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MORALITY BEFORE KNOWLEDGE

Food security dynamics in emerging regions: Integrating dietary diversity and expenditure-based measures

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ABSTRACT

Background: Intan Jaya Regency and Puncak Regency in Central Papua Province are among the five regencies with the lowest food security index in Indonesia. As a newly established province, ensuring adequate food security constitutes a strategic foundation for sustainable regional development. This study aims to analyze the level of food security, the degree of food diversification, and the socioeconomic factors influencing household food security in Central Papua Province. **Methods:** The research utilizes secondary data from the March 2024 SUSENAS (*Survei Sosial Ekonomi Nasional*/National Socio-Economic Survey), published by *Badan Pusat Statistik* (Central Bureau of Statistics), comprising a total sample of 1,060 households across Intan Jaya and Puncak Regencies. Food security analysis is conducted using the Johnsson and Toole method, which combines indicators of food expenditure share and energy adequacy levels, while the factors affecting food security are identified through binary logistic regression. **Findings:** The results indicate that (1) household food security in Central Papua Province falls into the food-insecure category, (2) the level of food diversification is categorized as high, and (3) significant socioeconomic determinants include household income, household size, and the education level of the household head. The integration of the Johnsson and Toole method with food diversification analysis within the context of a newly formed province enables this study to provide a more detailed and comprehensive depiction of food security dynamics in Central Papua Province. **Conclusion:** Household food security in Central Papua Province remains food-insecure despite diversified diets, with income, family size, and education as key determinants, underscoring the need for income support, agricultural training, and improved educational access. **Novelty/Originality of this article:** This study uniquely integrates the Johnsson and Toole method with dietary diversification analysis using 2024 SUSENAS data from Badan Pusat Statistik to uncover the paradox of high diet diversity yet persistent food insecurity in Intan Jaya Regency and Puncak Regency.

KEYWORDS: food diversification; food security; household dietary diversity score; johnsson and tools.

1. Introduction

Food security has emerged as one of the most critical global issues in recent years. According to the report by the Food and Agriculture Organization (FAO), an estimated 638 to 720 million people worldwide experienced hunger in 2024, with a significant proportion originating from countries in the Asian region (FAO, 2025). This situation indicates that ensuring adequate access to food and sufficient nutritional quality for the global population remains an ongoing challenge, particularly in developing countries.

In Indonesia, food security is a key national strategic agenda. In mid-2025, the President of the Republic of Indonesia emphasized that strengthening food security is one

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of the eight national priority agendas outlined in the Draft State Budget (RAPBN) (Government of the Republic of Indonesia, 2025). This statement reflects the government's commitment to improving the availability, affordability, and utilization of national food resources amidst various challenges, including climate change, population growth, and shifting consumption patterns.

Central Papua Province, officially established in July 2022, is one of Indonesia's newly formed provinces with considerable natural and agricultural resource potential. The formation of this new province aims to accelerate development and enhance government control (Fauzi et al., 2023). However, the region continues to face serious food security challenges. Based on national food security data, Intan Jaya Regency and Puncak Regency, both located within the administrative region of Central Papua, are identified as two of the five regions with the lowest food security index in Indonesia (National Food Agency, 2024). Limited infrastructure, restricted logistical supplies, and inadequate access to markets and public facilities further exacerbate food insecurity among communities in Central Papua Province (Novemyanto, 2025). This condition highlights the need for deeper examination of the factors influencing household food security in Central Papua, as well as the development of appropriate strategies to strengthen local food systems in the region.

Puncak Regency covers an area of approximately 7,396 km^2 divided into 25 districts, with a population of 117,359 people. More than 41% of its population lives below the poverty line (Central Bureau of Statistics of Puncak Regency, 2025). Meanwhile, Intan Jaya Regency covers around 6,536 km^2 divided into eight districts, with a population of 137,696 people, of whom more than 40% live below the poverty line (Central Bureau of Statistics of Paniai Regency, 2025). Economically, the main sectors supporting Intan Jaya's economy include construction, agriculture, forestry, and fisheries. Among these, the agriculture, forestry, and fisheries sector contributes 23.27% to the region's Gross Regional Domestic Product (GRDP)(Central Bureau of Statistics of Paniai Regency, 2024). This demonstrates that Intan Jaya Regency has substantial potential for enhancing food self-sufficiency through the optimization of these sectors.

More than one-third of the population in both regions lives below the poverty line, illustrating the significant challenges communities face in meeting basic needs, including food. Rising food prices further worsen the situation as they reduce household purchasing power and exacerbate poverty, particularly in areas with low average incomes (FAO, 2025). In developing countries, including Indonesia, increases in food prices often become a major factor undermining household food security. Research by Enakhe & Tamuno (2021) indicates that poverty is a primary barrier preventing households from accessing adequate food, proper housing, and other basic necessities. This is consistent with the findings of Andrianarison (2022) which reveal that poor households are more likely to experience food insecurity than households with higher incomes.

