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Coffee-goat integrated system for assessing livelihood vulnerability (LVI-IPCC) and household food security in Lampung Province, Indonesia

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Abstract. *Murniati K, Abidin Z, Firdasari, Marlina L, Seta AP, Arifatuzzakiyah M, Sari LW. 2026. Coffee-goat integrated system for assessing livelihood vulnerability (LVI-IPCC) and household food security in Lampung Province, Indonesia. Asian J Agric 10 (1): g100151. https://doi.org/10.13057/asianjagric/g100151.* This study analyzes the livelihood vulnerability and food security of farming households who implemented integrated coffee-goat farming system in Air Naningan Sub-district, Tanggamus District, Lampung Province, Indonesia. Primary data were collected through a structured survey of 88 farming households that selected purposively. Livelihood vulnerability was measured using the Livelihood Vulnerability Index-IPCC (LVI-IPCC) framework, which included three main components, namely exposure, sensitivity, and adaptive capacity. Household food security was classified based on a combination of the proportion of food expenditure and the level of energy consumption adequacy. The results showed an LVI-IPCC value was -0.00171, indicated as moderate vulnerability, with adaptive capacity relatively higher than the level of exposure. In terms of food security, 26% of households were classified food secure households, food vulnerable households (24%), food less secure households (39%), and food insecure households (11%). These findings confirmed that although coffee-goat integrated system strengthened the adaptive capacity of farming households, food security challenges remained a major issue that required more targeted policy interventions. The implications of these findings suggested that moderate vulnerability and unequal distribution of food security demand rural development policies that not only encourage agricultural integration but also strengthen household food diversification, income stabilization, and community-based nutrition interventions.

Keywords: Climate vulnerability, food security, integrated farming, livelihood vulnerability

INTRODUCTION

Coffee-goat integrated farming is a system widely adopted by smallholder farmers in coffee producing regions as a strategy to diversify income sources and optimize the use of locally available resources. This system combines coffee cultivation with goat husbandry and creating mutually beneficial linkages between crop and livestock components. Indonesia is one of the world's top five coffee producers, with global coffee production reaching approximately 11.1 million tons in 2023. A significant proportion, more than 80 percent, of this production is contributed by smallholder farmers who often face various challenges including climate variability, price instability, and limited access to capital and technology. These conditions make smallholders particularly vulnerable, thereby necessitating adaptive and resilient farming systems such as integrated agriculture (Food and Agriculture Organization (FAO) 2025; International Coffee Organization (ICO) 2025).

In Lampung Province, especially in Tanggamus District, the coffee-goat integrated system has developed rapidly due to favorable agroecological conditions and the availability of livestock resources. In this area, the goat manure that utilized as organic fertilizer is up to 70-80%, and livestock contributing is more than 50% to farmer household income (Herrero et al. 2017; Fembriarti et al. 2025). On the other side, coffee waste that utilized as animal feed, can increase input efficiency and farmer household income (Herrero et al. 2017; Hida et al. 2023).

Despite these advantages, most previous studies on integrated farming systems have primarily focused on economic aspects such as income generation and input efficiency. There is still limited research that systematically examines how coffee-goat integration affects household livelihood vulnerability and food security. In particular, the application of the Livelihood Vulnerability Index based on the Intergovernmental Panel on Climate Change framework or LVI-IPCC has generally been limited to single agricultural systems or broader regional analyses. As a result, there is a lack of empirical evidence explaining how integration at the household level influences the three main components of vulnerability, namely exposure, sensitivity, and adaptive capacity, and how these components are related to food security outcomes.

The LVI-IPCC framework conceptualizes vulnerability as a function of three interconnected dimensions. Exposure refers to the degree to which households experience external stresses such as climate variability, extreme weather events, and market fluctuations. Sensitivity indicates how strongly a household's livelihood is affected by these stresses, which is influenced by factors such as dependence on agricultural income, availability of food, and health conditions. Meanwhile, adaptive capacity represents the ability of households to respond to and recover from these stresses. This capacity is shaped by access to assets, diversification of income sources, institutional support, social networks, and knowledge or skills. Understanding these three dimensions in an integrated farming context is crucial for identifying the strengths and weaknesses of household resilience strategies.

