Determinants of rural household food security in Indonesia: the case of protein-based food consumption

R Umaroh¹ and E H Pangaribowò²

¹Faculty of Economics and Business, Universitas Gadjah Mada, Yogyakarta, Indonesia
²Faculty of Geography, Universitas Gadjah Mada, Yogyakarta, Indonesia

*Corresponding author: evitahp@ugm.ac.id

Abstract. A large number of households in Indonesia, especially those in rural areas, still depend on the agricultural sector. In order to meet their food needs, including protein-sourced food, rural households both produced and purchased their food consumption. This study aimed to analyze whether the consumption of certain self-produced protein-based food, namely, beans, tofu and tempeh, meat, poultry, fish, and milk, contributes to the food security of rural households in Indonesia. Using data from the fourth- and fifth-wave Indonesian Family Life Surveys in 2007 and 2014, the study applied the Quadratic Almost Ideal Demand System (QUAIDS) model to examine the determinants of protein-based food demand. The results reveal that rural households consume more plant-sourced protein than animal-sourced protein. It is also shown that the socio-demographic characteristic of the household such as household structure, the education and age of the household head affect differently on type of protein-based food consumption. These results suggest that self-produced food can be seen as a strategy for rural households to meet their protein-based food consumption. Self-produced food households also tend to be more food secure than the counterpart households.

1. Introduction

Freedom from hunger is the most fundamental of basic human rights and it could be achieved when the individual is food secure [1]. Globally, 815 million people in the world are suffering from hunger with the majority of them living in developing countries. Hunger has caused deaths for nearly 45% of the children under five or 3.1 million children per year. About two thirds of the total number of the hungriest people are found in Asia and most of them live in rural areas [2]. Indonesia is a developing country that is also faced with the problem of food security. Generally, food security is defined as a situation when the individual at all times has physical, social, and economic ways to access the fulfillment of food needs. According to Statistics Indonesia, the food security situation has an improvement which indicates an excess of non-food consumption over food consumption[3]. However, the level of malnourished children remains persistently high [4]

Food security is often linked to the agricultural sector. This is because agriculture has a major role in providing sufficient food. Despite the decline in the contribution of GDP, agriculture still becomes the major contributor of employment in Indonesia. In addition, agriculture is the main source of livelihood and earnings for 39.68 million people and they are more likely to live in rural areas [5]. However, rural food security is considered more vulnerable than food security in urban areas[1]. In order to cope with their food needs, rural households usually do several consumption smoothing through eating less amounts of preferred food [6] or skipping meals, which certainly is not good for health[7]. Households
also produced their own food crops as coping strategies during unfavorable time. According to FAO, 93% of Indonesian farmers are categorized as small-scale farmer as they tend to consume their own food crops in the case of food price increases [5]. Previous literature confirms that price increase causes decline in the welfare of both rural and urban households. But its effect is smaller for rural households because, besides being producers, they also play as consumer[6,7]. The benefit gained from one’s own farm production is also considered able to lead to a better access to a larger food supply. Thus, it could improve dietary diversity among household members[8].

Although the small-scale farming run by rural households could help them meet their food needs, there are other aspects to be concerned about, one of which is the quality of the food that they consume. It is important because, to decide an indicator of food security, one should not only look for food availability but also look for food utilization. In developing countries, rural households tend to have low food utilization because they consume more staple food which usually contains high carbohydrates but lacks high-nutrient food consumption. In Indonesia, it is accounted that the expenditure share of staple food is around 27-33% and 20-30% in rural and urban areas, respectively. Meanwhile, the share of high-nutrient food such as meat, fish, and dairy products is only around 4-17% and 6-18% [9][10]. The adequacy of such a high-nutrient intake as protein is substantial for the human body. It could be a prominent factor of good body health and thus the problems of hunger and food insecurity such as malnutrition, stunting, and being underweight could be solved.

Voluminous studies on rural household food security have been undertaken by researchers in developing countries [1,8,11]. However, little is known on the understanding on the determinant of role of self-produced food especially for high-nutrient food consumption. The urgency of the issue is related to the consideration that it is important to assess how agriculture, in particular of small-scale farming, plays a role in the improvement of household food security in rural areas. Therefore, the objective of a study concerned here was to analyze the consumption pattern of self-produced protein-based food in association with price and expenditure change. The Quadratic Almost Ideal Demand System was employed to find the elasticities concerned and thus the responsibility of rural households’ consumption of their own protein-based food products could be estimated. This writing is organized as follows: the first section is the introduction, followed by the methodology, the third showing the results and discussion, and the last being the conclusion.