Household food security can be influenced by various socioeconomic factors. Important factors include the age of the household head, household expenditure, the number of working family members, and the education level of the household head (Chi & Nguyen, 2023). For households that rely on agriculture for their livelihood, factors such as land ownership status, agricultural land quality, and the age of the household head also play significant roles. Land ownership is important because it relates to direct access to food sources, while land quality determines agricultural productivity. Moreover, the age of the household head often correlates with experience, managerial capability, and social networks in securing income (Degfachew et al., 2025).

Another key economic factor is total household income, which largely determines a family's ability to purchase food. Although many households work in the agricultural sector, a significant number still rely on market-sourced food, especially for commodities they cannot produce themselves (FAO, 2025). Consequently, fluctuations in market food prices directly affect household food security levels. On the other hand, education also plays an important role in food security. Higher education levels provide opportunities for better employment, increased income, and the adoption of new technologies that can improve food production efficiency (Herlina et al., 2024). Education also influences nutritional literacy—

the ability to understand the importance of food diversity and nutrient content—which may encourage household food diversification.

Beyond socioeconomic factors, food security is also influenced by environmental and demographic conditions. Research by Nyange et al. (2024) shows that population density, air temperature, agricultural land area, and carbon dioxide emissions contribute to determining a region's level of food security. Rising temperatures and environmental degradation can reduce agricultural productivity, while rapid population growth increases pressure on available food resources. Therefore, food security issues must be addressed comprehensively by considering interactions among economic, social, and environmental factors to ensure sustainable improvements in community welfare.

Food diversification is another important indicator that can influence food security. It refers to the variety of food types consumed to meet individual nutritional needs (Sinaga et al., 2021). Research by Herlina et al. (2024) shows that food diversification, particularly for local commodities, has proven to be an effective strategy for ensuring community food security. Local food diversification provides communities with greater options to meet their nutritional needs. This aligns with the findings of Adeyemi et al. (2025), who report that women in food-insecure households exhibit lower dietary diversity compared to those in food-secure households. Households with higher food diversification are more likely to be food secure, particularly in terms of food quality, as dietary diversity enables household members to access more balanced nutrient sources.

Regional development is closely linked to the quality of human resources, as development success depends heavily on the community's ability to manage its potential. One of the key factors in improving human resource quality is the fulfillment of basic needs, especially food. Food is a fundamental necessity, not only for survival but also for supporting productivity and well-being. As a newly established administrative region, no comprehensive assessment of household food security and food diversification has been conducted in Central Papua Province. Therefore, this study aims to determine the level of food security, the level of food diversification, and the socioeconomic factors influencing food security in Central Papua Province, serving as a basis for formulating sustainable development policies. The novelty of this study lies in the inclusion of food diversification aspects in the analysis of household food security, as well as the use of the Johnsson and Tool method, which examines food security from two perspectives: economic access and nutritional adequacy. By integrating these aspects, this study provides a more detailed and comprehensive depiction of food security conditions compared to conventional approaches that examine food security solely in general terms.

2. Methods

2.1 Research location and types of data

The research was conducted in Intan Jaya Regency and Puncak Regency, Central Papua Province. These locations were selected using a purposive sampling method based on the objectives of the study, as both regions are included among the five areas with the lowest Food Security Index in Indonesia. This study uses secondary data derived from the March 2024 (SUSENAS) National Socioeconomic Survey published by Badan Pusat Statistik (Central Bureau of Statistics),. The total sample consists of 1,060 households, comprising 530 households from Intan Jaya Regency and 530 households from Puncak Regency. The variables used in this study include household food expenditure, household non-food expenditure, total household expenditure, actual household energy consumption, household food groups consumed, household size, years of schooling of the household head, and the occupation of the household head.

2.2 Measurement of food security levels

The classification of food security levels in this study follows the method developed by Johnsson and Toole (1991), modified by Maxwell et al. (2000), which assesses food security based on a combination of energy adequacy levels and the share of food expenditure. The energy adequacy level is calculated as the percentage of household energy consumption per adult-equivalent relative to the national recommended energy intake, which is 2,100 kcal per capita per day according to the Ministry of Health Regulation No. 28 of 2019 (Government of the Republic of Indonesia, 2019). Meanwhile, the food expenditure share is measured as the percentage of household food expenditure relative to total household expenditure.

The intersection of energy adequacy levels and food expenditure share results in four food security categories: food secure, vulnerable to food insecurity, less secure, and food insecure. The thresholds used for classification are a food expenditure share of 60% of total household expenditure and an energy adequacy level of 80% of the national recommended intake (as shown in Table 1). A household is categorized as food secure if it has a food expenditure share of less than 60% of total expenditure and an energy adequacy level greater than 80% of the recommended requirement.

Table 1. Measurement of food security levels

Energy Adequacy Levels	Food Expenditure Share	
	Low (<60%)	High (≥60%)
Enough (>80 %)	Food secure	Vulnerable
Less (≤ 80 %)	Less Secure	Food insecure

(Maxwell et al., 2000) .

