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Article

Dynamics of living income for coffee farming households in agricultural area development policy: Socio-spatial integration

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Abstract: A decent income is an important part of overcoming economic disparities in agricultural development, especially in developing countries where most of the population are small farmers. As a developing country, Indonesia has also established a decent standard of living by setting a minimum wage as a reference for a decent income at the national and regional levels. However, this benchmark is not relevant to be applied uniformly at all levels of workers. This research determines the national coffee development area as the study center. We developed the Anker living wage methodology as a simple concept for determining living income for certain worker communities, especially for small farmers in rural areas who dominate the type of work in Indonesia. a socio-spatial approach is used to visualize the distribution of the dynamics of a decent life in various conditions of farming households. We found that 96.6% of coffee farming households in the national coffee development area had an inadequate living income, and only 3.4% were at an adequate level. We conclude that the current state of agricultural land management does not guarantee a decent income, even though efforts have been made to maximize agricultural crop productivity. The spatial description also shows that this condition is evenly distributed throughout residential areas. It is hoped that this approach can become an essential reference in implementing agricultural development programs that focus on welfare and equitable development as benchmarks for sustainable development goals in the future.

Keywords: coffee; socio-spatial; living income; agriculture; households

1. Introduction

Poverty is a social problem that has always been the center of public and government attention in developing countries. In Indonesia, the number of poor rural people reached 14.64 million people out of a total of 26.50 million poor people in Indonesia in 2023 (BPS-Statistics Indonesia, 2021). This data illustrates that the poor population in Indonesia is concentrated in rural areas, particularly among farmers and fishermen. It is ironic that those who are the backbone of food provision are themselves in a situation of insufficiency. This is, in fact, contrary to the direction and goals of national development, which direct agricultural development to achieve food balance, protecting and ensuring the prosperity of farmers as the main actors in food farming businesses. Based on the 2018 Indonesian Intercensal Agricultural Survey.

Based on the 2018 Indonesian Inter-Census Agricultural Survey, the area of agricultural land controlled by agricultural business households is less than 0.5 hectares, as many as 15.89 million households or 59.07% of the total farming

households. The number of Farmer households with land ownership of less than 0.5 hectares increased from 14.62 million in 2017 to 15.89 million in 2022. This condition of land ownership is attributed to y (1) increasing conversion of agricultural land for agricultural purposes, housing, and public facilities; (2) land fragmentation due to inheritance process; and (3) the sale of rice fields (Indonesian Ministry of Agriculture, 2020). Even as a result of the COVID-19 pandemic, the global poverty rate increased sharply from 8.3% in 2019 to 9.2% in 2020, which is the first increase in extreme poverty since 1998 and the most significant increase since 1990 and slowed down poverty eradication about three years (UNDESA, 2022)

Poverty is one of the main reasons for rural migration to urban areas and even for leaving their country in search of better life. This migration creates economic inequality and significantly impacts equitable development. Poverty is closely related to workers' ability to earn a decent living income for their families. Most people in developing countries do not have a decent living income even if they are employed. In low- and middle-income countries, nearly 3.2 billion people live in rural areas (IFAD, 2021). As many as 80% of farmers worldwide are small farmers, and most of them cannot survive on their farming income, let alone invest in their operations. (BMZ, 2020) Income in the agricultural sector that cannot support a living will continue to impact agricultural productivity, which is increasingly decreasing. This condition will force farmers to move to cities or even migrate to other countries to seek a better life with a better living income.

In Indonesia, the establishment of national areas based on superior agricultural commodities is an exceptional program launched to increase the competitiveness of superior agricultural products, which is expected to improve the welfare of farmers. However, since it was launched, this program has not significantly impacted farmers and the development of agricultural areas. It is experiencing a setback marked by the increasingly widespread conversion of the function of coffee land cultivation to the cultivation of other commodities. Since 2017, there has been a decrease in coffee land area of 1128 ha or 30.87% of the total area of coffee cultivation land. This decrease in land area was accompanied by a decrease in production; in 2017, coffee production reached 1851.35 tons, but in 2022, a reduction of 447.31 tons or 24.16% (BPS, 2022). This significant decrease in production has led to reduced farmers' incomes, raising the assumption that the government has failed to guarantee the welfare of coffee farming households through the national program it is implementing.

Establishing living standards for the coffee farming community is important as a reference for every policymaker to assess the achievements of each program aimed at improving farmer welfare. The living income standard can also be used as a target or reference in agricultural economic models, where changes to the farming system and other drivers of household income can be tested (modeled) to see how much specific improvements can move farming households towards a living income. Agricultural living income standards can be a powerful tool for understanding current livelihood conditions and examining changes' potential impacts (Komives et al., 2017). In other words, living income is a key factor moving forward to produce the right actions to encourage the success of each program (Bhattacharyya, 2019).

Researchers from various communities have conducted research studies highlighting the importance of a decent living income for marginalized communities such as farmers in developing countries to plan future program needs. However, they face challenges of accuracy and data availability, which hinder the representation of household communities' actual income. Secondary data may be reliable for explaining contextual understanding and various components if well available in the study area, but this condition is not fully supportive. Collecting primary data requires more resources, time, and comprehensive methods (Johnny, 2021).

This research aims to examine the dynamics of living income for coffee farmer households through a case study of a national coffee development area and to utilize the socio-spatial context in studying the socio-economic dynamics of coffee farmer households from a regional approach. This method highlights the importance of the micro-spatial scale to describe social phenomena in detail, which will be new in this research.

2. Materials and methods

2.1. Study area

The national coffee development area in Bantaeng Regency, South Sulawesi Province, Indonesia, was chosen as the study area for this case study (**Figure 1**). The National coffee farming areas in region area are designated based on Minister of Agriculture Decree Number 472 of 2018 to increase regional competitiveness through establishing national superior commodity areas to improve coffee farmers' welfare. The selection of research locations targets excellent regional commodities competitive at the export level.

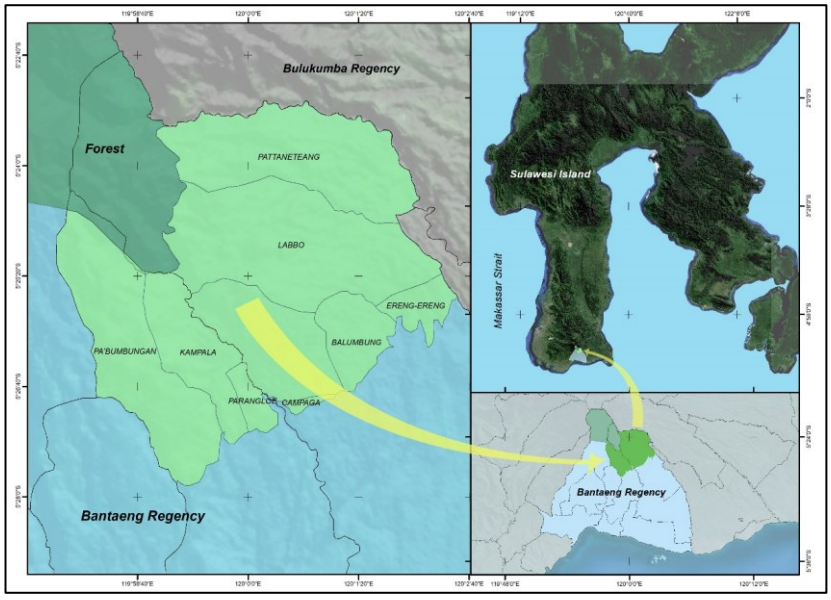


Figure 1. Location of study area at coffee development area in Bantaeng regency.

2.2. Data collection

The selection of research samples was carried out using cluster sampling, which considered the distribution of coffee farmers in the national coffee area as a source of

spatial visualization data. This study involves personal data on the characteristics of farming families in the research area, which will then be linked to several existing spatially connected maps to obtain a more detailed and accurate spatial structure at any given time.

