, potentially enhancing pepper farming yield. The relatively young age of farmers alleviates the physical limitations typically faced by older farmers, enabling them to tackle agricultural challenges with enhanced efficacy and efficiency (Sudarsanan & Bloom, 2018).

Moreover, the gender role in pepper production is predominantly held by men, as the labor is physically demanding and requires considerable strength. Women have a vital supportive role in the domestic sector, with some engaging in vegetable growing to enhance family income. This shows an efficient distribution of duties within the family, with males focusing on agricultural labor while females manage home needs and engage in additional farming activities (Fabiyi & Akande, 2015). The gender role of farmers influences agricultural income, especially in traditional industries where male laborers often have greater significance due to the physical demands of the work (Atreya & Gartaula, 2022; Fanelli, 2022).Table 1 illustrates the research findings on the attributes of pepper producers, encompassing age, education, gender, number of dependents, farming area, and farming experience.

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Table 1. Characteristics of Farmers

No	Characteristics	Average	Range	Total	Percentage (%)
1	Age				
	> 35	41.36 years old	35 – 55 years old	30	26.55
	35 - 55			73	64.60
	< 55			10	8.85
2	Education				
	Not graduated from Elementary School	Senior High School		12	10.62
	Elementary School			26	23.01
	JuniorHigh School			29	25.66
	Senior High School			36	31.86
	Post Graduate			10	8.85
	Senior High School			36	31.86
	Post Graduate			10	8.85
3	Gender				
	Male	Male		80	70.80
	Female			33	29.20
4	Number of dependents				
	1 -2 people	3.34	3-4 people	28	24.78
	3 - 4 people			62	54.87
	> 4 people			23	20.35
5	Area				
	> 0.5 ha	0.96 ha	0.5 - 1 ha	9	7.96
	0.5 - 1 ha			89	78.76
	> 1 ha			15	13.27
6	Farming experiment				
	> 10 years	13.57 years	10 - 20 years	39	34.51
	10 - 20 years			61	53.98
	21 - 30 years			4	3.54
	31 - 40 years			8	7.08
	< 40 years			1	0.88

The farmers' education level, predominantly comprising individuals with at least a high school degree, indicates they have a solid comprehension of the significance of enhancing family welfare through efficient cultivation techniques. Elevated educational attainment enables farmers to utilize innovative agricultural technologies and techniques, resulting in enhanced production and income generation. This increased knowledge of education motivates farmers to investigate diverse methods for enhancing their revenue, so contributing to their total economic welfare (Fiqri & Bukhori, 2022; Rahman & Haider, 2023).

The limited quantity of dependents (3-4 individuals) suggests that familial obligations do not excessively encumber the farmers, so affording them more independence to concentrate on the advancement of their pepper farming enterprise. A reduced number of dependents signifies more available workers in the household to aid in crop cultivation, hence enhancing the labor capacity of the family unit (Gebre et al., 2023; Semiyu et al., 2022).

Ultimately, with farm sizes primarily between 0.5 and 1 hectare, farmers possess a viable output potential, albeit with considerable maintenance expenses. The extensive experience of farmers, many possessing 10 to 20 years in agriculture, enables them to manage their land and pepper crop effectively. Despite possessing the requisite skills and expertise, issues persist concerning the expenses related to land management, which may affect their overall revenue.

These qualities indicate that the pepper farmers in the region possess significant potential for improving productivity and revenue, bolstered by factors such as productive age, sufficient education, and vast agricultural experience. These attributes establish a robust basis for advancing pepper cultivation methods and increasing economic results in the region.