After being classified using the Johnsson and Toole method, all household samples in this study were converted into a dummy variable. A dummy value of 1 was assigned to households categorized as food secure, while a value of 0 was assigned to all other households. The conversion into a dummy variable was intended to facilitate the analysis of factors influencing food security using a binary logit regression method.

2.3 Measurement of food diversification levels

The measurement of food diversification levels in this study used the Household Dietary Diversity Score (HDDS) method. This method consists of 12 food groups, as presented in Table 2.

Table 2. The measurement of household dietary diversity score (HDDS)

Indicator Code	Food Group	Scoring Criteria	Max Score
A.	Cereals	0 = not consume; 1 = consume	1
B.	White roots and tubers	0 = not consume; 1 = consume	1
C.	Vegetables	0 = not consume; 1 = consume	1
D.	Fruits	0 = not consume; 1 = consume	1
E.	Meat	0 = not consume; 1 = consume	1
F.	Eggs	0 = not consume; 1 = consume	1
G.	Fish and other seafood	0 = not consume; 1 = consume	1
H.	Nuts, legumes, and seeds	0 = not consume; 1 = consume	1
I.	Milk and milk products	0 = not consume; 1 = consume	1
J.	Oils and fats	0 = not consume; 1 = consume	1
K.	Sweets	0 = not consume; 1 = consume	1
L.	Spices, condiments, and beverages	0 = not consume; 1 = consume	1
Total			12

(FAO, 2011)

The calculation of the Household Dietary Diversity Score (HDDS) is conducted by

assigning a score to each food group consumed by the household. A score of 1 is given if the household consumes at least one type of food within the group, while a score of 0 is given if the household does not consume any food from that group. The formula used to calculate the HDDS is as follows:

$$\text{HDDS} = Sum(\text{A+B+C+D+E+F+G+H+I+J+K+L}) \quad \text{(Eq. 1)}$$

The HDDS scores obtained are then categorized into two groups: scores < 7 are classified as low, while scores ≥ 7 are classified as high. According to (Swindale & Bilinsky, 2006)), the average level of dietary diversification in each region can be measured using the following formula:

$$\text{Average HDDS:} \frac{SUM\ (HDDS)}{Total\ rumah\ tangga\ yang\ disurvei} \quad \text{(Eq. 2)}$$

2.4 Analysis of socioeconomic factors

The analysis of socioeconomic factors influencing food security in Central Papua Province is conducted using a multiple logistic regression method. Multiple logistic regression is a logistic regression model that incorporates several independent variables (X). The key difference between logistic regression and linear regression lies in the nature of the outcome variable (Y), which is binary or dichotomous in logistic regression (Hosmer et al., 2013). The logistic regression model is influenced by variables known as predictors. The following is the form of the binary logistic equation according to Hosmer et al., 2013)

$$\pi(x) = \frac{e^{g(x)}}{1 + e^{g(x)}}$$

where,

$$g(x)=\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \quad \text{(Eq. 3)}$$

In Equation 3, β_0 represents the constant term, while β_1, β_2, … β_n denote the regression coefficients for each independent variable included in the analysis. The variable X_1 refers to the Household Dietary Diversity Score (HDDS) value, X_2 represents household income, and X_3 indicates household size. Furthermore, X_4 describes the education level of the household head, whereas X_5 is a dummy variable representing the occupation of the household head.This study analyzes a set of factors that influence household food security. The dependent variable in this study is a dummy variable representing the level of food security, where food-secure households are the category of interest. The independent variables include a dummy variable for the level of food diversification (high diversification being the category of interest), household income measured using the household expenditure approach (assuming that all income is fully spent), household size, the number of years of formal education completed by the household head, and a dummy variable for the household head's occupation (with agricultural employment as the category of interest).

2.5 Model fit tests

The Hosmer–Lemeshow goodness-of-fit test and the classification test are employed to evaluate the suitability of the model. The Hosmer–Lemeshow test is derived from the Pearson Chi-Square statistic. When the p-value (probability of the chi-square statistic) is greater than 0.05, the model is considered to have a good fit (Hosmer et al., 2013). Meanwhile, the classification test is used to assess whether the estimated probabilities fall above or below the cutoff value of 0.5. If the correctly classified proportion exceeds 0.5, the model is considered to be appropriately specified (Chatterjee & Simonoff, 2013).