Geographic Information Systems (GIS), with a focus on socio-spatial analysis, can be effectively used to visualize socio-economic dynamics within agricultural areas. This visual representation of socio-spatial analysis through maps, containing a collection of important spatially referenced data regarding geographic patterns, spatial relationships, and related phenomena can be made available to decision-makers and researchers in the field of social agriculture. This model refers to a detailed model known as a micro-scale spatial model. Additionally, there is a requirement in micro-scale spatial modeling to locate individual households precisely along with their demographic description. These models are used to represent the individual behavior of socio-spatial phenomena, revealing important limitations for the purpose of more accurate predictive modeling (Miller and Goodchild, 2014). This accuracy is achievable because conclusions can be checked against survey research data collected from households (Boucek and Moran, 2004) However, one weakness of working at the individual and household level is the privacy of the data, necessitating the protection of individual and household behavior using spatial data that links household and community behavior (Sullivan, 2002).

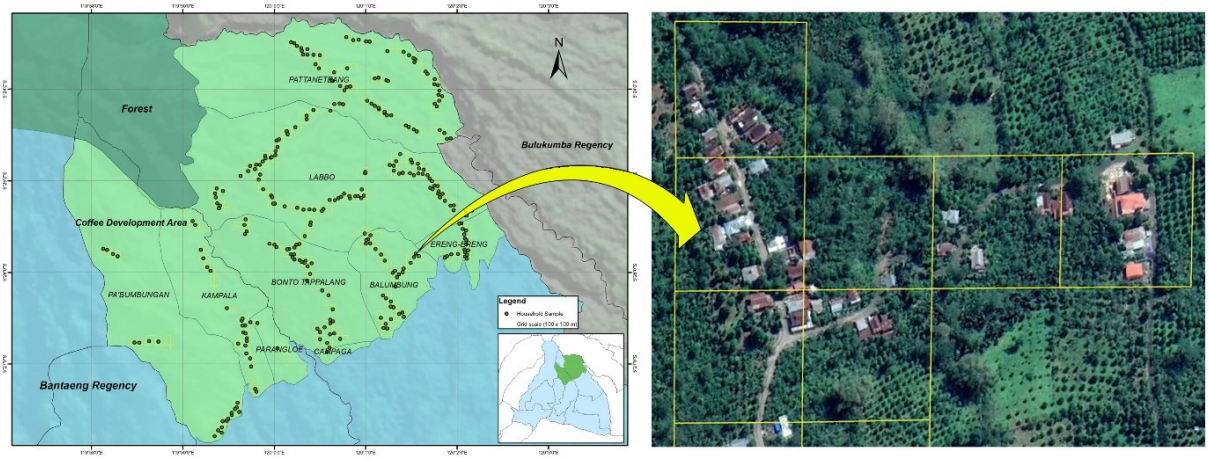


Figure 2. Sampling cluster using grid parameters.

References for the size and composition of households in the national coffee development area of Bantaeng regency were obtained from a survey of farmer households, which had been clustered based on spatial principles. The determination of samples followed spatial criteria based on Cluster Sampling, which is made in the form of a grid with a 100 × 100 meters distance. Each grid was represented by one sample, which was selected based on its location within the grid (**Figure 2**). Of the 465 Grids identified, 319 verified samples were obtained. Collecting primary data at the farmer household level is expected to produce a scenario that accurately reflects the actual situation of farmer families, with this pattern representing most farmer households in the study area. The living income calculated from this data also refers to district/city conditions.

A reference to household size is an important aspect in explaining conditions in the study area. The Anker methodology refers to the nuclear family whenever possible (Anker and Anker, 2017). However, in this study, we compiled the average household size in more detail. We consider household size important to study in detail because it directly relates to the amount of household expenditure. It is recommended that the data used be region-specific because household composition can vary between urban and rural areas, especially given small-scale farming is a family business (Ven et al., 2021).

2.3. Data analysis

The Anker Methodology is a new, widely accepted, and published methodology for estimating living wages that are both internationally comparable and locally specific. The methodology has catalyzed global action on living wages and has been used to estimate living wages in rural, urban, and suburban areas around the world (Anker and Anker, 2017). Anker's methodology has been widely accepted and used to estimate living wages and living incomes across various regions. One application of this method can be used to assess the estimated gap in living income for specific farmers in a particular region (Impact Institute, 2020).

This methodology stipulates that to calculate a living wage or income, we must first identify how much a household would cost to meet a decent standard of living. In terms of living income, this decent cost of living can then be used as a benchmark **(Figure 3)**. If a household collectively earns a payment equal to or greater than the cost of living, it can be assumed that they are, in fact, making a living income.

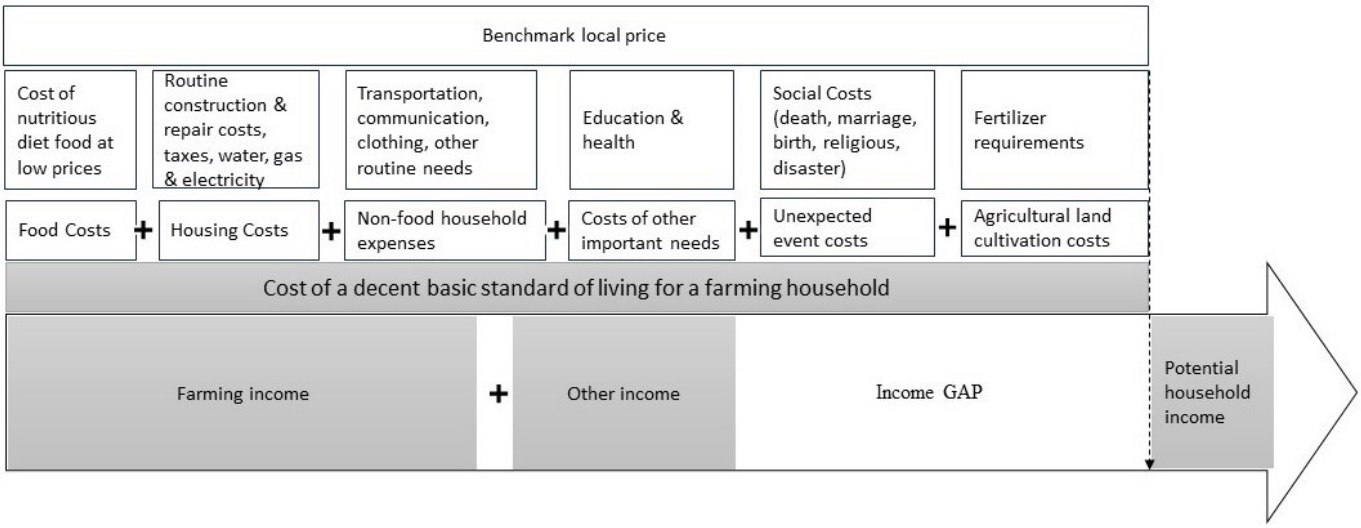


Figure 3. Perspective of living income for farming households.

Assumptions regarding the implemented production system refer to applicable production data based on primary or secondary household-level data. These assumptions are based on production costs, the level of results achieved, and investments made by farmers. Then, farmers are grouped into segments or groups that reflect different levels of efficiency and profit. The reference price calculation focuses on the (most) profitable farmer segment, thereby assuming a higher level of yield and production costs incurred.

Anker's methodology begins by building an initial model diet based on current diets, diets relative to the poverty line, or diets proposed by nutritionists. It has gradually been adapted to meet WHO standards for nutritious diets. It was further developed to calculate i) household energy requirements based on age, gender, body size, and physical activity and ii) low-cost dietary patterns through an iterative procedure (Anker and Anker, 2017).

In the next stage, we use a spatial approach to explain the social conditions that occur in an area through spatial visualization. In this research, we predict social phenomena using the kriging interpolation geostatistical method. Interpolation can be used to reflect spatially based phenomena (ESRI, 2024). Kriging provides weights based on measured values in the surroundings to get predictions at locations that are not measured. This method assumes that the distance and orientation between data samples show the spatial relationship that forms interpolation. Universal Kriging assumes that there is a structural component and that local trends vary from location to location (ESRI, 2023). The general formula for the kriging interpolator as a weighted amount of data is described in the formula:

$$\hat{Z}\ (S_0) = \sum_{i=1}^{N} \lambda_i\ Z\ (S_i)$$

where N is the distribution of the number of measured values, S_0 is the predicted location, λi is the unknown weight for the measured value at the–i location, and $Z(S_i)$ is the measured value at the–i location (ESRI, 2024). The assumption built to form this interpolation is that the population in the measurement zone is homogeneous. We used ArcGIS 10.7 software to analyze spatial interpolation data and visualize the dynamics that occur in this research area.