Income Analysis

On Farm Income Analysis

Managing a farming business requires sufficient knowledge, tenacity and perseverance in running it. This is the case with pepper farming; it must be handled in the right ways so that it can become a productive crop. The harvestable age of pepper plants is around 3-4 years. To increase the productivity of pepper plants, fertilization is necessary. There are two types of fertilizer used by farmers in Pisak Village, namely KCl, NPK, TSP, Urea and SP 36 fertilizer. Urea fertilizer functions to stimulate vegetative growth, both stems and leaves. NPK fertilizer also has almost the same function, but it has another function, to stimulate fruit formation. Apart from fertilizer, the use of pesticides also plays an important role in eradicating weeds so that the growth and formation of pepper fruit is more optimal. Farmers in Pisak Village generally use several types of pesticides, including Akostrin, Darmasan, Matador, Reagent, Kansas, Armada, Gandasil and Sidametrin.

Labor is still used in pepper farming in Pisak Village, although it does not contribute much to the variable costs of pepper farming because most farmers use family labor. The use of family labor is very effective in reducing variable farming costs. Pepper farmers only use labor during harvest, because this needs to be done immediately to avoid rotten fruit.

The amount of income earned by farmers depends on the productivity of the pepper plant. Apart from that, the amount of costs incurred by farmers also determines the amount of income. The greater the farming costs incurred, the more the income will decrease. For more details regarding pepper farming income in Pisak Village, see Table 2.

Household income refers to the total gross income earned by all members of a household within a specified period, typically a year. This includes various forms of income such as wages, salaries, self-employment earnings, and income from other sources. It is an important measure used to evaluate the economic well-being of a household and is utilized by lenders for underwriting loans. Additionally, off-farm income-generating activities have become increasingly important in determining the overall economic performance of farm households, contributing significantly to total household income and improving efficiency.

With all the failures encountered by farmers in their pepper farming business, most of the pepper farmers in Pisak Village are trying to find additional income outside their main job. Pepper farmers look for sources of income through the off-farm and non-farm sectors, armed with the experience and knowledge they have (Chang et al., 2022; Hou et al., 2023; Knoke et al., 2022).

Table 2. Annual Average Production Costs and Income of Pepper Farmers

Number	Description	Amount (IDR)
1	Gross Income	48,331,800
2	Variable Cost	16,322,980
	a. Fertilizer	13,898,300
	- Dolomit	850,200
	- KCl	4,536,800
	- NPK	1,417,800
	- Urea	7,093,500
	b. Chemicals	1,852,680
	- Pesticides	5,680
	- Insecticides	285,000
	- Herbicides	426,000
	c. Labour	572,000
	- Fertilizing	204,000
	- Spraying	119,000
	- Harvesting	249.000
3	Fixed Cost	544,347
	a. Deppreciaton	493,798
	b. Tax	50,549
4	Net Income	31,464,473

Off Farm Income Analysis

Activities in the off-farm sector include various jobs such as farm labourers, vegetable farmers, and livestock farmers. As many as 57.89% of respondents reported that they had income from the Off-Farm sector. With a significant contribution to the average income of farmers, the off-farm sector has the potential for further development to obtain higher incomes, as long as it is managed efficiently (Adam et

al., 2022; Chang et al., 2022; Gebrtetsadik, 2022). Details regarding off-farm income can be found in Table 3.

Table 3. Off Farm Income

No	Description	Population of Respondents (People)	Average Respondent Income/Year (IDR)
1	Farm labour	60	8,626,000
2	Vegetables farmer	25	53,418,000
3	Livestock farmer	3	2,400,000
	Total	88	38,954,318

Non-Farm Income Analysis

Unlike off-farm, which is still related to the agricultural sector, non-farm work involves activities outside of farming that are not related to agriculture. 10.53% of pepper farmer respondents have income from the non-farm sector. In this study, non-farm income is obtained by farmers from work as village officials, entrepreneurs, drivers, and construction workers. Details regarding non-farm income can be found in Table 4.

Table 4. Non Farm Income

No.	Description	Population of Respondents (People)	Average Respondent Income/Year (IDR)
1	Village official	2	30,102,000
2	Enterpreneur	13	40,111,385
3	Driver	5	21,120,000
4	Construction worker	23	5,973,913
	Total	43	19,177,953

Results of research show that pepper farmers not only get sources of income from on-farm agriculture, but also from the off-farm and non-farm sectors, as shown in Figure 1.