Based on these research gaps, this study aims to analyze the livelihood vulnerability of households engaged in coffee-goat integrated farming using the LVI-IPCC framework, focusing on exposure, sensitivity, and adaptive capacity components. Furthermore, the study seeks to classify household food security status by combining indicators of food expenditure share and energy consumption adequacy. By doing so, the research also intends to examine the relationship between livelihood vulnerability and food security conditions at the household level. The findings are expected to provide a more comprehensive understanding of how integrated farming systems contribute not only to economic performance but also to resilience and food security, particularly in rural areas such as Tanggamus District, Lampung Province.

MATERIALS AND METHODS

Study area

The study location within Air Naningan Sub-district, Tanggamus, Lampung, Indonesia, is presented in Figure 1. The map illustrates agroecological characteristics of an altitude of 600-900 meters above sea level, an average temperature of 22-28°C, and annual rainfall of 2,200-2,500 mm. These highland conditions support coffee growth, but at the same time increase exposure to climate variability, particularly changes in rainfall patterns and extreme events that are common in tropical mountainous regions (Intergovernmental Panel on Climate Change (IPCC) 2014; FAO 2017). High and uneven rainfall can increase the risk of erosion, plant disease attacks, and production instability, thereby strengthening the sensitivity of the coffee farming system (Schroth et al. 2016; Rahn et al. 2018).

Data collection

This study employed a descriptive quantitative approach with a survey method. The population consisted of all farmer households that implemented coffee-goat integrated system in Air Naningan Sub-district, Tanggamus, Lampung. Based on the primary data gathered from the survey, most farmers who integrated coffee cultivation with goat farming were located in Air Naningan Sub-district, which were 272 farmers in total. Based on this population, the sample size for this study was 88 farmers. The sample size was determined by taking 30% of the total population. This approach refers to Arikunto's (2010) opinion, which states that if the population is more than 100 and relatively homogeneous, then a sample size of 20-30% is sufficient to represent the population. In additions, heterogeneity in this study was relatively low, both in terms of land area, number of coffee plants, and plant age. This study took a sample of 30% because it is the maximum percentage in theory, so it is considered to be representative of the entire population. Therefore, the methods based on Arikunto (2010) can be applied.

This study used purposive sampling for selection of locations, and simple random sampling for farmers households. This sample was represented the households who implemented coffee-goat integrated system at the study villages, and was not intended to represent all coffee farmers in Tanggamus District, Lampung, Indonesia.