3. Results and discussion

3.1. Social demographics

Socio-demographic information provides an overview of the living standards of coffee farming communities in the Bantaeng Regency coffee development area. Socio-demographic conditions in the educational aspect show a high gap, with the average adult population who have not received education showing a high percentage; the average level of education is only at the elementary school level (**Table 1**).

Table 1. Socio-demographic characteristics of farmers in the Bantaeng regency coffee development area.

Characteristics	**Values**
	N = 319
Education average (%)	
Not attending school	29.6
Elementary school	28.9
Junior high school	14.8
Senior High School	18.8
Bachelor's degree	8.4
Age group (%)	

Table 1. (*Continued*).

Characteristics	Values
Adult Male (> 18)	35.4
Adult Female (> 18)	30.3
Children 10–18 years old	26.6
Children 1–9 years	7.8
Male as head of family (%)	96.20
Women as heads of families (%)	3.80
Family dependents (mean)	4.7
Number of people working in the household (mean)	1.25
Household income pattern (%)	
Farmer	53.3
Diversification	46.7

Source: data from field surveys with a sample size (*n*) of 319 coffee farming households in the coffee development area of Bantaeng regency 2023.

Education is an important variable that can change behavior patterns and civilization for the better. Most coffee farmers have no education and only reach elementary school level. The low level of education of coffee farmer households affects the farmers' literacy and ability to adopt new things. Considering it as social capital, education can provide additional opportunities for farmers to improve society's condition (Adjimoti and Kwadzo, 2018). The socio-economic aspect explains the livelihood patterns of coffee farming households as a source of family livelihood. 53.3% of households still depend on coffee farming for their livelihood, and another 46.7% have diversified their livelihood patterns. Households do this to gain income variation. Diversification strategies continue to be implemented by farming households as a form of resilience towards a decent living, even though this strategy may negatively impact coffee land's cultivation due to gaps in working time outside the agricultural business.

3.2. Household size

The concepts of household and family in this study show different definitions in constructing household size. A household is defined as a group of relatives who live in the same house, share meals from the same kitchen, and share income to live together. The kinship relationship in question is not tied to blood relations. In contrast to the term family, in social science literature and in general usage, family refers to a group of relatives—people related by blood, marriage, or adoption (Bongaarts, 2001). The average household size observed in a particular household survey does not necessarily provide a good measure of an appropriate reference family size for a living wage. For example, when couples migrate to cities for work, this reduces the average size of resident households (Anker and Anker, 2017). Therefore, the criteria for measuring household income from families in other areas are not included in the study's reference households.

The study begins by using average household size to estimate living wages (**Table 2**). Average household size can be established through a statistical approach

to determine a reference family size. Using average household size to estimate living wages is representative of location-specific household populations (Anker, 2011).

Table 2. The average size of coffee farming households.

Age group and gender	Frequency
Adult male	1.60
Adult female	1.80
Children under < 18 years	1.07
Household group average	4.47

Source: data from field surveys with a sample size (*n*) of 319 coffee farming households in the coffee development area of Bantaeng regency 2023.

The size of household members is a benchmark in determining a decent household income, which is because household members vary significantly in a location (Ven et al., 2021). For this reason, although the approach is more complicated, it is advisable to adjust household size to more contextual conditions (Grillo, 2018). We have identified household sizes in research locations specifically using spatially measured sampling, which considers sample distribution on a more even scale to represent the location. This is based on the fact that poverty is greatly influenced by household size. The larger the household size, the higher the dependency ratio and the more limited resources each individual will have (Debebe and Zekarias, 2020). On the other hand, calorie consumption and food consumption are also negatively and significantly related to household size, this result is in accordance with previous research in several developing countries (Agidew and Singh, 2018; Awoke et al., 2022; Gebre et al., 2021; Jemaneh and Shibeshi, 2023). At the study location, we identified 29 household size groups which later become the size for calculating household needs (**Table 3**).

Table 3. Composition of coffee farming households in the national coffee development area.

Household size*	Frequency (*n*)	Percentage (%)	People work in the household (mean)	Number of people working in the household
Adult (1M), child (2)	2	0.63	1.00	1
Adult (1M–1F)	33	10.34	1.03	2
Adult (1M–1F), child (1)	59	18.50	1.07	2
Adult (1M–1F), child (2)	51	15.99	1.18	2
Adult (1M–1F), child (3)	12	3.76	1.25	2
Adult (1M–2F)	33	10.34	1.22	2
Adult (1M–2F), child (1)	14	4.39	1.07	2
Adult (1M–2F), child (2)	8	2.51	1.63	2
Adult (1M–3F)	5	1.57	1.60	2
Adult (1M–3F), child (2)	3	0.94	2.33	3
Adult (2M–1F)	21	6.58	1.29	2
Adult (2M–1F), child (1)	11	3.45	1.00	1
Adult (2M–1F), child (2)	3	0.94	1.67	2
Adult (2M–1F), child (3)	2	0.63	1.00	1

Table 3. (*Continued*).

Household size*	Frequency (*n*)	Percentage (%)	People work in the household (mean)	Number of people working in the household
Adult (2M–2F)	9	2.82	1.44	2
Adult (2M–2F), child (1)	6	1.88	1.50	2
Adult (2M–2F), child (2)	2	0.63	1.50	2
Adult (2M–3F)	2	0.63	2.00	2
Adult (2M–3F), child (2)	3	0.94	1.67	1
Adult (2M–4F)	1	0.31	3.00	3
Adult (2M–4F), child (2)	1	0.31	1.00	1
Adult (3M–1F)	9	2.82	1.44	2
Adult (3M–1F), child (1)	8	2.51	1.75	2
Adult (3M–2F)	3	0.94	1.33	2
Adult (3M–3F)	1	0.31	2.00	2
Adult (4M–1F)	5	1.57	2.60	3
Adult (1F), child (1)	2	0.63	1.00	1
Adult (1F), child (2)	6	1.88	1.00	1
Adult (2F)	3	0.94	1.00	1
Adult (2F), child (2)	1	0.31	1.00	1
*Adult F (Female), M (Male)				

Source: data from field surveys with a sample size (*n*) of 319 coffee farming households in the coffee development area of Bantaeng regency 2023.

Anker's methodology limits the number of members to a minimum of four people and a maximum of six people per referral household and the number of full-time workers to between one and two people per referral household (Anker and Anker, 2017). In this study, we use existing household groups that have been converted to adult male equivalent weight units. Using existing data provides a projection that is closer to the actual situation.

3.3. Decent living income standard

3.3.1. Food menu and food costs

We set out to model the composition of nutritious foods at the lowest cost based on the current diet of farming households. Next is the classification into nine food groups, which include starchy staple foods, vegetables, fruit, meat, fish and seafood, eggs, dairy products, nuts and seeds, and fats and oils. It is possible to use reference price calculations to measure the actual income of coffee farming households. Therefore. The main activity is to use household surveys and other primary data collection methods to build a picture of farmer incomes (Yao et al., 2017). The first step is to group food choices that are cheap and commonly consumed by farming households as available at several local traders, such as local markets and small shops and traders in villages, especially places where farming communities buy their food needs. To ensure adequate choices of inexpensive, nutritious food are available, prices are aggregated for at least three food items of acceptable quality per (sub)

food group. Two of them are the cheapest foods (per kg or liter), and one is the most consumed food. For all selected foods, current prices (at the time of collection) were collected from 4 different vendor locations, subject to price variability. If there are strong fluctuations throughout the year (> 25%), the most common prices are collected from the same vendor location and used in the calculation for comparison. Starchy staples, vegetables, and fruit are likely to require price corrections due to their seasonal availability. For current prices and most common prices, the median price is used in our calculations (**Table 4**).

Table 4. Composition and costs of low nutritional foods based on local market prices per 100 grams.