3. Results and Discussion

3.1 Identification of the research area

Astronomically, Intan Jaya Regency is located between 137°57'–136°58' E and 3°0'0"–4°0'0" S. Geographically, the regency lies within the mountainous region of Central Papua and was established through the administrative division of Paniai Regency. Intan Jaya encompasses an area of 6,536.27 km^2 and consists of eight districts, with Biandoga District constituting the largest proportion of land area (35.80%). The regency has a population of 137,696, and in 2023, approximately 40% of its residents were classified as living below the poverty line. In 2024, the agricultural sector ranked as the second-largest contributor to the Gross Regional Domestic Product (GRDP) after the construction sector, accounting for 23.27% (Central Bureau of Statistics of Paniai Regency, 2025). Within the agricultural sector, the livestock subsector placed Intan Jaya second in total livestock production in Central Papua Province, amounting to 64,357 head (15% of provincial output). Fishery production in the regency is predominantly derived from aquaculture, with total output reaching 244,323 tons (Central Bureau of Statistics of Central Papua Province, 2025).

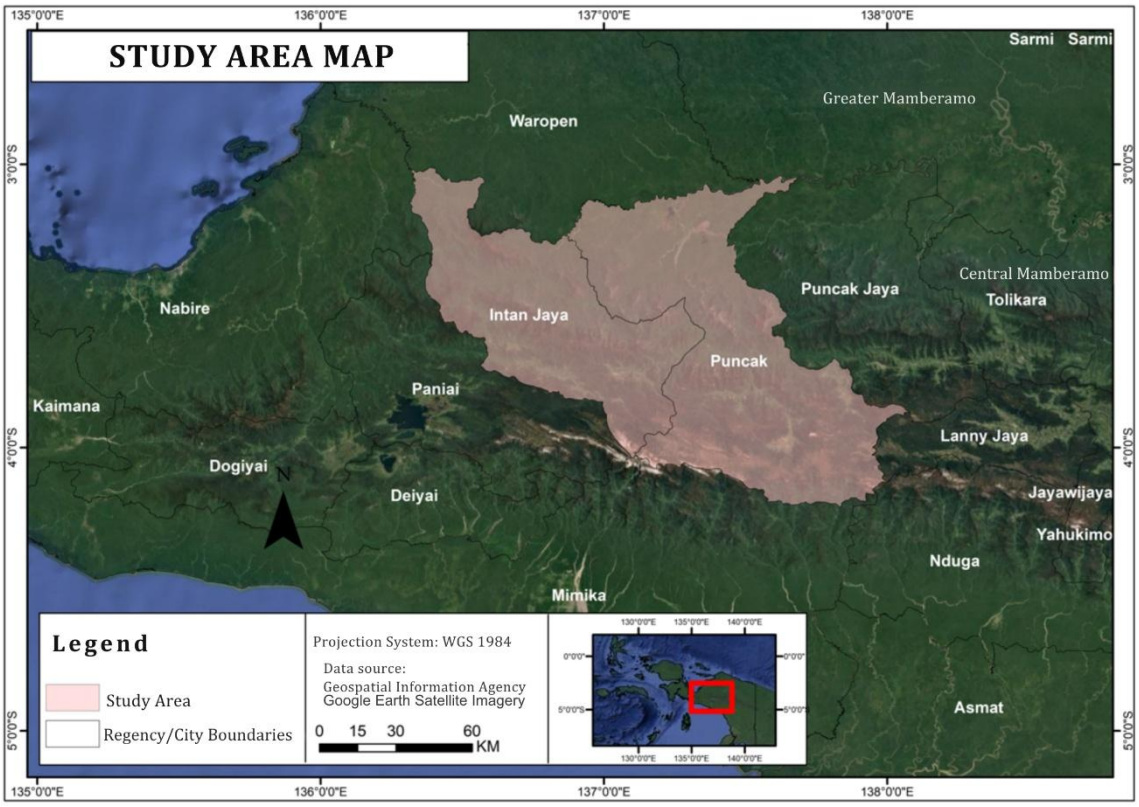

Fig.1 Map of the study area

Puncak Regency is located between 3°0'0"–4°0'3" S and 136°40'–138°05' E. Geographically, it occupies the central highlands of Papua. The regency covers 7,394.5 km^2 and comprises 25 districts, with North Ilaga District being the largest. Puncak Regency has a total population of 178,072 and an annual population growth rate of 1.13%. Approximately 86,964 individuals (2% of the population) constitute the labor force. Similar to Intan Jaya, the incidence of poverty in Puncak Regency remains high, reaching 36.34% of the population. The agricultural sector contributes 13.74% to the GRDP. In the livestock subsector, Puncak recorded 59,624 head of livestock, entirely pigs, positioning it as the third-largest livestock-producing regency in Central Papua Province. As in Intan Jaya, fishery production in Puncak is dominated by aquaculture, with a total output of 104,000 tons (Central Bureau of Statistics of Central Papua Province, 2025).

3.2 Respondent household characteristics

3.2.1 Household head characteristics by education level

Based on the analysis presented in Table 3, 55.28% of household heads in Intan Jaya Regency have never attended school. A more concerning condition is observed in Puncak Regency, where more than 80% of household heads have no formal education, and approximately 16.23% completed only elementary school. These data indicate a substantial disparity in educational access between regions in Central Papua Province. They also highlight a significant gap between the average years of schooling in these areas and the national average of nine years, equivalent to the completion of junior secondary school (BPS).