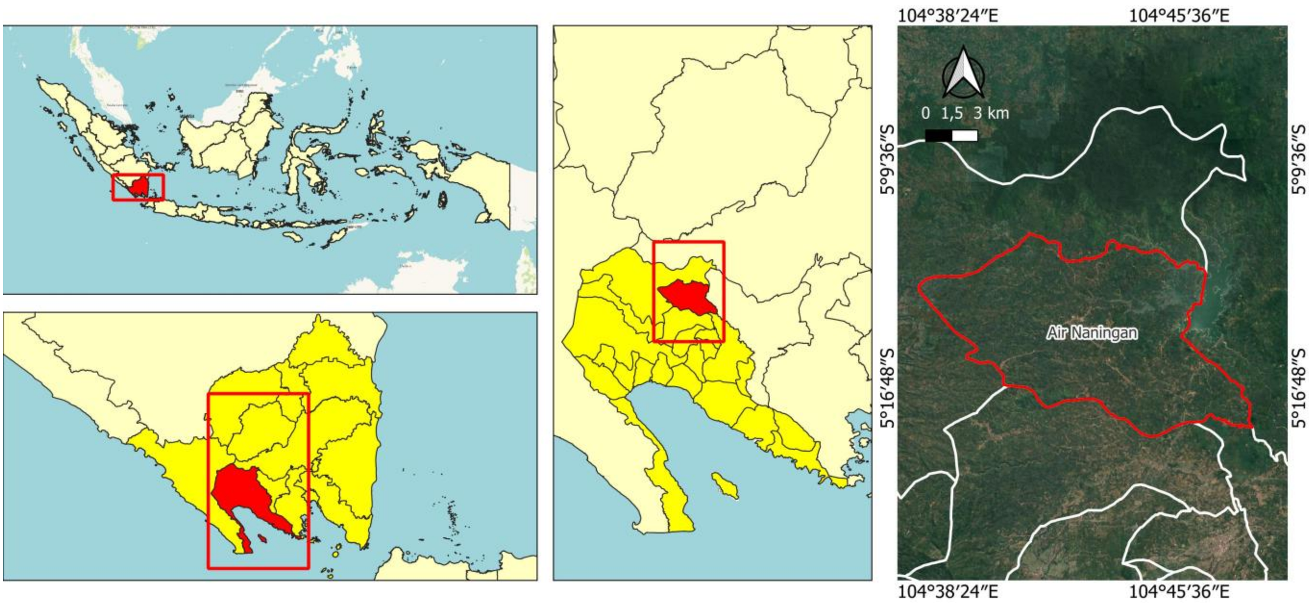

Figure 1. The map illustrates of study area

The types of data used consisted of: (i) Primary data, obtained through direct interviews using questionnaires compiled based on the Intergovernmental Panel on Climate Change Livelihoods Vulnerability Index (LVI-IPCC) framework (Hahn et al. 2009; Speranza et al. 2014). In term of ethics, all respondents were informed a consent letter related to the purpose of the study, data confidentiality, and their right to withdraw. So, only participants that agreed to be interviewed became respondents. Historical data related to disaster happens at the result location for the last five years carded from local community knowledge. (ii) Secondary data obtained from local government, for example data related local population, and the data related to coffee production obtained from Indonesia Central Bureau of Statistics and FAO.

The data were classified into two main categories: (i) Livelihood vulnerability indicators, which included adaptive capacity, exposure, and sensitivity; and (ii) Food security indicators included the proportion of food expenditure and household energy consumption levels.

Data analysis

Data analysis was conducted using two main approaches, namely the livelihood vulnerability index-Intergovernmental Panel on Climate Change (LVI-IPCC) and household food security analysis.

Livelihood Vulnerability Index (LVI-IPCC) includes the following components:

Exposure: rainfall variability (mm/year), frequency of extreme weather events (events/year), changes in planting seasons (dummy).

Sensitivity: dependence of income on coffee (%), area of coffee land (ha), proportion of food expenditure (%).

Adaptive capacity: head of household education (years), number of income sources, goat ownership (heads), access to credit/assistance (dummy), farmer group participation (dummy).

All sub-indicators were normalized using the minimum-maximum method based on the data obtained in the study area. The values for exposure (E), sensitivity (S), and adaptive capacity (AC) components were calculated as the average of their constituent sub-indicators.

Livelihood vulnerability analysis (LVI-IPCC)

The LVI-IPCC calculation was carried out using the following steps:

Standardization of each sub-indicator using the formula:

$$I_{sv} = \frac{S_v - S_{min}}{S_{max} - S_{min}}$$

Where:

Isv: Standard value of sub-component v

Sv: Actual value of sub-component

Smin and Smax: Minimum and maximum values of sub-component.

The value of each main component (adaptive capacity, sensitivity, and exposure) was calculated as the weighted average of the related sub-components:

$$M_d = \frac{\sum_{i=1}^{n} W_i I_{sv}}{\sum_{i=1}^{n} W_i}$$

Where:

M: Principal component value, and Wi is the weight of each indicator.

The final Livelihood Vulnerability Index value is calculated based on the IPCC approach:

$$LVI_{IPCC} = (E - A) \times S$$

Where:

E: Exposure,

A: Adaptive capacity, and

S: Sensitivity.

According to Hahn et al. (2009), the LVI-IPCC scale ranges from -1 (low vulnerability) to 1 (high vulnerability).

Household food security analysis

Food security was analyzed using two indicators, namely the proportion of food expenditure and the level of energy consumption. Household food security is measured using a combination of food expenditure share (% of total household expenditure) and energy consumption adequacy level, calculated based on the standard requirement of 2,100 kcal/capita/day, to classify households into food secure, food vulnerable, and food insecure categories.