Food groups	**Type of food**[1]	**Size**	**Unit**	**The market price for dietary menu needs**[2]	
				Price (IDR)	**Price (USD)**
Starchy staple food	Medium White Rice	100	g	1200	0.08
	Sweet potato	100	g	500	0.03
Side Dish/Meat	Egg	100	g	2700	0.18
	Chicken	100	g	2400	0.16
	salted Fish	100	g	5000	0.33
	Flying fish	100	g	3300	0.22
	Milkfish	100	g	3600	0.24
	Tempeh (local food)	100	g	820	0.05
Green vegetable	Spinach	100	g	1660	0.11
	Chickpeas	100	g	1300	0.09
	Cassava leaves	100	g	500	0.03
	Water spinach	100	g	1500	0.10
	Mustard greens	100	g	2200	0.15
Nuts and Seeds	Corn	100	g	710	0.05
	Long beans	100	g	1660	0.11
Fruits	Banana	100	g	1260	0.08
	Papaya	100	g	320	0.02
Cooking oil	Palm oil	100	mL	1800	0.12
Drink	Sugar	100	g	1550	0.10
	Coffee	100	g	4400	0.29
	Tea	100	g	14,000	0.93
Spice	Red onion	100	g	5700	0.38
	Garlic	100	g	12,000	0.80
	Chili	100	g	1500	0.10
	Salt	100	g	1130	0.08
	Elderly Coconut	100	g	1400	0.09
	Pepper a	100	g	44,000	2.93
	Tomato	100	g	640	0.04

[1] Data the type of food served is the type of food most consumed by coffee farming households, which has high nutritional value and is cheap, obtained based on field survey results.

[2] The market prices presented are price data from market surveys in locations where farming households usually have access to shop for basic food needs.

Determining the price of cheap and nutritious food is the basis for determining a menu with nutritional standards according to the needs of farming households. We grouped six standards of dietary needs in farming households, namely nutritional requirements for adult men as heads of household who earn a living, adult women as heads of household who earn a living, adult men, adult women, children aged 10–18 years and children aged 1–9 years (**Table 5**). This classification is based on the existing conditions of farming households, which are based on different daily nutritional requirement standards.

Table 5. Nutritional standards for recommended diet models in preparing living income in the coffee development area.

Nutrient components	Unit	Required intake					
		Male head of household	Female head of household	Adult male	Adult female	Children 10–18 Years	Children 1–9 years
Energy	kcal/day	3525.00	2850.00	2725.00	2300.00	2100.00	1650.00
Carbohydrate	g/day	430.00	360.00	430.00	340.00	350.00	220.00
Protein	g/day	75.00	60.00	70.00	60.00	65.00	40.00
Total lipid	g/day	75.00	70.00	80.00	70.00	50.00	50.00
Calcium (Ca)	g/day	850.00	850.00	800.00	800.00	900.00	500.00
Iron (Fe)	g/day	27.40	58.80	27.00	58.00	29.00	11.60
Zinc (Zn)	g/day	15.00	43.00	36.00	36.00	61.00	138.00
Vitamin A	IU/day	686.00	600.00	300.00	270.00	330.00	200.00
Vitamin C	µg/day	43.00	45.00	45.00	45.00	35.00	30.00
Vitamin D	µg/day	10.00	10.00	10.00	10.00	5.00	5.00
Vitamin B12	µg/day	2.00	2.00	2.00	2.00	2.00	1.50
Folate acid	µg/day	320.00	320.00	320.00	320.00	330.00	250.00
Thiamine	g/day	1.20	1.20	1.10	1.10	1.10	0.50
Magnesium	g/day	260.00	220.00	220.00	220.00	220.00	60.00
Riboflavin	g/day	1.30	1.30	1.30	1.10	1.00	0.50

The daily intake of food components required is the minimum intake and maximum limit that does not pose a risk or adverse impact on health according to WHO standards, FAO 2004, and Indonesian Minister of Health Regulation No.29 of 2019 (FAO and WHO, 2004; Minister of Health, 2019).
The dietary model that has been prepared meets WHO recommendations for macronutrients, protein (10–15% of all calories), fat (15–30% of all calories), carbohydrates (less than 75% of all calories), and micronutrients. (FAO/WHO/UNU, 2001; FAO, 2000; WHO and FAO, 2003).
The dietary model that has been prepared meets WHO recommendations for macronutrients, protein (10–15% of all calories), fat (15–30% of all calories), carbohydrates (less than 75% of all calories), and micronutrients (FAO, 2021; FAO and WHO, 2004).

Furthermore, the cost of cheap and nutritious food menus is arranged based on the composition of the nutritional content that has been obtained (**Table 5**) to meet the standard nutritional requirements for cheap food offerings for various sizes of farming households that have been identified and what prices are required for each size of household (**Table 6**) to meet the recommended nutritional intake standard food menu for farming households in national coffee development areas. Household size greatly influences the cost of household food needs.

Table 6. Cost of cheap and healthy food menus for the needs of coffee farming family groups.

Age group and gender of household members*	Cost of food (IDR/day)	Cost food (USD/day)
Adult (1M), child (2)	53,468	3.56
Adult (1M–1F)	41,766	2.78
Adult (1M–1F), child (1)	55,772	3.72
Adult (1M–1F), child (2)	69,779	4.65
Adult (1M–1F), child (3)	83,785	5.59
Adult (1M–2F)	58,077	3.87
Adult (1M–2F), child (1)	72,083	4.81
Adult (1M-2F), child (2)	102,400	6.83
Adult (1M–3F)	74,388	4.96
Adult (1M–3F), child (2)	102,400	6.83
Adult (2M–1F)	61,933	4.13
Adult (2M–1F), child (1)	75,939	5.06
Adult (2M–1F), child (2)	95,234	6.35
Adult (2M–1F), child (3)	109,240	7.28
Adult (2M–2F)	83,532	5.57
Adult (2M–2F), child (1)	97,538	6.50
Adult (2M–2F), child (2)	111,544	7.44
Adult (2M–3F)	99,843	6.66
Adult (2M-3F), child (2)	127,855	8.52
Adult (2M–4F)	116,153	7.74
Adult (2M–4F), child (2)	144,166	9.61
Adult (3M–1F)	87,388	5.83
Adult (3M–1F), child (1)	101,394	6.76
Adult (3M–2F)	103,699	6.91
Adult (3M–3F)	120,009	8.00
Adult (4M–1F)	107,555	7.17
Adult (1F), child (1)	33,672	2.24
Adult (1F), child (2)	47,679	3.18
Adult (2F)	35,977	2.40
Adult (2F), child (2)	63,990	4.27

*Adult Male (M) dan Female (F), 1 USD equivalent to 15,000 IDR.

Table 7. Average composition of coffee farming households.

Age group and gender	Average family size	Cost of food (IDR/day)	Cost food (USD/day)
Adult male	1.60	32,267	2.15
Adult female	1.80	29,360	1.96
Children under < 18 years old	1.07	14,940	1.00
Household size	4.47	76,567	5.10

We present data on food costs for the average household size (**Table 7**) in national coffee development areas. The average household size of coffee farmers is

4.47, or around 4 to 5 people in one household, with an average food cost of 76,567 IDR (5.10 USD) per day.

3.3.2. Housing costs

Estimated housing costs for houses that meet local minimum standards for adequate housing for farming households include construction costs within one year, routine repair costs, land and building taxes, building rent, water, electricity, and gas requirements (**Table 8**). We do not provide assumed values for estimating costs incurred by housing as established by some researchers. If unclear, researchers estimate routine maintenance and repair costs at 0.3% (Ven et al., 2021). Obtain information on housing needs through interviews with respondents to obtain valid data.

Table 8. Estimated housing costs for houses that meet local minimum standards for adequate housing for coffee farming households in the Bantaeng regency coffee development area.

Cost variables	Unit	Housing costs	
		(IDR)	(USD)
Construction costs and routine repairs	Household/year	7,500,000	500.00
Property taxes	Household/year	150,000	10.00
Water	Household/year	Free	Free
Electricity	Household/year	1,140,000	76.00
Gas	Household/year	528,000	35.20
Total housing costs	Household/year	9,310,000	621.20
Total housing costs	Household/day	25,883	1.73

Source: data from field surveys with a sample size (*n*) of 319 coffee farming households in the national coffee development area of Bantaeng regency 2023.

3.3.3. Non-food household expenses

Non-food household needs are calculated separately from housing. Usually, the costs incurred by these needs fluctuate in nature, influenced by the size of the conditions or usage of family members at a certain time. These costs cover needs arising from routine household costs such as washing soap, toothpaste, shampoo, use of credit or data packages, clothes, and cigarettes (**Table 9**).