Unequal access to education has the potential to exacerbate economic disparities among social groups. Individuals with low educational attainment tend to possess limited skills and have more restricted access to formal employment opportunities. As a result, they face a higher risk of unemployment or are more likely to engage in informal-sector work with unstable income (Wang & Ruan, 2024). Findings by Ginting et al. (2020) further reinforce this, showing that low education levels negatively affect financial independence among communities in Papua. This condition may indirectly worsen poverty and become a significant barrier to regional economic growth.

Beyond educational factors themselves, social conditions and regional security also contribute to the slow development of education in Papua, particularly in Puncak Regency. According to Indonesia (2021), social conflicts among local community groups often disrupt regional stability, hindering teaching and learning activities, diminishing community interest in attending school, and delaying the development of educational facilities. Thus, improving the quality and equitable distribution of education must become a primary priority for local governments to develop a more competitive human resource base and strengthen the economic foundations of communities in Papua.

Table 3. Characteristics of household heads by education level

Education Level	Intan Jaya District		Puncak District	
	Number	Percentage	Number	Percentage
No schooling	293	55.28%	427	80.57%
Elementary equivalency	2	0.38%	0	0.00%
Elementary School	77	14.53%	86	16.23%
Junior High School	50	9.43%	6	1.13%
Senior High School equivalency	9	1.70%	2	0.38%
Senior High School (	81	15.28%	8	1.51%
Diploma I / Diploma	5	0.94%	0	0.00%
Diploma III	3	0.57%	0	0.00%
Bachelor's Degree	10	1.89%	1	0.19%
Total	530	100.00%	530	100.00%

(SUSENAS, 2024)

3.2.2 Household head characteristics based on occupation

The occupation of the household head is an essential factor influencing household welfare and food security. The type of occupation determines income levels, economic stability, and the household's ability to meet basic needs, including food. According to Mbewana & Kaseeram (2025) households with more diverse sources of income are less likely to experience food insecurity. The analysis shows that the majority of household heads in Intan Jaya Regency (81%) work as farmers cultivating rice and secondary crops, while approximately 8% are employed in the plantation sector. This indicates that agriculture remains the primary source of livelihood for the community. Meanwhile, in Puncak Regency, dependence on the agricultural sector is even higher, with about 98% of

household heads working as farmers, and only a small proportion employed in government administration, defense, and social security.

Research by Wen & Zeng, (2024) reported that workers in the non-agricultural sector face greater challenges in achieving food security due to unstable income and limited access to direct food sources. These findings contrast with those of Zdeněk et al. (2022) who revealed that household incomes reliant on the agricultural sector tend to be lower than those of households in general. Agriculture is also highly dependent on natural conditions; therefore, disasters related to extreme weather, such as droughts, floods, and strong winds, can lead to crop failure and loss of household income (Karakara, 2025).

Table 4. Household head characteristics based on occupation

Type of occupation	Intan Jaya District		Puncak District	
	Number	Percentage	Number	Percentage
Rice and secondary crop farming	428	81%	517	98%
Horticulture	10	2%	0	0%
Plantation agriculture	40	8%	0	0%
Fisheries	1	0%	0	0%
Livestock	15	3%	0	0%
Forestry and other agricultural activities	6	1%	0	0%
Accommodation and food service activities	0	0%	1	0%
Wholesale and retail trade, repair and maintenance of motor vehicles	1	0%	0	0%
Public administration, defense, and social security	10	2%	3	1%
Education	7	1%	1	0%
Human health and social work activities	1	0%	0	0%
Unemployed	11	2%	8	2%
Total	530	100%	530	100%

(SUSENAS, 2024)

3.3 Household expenditures

Household expenditure refers to all costs incurred for the consumption of all family members and is classified into two categories: food expenditure and non-food expenditure. According to data from the National Socioeconomic Survey (SUSENAS), food expenditure includes costs used to purchase food items such as cereals, tubers, fish, meat, eggs and milk, vegetables, fruits, legumes, oil and coconut, spices, beverages, other food ingredients, as well as prepared foods and drinks. Meanwhile, non-food expenditure consists of costs allocated for non-food purposes, including housing and household facilities, various goods and services, clothing, taxes, levies, insurance, and expenses for social gatherings or ceremonial events.

The results presented in Table 5 indicate that the average household expenditure in Intan Jaya Regency is IDR 5,272,689, while in Puncak Regency it is IDR 3,502,704. Per capita expenditure in both regions is dominated by food-related spending. The average food expenditure in Intan Jaya Regency is IDR 3,584,647, which is higher than the average food expenditure in Puncak Regency at IDR 2,561,445. These figures exceed the national average household food expenditure in Indonesia, which is IDR 2,519,685 (Central Bureau of Statistics, 2024a). Based on an average household size of three persons, as reported in SUSENAS, the per capita food expenditure in Intan Jaya Regency amounts to IDR 1,194,882, while in Puncak Regency it is IDR 853,815. Rashid et al. (2024) reported that larger household size and lower educational attainment of the household head contribute to a higher proportion of food expenditure.