The proportion of food expenditure is calculated using the following formula:

$$Proportion\ of\ food\ expenditure = \frac{Food\ expenditure}{Total\ expenditure} \times 100\%$$

Households with a food expenditure share ≤60% were classified as having low food expenditure share, while those with >60% were classified as high food expenditure share, consistent with the Jonsson and Toole threshold widely adopted in Indonesia (FAO 2021).

The energy consumption level was calculated based on total energy intake per capita per day:

$$ECL = \frac{Total\ energy\ consumption\ (kcal)}{Number\ of\ household\ members}$$

Households were categorized as food secure if the ECL value is ≥2,150 kcal/capita/day according to national energy requirements standards (Badan Pusat Statistik (BPS) 2023). The recommended nutritional adequacy for energy consumption is based on Indonesia Minister of Health Regulation No. 28 year 2019, which states that nutritional adequacy figures of 80-90% are included in the sufficient category.

Food security

Food security was measured by cross-comparing the share of food expenditure and energy consumption utilized the indicators recommended by Johnson and Toole (1991) (Maxwell et al. 1999) employed a cross-classification between the share of food consumption expenditure and adult equivalent energy consumption, which was categorized into 4 categories as presented in Table 1.

Table 1. Household food security levels

Energy consumption per adult equivalent unit	Food expenditure share	
	Low (60% of total expenditure)	High (≥ 60% of total expenditure)
Adequate (>80% energy adequacy)	Food secure	Food vulnerable
Inadequate (≤80% energy adequacy)	Food inadequate	Food insecure

Source: Johnson and Toole (1991) and Maxwell et al. (1999)

Household energy intake was calculated from 7-days food consumption recalled data. For each food item, the quantity consumed was converted to edible portion and then to energy (kcal) using the Indonesian Food Composition Tables (TKPI) published by the Ministry of Health of Indonesia (Kementerian Kesehatan RI 2019). Total household energy intake was then converted to energy per adult equivalent (KED) by dividing by the total number of adult-equivalent household members, and compared with the normative requirement (2,000-2,150 kcal per adult per day) to obtain the percentage of energy adequacy (PKE), following the standard used in Indonesian nutrition studies (Kementerian Kesehatan RI 2019).

Households with PKE >80% were categorized as having adequate energy consumption, while those with PKE ≤80% were categorized as having inadequate energy consumption, following earlier Indonesian studies on household food security (e.g., Widada et al. 2014). Findings from studies published on platforms such as ResearchGate and Atlantis Press also apply the same >80% threshold when assessing rural household calorie adequacy.

The combination of these two indicators produced four food security categories (Johnson and Toole 1991; Maxwell et al. 1999):

Food secure: PF ≤ 60% and PKE > 80%

Vulnerable to food insecurity: PF > 60% and PKE > 80%

Less food secure (food deficit with low share): PF ≤ 60% and PKE ≤ 80%

Food insecure: PF > 60% and PKE ≤ 80%

RESULTS AND DISCUSSION

Livelihood vulnerability of farmer households integrating coffee plantations and goat farming

The vulnerability of farmers' livelihoods was measured using the framework developed by Hahn et al. (2009), which divides vulnerability into three main components: exposure, sensitivity, and adaptive capacity. The main indicators used were adapted from Murniati et al. (2017) in accordance with the context of highland agriculture. The exposure component covers natural disasters and climate variability; the sensitivity component covers health, food, and water aspects; while adaptive capacity covers socio-demographic profiles, social networks, and livelihood strategies.

Based on Table 2, the exposure value was 0.237, indicating a low to medium level of vulnerability. This value was mainly influenced by several climatic events such as erratic rainfall and longer dry seasons, but the frequency of extreme events (floods, landslides, strong winds) was relatively low. This condition is in line with the research by Quandt et al. (2017) on the coast of Pekalongan, which explains that areas with limited access to resources were more vulnerable to climate impacts. In the context of highland agriculture, low exposure means that climate risks were still manageable, although seasonal uncertainty continues to impact coffee productivity. The fact that communities have long adapted to local climate patterns also reduces exposure. However, changes in rainfall patterns in recent years indicate that risks remain and need to be anticipated through sustainable adaptation strategies.