Table 9. Estimated costs of non-food household needs for coffee farming households in the national coffee development area.

Variable Costs[1]	IDR/household/month	USD/household/month
Transportation	16,100	1.07
Clothing, footwear and headgear[3]	33,500	2.23
Communication and Internet data	95,000	6.33
Costs for routine household needs[2]		
Toothpaste (75 g)	5500	0.37
Laundry soap (1.015 mL)	17,500	1.17

Table 9. (*Continued*).

Variable Costs[1]	**IDR/household/month**	**USD/household/month**
Bath soap (75 g)	5000	0.33
Kitchen utensil soap (210 mL)	5000	0.33
Shampoo (150mL)	15,000	1.00
Variable Costs[1]	IDR/household/month	USD/household/month
Total costs other than housing and food	192,600	12.84
Total costs other than housing and food per day	6420	0.43

[1] Non-food household costs are determined based on primary data from a survey of coffee farming households.
[2] Using standard needs for average family size (4 people) based on primary data from survey results.
[3] Standard population expenditure based on 2021 BPS data (BPS-Statistics Indonesia, 2021).

3.3.4. Healthcare costs

Healthcare costs are costs that include all annual household expenditures to cover essential health services based on services available locally. If basic health insurance is available, it is assessed as a form of coverage with coverage that still needs to be identified. If insurance is not available or only part of it is covered. Additional assessments are needed to estimate the costs of health services not covered by insurance. We assess that the local health services that apply in the identified study areas are government insurance services generally required at the national level and managed na

tionally by the Badan Penyelenggara Jaminan Sosial (BPJS), or Social Security Administration Agency. The determination of health insurance contributions is classified based on the economic strata of the community. Three types of contributions are mandatory, namely work accident insurance, death insurance, and old age insurance, with a total monthly expenditure of 36,800 IDR /person, which applies to all ages (**Table 10**).

Table 10. Estimated annual health costs for coffee farming households in the Bantaeng regency coffee development area in 2023.

Health costs	**Costs**	
	IDR/capita/month	**USD/capita/month**
Health insurance costs[1]	36,800	2.45
Doctor consultation	Covered by BPJS	Covered by BPJS
Medicine	Covered by BPJS	Covered by BPJS
Total monthly health costs	165,600	11.04
Total household health costs per day[2]	5520	0.37

[1] Work accident insurance 10,000 IDR, Death insurance 6800 IDR and old age insurance 20,000 IDR, Fees can be seen in Appendix Indonesian Government Regulations No. 44 of 2015 and attachment to Government Regulations No. 46 of 2015.
[2] Daily household health costs are obtained from the value of per capita health costs multiplied by the average number of dependents of coffee farming families.

3.3.5. Education costs

In Indonesia, primary education is not always free, even though it is stated in Article 26 of the International Declaration of Human Rights and the Constitution of the Republic of Indonesia that education is part of human rights. We have confirmed that the public schools in the research locations provide adequate quality education. Information regarding education costs was obtained from primary data through interviews with household informants who had school children. Then, we verified these findings with several key informants who were educational experts. Education is considered a human right in today's world. The right to education is part of the 1948 UN Declaration of Human Rights, the 1959 Declaration of the Rights of the Child, and the 1966 International Covenant on Economic, Social, and Cultural Rights (UN General Assembly, 1984). Therefore, postal checks are carried out to ensure that sufficient funds are included in non-food non-housing (NFNH) costs, and therefore, in living wages, so that workers can send their children to school (Anker and Anker, 2017).

Table 11. Estimated education costs for coffee farming households in the Bantaeng regency coffee development area in 2023.

Level of education	Cost variable	Unit	Cost (IDR)	Cost (USD)
Elementary School	Uniform	Rp/child/year	500,000	33.33
	Material SS[1]	Rp/child/year	1,200,000	80.00
	School fees	Rp/child/year	free	free
	Duration	year	1,700,000	113.33
Junior high school	Uniform	Rp/child/year	750,000	50.00
	Material SS[1]	Rp/child/year	900.000	60.00
	School fees	Rp/child/year	free	free
	Duration	year	1,650,000	110.00
High School	Uniform	Rp/child/year	750,000	50.00
	Material SS[1]	Rp/child/year	1,500,000	100.00
	School fees	Rp/child/year	free	free
	Duration	year	2,250,000	150.00
Total cost per child			5,600,000	373.00
Average cost of children per household			1.00	1.00
Average cost of a child per year			5,600,000	373.33
Total monthly education costs			466,667	31.11
Total daily education costs			15,556	1.04

[1] SS (School Stationery) covers stationery costs. books and school equipment/supplies.
Source: Results of price benchmarking survey data processing.

The education costs calculated in this study include all annual household expenses to finance basic education, junior high school, and post-secondary appropriate undergraduate education for all children in sample households. The national education system that applies regionally and nationally in Indonesia has a mandatory education period of 12 years, including six years of primary school

education, three years of junior high school education, and three years of senior high school education. In most countries, education is mandatory from ages 5 to 7 to ages 11 to 18, which roughly includes primary and lower secondary school (UNESCO, 2000).

We compiled household education expenditure referring to the national education system with a length of education of 12 years, namely up to high school. Household expenses for children's school need only include parents' responsibility to meet children's basic needs, such as school fees. Clothing/uniforms and stationery. A child's education costs are then assessed and divided over 12 years. Thus, producing an average annual education cost per child. Next, these results are converted into daily unit costs for each child (**Table 11**).

The level of participation of farming communities in education in this study is relatively low. On average, most of the farming community only completed primary and secondary education levels, and only a small number, namely 8%, continued to tertiary level. The low level of household school participation affects household expenditure data. When many children are not in school, household survey expenditure data shows low general household expenditure. With low education and limited farming skills, households do not have viable employment options (Nguyen, 2021).

3.3.6. Social costs

We take into account social expenditure in this research. This social expenditure includes social donations for various activities such as weddings, deaths, birth events, mosque donations, and donations for disaster events. The community's habit of setting aside part of its wealth for social needs is driven by a high sense of humanity and based on religious beliefs, which suggests that providing assistance in the form of property to those in need is part of religious recommendations whose practice is guaranteed by the creator. The survey results show that the average social expenditure of coffee farming households in this area was 2160 IDR (0.4 USD) per day (**Table 12**). This condition may be different from several other coffee-producing countries; the coffee farming community, the majority of which are Muslim, is the driving factor for the significant allocation of social expenditure in this region.

Table 12. Estimated social costs for coffee farming households in the Bantaeng regency coffee development area in 2023.

Social costs	Cost (IDR)	Cost (USD)
Donations to mosques, disasters, and donations for deaths, marriages, and births of relatives	64,700	4.32
Total monthly social costs	64,700	4.32
Total social costs per day	2160	0.14

Source: data from field surveys with a sample size (*n*) of 319 coffee farming households in the coffee development area of Bantaeng regency 2023.

3.3.7. Agricultural business costs

We include expenditure on agricultural costs in calculating household living income. Farmers are different from workers in industry and agricultural workers who are paid wages. The need to address social injustice in international supply chains for

essential agricultural commodities such as tea and coffee has become critical, leading to an increased focus on living wages for plantation workers (Impact Institute, 2020).

Coffee farmers still bear the burden of production factor costs as part of household expenses, while those who work in companies do not bear these costs. We set the standard for expenditure on coffee farming activities as the standard for spending on agricultural business for farmer households in this region (**Table 13**). This production factor cost requirement standard refers to the standard set by the government through a Ministry of Agriculture regulation regarding guidelines for good coffee cultivation.

Table 13. Estimated agricultural business costs for coffee farming households in the Bantaeng regency coffee development area in 2023.

Types of fertilizer[3]	**Requirements (kg/year)[1]**	**Unit price (IDR)[2]**	**Unit price (USD)[2]**	**Cost (IDR)[2]**	**Cost (USD)**
Inorganic fertilizer					
Urea (government subsidy)	723.20	2400	0.16	1,735,680	115.71
Types of fertilizer[3]	Requirements (kg/year)[1]	Unit price (IDR)[2]	Unit price (USD)[2]	Cost (IDR)[2]	Cost (USD)
SP 36	361.60	3000	0.20	1,084,800	72.32
KCL	452.00	20,000	1.33	9,040,000	602.67
Dolomite	253.12	3400	0.23	860,608	57.37
Total costs per month				1,060,091	70.67
Total cost per day				35,336	2.36

The basis for the determination uses existing farmer data from the average farmer's land area of 1.13 ha.
[1] Fertilization for coffee plantation cultivation is carried out twice a year at the beginning and end of the rainy season.
[2] Unit prices are based on the results of a survey of existing prices in 2023 at markets where farmers usually buy agricultural needs.
[3] Fertilizer requirements refer to the standards of Minister of Agriculture No. 49 of 2014 concerning GAP of Coffee with an estimated 1600 trees in 1 ha of land.