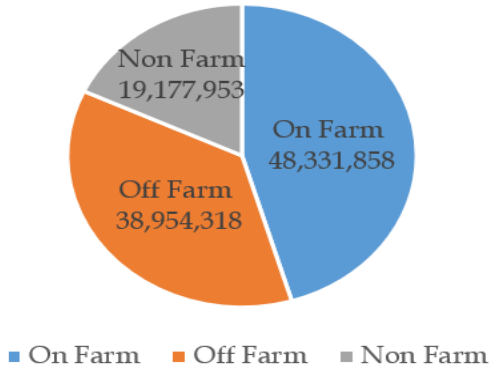

Figure 1.
Farmer's Income Structure

Based on Figure 1. it can be seen that the majority of farmers' income comes from the on-farm sector, namely IDR 48,331,858,- (45.40%), the second largest respondent's income comes from the off-farm sector, namely IDR 38,954,318,- (36.59%), and the smallest respondent's income comes from the non-farm sector, namely IDR 9,177,953 (18.01%).

The results from Figure 1 highlight the importance of the on-farm sector as the primary income source for farmers, contributing 45.40% of their total income. This suggests that agricultural activities directly related to the farm, such as crop cultivation and livestock farming, are still the cornerstone of farmers' livelihoods. The off-farm sector, contributing 36.59%, indicates that farmers are increasingly diversifying their sources of income, relying on supplementary activities outside the farm, such as agricultural labor, processing, or trading. Being dependent on off-farm income has significance as it contributes in stabilizing farmers' finances, particularly when agricultural activities alone may not yield sufficient profits.

The non-farm sector accounts for merely 18.01% of total income, indicating little participation in non-agricultural industries such as retail, services, or transportation. The reduced contribution from this sector may arise from factors such as inadequate skills, constrained opportunities, or limited access to capital, suggesting that farmers may not leverage non-agricultural revenue streams.

The findings demonstrate that agricultural activities, both on-site and off-site, remain the principal source of income for farmers. Despite farmers diversifying via off-farm jobs, opportunities for augmenting non-farm income sources persist. Enhancing these non-agricultural sectors may alleviate the risks associated with sole reliance on agriculture, particularly in the face of market price fluctuations, weather changes, or other agricultural uncertainties.

This aligns with the findings of Fernandez-Cornejo et al. (2007), which demonstrate that the economic well-being of farm households often depends on both on-farm and off-farm income. Smaller agricultural households generally improve their economic outcomes by augmenting involvement in off-farm endeavors.While this may diminish the technical efficiency of agricultural activities, it enhances total household efficiency. Therefore, increasing off-farm income opportunities is a strategy for improving the financial resilience of farming households.

In conclusion, while farming remains the central source of income for most farmers, there is potential for expanding non-farm income sources to diversify risk further and improve the economic stability of farming households.

Level of Food Security

The food security level of pepper farmers is measured by the share of food expenditure, calculated as the ratio of food to total household expenditure. Food expenditure consumption consists of carbohydrates, protein, vegetables, beans, fruits, oils, drinks, seasonings, others and cigarettes. Food expenditure is calculated as an average expenditure per month.

Table 5. describes the average food expenditure of farmers. According to Table 5, the largest portion of food expenditure comes from protein, accounting for 32.89%, followed by carbohydrates at 23.84%. The large proportion of spending on protein can be attributed to several factors, particularly the importance of protein in maintaining body health. Protein is a vital component of cells, tissues, and organs in

the human body, playing a crucial role in the formation and maintenance of body structure, as well as acting as enzymes, hormones, and antibodies that regulate biological processes (Council, 2003; (WHO), 2007; Wu, 2016).

