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PROBIT ESTIMATION MODEL: INFLUENCE OF SOCIO-ECONOMIC FACTORS ON THE PROBABILITY OF FARMERS' HOUSEHOLD FOOD SECURITY LEVEL

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SUMMARY

Food security is one of the global strategic issues in a country's development. This research conducted in Bone Regency, Indonesia, analyzes the influence of socio-economic factors on the probability of food security in farmer households. The research method used is quantitative with cross-sectional data and model analysis with ordered probit estimation with the Maximum Likelihood Estimation (MLE) method. The research location was chosen by purposive sampling, considering that this location is still classified as food insecure based on the Bone District Food Security and Vulnerability Atlas (FSVA) Report. The sampling technique was accidental sampling, with 84 farmer households. The findings indicate that the probability of the food security level of farmer households is positively influenced by certain socio-economic conditions, including household income and education level, while other socio-economic factors, such as the age of the household head and the number of family members, have no significant effect. Special attention to variables that have no significant effect is expected to increase the chances of food security in farmer households. There is a need to provide and support access to information on the importance of food security and economic opportunities for many family members. Likewise, food support is protection against food insecurity for household heads who are no longer at productive age.

Key words:
probit estimation, socio-economic factors, food security, farmer household

INTRODUCTION

The concept of food security is an aspect of food availability or adequacy of food quantity, food security, food equity, and food affordability or household convenience to obtain food at affordable prices (Abdullah et al., 2019). The concept of food security has been contained in various definitions stated by Peng & Berry (2019): *food security* is defined as a situation that occurs when everyone, at all times, has physical, social and economic access to sufficient, safe and nutritious food to have active and healthy lives. Food security is also at the center of the global social policy and sustainable development agenda (Rohr et al., 2021), and it is one of the strategic issues in a country's development, especially culturally, which means that every member of the household can live a healthy life (Abdullah et al., 2019).

Sustainability is essential for food nutrition security policies that require long-term processes to achieve impact (Escobar-Alegria et al., 2022). Sustainability involves ecology, biodiversity and supra-national/regional climate change indicators, and socio-cultural and economic factors (Berry et al., 2015). These indicators will affect the food security of future generations. More recent developments emphasize the importance of food sustainability, which can be considered a long-term dimension of food security (Peng & Berry, 2019). Furthermore, Peng & Berry (2019) said

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that four dimensions of food security had been identified at different levels, including (1) national availability, (2) accessibility to households, (3) individual utilization, and (4) stability, which can be thought of as a time dimension that affects all levels. These four dimensions must be intact for complete food security.

The Sustainable Development Goals (SDGs) aim to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture (Diehl et al., 2019). Food security studies are critical because they help individuals, including helping individuals against the risk of foodborne diseases that affect human health, which can result in allergies or even death. Agriculture also contributes significantly to export-import, the national economy, and people's livelihoods (Hilemelekot et al., 2021). Agriculture positively impact household food security (Diehl et al., 2019). Growing food can offer protection against food insecurity by improving the quantity, quality, and diversity of food choices.

Food security is reflected in the availability of sufficient food, both in quantity and quality, i.e., safe, diverse, nutritious, equitable, and affordable food, which does not conflict with the religion or culture of the community and is guaranteed to be productive in a sustainable manner. Food security studies have been correlated with Sustainable Livelihood in several developing countries, including Uganda, Malaysia, and Ethiopia, to address food problems (Manlosa et al., 2019; Sasanti & Purwaningsi, 2021). In addition, a study on household consumption expenditures on selected staple foods was conducted in Nigeria (Ndubueze-Ogaraku et al., 2016).

Food security in Indonesia focuses on providing food at the regional level as well as the household and individual levels, especially in Bone Regency as the research area. The *Food Security and Vulnerability Atlas* (FSVA) Report for Bone Regency identified several villages in Libureng District that are still classified as food insecure (Dinas Ketahanan Pangan Kabupaten Bone, 2019). Although farming households in this area have been able to produce rice as a staple food, more is needed to guarantee that area will become food secure. The availability of sufficient food in the community does not necessarily reflect household food security. Based on these reasons, the determinants of farmers' household food security are selected as the critical issues of this study.