Table 5. Household expenditures

Type of Expenditure	Intan Jaya District	Puncak District
Total expenditure	IDR 5,272,689	IDR 3,502,704
Food expenditure	IDR 3,584,647	IDR 2,561,445
Non-food expenditure	IDR 1,688,042	IDR 941,259

(SUSENAS, 2024)

3.4 Food diversification

Based on the results presented in Table 6, the types of foods consumed by all respondents in Intan Jaya Regency consist primarily of vegetables and spices. Meanwhile, in Puncak Regency, the most commonly consumed food groups include tubers, vegetables, oils and fats, sweeteners, and spices. As their main food sources, communities in both regions tend to prefer consuming tubers over cereals, even though cereals are generally the staple foods of most Indonesians.

There is also a notable difference in fruit consumption, with 67% of respondents in Intan Jaya Regency reporting fruit consumption, compared to only 29% in Puncak Regency. Regarding protein sources, meat is the most widely consumed protein source in both regions. According to the 2025 Central Papua in Figures report, pigs are the most widely raised livestock in Central Papua Province, with a population of 435,434 in 2024. Meanwhile, fish and marine products are the least consumed food group in Puncak Regency, as the region is not a fish-producing area and contributes only 5% to the total fisheries output of Central Papua Province (Central Bureau of Statistics of Central Papua Province, 2025).

Overall, the foods most commonly consumed by communities in Central Papua include tubers, vegetables, cereals, oils and fats, sweeteners, as well as seasonings, spices, and beverages. Consumption of protein sources, livestock products, and legumes tends to be lower. These findings are consistent with the Central Papua Agricultural Potential data, which indicate that 77% of households in Central Papua cultivate food crops, while only 5% engage in the fisheries subsector (Central Bureau of Statistics of Central Papua Province, 2024).

Table 6. Distribution of households by food group consumed

Food Group	Intan Jaya District		Puncak District	
	Number	Percentage	Number	Percentage
Cereals	521	98%	426	80%
White roots and tubers	510	96%	528	100%
Vegetables	529	100%	530	100%
Fruits	357	67%	154	29%
Meat	449	85%	440	83%
Eggs	498	94%	290	55%
Fish and other seafood	353	67%	6	1%
Nuts, legumes, and seeds	199	38%	73	14%
Milk and milk products	252	48%	332	63%
Oils and fats	506	95%	530	100%
Sweets	519	98%	530	100%
Spices, condiments, and beverages	528	100%	530	100%

(SUSENAS, 2024)

The level of food diversification in this study was measured using the Household Dietary Diversity Score (HDDS), which reflects the variety of food types consumed by a household. An HDDS score is categorized as high when it is ≥ 7, indicating a diverse food consumption pattern and a condition associated with household food security.Based on the results presented in Table 7, more than 90% of households in Intan Jaya Regency and Puncak Regency have high HDDS scores. The average HDDS in Intan Jaya is 10, while in Puncak it is 8. This means that, on average, households in Intan Jaya consume foods from 10

different food groups, whereas households in Puncak consume foods from 8 groups. These findings suggest that households in Intan Jaya exhibit a more diverse dietary pattern compared to those in Puncak, likely due to differences in access to food sources and geographical conditions. This result aligns with the findings of Cordero-Ahiman et al. (2021), who reported that households working in the agricultural sector tend to have higher HDDS scores because they have direct access to a variety of food products.

Table 7. Distribution of households based on HDDS scores

Location	Low HDDS (<7)		High HDDS (≥7)	
	Number	Percentage	Number	Percentage
Intan Jaya District	5	1%	525	99%
Puncak District	38	7%	492	93%

(SUSENAS, 2024)

Table 8. Average HDDS scores

Location	Average HDDS scores
Intan Jaya District	10
Puncak District	8

(SUSENAS, 2024)

3.5 Food expenditure share

The share of food expenditure can serve as an important indicator for assessing a household's food security from an economic perspective. Generally, the higher the proportion of income allocated to food, the lower the household's level of welfare, as a large portion of their income must be spent merely to meet basic food needs. A study by Hutapea & Prasetyo (2025) reported an increase in the percentage of food expenditure in several remote regions of Indonesia, including areas in Papua, during the period of 2018 to 2022. This increase indicates underlying issues related to infrastructure, food availability, and limited access to adequate food sources in these regions.

Based on the data presented in Table 9, the majority of households in Intan Jaya Regency and Puncak Regency allocate 60% or more of their total expenditure to food, which is categorized as a high food expenditure share. This condition reflects significant economic constraints faced by most households in meeting their food needs. In Puncak Regency in particular, as many as 97% of households are recorded as having a high food expenditure share, indicating that nearly the entire household population in the region experiences low welfare levels and is highly dependent on food-related expenses.