Table 5. Average Food Expenditure of Farmers

Food	Expenditure / Month (IDR)	Percentage (%)
Carbohydrates	527,393	23.84
Protein	727,777	32.89
Vegetables	114,400	5.17
Beans	204,786	9.26
Fruits	132,222	5.98
Oils	107,607	4.86
Drinks	215,536	9.74
Seasonings	1,429	0.06
Others	64,214	2.90
Cigarettes	117,089	5.29
Total	2,212,453	100.00

Farmers' non-food expenses consist of electricity, water, education, health, taxes, gas, loans, savings and other expenses. Non-food expenditure is calculated from the monthly average. An overview of farmers' non-food expenditure can be seen in Table 6.

Table 6. Average Non-food Expenditure

Non Food	Expenditure / month (IDR)	Percentage (%)
Education	737,074	37.67
Health	119,945	6.13
Savings	398,182	20.35
Households	701,498	35.85
Total	1,956,699	100.00

The proportion of food consumption expenses to total household expenditures is the percentage of food expenditure compared to total expenses. Table 7 below shows the proportion of farmers' food expenditures.

Table 7. Proportion Of Farmers' Food Expenses

No.	Type of Expenses	Amount of Expenses / Farmer (IDR)	Proportion of Expenses (%)	Cathegory
1	Food	2,212,453	53.07	Low
2	Non Food	1,956,699		
	Total	4,169,151		

The results show that the average amount of food expenses per farmer is IDR 2,212.453, while non-food expenses are IDR 1,956.699, so the average total expenditure of farmers is IDR 4,169,151. The proportion of farmers' food expenditure is 53.07%; therefore, the farmer respondents are classified as food secured.

Effect of Total Income to Food Security Condition

This study used a binary logistic regression model including three independent variables simultaneously. Assume the Hosmer and Lemeshow test has a P-value ≥ 0.05 (the threshold for significance). This implies that there is no substantial disparity between the model and the data, implying that the model effectively forecasts the observed value. Ghozali, 2016. Table 8 displays the results of the Hosmer and Lemeshow Test.

The regression analysis results in Table 6 reveal that the Hosmer and Lemeshow Goodness of Fit Test yielded a chi-square value of 0.606 with a significance level of 0.738. The test findings imply that the probability value (P-value) is ≥ 0.05, specifically 0.738 ≥ 0.05. Consequently, the null hypothesis (H0) is validated. This signifies that there is no significant difference between the model and the data, proving the feasibility of the regression model in this study and its ability to predict the observed values.

Table 8. Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	2,557	7	.923

The measurement of the variability of independent variables in elucidating dependent variables is gauged through the coefficient of determination, which is evident in the Nagelkerke R Square value. This value, expressed in decimal form, can be converted into percentages for simplicity in comprehension and interpretation, as highlighted by (Ghozali, 2016).

Table 9. Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	40.115[a]	.586	.826

[a.] Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

The regression analysis results in Table 9 indicate that the Nagelkerke R Square value, or coefficient of determination, is 0.045. This shows that the independent variables—on-farm income, off-farm income, and non-farm profit—account for just 82.6% of the variance in the dependent variable, which is the food security of pepper producers. Seventeen point four percent of the probability is ascribed to factors beyond the parameters of this research model.

Additionally, the classification matrix presented in Table 10 demonstrates the predictive efficacy of the logistic regression model in estimating the likelihood of achieving food security among agricultural households.

Table 10 indicates that the model's accuracy in predicting food secure or food insecure scenarios is 92%. The table indicates a 91.4% likelihood of food insecurity and a 92.3% likelihood of food security. The potential for food insecurity pertains to the entire sample. The outcomes of the logistic regression model are displayed in Table 11.

Table 10. Classification Table

Classification Table[a]					
	Observed		Predicted		
			Food secured		
			Food insecured	Food secured	Percentage Correct
Step 1	Food secured	Food insecured	32	3	91.4
		Food secured	6	72	92.3
	Overall Percentage				92.0

a. The cut value is .500

Tabel 11. Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	X1	1.488	.394	14.230	1	.000	4.427	2.044	9.589
	X2	.077	.033	5.264	1	.022	1.080	1.011	1.153
	X3	-.022	.022	1.020	1	.313	.978	.936	1.0.1
	Constant	-4.821	1.371	12.366	1	.000	.008		

a. Variable(s) entered on step 1: X1, X2, X3.