The sensitivity component value was 0.427 and it categorized as moderate, with the largest contributor came from the food subcomponent which was 0.672. This condition shows that some households did not have sufficient food reserved or seeds to meet their needs until the next planting season, and still have a very high dependence on food purchased from the market. The lack of non-coffee food production, such as vegetables and staple foods, also increased the risk of vulnerability, as households have no reliable alternative food sources when income declined or food prices increased. These findings are in line with research by Thiault et al. (2018), which explains that limited food reserves and access to clean water are the main factors that increase the sensitivity of coastal communities to climate change.

High sensitivity related to food security confirmed that the coffee-goat integrated system did not automatically guarantee household food security. Although this system could have increased income and reduced fertilizer costs, it has not directly provided food for household consumption. Meanwhile, the health sensitivity value was 0.72 and it categorized as relatively low. It indicated that community access to health services was adequate, the prevalence of infectious diseases was relatively low, and the distance to health facilities was remained reachable. However, the water subcomponent has a value of 0.488 and was at a moderate level of vulnerability, mainly because most households depend on natural water sources for domestic and agricultural needs, making them highly vulnerable to seasonal fluctuations and climate change.

Based on the calculation, adaptive capacity value was 0.241 indicated that the adaptive capacity of farming households was in the fairly good category and slightly stronger than the exposure and sensitivity levels. The coffee-goat integrated system contributed significantly to increase the adaptive capacity because it provided an additional source of income, produced organic fertilizer that reduced production costs, and created business diversification that reduced the risk of dependences on a single commodity. This finding is consistent with the research by Quandt (2018), which confirms that business diversification in integrated agricultural systems can strengthen the economic resilience of households to environmental and social pressures.

Table 2. Main indicators and sub-indicator values

Sub-indicator	**Integrated farmers score**	**Main component**	**Integrated farmers indicator score**	**LVI-IPCC**
Number of households have no information related to climate change	**0.62**	**Natural disasters and climate variability**	**Exposure**	
Number of flood events in the past 6 years	0.0285	0.237	0.237	-0.00171
Number of drought events in the past 6 years	0.011			
Number of strong wind events in the past 6 years	0			
Number of erosion (landslide) events in the past 6 years	0			
Average annual rainfall in 2024	0.5			
Average dry season in 2024	0.5			
Time used to access health facilities	0.22	Health	Sensitivity	
Distance from home to health facility	0.25	0.172	0.427	
Number of families frequently suffering from recurrent illness	0.02			
Number of family members ill within last 4 weeks causing inability to work/school	0.09			
Duration of malaria/dengue fever (month)	0			
Number of families using mosquito nets or repellent	0.45			
Number of households without food reserves until next planting season	0.86	Food		
Number of households without daily food reserves	0.75	0.672		
Number of households without seed reserves for next planting	0.81			
Number of households whose food is not self-produced	0.94			
Average number of households have difficulty obtaining food (month)	0			
Number of households having water problems	0.05	Water		
Number of households using natural water sources for farming	0.95	0.488		
Number of households using natural water sources for domestic use	1			
Time waste to fetch water from natural sources	0.081			
Water needs per household	0.36			
Number of under-18s orphan who live with relatives	0	Social Demographic Profile	Adaptive Capacity	
Number of female household leaders	0.057	0.278	0.241	
Number of respondents not attended formal education	0.011			
Average age of respondents	0.43			
Dependency ratio	0.95			
Number of respondents/families providing help to others	0.13	Social Relationships		
Average help provided by respondents/families	0.25	0.137		
Number of neighbors/relatives receiving help	0.31			
Number of respondents receiving help	0.1			
Number of respondents lending money to others in the last month	0.02			
Average money lent by respondents	0.079			
Number of respondents borrowing money from others	0.11			
Number of respondents lending to neighbors in last month	0.064			
Number of respondents receiving help from village/district leaders (%)	0.17			
Cultivated land area	0.34	Livelihood Strategy		
Type of cultivated food crops	0.5	0.392		
Number of households depending on solely on agriculture	0.83			
Agricultural diversification index	0.2			
Number of households which members having off-farm jobs	0.09			