Adoption of good agricultural practices, maximizing efficiency, and diversifying income sources are equally relevant levers for optimizing agricultural yields and increasing income resilience and can contribute if implemented well and conditions such as access to inputs, finance, and others are in place to increase farmer income. However, even when full-time farmers have reached their full productivity potential, current market prices are often too low to provide a viable level of income. Calculating reference prices serves to estimate the farm-gate costs required for producers to reach specific income benchmarks (Loos et al., 2022).

3.3.8. Living income for coffee farming households in the case study area

This study estimates that the standard cost of living for a household in a coffee plantation area in Bantaeng Regency is 5,023,200 IDR (334.80 USD) per month, assuming an average household size of 4.47 for a typical family consisting of two adults and two adults or three children. This standard represents the general average size of farming households with an average number of working adults of 1.45. The average land cultivation area is 1.13 ha. This family income must cover the costs of food (45.7%) and housing (15.5%). Non-food and non-housing (3.8%), health costs

(3.3%), education costs (9.3%), social costs (1.3%), and agricultural business costs (21.1%) (**Table 14**).

Household living costs describe the standard of living income that must be met by coffee farming households in the study location. If the number of people working in the household is 1.45, then the average minimum wage must be earned is 5,023,200 IDR (334.80 USD) or 3,464,307 IDR (230.95 USD) for one worker in a household; this standard is far above the minimum wage standard set by the provincial government, which is 3,385,145 IDR (225.68 USD), as well as the district regional minimum wage, which is 3,384,876 IDR (225.66 USD).

Table 14. Decent living income standards for coffee farming households in the Bantaeng regency coffee development area in 2023.

Cost item	IDR/ household/month	USD/household/month	(%)
Food	2,297,000	153.13	45.7
Housing costs	776,500	51.77	15.5
Non-housing and food costs	192,600	12.84	3.8
Health Costs	165,600	11.04	3.3
Cost of education	466,600	31.11	9.3
Social costs	64,780	4.32	1.3
Agricultural business costs	1,060,090	70.67	21.1
The total cost of living is decent	5,023,200	334.80	100
Standard of living income/capita/day	37,487	2.50	
Standard net living income/household/month[1]	3,464,307	230.95	
Extreme poverty line[2]	32,250	2.15	
Poverty line[3]	54,750	3.65	
Provincial minimum wage[4]	3,385,145	225.68	
Regional minimum wage[5]	3,384,876	225.66	

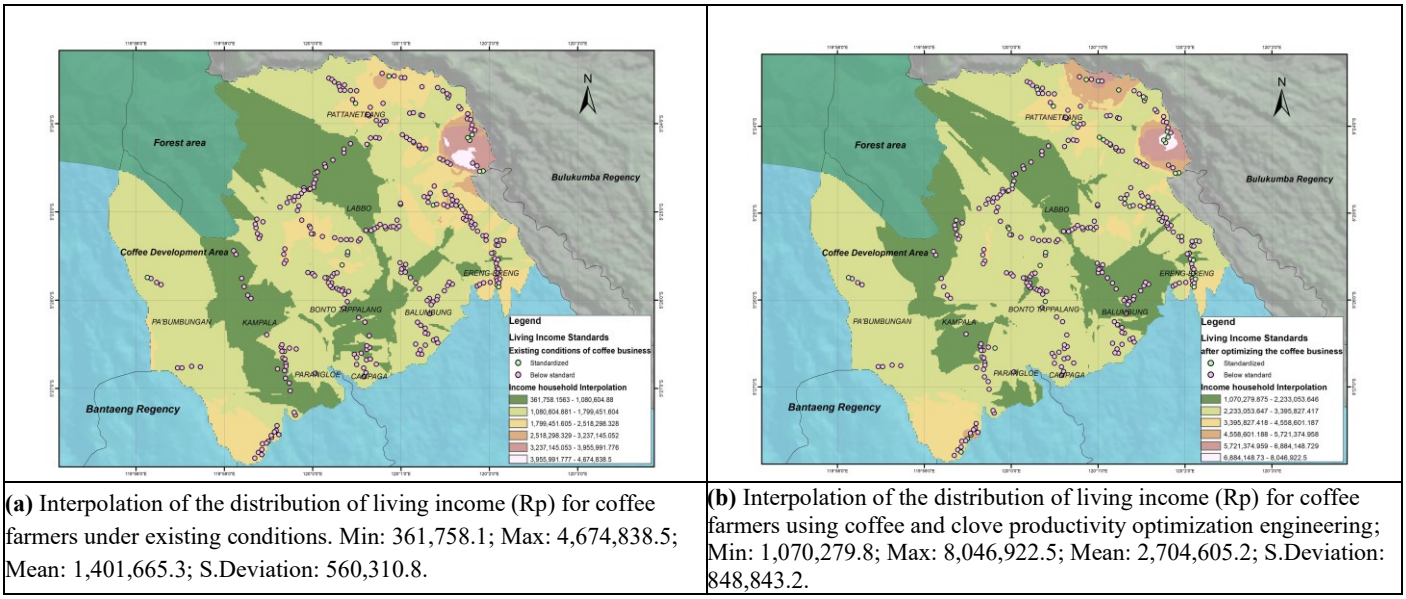
[1] Family size uses the local average family size of 4.47 with an average number of workers in the family of 1.45.
[2] The extreme poverty figure in Indonesia still uses purchasing power parity (PPP) as a reference of 2.15 USD per day (exchange rate of 15,000 IDR per USD) (Jolliffe et al., 2022).
[3] Meanwhile, lower middle-income countries already use a base measure of 3.65 USD per person per day.
[4] South Sulawesi province's minimum wage is 225.68 USD in 2023.
[5] Regional minimum wage for Bantaeng regency is 225.66 USD in 2023.

In practice, calculating income gaps also faces many obstacles from conceptual and methodological aspects. Because the calculation of net income from various sources for farming households still needs to be validated, the data is incomplete and unavailable for all households. Net income from coffee is also difficult to estimate due to poor record keeping by farmers, especially regarding production costs. Annual income is only estimated by exploring the net income calculated from coffee production from ownership of a number of productive coffee trees, which is reported as income derived from coffee sales. These annual income estimates do not include the value of crops consumed at home.

Table 15. Decent living income standards for coffee farming households at 29 household sizes in the Bantaeng regency coffee development area in 2023.