Based on the results of the analysis from logistic regression in Table 11, the logistic regression equation can be formulated as follows:

$$Y = 0.008 + 4.427X1 + 1.080X2 + 0.978X3 + e$$

Furthermore, a partial test is carried out to find out which variables have a significant effect. Parameter estimates and partial hypothesis test results from the logistic regression model are shown in Table 12.

Tabel 12. Wald Test (t)

Variabel	B	S.E	Wald	Df	Sig
X1	1.488	0.394	14.230	1	0.000
X2	0.077	0.033	5.264	1	0.022
X3	-0.0022	0.022	1.020	1	0.313

With a total of (n=113) observations and a total of (k = 2) independent and dependent variables, the degrees of freedom (df) can be calculated as n-k = 113-2 = 111, with a significance level of α = 0.05. Next, the t-table value can be calculated using a formula in Microsoft Excel using the "insert function" as follows:

ttable = TINV(Probability,deg_freedom)

ttable = TINV (0.05; 54)

ttable = 1.981567

The outcomes of hypothesis testing through logistic regression analysis are as follows:

The first hypothesis (H1) posits that on-farm revenue positively influences food security. The Wald (t) test results indicate that the tcount value above the ttable (14.237 > 1.981567) and the probability value is less than the significance level (0.000

< 0.05). The test results indicate that on-farm revenue positively influences Food Security. This suggests that on-farm income affects the food security of pepper farmers.

The second hypothesis (H2) posits that off-farm income positively influences food security. The Wald (t) test findings indicate that the tcount value is less than ttable (5.264 > 1.981567) and the probability value above the significance level (0.022 < 0.05). The test results indicate that off-farm income positively influences food security. This suggests that on-farm income affects the food security of pepper farmers.

The third hypothesis (H3) posits that on-farm revenue positively influences food security. The Wald (t) test findings indicate that the tcount value is less than the ttable (1.020 < 1.981567) and the probability value above the significance level (0.313 > 0.05). The test results indicate that Non-Farm Income adversely affects Food Security. This suggests that non-farm income does not influence the food security of pepper farmers. The Omnibus Tests of Model Coefficients is utilized to evaluate whether the independent variables—on-farm income, off-farm income, and non-farm income—collectively influence the dependent variable, food security.

Table 13. Omnibus Tests of Model Coefficients

Chi Square	Df	Sig
99.753	3	0.000
99.753	3	0.000
99.753	3	0.000

It is known that the number of respondents is (n=113) and the number of independent and dependent variables is (k=4), then the degrees of freedom (df1) = k-1 = 4-1 = 3 and (df2) = n-k = 113-3 = 110, with a significant level of α = 0.05. So the f table can be calculated using the MS Excel formula with the insert function formula as follows:

ftable = FINV(Probability,deg_freedom1,deg_freedom2)

ftable = FINV(0.05,3.110)

ftable = 2.6871

Based on Table 13, it can be obtained that the fcount value is greater than ftable (99.753 > 2.6871) with a significance level (0.000 < 0.05), so H1 is accepted. On-farm income, off-farm income and non-farm income simultaneously influence the food security of pepper farmers.

Based on the logistic regression equation above, the influence of the independent variable on the dependent variable can be analyzed, including:

The on-farm income variable (X1) has a sig value of 0.000 < 0.05 indicating that the on-farm income variable has a real influence on the food security conditions of pepper farmers, and the OR (Odds Ratio)/ EXP (B) value of 4.427 shows that the on-farm income a high farm provides a 4.427 times greater opportunity to achieve food security conditions compared to farming families who do not have on-farm income. The regression coefficient value is 1.488, which means that if there is an increase in on-farm income of 1 million rupiah, the chance of achieving food security conditions increases by 1.488.