The low social network subcomponent value (0.137) indicated that the social capital of farming households was relatively limited, suggesting that access to both formal and informal social support networks remain weak. This value reflected the limitations in the intensity of cooperation between farmers, involvement in farmer groups, and access to mutual assistance mechanisms, information exchange, and informal financial support. Although mutual assistance practices were still found in the form of support for basic food needs at certain social moments and the exchange of agricultural inputs such as manure, the scale and sustainability of this support are not yet strong enough to function as an effective risk buffering mechanism. This condition is in line with the patron-client framework proposed by Raj et al. (2021), which emphasized that when social relationships were limited or asymmetrical, households' adaptive capacity to economic and environmental pressures became less than optimal.

The low-value health subcomponent (0.132) indicated that farmers' households still have limited access to formal health services, mainly due to the long distance to reach the health facilities and limited means of transportation. This condition reflected the structural vulnerability in the health dimension, as the low affordability of preventive and curative services has the potential to increase risks in the event of health problems or emergencies. Thus, although the reported disease rate was relatively low, limited access to health care remain a limiting factor in strengthening the adaptive capacity of farming households. The findings are in line with Thiault et al. (2018), who emphasise that limited access to health services in rural areas contributes significantly to increased vulnerability and weakened community adaptive capacity.

Conversely, the livelihood strategy subcomponent showed a fairly high value (0.392), indicating that most households were still heavily dependent on agriculture as their main source of income. Dependences on a single sector increased vulnerability, especially when there were fluctuations in coffee prices or production failures due to climate change. This condition is in line with the findings of Thiault et al. (2018), which show that communities that depend on natural resources for their income are highly vulnerable to climate variability and environmental disturbances.

Based on the seven main components of the Livelihood Vulnerability Index (LVI), namely natural disasters and climate variability, water, food, health, social networks, livelihood strategies, and socio-demographic profiles, the LVI value was 0.323 indicated that farming households were moderately vulnerable to the impacts of climate change. This meant that although they have a certain capacity for adaptation, their exposure and sensitivity to climate and livelihood stressors were quite significant and have the potential to reduce their overall resilience.

The LVI-IPCC calculation was carried out in stages and hierarchically. First, each sub-indicator in the social, economic, environmental, and institutional dimensions (e.g. access to health care, social networks, income dependency, and climate exposure) was normalized using the min-max method to place it on a scale of 0-1. Second, the normalized sub-indicators were averaged to form major components. Third, the major components were then grouped into three IPCC contribution factors, namely exposure, sensitivity, and adaptive capacity, with weights assumed to be equal in accordance with the standard LVI approach. Finally, the LVI-IPCC value was calculated as the difference between exposure and adaptive capacity multiplied by sensitivity, thus reflecting the relative vulnerability of households to climatic and socio-economic pressures (Speranza et al. 2014).

Based on Hahn et al. (2009), the LVI-IPCC scale ranged from -1 (least vulnerability) to 1 (most vulnerability). Therefore, the LVI-IPCC value of -0.00171 (Table 2) indicated that the vulnerability of coffee-goat integrated farming households fell into the medium category because -0,00171 near to 0. Adaptive capacity slightly exceeding both exposure and sensitivity. The negative value signified that households possess a relatively strong ability to balance climate-related risks. Table 2 confirmed that adaptive capacity was stronger than exposure and sensitivity, demonstrating that this integrated farming system served as an effective local-resource, based on adaptation strategy. These findings aligned with evidence from other regions in Southeast and South Asia, where integrated farming systems strengthen livelihood resilience but do not automatically improve food security unless accompanied by food-production diversification.