Household size*	Standard household living income/ month		Standard of net living income/ capita/month		Standard of living income/ capita/day		Description
	IDR	USD	IDR	USD	IDR	USR	
Adult (1M), child (2)	4,674,917	311.7	4,674,917	311.7	51,943.52	3.5	**
Adult (1M–1F)	3,430,814	228.7	3,329,908	222.0	57,180.23	3.8	***
Adult (1M–1F), child (1)	4,765,027	317.7	4,462,486	297.5	52,944.75	3.5	**
Adult (1M–1F), child (2)	5,791,814	386.1	4,923,042	328.2	48,265.12	3.2	**
Adult (1M-1F), child (3)	6,362,762	424.2	5,090,209	339.3	42,418.41	2.8	**
Adult (1M–2F)	4,547,711	303.2	3,731,455	248.8	50,530.12	3.4	**
Adult (1M–2F), child (1)	5,521,493	368.1	5,153,394	343.6	46,012.44	3.1	**
Adult (1M–2F), child (2)	7,122,413	474.8	4,383,024	292.2	47,482.76	3.2	**
Adult (1M-3F)	4,710,526	314.0	2,944,079	196.3	39,254.38	2.6	**-***
Adult (1M–3F), child (2)	8,492,048	566.1	3,639,449	242.6	47,178.04	3.1	**
Adult (2M–1F)	4,461,974	297.5	3,470,424	231.4	49,577.49	3.3	**
Adult (2M–1F), child (1)	5,499,361	366.6	5,499,361	366.6	45,828.01	3.1	**
Adult (2M–1F), child (2)	6,271,356	418.1	3,762,814	250.9	41,809.04	2.8	**
Adult (2M–1F), child (3)	6,831,703	455.4	6,831,703	455.4	37,953.90	2.5	**
Adult (2M–2F)	5,006,051	333.7	3,465,728	231.0	41,717.09	2.8	**
Adult (2M–2F), child (1)	5,661,806	377.5	3,774,537	251.6	37,745.37	2.5	**
Adult (2M-2F), child (2)	6,752,198	450.1	4,501,466	300.1	37,512.21	2.5	**
Adult (2M–3F)	6,896,814	459.8	3,448,407	229.9	45,978.76	3.1	**
Adult (2M–3F), child (2)	7,423,857	494.9	4,454,314	297.0	35,351.70	2.4	**
Adult (2M–4F)	5,745,117	383.0	1,915,039	127.7	31,917.32	2.1	*-**-***
Adult (2M–4F), child (2)	8,307,534	553.8	8,307,534	553.8	34,614.73	2.3	**
Adult (3M–1F)	5,227,740	348.5	3,619,205	241.3	43,564.50	2.9	**
Adult (3M–1F), child (1)	6,498,348	433.2	3,713,342	247.6	43,322.32	2.9	**
Adult (3M–2F)	5,422,358	361.5	1,084,472	72.3	36,149.05	2.4	**-***
Adult (3M–3F)	6,390,842	426.1	1,065,140	71.0	35,504.68	2.4	**-***
Adult (4M–1F)	5,877,267	391.8	1,175,453	78.4	39,181.78	2.6	**-***
Adult (1F), child (1)	4,015,110	267.7	2,007,555	133.8	66,918.50	4.5	**-***
Adult (1F), child (2)	4,448,246	296.5	1,482,749	98.8	49,424.96	3.3	**-***
Adult (2F)	3,172,340	211.5	1,586,170	105.7	52,872.34	3.5	**-***
Adult (2F), child (2)	4,536,855	302.5	1,134,214	75.6	37,807.13	2.5	**-***
(d) Extreme poverty line[1]	32,250 IDR		2.15 USD				
(e) Poverty line[2]	54,750 IDR		3.65 USD				
(f) Provincial minimum wage[3]	3,385,145 IDR		225.6 USD				
(g) Regional minimum wages[4]	3,384,876 IDR		225.6 USD				

*Adult F (Female), M (Male).
[1] The extreme poverty figure in Indonesia still uses a purchasing power parity (PPP) reference of 2.15 USD per day (exchange rate of 15,000 IDR per USD).
[2] Lower middle income countries already use a base measure of 3.65 USD per person per day, World Bank.
[3] South Sulawesi province's minimum wage is 225.68 USD in 2023.
[4] Regional minimum wage for Bantaeng regency is 225.66 USD in 2023.
* Below the extreme poverty line, **below the poverty line, ***below provincial and regional minimum wages.



(a) Interpolation of the distribution of living income (Rp) for coffee farmers under existing conditions. Min: 361,758.1; Max: 4,674,838.5; Mean: 1,401,665.3; S.Deviation: 560,310.8.

(b) Interpolation of the distribution of living income (Rp) for coffee farmers using coffee and clove productivity optimization engineering; Min: 1,070,279.8; Max: 8,046,922.5; Mean: 2,704,605.2; S.Deviation: 848,843.2.

Figure 4. Interpolation of the spatial distribution of projections of the feasibility of living income for coffee farming households under existing conditions and engineering to increase the optimization of coffee and clove productivity.

We present data comparing the feasibility of a living income for coffee farmers under existing conditions and conditions when their coffee productivity is optimized (**Figure 4**). The results show that as many as 96.6% of coffee farming households in the national coffee development area are in an inadequate living income condition, and only 3.4% are at an adequate level (**Table 15**). Next, we tried to look at trends in conditions of the productivity of coffee and clove plants as farmers optimized the main crops. The results showed that as many as 86% of farming households were in an inadequate living income condition, and 13.3% were in a decent condition. These findings indicate that optimizing the productivity of coffee and clove plants can only increase 9.7% of coffee farming households with a decent living income. We consider this not enough to impact expanding the number of coffee farming households living in decent conditions. Household income is a significant determining factor in meeting household living needs, and this will be correlated with reduced food intake and low nutritional status of household members (De Cock, 2012; Dil Farzana et al., 2017; Tambe et al., 2023).

4. Discussion

As a developing country, Indonesia has also set a minimum wage as a reference for a decent income at the national, regional, and local levels. However, this benchmark is still very biased towards being applied equally to all levels of workers. Calculating the standard of living for farmers is different from the standard of living for those who work in companies. Farming households are small businesses that depend on land cultivation to support their household income. The family will bear the costs of production factors resulting from land exploitation activities because their land is their life.

We found that the current condition of agricultural land management in the study area does not guarantee a decent income, even though efforts have been made to maximize the productivity of agricultural crops, so it needs to be a concern for the

government to take concrete steps in establishing better national agricultural area development policies in the future.

Several factors that influence this condition need to be studied further. We observe a tendency for the system of distributing family inherited land that has been carried out from generation to generation to cause the land ownership of farming households to become increasingly narrow. Apart from that, farmers' low knowledge regarding good coffee cultivation methods and a lack of capital resources means that land cultivation is still not optimal, the biophysical conditions of old coffee plants also provide poor productivity and relatively low selling prices at the farmer level. High and sustainable commodity prices can contribute to increasing agricultural income (Nigatu et al., 2020).

Raising agricultural commodity prices is perhaps the easiest way to increase the income of small farmers. However, determining an appropriate price for coffee farmers is difficult to achieve under ideal conditions. Various political business policies, market chain conditions that tend to be exclusive, and the impact of climate change which has begun to be felt affecting the seasons in recent years, are real challenges that vulnerable groups are thinking about (Birkmann et al., 2022).

Off-farm livelihood diversification is also an alternative option to increase the income of farming households to escape poverty status (Ho et al., 2024), but it also has real risks to the sustainability of agricultural activities. Farmers are slowly starting to spend less time looking after their farms, meaning that if off-farm livelihoods are more productive, it will be a logical reason for farmers to abandon their farming business. We encourage steps to diversify on-farm livelihoods through the diversification of productive intercrops and the development of integrated livestock businesses that will be better for farmers to carry out. Next, optimize land cultivation with a sustainable cultivation system, selecting plants that are biophysically suitable, socially acceptable, and economically feasible to cultivate. so that it can support increasing farmer income.

We highlight that agricultural policy planning in Indonesia currently only focuses on increasing agricultural productivity, but increasing productivity does not guarantee benefits that always favor farmers. Government planning policies through the development of national agricultural areas in the future must emphasize achieving a decent standard of living for farming households as beneficiaries of each program. Farmers as the main subject play an important role in managing land resources. Central government policy through the Ministry of Agriculture must synergize with regional governments in formulating technical policies that adapt to regional conditions (Ulya et al., 2023).

5. Conclusion

The decent income methodology is a straightforward concept for determining a decent income for certain worker communities, especially for small farmer workers in rural areas who dominate the type of work in Indonesia. This methodology provides a more representative benchmark to reflect the conditions of the study area to assess development opportunities for rural households. Furthermore, the interpolation and socio-spatial data provides a more specific picture of the conditions

of farmer households, contributing to new studies in the social field. We acknowledge the challenge that collecting spatial data requires substantial resources and time. We also recommend using trained enumerators to obtain representative social data.

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References

Adjimoti, G. O., & Kwadzo, G. T.-M. (2018). Crop diversification and household food security status: evidence from rural Benin. Agriculture & Food Security, 7(1). https://doi.org/10.1186/s40066-018-0233-x

Agidew, A. A., & Singh, K. N. (2018). Determinants of food insecurity in the rural farm households in South Wollo Zone of Ethiopia: the case of the Teleyayen sub-watershed. Agricultural and Food Economics, 6(1). https://doi.org/10.1186/s40100-018-0106-4

Anker, R. (2011). Estimating a living wage: A methodological review. ILO: Conditions of Work an Employment Series No. 29, 29, 1-126.