Table 9. Food expenditure share

Food expenditure share	Intan Jaya District	Puncak District
Low (<60%)	154	18
	(29%)	(3%)
High (≥60%)	376	512
	(71%)	(97%)

(SUSENAS, 2024)

3.6 Energy adequacy level

The energy adequacy level is an indicator of food security from the perspective of meeting daily energy requirements. Rüschhoff et al. (2022) state that food demand, agricultural production levels, and land availability influence energy adequacy. A household is considered adequate in meeting its energy needs when its energy adequacy percentage exceeds 80% of the recommended intake (2,100 kcal). The analysis presented in Table 10 shows that more than 50% of households in Intan Jaya Regency and Puncak Regency have low energy adequacy levels, defined as equal to or less than 80% of the recommended energy requirement.

Table 10. Energy adequacy level

Energy Adequacy Level	Intan Jaya District	Puncak District
Less (≤ 80 %)	325 (61%)	273 (52%)
Enough (>80 %)	205 (39%)	257 (48%)

(SUSENAS, 2024)

3.7 Food Security Level

Table 11 shows that 50% of the population in Central Papua is in a food-insecure condition. Food insecurity occurs when households are unable to meet their food needs, both economically and in terms of energy adequacy. Meanwhile, only 11% of households in Intan Jaya Regency are categorized as food secure, and an even more severe condition is observed in Puncak Regency, where only 2% of households fall into the food-secure category.

Militao et al. (2023) state that households with low levels of education and income, as well as those working in the informal sector, are more likely to experience food insecurity. Household heads with lower education and income face greater challenges in generating sufficient earnings to meet the food needs of their family members. Barati et al. (2024) highlight that one of the primary causes of food insecurity in rural areas is inadequate infrastructure, including limited access to functional markets that provide food. Another factor contributing to food insecurity in remote regions is the weakening of the agricultural sector, which further restricts community access to food sources (Dehrashid et al., 2021).

Table 11. Food security levels

Energy Adequacy Level	Intan Jaya District		Puncak District	
	Food expenditure share			
	Low (<60%)	High (≥60%)	Low (<60%)	High (≥60%)
Enough (>80 %)	Food secure 58 Households (11%)	Vulnerable 147 Households (28%)	Food secure 10 Households (2%)	Vulnerable 247 Households (47%)
Less (≤ 80 %)	Less secure 96 Households (18%)	Food insecure 229 Households (43%)	Less secure 8 Households (2%)	Food insecure 265 Households (50%)

(SUSENAS, 2024)

3.8 Factors influencing food security

Table 12 presents the results of the binary logistic regression analysis used to identify the socioeconomic factors, household income, household size, education level of the household head, and the employment-type dummy variable of the household head that influence household food security, along with the model's goodness-of-fit assessment. Based on the binary logistic regression analysis, the Hosmer–Lemeshow test produced a value of 1, which is greater than the alpha levels of 1%, 5%, and 10%. This indicates that H_0 fails to be rejected, meaning the model is appropriate. Furthermore, the analysis shows a correctly classified value of 94.06%, which exceeds 50%, indicating that the model is suitable and can be analyzed using binary logistic regression. The Nagelkerke R^2 value is 0.45, meaning that the independent variables in the model explain 45% of the variation in the dependent variable, while the remaining 55% is explained by other variables outside the model. The chi-square probability value is 0.000, which is lower than the alpha levels of 1%, 5%, and 10%, indicating that all independent variables collectively have a significant effect on the dependent variable. Based on the partial significance tests, household income, household size, and the education level of the household head significantly influence food security levels in Central Papua Province. The education level of the household head and

household income have a positive effect on food security, while household size has a negative effect.

Table 12. Binary logistic regression results for food security

Variables in Equation	B	S.E	Wald	Sig.	Odds
Food Diversification Dummy Variable	-0.684 ^{ns}	0.339	-1.02	0.310	0.504
Household Income	6.53e-07***	7.19e-08	9.08	0.000	1.000
Household Size	-.659***	0.038	-8.25	0.000	0.190
Years of Education of Household Head	0.062*	0.033	1.99	0.047	1.064
Employment Dummy of Household Head	1.280^{ns}	3.009	1.53	0.126	3.598
Constanta	-2.922	0.558	-2.82	0.005	0.053
Model fit statistic	:				
Prob > chi2	: 0.000				
Pseudo R2	: 0.390				
Negelkerke R2	: 0.448				
Prob Hosmer and Lemeshow	: 1.000				
Correctly classified	: 94.06%				

(SUSENAS, 2024)

3.8.1 The influence of household income on food security

In this study, household income was estimated using household expenditure data adjusted to the secondary data available from the National Socioeconomic Survey (SUSENAS), under the assumption that all income is fully spent. The results indicate that household income has an odds ratio of 1, meaning that for every additional 1 rupiah of household income, the likelihood of a household being food secure increases by one unit. As shown in Table 9, most household income in both study areas is allocated to purchasing food. These findings align with the study by Shivolo-Useb et al. (2025) which reported that 65.2% of food shortages among households in Windhoek, Namibia, were driven by declining household income. Lower household income reduces purchasing power and limits access to sufficient food. Income diversification can be an effective strategy to improve earnings (Dehrashid et al., 2021). Mbewana & Kaseeram (2025) also suggest that households with diversified sources of income have a greater likelihood of achieving food security.