Vulnerability of farming households in the coffee-goat integrated system arose from a combination of interrelated factors. High dependence on purchased food has made households very vulnerable to food price fluctuations and income declines, especially when coffee yields decline. Limited income diversification also reinforces this vulnerability; although integration with goats provided additional income, the majority of household income remains dependent on coffee, a commodity with unstable prices. In addition, many households did not have sufficient food or seed reserved to last until the next planting season, increasing the risk of food insecurity during lean periods.

Dependence on natural water sources made household consumption highly sensitive to seasonal changes, especially during long dry seasons. Low levels of education also have an impact, as education determines managerial skills, access to information, and the quality of adaptive decision-making, in line with the findings of Chandran et al. (2023). Thus, although the coffee-goat integrated system could increase adaptive capacity through additional income and reduced production costs, this system did not directly increase food security because it has not replaced the main source of household food, which remained dependent on the market.

Food security of coffee-goat integration farmer households

Household energy consumption and food expenditure reflected the household's ability to fulfil food needs quantitatively and economically. In this study, the level of energy consumption was measured based on the number of calories consumed per capita per day, while food expenditure reflects the proportion of household income allocated to purchasing food. These two indicators were used to assess the level of welfare and food security of farming households, because higher energy consumption and lower proportion of expenditure on food indicate better and more sustainable food security.

The level of food security can be examined from two types of indicators, namely process indicators and impact indicators. Process indicators include aspects of food availability and accessibility that describe the conditions of food production and distribution in farming households.

Meanwhile, impact indicators were a direct reflection of household food consumption, which was measured based on the quantity and quality of food consumption and the frequency of daily meals. Indirect impact indicators also included aspects of food storage and household nutritional status (Jones et al. 2013; Kuchenbecker et al. 2017; Reber et al. 2019).

Table 3 shows that the proportion of food and non-food consumption expenditure was calculated based on the ratio of food expenditure to total household expenditure. According to the data, non-food expenditure was higher at 56% compared to food expenditure, which was only 44% of total household expenditure.

Table 4 shows that 57 households (65%) had a food expenditure share of <60% and are classified as less to food secure, meaning that most respondents were able to allocate their expenditure not only to food but also to other non-food needs such as education, health, and savings. Meanwhile, there were 31 households (35%) with a food expenditure share of ≥60% that fall into the vulnerability to food secure category, indicating that this group is still highly dependent on food expenditure and therefore more vulnerable to price changes and income constraints.

Meanwhile, based on Table 5, the average energy consumption of the respondents' households was 5,966 kcal/person/day, while the recommended Adequate Nutrient Intake (ANI) was 7,495 kcal/person/day. Based on the criteria of the 11th National Conference on Food and Nutrition (WNPG) in 2018, which was adopted in Indonesian Ministry of Health Regulation No. 28 of 2019, this achievement fell into the moderate category (80-90% of the RDA). This indicated that energy sufficiency remains a major issue in household food security (Kementerian Kesehatan RI 2019).

All the household respondents (100%) were able to consume meals three times per day with a variety of food ingredients that included animal and plant-based protein sources. This condition is in line with the research by Chandran et al. (2023), which shows that increased income and diversification of food sources in farming households directly contribute to an increase in the frequency and quality of food consumption. High dependence on a single agricultural product such as rice without business diversification causes household food security to become fragile when there is a decline in crop yields or climate disturbances. This is in line with Murniati et al. (2019), who found that farmers with diversified livelihoods are better able to maintain household food stability than farmers who depend on a single commodity.

Furthermore, research by Quandt (2018) also shows that sustainable livelihood strategies, such as the integration of farming and livestock businesses, can strengthen food security through increased income and access to animal protein sources. Thus, efforts to strengthen farmers' adaptive capacity through business diversification and community-based food management are important for maintaining the availability and quality of household food in a sustainable manner.

Based on Table 6, the combination of Food Expenditure (FE) and Energy Adequacy (EA) levels, households in this study were divided into four food security categories, namely food secure households (26%), food vulnerable households (24%), food less secure households (39%), and food insecure households (11%). This distribution showed that although coffee-goat integrated system has contribution to increased income and availability of animal protein sources, most households still faced energy deficiencies. This condition indicated that income-generating efforts have not been fully improved overall food security, as energy adequacy remains the main limiting factor in achieving optimal food security status.