Several studies have been conducted in various countries regarding this issue. Among other things, a study of the factors affecting the food security of smallholder households in Mudzi District, Zimbabwe, includes socio-economic factors, livestock ownership, and access to market information (Mango et al., 2014). Likewise, essential factors determining household food insecurity in Pakistan include socio-economic factors, remittances, unemployment, inflation, assets, and disease (Abdullah et al., 2019). From the perspective of sustainable livelihoods, determinants of household food security were identified using time-lapse data series, including socio-economic factors, natural disaster risk, access to information, and *arisan* (regular social gathering) participation (Sasanti & Purwaningsi, 2021). However, research on the socio-economic determinants of the probability of food security in rural areas using the ordered probit estimation model using the Maximum Likelihood Estimation (MLE) method on cross-sectional data has never been done. The studies above are used as assumptions in selecting research variables to determine the probability of food security for farmer households.

MATERIAL AND METHODS

The primary method of this research is a quantitative method with a survey approach. This research was conducted in Ponre-ponre Village, Libureng District, Bone Regency (Fig. 1). The research location was selected by purposive sampling, considering that the location was still classified as food insecure based on the Bone District Food Security and Vulnerability Atlas (FSVA) Report (Dinas Ketahanan Pangan Kabupaten Bone, 2019). In addition, most of the population are farmers, and rice is a leading commodity in the agricultural sector. A sample of 84 farmer households was taken based on the *Slovin* formula with an error rate of 10% of the total population of 500 households. Based on the time dimension, cross-sectional data is sourced from primary data. The data collection method was done through direct observation and interviews with farmers using a questionnaire conducted by accidental sampling.

Technical data analysis based on indicators of cross-classification of the food expenditure share is used to analyze the factors that affect the probability of food security for farmer households in the research location using the probit estimation model (Gujarati & Porter, 2009) as follows:

$$\frac{Pi}{1-Pi} = FSHE = \beta_0 + \beta_1 NFM + \beta_2 AgHH + \beta_3 HHInc + \delta_1 EdHH + e$$

where *FSHE* is the food security level with household food expenditure (1, for food security and 0, for food insecurity based on the proportion of expenditure of 60%). β_0 is an intersept; $\beta_1,\ldots,\beta_3$ are regression coefficients of independent variable; δ_1 is the dummy variable regression coefficient; and P_i is probability with a value between 1

and 0. *NFM* is the number of family members (persons); *AgHH* is the age of the household head (years); *HHInc* is the household head's income (IDR); and *EdHH* is the dummy of the education level of the household head (1 for High School and 0 for others).



Figure 1. Map of Ponre-ponre Village, Libureng District, Bone Regency
Source: (Badan Pusat Statistika Kabupaten Bone, 2020)

Completing the logit model regression using the Maximum Likelihood Estimation (MLE) method, namely, the Likelihood Ratio Index (*LRI*) and Likelihood Ratio (LR) test, is used to measure the model's accuracy, expressed by the percentage of the dependent variable explained by the independent variable. This *LRI* is equivalent to the coefficient of determination (R^2) in OLS. *LRI* value = R^2 or Mc. Fadden's R^2 or abbreviated as R^2mcF (Borooah, 2002) with the following formula:

$$LRI = R^2mcF = 1 - LnL / LnLo$$

where *LRI* is Likelihood Ratio Index or Mc. Fadden's R^2; *LnL* is the maximum value of the log-likelihood function without restriction (involves all parameters including independent variables); and LnLo is the maximum value of log-likelihood function with restriction model (without involving independent variable or coefficient value of all parameters (a, b,...,1 = 0). The LR test is used to determine the level of influence of all independent variables together on the dependent variable, with the following formula:

$$LRI = -2(LnL - LnLo)$$

RESULTS AND DISCUSSION

The Likelihood Ratio Index (LRI) test is equivalent to the coefficient of determination (R^2) in the OLS regression. The R-Squared value in the regression is 0.5612 (Tab. 1). This value means that the independent variable of 56.12% can explain farmer households' food security level. Variables outside the model explain the remaining 43.98%. Furthermore, the Likelihood Ratio test is equivalent to the F test on the OLS. This test determines the influence of all independent variables together on the dependent variable. The value test is 52.6451 and 0.000 on the probability value. It means that the independent variables (number of family members, the household head's age, income, and education level) have influenced the food security level of the farmer households or the households that have the opportunity to be food secure.