Anker, R., & Anker, M. (2017). Living Wages Around the World. Edward Elgar Publishing. https://doi.org/10.4337/9781786431462

Awoke, W., Eniyew, K., Agitew, G., et al. (2022). Determinants of food security status of household in Central and North Gondar Zone, Ethiopia. Cogent Social Sciences, 8(1). https://doi.org/10.1080/23311886.2022.2040138

Bhattacharyya, M. (2019). Using the Anker Methodology for Living Income. Available Online: https://www.globallivingwage.org/about/anker-methodology/ (accessed on 23 December 2023).

Birkmann, J., Liwenga, E., Pandey, R., et al. (2022). Poverty. Livelihoods and Sustainable Development. Available online: https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-8/ (accessed on 23 December 2023).

BMZ. (2020). Why working together is the way to a living income. Available Online: https://www.globalcause.co.uk/world-food-day/why-working-together-is-the-way-to-a-living-income/. (accessed on 23 December 2023).

Bongaarts, J. (2001). Household size and composition in the developing world in the 1990s. Population Studies, 55(3), 263–279. https://doi.org/10.1080/00324720127697

Boucek, B., & Moran, E. F. (2004). Inferring the Behavior of Households from Remotely Sensed Changes in Land Cover: Current Methods and Future Directions. Spatially Integrated Social Science, 23–47. https://doi.org/10.1093/oso/9780195152708.003.0002

BPS. (2022). Bantaeng Regency in 2022 figures. Available online: https://bantaengkab.bps.go.id/publication.html. (accessed on

10 November 2023).
BPS-Statistics Indonesia. (2021). Welfare Indicators 2021. Available online: https://www.bps.go.id/en/publication/2021/11/30/d34268e041d8bec0b25ba344/welfare-indicators-2021.html. (accessed on 21 December 2023).
De Cock, N. (2012). A comparative overview of commonly used food security indicators, case study in the Limpopo Province, South Africa. Faculty of Bioscience Engineering. 2012. Masters, 2-116.
Debebe, S., & Zekarias, E. H. (2020). Analysis of poverty, income inequality and their effects on food insecurity in southern Ethiopia. Agriculture & Food Security, 9(1). https://doi.org/10.1186/s40066-020-00269-3
ESRI. (2023). Kriging (Spatial Analyst). Available online: https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/kriging.htm (accessed on 13 January 2024).
ESRI. (2024). GIS Dictionary. Available online: https://support.esri.com/en-us/g. (accessed on 26 December 2023).
FAO, & WHO. (2004). Vitamin and mineral requirements in human nutrition Second edition. World Health Organization, 1-20. https://doi.org/92 4 154612 3
FAO. (2000). Food Insecurity in the World 2000. Available online: https://www.fao.org/agrifood-economics/publications/detail/en/c/122102/ (accessed on 13 January 2024).
FAO. (2021). The State of Food and Agriculture 2021. FAO. https://doi.org/10.4060/cb4476en
FAO/WHO/UNU. (2001). Human energy requirements. Available online: https://openknowledge.fao.org (accessed on 23 December 2023).
Farzana, F. D., Rahman, A. S., Sultana, S., et al. (2017). Coping strategies related to food insecurity at the household level in Bangladesh. PLOS ONE, 12(4), e0171411. https://doi.org/10.1371/journal.pone.0171411
Gebre, G. G., Isoda, H., Amekawa, Y., et al. (2021). What Explains Gender Gaps in Household Food Security? Evidence from Maize Farm Households in Southern Ethiopia. Social Indicators Research, 155(1), 281–314. https://doi.org/10.1007/s11205-020-02600-8
Grillo, J. (2018). From Living Wage to Living Income: Considerations for the use of the Anker methodology for calculating living wages to inform living income estimates. Available online: https://www.nachhaltige-agrarlieferketten.org (accessed on 23 January 2024).
Ho, N. N., Lai, P. T., Anh Truong, T. C., et al. (2024). The contribution of livelihood diversification activities to poverty reduction of ethnic minority households: A case study in Son La Province, Vietnam. Journal of Infrastructure, Policy and Development, 8(6), 6465. https://doi.org/10.24294/jipd.v8i6.6465
IFAD. (2021). Rural development report 2021 - Transforming food systems for rural prosperity. Available online: https://ageconsearch.umn.edu/rec (accessed on 22 January 2024).
Impact Institute. (2020). Estimating farmer household income. Available online: https://www.impactinstitute.com (accessed on 20 January 2024).
Indonesian Ministry of Agriculture. (2020). Ministry of Agriculture strategic plan for 2020-2024. Kementerian Pertanian RI.
Jemaneh, S. A., & Shibeshi, E. M. (2023). Women empowerment in agriculture and its effect on household food security: evidence from Gamo Zone of Southern Ethiopia. Agriculture & Food Security, 12(1). https://doi.org/10.1186/s40066-023-00437-1
Johnny, F. I. (2021). A case study of income estimation using secondary data: Cashew smallholder income baseline, Tanzania. 1-4. Available online: https://www.fairtrade.net/ (accessed on 25 January 2024).
Jolliffe, D. M., Mahler, D. G., Lakner, C., et al. (2022). Assessing the Impact of the 2017 PPPs on the International Poverty Line and Global Poverty. Policy Research Working Papers. https://doi.org/10.1596/1813-9450-9941
Komives, K., Alliance, I., Grunze, S., et al. (2017). U.S. Organic Grains Report. Available online: https://sustainablefoodlab.org/wp-content/u (accessed on 25 January 2024).
Loos, K., Krain, E., Veldhuyzen, C., & Petri, A. (2022). How to calculate (living income) reference prices of agricultural commodities (Issue October). Available online: https://www.living-income.com/tools-resources/publications (accessed on 25 January 2024)
Miller, H. J., & Goodchild, M. F. (2014). Data-driven geography. GeoJournal, 80(4), 449–461. https://doi.org/10.1007/s10708-014-9602-6
Minister of Health. (2019). Republic of Indonesia Minister of Health Regulation No. 28 of 2019 Concerning recommended nutritional adequacy figures for Indonesian society. Minister of Health of the Republic of Indonesia.

Nguyen, T. T. (2021). Conversion of land use and household livelihoods in Vietnam: A study in Nghe An. Open Agriculture, 6(1), 82–92. https://doi.org/10.1515/opag-2021-0010

Nigatu, G., Badau, F., Seeley, R., & Hansen, J. (2020). Factors Contributing to Changes in Agricultural Commodity Prices and Trade for the United States and the World. Economic Research Report.

O'Sullivan, D. (2002). Toward micro-scale spatial modeling of gentrification. Journal of Geographical Systems, 4(3), 251–274. https://doi.org/10.1007/s101090200086

Tambe, B. A., Mabapa, N. S., Mbhatsani, H. V., et al. (2023). Household socio-economic determinants of food security in Limpopo Province of South Africa: a cross sectional survey. Agriculture & Food Security, 12(1). https://doi.org/10.1186/s40066-023-00424-6

Ulya, N. A., Harianja, A. H., Sayekti, A. L., et al. (2023). Coffee agroforestry as an alternative to the implementation of green economy practices in Indonesia: A systematic review. AIMS Agriculture and Food, 8(3), 762–788. https://doi.org/10.3934/agrfood.2023041

UN General Assembly. (1984). Universal declaration of human rights. UN General Assembly, 14-25.

UNDESA. (2022). The Sustainable Development Goals Report 2022. Available online: https://unstats.un.org/sdgs/report/2022/. (accessed on 28 January 2024).

van de Ven, G.W.J., de Valença, A., Marinus, W. et al. (2021). Living income benchmarking of rural households in low-income countries. Food Sec. 13, 729–749. https://doi.org/10.1007/s12571-020-01099-8.

World Education Report. (2000). The right to education: Towards education for all throughout life. UNESCO Publishing.

Yao, C., Parker, J., Arrowsmith, J., et al. (2017). The living wage as an income range for decent work and life. Employee Relations, 39(6), 875–887. https://doi.org/10.1108/er-03-2017-0071

Zimmermann, M. (1994). Diet, Nutrition, and the Prevention of Chronic Diseases. The American Journal of Clinical Nutrition, 60(4), 644–645. https://doi.org/10.1093/ajcn/60.4.644a