Table 3. Proportion of food and non-food expenditures in total household expenditures

Type of expenditure	Amount (Rp/Month)	Proportion (%)
Total Food Expenditure	1,889,261.67	44
Total Non-Food Expenditure	2,382,602.70	56
Total	4,271,864.37	100

Table 4. Distribution of households based on food expenditure share

Description	Amount	Percentage	Description
Food expenditure share <60%	57	65	Less to food secure
Food expenditure share >60%	31	35	Vulnerability to food secure

Table 5. Average energy and protein consumption and nutritional intake levels of farmers

Nutritional content	Energy/person/day/(kcal)
Consumption	5,966
Recommended nutritional adequacy rate	7,495
Nutritional adequacy level (%)	80%

Table 6. Distribution of household food security of farmers integrating coffee and goats

Food Security Indicator	Number of households	Percentage (%)
Secure (FES≤60%, ECA>80% RDA)	23	26
Vulnerable (FES>60%, ECA>80% RDA)	21	24
Less Secure (FES≤60%, ECA≤80% RDA)	34	39
Insecure (FES>60%, ECA≤80% RDA)	10	11
Total	88	100

A larger portion of household expenditure on non-food items indicated economic flexibility, but did not guarantee adequate energy intake because most staple foods were still purchased from the market. High dependence on purchased food made the households very vulnerable to price and income fluctuations. This result is in line with the findings of Mutisya et al. (2016), which confirm that socioeconomic factors, including income and access to capital, greatly affect the level of household food security. Hirvonen et al. (2017) also show that food consumption patterns dominated by staple foods, with limited consumption of animal protein and vegetables, increase the risk of food insecurity even when income is relatively stable.

Energy consumption, which only reaches 80% of the Daily Nutritional Adequacy Rate (AKG), indicates an energy deficit, even though protein consumption is relatively high. This is in line with the study by Costlow et al. (2026), which found that a healthy diet is theoretically achievable for households in Indonesia, but actual consumption is often diverted, resulting in suboptimal energy and nutrient intake. This imbalance in consumption patterns also showed that coffee-goat integration has increased animal protein consumption, but has not significantly increased access to energy-rich foods such as carbohydrates, because in this case coffee is not a staple food that provides carbohydrates. Similar to the findings of Almughni et al. (2024) increased agricultural income does not automatically translate into optimal food security without food diversification.

The distribution of food security, which shows that 39% of households were in a state of food insecurity and 11% were in a state of food insecurity, confirmed that coffee-goat integration has not been able to optimally improved food security for all households. This condition is consistent with the analysis by Sultan et al. (2024), which highlights that integrated agricultural systems can increase income but do not always improve food security, because integration does not produce staple foods, and income is not sufficiently diversified into food crops. So, it is necessary income stability and food diversification.

In conclusion, the results of this study indicated that adaptive capacity can be improved through coffee-goat integration system, howeve it cannot improve food security because the integration system implemented did not produce staple foods (farmers' main source of food was not from their own farm, instead they bought them). Based on the findings, the study emphasized some importance suggestions that the integrated system of coffee-goat can be implemented along with intercropping systems by planting nutrient-rich crops such as tubers, for example, planting cassava and sweet potato between the coffee trees; integrating poultry for eggs, or developing local food storage systems.

The coffee-goat integrated system in Lampung province showed moderate livelihood vulnerability, with relatively stronger adaptive capacity compared to exposure and sensitivity. However, food vulnerability remains dominant, characterized by high dependence on market food, limited food reserves, and energy consumption that reached about 80% of nutritional adequacy. Moreover, about 74% of households (the sum of vulnerable, less secure, and insecure) were not fully food secured. These findings confirmed that increased income did not automatically improved food security. Therefore, requiring policies that emphasize diversification of household food production, access to capital, and nutrition literacy, for example by promoting intercropping systems by planting nutrient-rich crops such as cassava and sweet potato between the coffee trees; integrating poultry for eggs, or developing local food storage systems.

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