Off-farm Income variable (X2) sig value 0.022 < 0.05 shows that the off-farm income variable has a real influence on the food security conditions of pepper

farmers, and the OR (Odds Ratio)/ EXP (B) value of 1.080 shows that off-farm income A high farm provides a 1,080 times greater opportunity to achieve food security conditions compared to farming families who do not have off-farm income. The regression coefficient value is 0.077, which means that if there is an increase in off-farm income of 1 million rupiah, the chance of achieving food security conditions increases by 0.077.

Non-farm income variable (X3) sig value of 0.313 > 0.05 shows that the non-farm income variable has no real influence on the food security conditions of pepper farmers, and the OR (Odds Ratio)/ EXP (B) value of 0.978 shows that income high non-farm income provides a 0.978 times greater opportunity to achieve food security compared to farming families who do not have non-farm income. The regression coefficient value is -0.022, which means that if there is an increase in Nonfarm income of IDR. 1,000,000, the chance of achieving Food Secured conditions decreases by 0.077.

The result of the analysis contradicts Keynes' Law, which asserts that income is a significant component of consumption. Income is closely linked to changes in family food consumption, where an increase in income can directly influence a family's consumption. Keynes contended that the primary determinant of consumption expenditure is income. According to Keynes, the consumption function illustrates the connection between national income and consumption expenditure, both expressed at a constant price level. This relationship, as per Keynes, emphasizes the dependence of consumption expenditure (C) on income (Y), where increased income correlates with higher levels of consumption.

Income does not always have a direct effect on food security in border areas because economic factors do not always reflect the food security conditions of local communities. Although income can be an indicator of individual or family wealth, food security is more comprehensive, involving the availability, accessibility and adequate utilization of food. In border areas, geographic, political and social factors often have a significant impact on food security.

One study that found that income does not always have a direct effect on food security was carried out by (Haini et al., 2023), who found that unemployment or no income did not actually affect food security in 143 developed and developing countries from 2000 to 2019.

Especially for border areas, income plays an important role in influencing access to food, but food security is strongly influenced by other multidimensional factors. Cross-border trade is critically important to the well-being of many households and communities. Cross-border trade is critically important to the well-being of many households and communities (Afrika & Ajumbo, 2012; Brenton et al., 2013; World Bank, 2020). Therefore, a holistic and community-based approach needs to be applied to overcome food security challenges in border areas, taking into account the local context and building community capacity in managing food resources sustainably.

The first thing detected in this research is that income is not distributed evenly, causing there to be farmers who still experience food insecurity even though there has been an increase in income at the aggregate level. In the location where the research was conducted, which is in a border area, even though the community's main income is from the pepper farming sector (on farm), and has additional income

from the off-farm and non-farm sectors, respondents are still found who fall into the "food insecure" category when reviewed from food production. Food-insecure people use most of their income to buy food necessities, while on the other hand, they experience difficulty accessing food where they live in border areas. According to the West Kalimantan Provincial Food Security Agency (2022), the high share of food expenditure is one of the causes of high food vulnerability in West Kalimantan Province.

When income distribution is unequal, poor communities in border areas face difficulties in meeting their food needs. Underprivileged economic groups have limiting access to high-quality food and sufficient food. Furthermore, the agricultural industry, sometimes the cornerstone of the economy in border regions, is similarly impacted by income inequality. Low-income farmers struggle to acquire essential agricultural inputs, technology, and education necessary for improving production and food security. The reduction in food commodity production may jeopardize food security and precipitate a food crisis (Mulyono et al., 2023).

This corresponds with the research conducted by Weigel et al. (2007), which demonstrated that food insecurity among 100 migrant households and seasonal agricultural laborers residing along the US-Mexico border was primarily due to the region's isolation. Alongside food insecurity, persons in these border regions confront additional health challenges, such as obesity, hypertension, and various disorders related to sugar and fat metabolism. Akter (2014) asserts that research demonstrates the immediate negative impacts of elevated food costs were predominantly experienced by the underprivileged, while the long-term effects were more uniformly distributed among both the rich and the disadvantaged, ultimately favoring day laborers.