According to Table 4, most household heads in Intan Jaya and Puncak Regencies work in the agricultural sector. Based on average net income data for self-employed workers in Central Papua, agricultural workers earn the lowest income, IDR 1,610,500 per month, significantly lower than workers in other sectors, such as the industrial sector, which earns IDR 3,465,500 per month (Central Bureau of Statistics, 2024b) . This relatively low income contributes to the widespread food insecurity experienced by households in both regions. The mountainous geography of these areas also limits market access for agricultural products, preventing households from optimizing their income. According to the 2024 Central Papua Agricultural Economic Survey (SEP), 73.36% of farmers reported difficulty marketing their harvests, while 84.25% experienced difficulty obtaining agricultural inputs. The survey also noted that 57.22% of farmers attributed their marketing challenges to high transportation costs (Central Bureau of Statistics, 2024c). Sudirjo et al. (2024) found that improved food distribution systems positively affect food price stability, which indirectly influences food availability.

3.8.2 The influence of the household head's years of education on food security

The partial logistic regression analysis shows that the household head's years of education have a positive effect on food security. The education variable has an odds ratio of 1.064, meaning that for every additional year of schooling completed by the household head, the likelihood of being food secure increases by 1.064 units. A longer duration of schooling reflects a higher educational attainment level. According to Nwokolo (2015), education plays a significant role in increasing household income, which indirectly

improves food security status. Higher education levels equip household heads with more skills that can support income diversification. This finding is consistent with research showing that farmers who receive food-security-related education are more willing to adopt nutritional concepts, household water treatment, and improved agricultural production practices (Landaverde et al., 2021).

As shown in Table 3, most household heads in Intan Jaya and Puncak Regencies have never attended school or did not complete primary school. This low level of education restricts employment opportunities, limiting household heads to low-wage and economically less promising jobs. These limited opportunities make it difficult for them to earn sufficient and sustainable income. As a result, many households in Central Papua face limited purchasing power, especially for obtaining more nutritious and higher-quality food. This indirectly increases their risk of food insecurity, as financial constraints limit their ability to meet adequate and balanced dietary needs.

3.8.3 The influence of household size on food security

The analysis in Table 12 shows that the odds ratio for household size is 0.190. This indicates that each additional household member reduces the likelihood of being food secure by 0.190 units. This result demonstrates a negative relationship between household size and food security, consistent with the findings of Olayemi (2012). As the number of household members increases, so does the amount of food required, making larger households more vulnerable to economic hardship and poverty. Furthermore, Ojofeitimi et al. (2010) emphasize that larger households are not only more food insecure but may also have poorer child-care practices. Consequently, children in these households are at greater risk of malnutrition and stunted growth, which can negatively affect their long-term quality of life. These conditions underscore the need for comprehensive strategies to improve food security, including efforts to increase household income, enhance food access, and provide nutrition education—particularly for households with many members.

4. Conclusions

The findings of this study indicate that household food security levels in Central Papua Province remain within the food-insecure category, demonstrating that a substantial proportion of households are still unable to meet their dietary needs in a stable and sustainable manner. Despite this, the region exhibits a relatively high level of food diversification, suggesting that households consume a variety of food types, although such diversity has not yet translated into adequate food security outcomes. Socioeconomic factors were found to play a significant role in shaping household food security conditions. Household income, family size, and the educational attainment of the household head emerged as key determinants influencing the capacity of households to access, manage, and utilize food resources effectively. To strengthen household food security, targeted strategies are required. Efforts to increase household income, particularly through training and capacity-building programs on agricultural technologies, are essential, considering that most household heads work as farmers. Improvements in educational infrastructure, coupled with the provision of educational support for local communities, are also critical. Enhancing access to quality education is expected to equip future household heads with the knowledge, skills, and capacities necessary to improve overall welfare and ensure sustainable access to food resources.

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Author Contribution

The author is solely responsible for the conception and design of the study, the acquisition and analysis of the data, the interpretation of results, and the writing and revision of the manuscript. The author has read and approved the final manuscript.

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Data Availability Statement

The data supporting the findings of this study were obtained from the Survei Sosial Ekonomi Nasional (SUSENAS) administered by Badan Pusat Statistik (BPS) Indonesia. These data are not publicly available due to BPS confidentiality and access restrictions but may be provided by the authors upon reasonable request and are subject to approval from BPS as the data owner.

Conflicts of Interest

The author declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author(s) used Grammarly and ChatGPT to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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