Table 1. Influence of Socio-Economic Factors on the Probability of the Food Security Level of Farmers' Households

Independent Variable	E.S.	Coefficient	z-test	Odds Ratio
Number of family members	+	-0.0361^{ns}	-0.8108	0.6605
Age of household head	+	-0.0003^{ns}	-0.0066	0.9997
Household head's income	+	0.0001***	3.3401	1.0000
Dummy of household head's education	+	2.3627**	2.1178	13.5339
Intercept				14.4946
R^2				0.5612
LR test				52.6451
Prob.				0.0000

Legend: *** - a level error significance of 1%; ** - a level error significance of 5%; ^{ns} - not significant; ES - an expectation sign

Furthermore, socio-economic variables in this study were used to effect the probability of food security, including the number of family members, the household head's age, income, and education (Tab. 2).

Table 2. Socio-Economic Characteristics of Farmer Households

No.	Characteristics of Sample	Frequency	Percentage
1.	Age of household head (years)		
	25 - 29	4	4.76
	30 - 34	6	7.14
	35 - 39	20	23.81
	40 - 44	14	16.67
	45 - 49	19	22.62
	50 - 54	12	14.29
	55 - 59	9	10.71
	Total amount	84	100.00
	Average		43 years
2.	Education (year)		
	Senior high school and above	28	33.33
	Junior high school at the lower level	56	66.67
	Total amount	84	100.00
3.	Number of family members (person)		
	2	8	9.52
	3	18	21.43
	4	27	32.15
	5	24	28.57
	6	4	4.76
	7	3	3.57
	Total amount	84	100.00
	Average		4 person
4.	Income (IDR/mount)		
	$y < 1.500.000$	14	16.67
	$1.500.000 < y \leq 3.000.000$	57	67.86
	$3.000.000 < y \leq 4.500.000$	7	8.33
	$4.500.000 < y \leq 6.000.000$	4	4.76
	$6.000.000 < y \leq 7.500.000$	2	2.38
	Total amount	84	100.00
	Average		IDR 2,354,214.00

Food security in question is food security or food insecurity. The number of family members does not influence the probability of food security in food consumption (Tab. 1). It is caused by the fact that families have many members, namely 5-7 persons (Tab. 2), so much food is needed, and they are vulnerable to food insecurity. The greater the number of family members, the more income is spent on food, resulting in food insecurity. On the other hand, the fewer family members, the less income is expended to make food security. In the sample, the most common are families with four household members (frequency is 27 or 32.15%). Families with seven household members are the least frequent (frequency is 3 or 3.57%). According to Rahim et al. (2021a), family members such as wives and children play an essential role in household diversification in finding and increasing sources of household income.

Likewise, the age of the household head does not influence the probability of food security level (Tab. 1). Older family heads (farmers) will reduce food consumption so they will be food secure. On the other hand, the findings of

Abdullah et al. (2019) in Bangladesh indicate that age affects food insecurity. Empirically, the average age of the household head in our study was at most 35-30 years in 20 families (23.81%). The smallest number of families has household heads aged 25-29 (4 families or 4.76%). Farmers are still in their productive ages, their lowest age being 25 years and the highest at 59 years (Tab. 2). Age greatly influences household economic management decisions, especially consumption expenditures, both food and non-food (Rahim et al., 2021b).

$$\frac{Pi}{1-Pi} = FSHE = 14.4946 - 0.0361NFM - 0.0003AgHH + 0.0001HHInc + 2.3627EdHH + e$$