The distribution of wealth significantly impacts food insecurity in border regions. Economic disparities can lead to unequal access to essential resources and services necessary for food security. In border regions, where political and physical considerations often create complexity, income inequality can exacerbate food insecurity.

Elmes (2018) contends that economic inequality in the USA precipitates poverty, food insecurity, and obesity. This study delineates the erosion of capability equality due to economic disparities, emphasizing its repercussions on food security and overall well-being.

Thus, economic disparities may create inequalities in access to agricultural and food resources (Akhtar et al., 2023; Joyner et al., 2022). This exacerbates food poverty among marginalized individuals and families and may also threaten the overall sustainability of food security in border regions. Thus, initiatives focused on income redistribution and improving access to essential resources and services can substantially mitigate food insecurity and strengthen food security in border regions.

A study by Bonuedi et al. (2020) demonstrates the impact of political and bureaucratic elements on food security in border areas, indicating that the enhancement of cross-border trade—through the reduction of paperwork, time, and costs related to exports and imports—affects food resilience in Africa. Inadequate trade facilitation among cross-border communities in Africa is the principal factor contributing to food insecurity and hindering access to food.

Income inequality is strongly correlated with increased food prices (Umaru et al., 2014). Prices influence food security in two ways: by affecting consumer purchasing power and by determining producer incentives. Increased food prices may hinder low-income consumers from obtaining adequate food to meet their nutritional needs, leading to food insecurity and malnutrition (Amolegbe et al., 2021; Headey & Martin, 2016; Sharanagouda et al., 2021).

Increased food prices may reduce dietary diversity, since customers may choose more economical and less nutritious alternatives (Brinkman et al., 2010). Conversely, as food prices decline, farmers may experience inadequate income to cover production costs, leading to less investment, reduced productivity, and a smaller future food supply. Rising food prices can exacerbate economic inequality, since wealthy individuals are willing to spend greater amounts to maintain their food consumption levels. This may lead to reduced daily nutrition and increased food insecurity among the disadvantaged.

CONCLUSION

This study demonstrates that the revenue structure for pepper producers includes three primary sectors: on-farm, off-farm, and non-farm, with the on-farm sector yielding the largest income at 45.40%. The degree of farmer food security is classified as "Food Secured," implying a comparatively favorable status. The binary logistic regression analysis results indicate that all three income sources (on-farm, off-farm, and non-farm) have significant effects on food security, with on-farm and off-farm incomes exerting the most substantial impact.

The research underlines the necessity for a comprehensive, community-oriented strategy for dealing with food security issues in bordering areas, where disparities in income exacerbate food insecurity. Notwithstanding a rise in overall wealth, deprived individuals continue encountering challenges in obtaining decent food and sufficient nutrition. This, in turn, affects both individuals and the agricultural sector. Economic disparities and political complexities also exacerbate food insecurity, making income redistribution, improved trade facilitation, and increased access to resources and services essential for sustainability.

To address these challenges, it is recommended that pepper farmers focus on increasing on-farm productivity through the adoption of improved cultivation technologies, superior seeds, and technical training. Expanding the off-farm sector by engaging in agricultural product processing or side jobs related to agriculture can enhance income stability. Additionally, developing the non-farm sector through small household-based businesses will diversify income sources. The government and stakeholders should support these efforts by strengthening household food security programs, ensuring access to training, providing capital, and improving infrastructure such as roads and markets. These strategies will help enhance farmers' incomes and improve food security in the region.

AUTHOR CONTRIBUTION STATEMENT

Author 1 collected and analyzed the data, drafted the initial manuscript, edited the manuscript, and responded to reviewer comments. Authors 2 and 3 designed the study, supervised the research, conceptualized the study, and provided

analytical guidance. All authors reviewed and approved the final version of the article.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHIC STATEMENT

Ethical review and approval were waived for this study as it did not involve any intervention and posed minimal risk to participants. Nevertheless, informed consent was obtained from all respondents prior to participation, and all data were anonymized and kept confidential.

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