Farmer household income positively influences the probability of food security (Tab. 1). Income is the main factor in household food security. Income means the purchasing power for household needs such as buying food and non-food. These results align with the findings of Fami et al. (2021) in Tehran City, Iran, and Ndubueze-Ogaraku et al. (2016) in the Northeastern Ika Regional Government Area Delta State, Nigeria, especially for staple foods. The higher the income, the higher the food purchasing power, so the level of food security is also higher. On the other hand, if the income is low, the food purchasing power will decrease, so food security will be low. Empirically, the average household income of farmers in Bone Regency is IDR 2.3 million per month. The minimum or lowest income of the farmer households is IDR 660 thousand, and the maximum or highest income is IDR 7.5 million. The highest number of farmer households has an income level between IDR 1.5 million to IDR 3 million or 67.86%, while the smallest number of households is at an income level of IDR 6 million to IDR 7.5 million or 2.38% (Tab. 2). Household income from work is an essential factor influencing food insecurity (Loopstra & Tarasuk, 2013).

The education level of the household head has a positive effect on the probability of food security. Although the farmers' level of education is still high school, there is much knowledge about the benefits of food security. It can provide opportunities for farmer households to be in the food security category. Empirically, 56 persons (66.67%) have a junior high school education, and more than 28 persons (33.33%) have a high school education at the upper level. The results of this study are in line with the findings of Abdullah et al. (2019) in Pakistan that the education level of the household head (husband) positively affects the food security status. The higher the education of the family head, the better the household food security will be. The wife's education level also supports food security because it provides additional household income and regulates food expenditure in the household. Formal education can also help manage family financial expenditures (Rahim et al., 2021c).

Discussions about household food security have become the world's primary focus in tackling the problem of global hunger. Every household always tries to maximize utility in consuming goods and services, with price and income levels as constraints (Hastuti et al., 2021). Fishers or farmer households have a variable influence on the level of food security (Rahim et al., 2018). Food insecure households tend to experience hunger because access to food is deficient, thus affecting food availability (Sasanti & Purwaningsi, 2021). Rural food insecurity is often the result of food scarcity, manifested in malnutrition. In contrast, in urban environments, food insecurity is often the result of poor-quality food leading to micronutrient deficiencies and malnutrition (Diehl et al., 2019).

The factor that causes households in rural areas to be more food secure than those in urban areas is that rural areas produce food that people can obtain by themselves in their yards, fields, or rice fields planted as food crops. Real income will decrease owing to an increase in food prices, with the assumption of fixed income. The trend of increasing food prices is caused by climate change which causes unpredictable rainy and dry seasons, cropping patterns, and production estimates. Rising food prices have negatively impacted the urban poor compared to the rural poor because the urban poor is less likely to produce their food and rely on the market for their food.

In addition, this issue is also related to gender decisions. According to Yusof & Duasa (2010), women are commonly the final decision-makers about daily household expenses, while men make decisions about large households. However, men and women practice autonomy in decisions related to financial investments. Furthermore, a study in Kenya found that households headed by women were still less food secure than those headed by men (Kassie et al., 2014). Gender equality in the field can enable communication between female and male farmers to achieve targets for increasing food production, food security, and nutritional status (Ingutia & Sumelius, 2022).

CONCLUSION AND SUGGESTION

The findings in this study indicate that the probability of food security for farmer households is positively influenced by socio-economic factors such as the household income and education level. In contrast, other socio-economic factors, such as the age of the household head and the number of family members, have no significant effect.

The probability of the food security level of the farmer households in this study was aimed at those variables that were not significant, namely the number of family members and the age of the household head. Regardless of the

number of family members, farmer households in rural areas still follow traditional customs or maintain the culture of entertaining guests or sharing food and drinks with their neighbors. For this reason, it is necessary to provide and support access to information on the importance of food security and economic opportunities. The objective is to improve the health and welfare of the families as most of the family members still have low elementary school education and lower secondary school or have not attended school. Likewise, household heads of varying ages who are not productive cannot support the opportunity to achieve food security for farmer households. For this reason, food support is protection against food insecurity by improving the quantity, quality, and diversity of food choices for a healthy life.

Conflict of interest: The authors declare that they have no conflict of interest.

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