2. Methodology

2.1. Data

The study used secondary data obtained from the fourth wave of the Indonesian Family Life Survey (IFLS) in 2007 and its fifth wave in 2014. IFLS has been the longest longitudinal data survey conducted in Indonesia since 1993. The IFLS survey collected data of respondents at the individual, family, household, and community levels, including data of the facilities that they use such as educational and health facilities. The IFLS sample represents 93% of the Indonesian population in 13 provinces [15].

| Type of food       | Details                              |
|--------------------|--------------------------------------|
| Beans              | peanuts, green beans, kidney beans, soybeans, and the like. |
| Tofu and Tempeh    | tofu, tempeh, and oncom               |
| Meat               | beef, lamb, buffalo meat, and the like. |
| Poultry            | poultry meat, duck meat, and the like |
| Fish               | fresh fish, shellfish, shrimp, squid, and the like as well as salted fish and smoked fish |
| Milk               | fresh milk, canned milk, powdered milk, and the like |

Source: Authors calculation IFLS Data

IFLS has data on food and non-food consumption expenditures at the household level. The questionnaire used also collected information about food consumption expenditures differentiated according to the food source, meaning, with the food as result of purchase and with it as result of one’s
own production. The consumption expenditure of selected protein-source food is used in this study (Table 1). The food of the selected types was chosen because of its having a relatively higher protein content compared to other food. In addition, another type of information needed was of the price of the food. Fortunately, IFLS provides price data at the market level in one enumeration area. Details about market prices are presented in the Table 2. Furthermore, to capture more valid research results, household and community characteristics were included in the equation model. For the purpose of our analysis, estimates were differentiated on the basis of consumption of food purchased and that of food self-produced. This procedure was performed in order to learn whether self-produced food has a role in maintaining food security in rural households. In total, for the study there were approximately 3.264 observations of self-produced food households and 9.887 observations of purchased food households. The difference in the number of observations was due to the condition of many households not having self-produced food consumption or being zero in it and, hence, it could not be estimated.

Table 2. Market price (in rupiah)

| Type of Food      | Pooled  | 2007  | 2014  |
|-------------------|---------|-------|-------|
| Beans             | 6,265.75| 4,976.52| 7,416.53 |
| Tofu and Tempeh   | 10,083.88| 6,967.77| 12,865.36 |
| Meat              | 72,140.50| 46,242.67| 95,257.18 |
| Poultry           | 24,625.09| 19,882.74| 28,858.17 |
| Fish              | 26,320.76| 18,926.58| 32,920.88 |
| Milk              | 31,913.15| 25,989.03| 37,201.08 |

Source: Authors calculation based on IFLS Data

2.2. Estimation strategy

The analysis model used in the study was the Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks et al [16]. The QUAIDS model is a development of a previous model called AIDS, which was first initiated by Deaton. QUAIDS has an attractive feature not found in the previous model, namely, being able to assess the existence of the nonlinearity of the Engel curve shown by a squared expenditure parameter. It means that the nature of the goods could change according to the level of household expenditure. The equation is presented as follows:

\[ w_i = a_i + \sum_{j=1}^{n} y_{ij} \ln p_j + \beta_i \ln \left( \frac{m}{a(p)} \right) + \lambda_i \left( \ln \left( \frac{m}{a(p)} \right) \right)^2 + \sum_{s=1}^{s} \delta_{is} D_{st}^h + u_{it}^h \]  

(1)

where \( w_i \) is the expenditure share of each of the six types of protein-source food (i), \( p \) stands for price, \( m \) is the total expenditure on all food commodities, and \( D \) is the set of demographic characteristics including household characteristics (i.e., number indicating household size, number of under-five children, number of adolescents, number of adults, number of wage earners, household head’s years of schooling, household head’s age, household head’s sex, and farm business) and community characteristics (i.e., distance to a traditional market island, and region).

3. Results

3.1 Pattern of protein-based food consumption

Figure 1. shows the proportion of consumption expenditure based on the selected classification. From the picture, it can be seen that households living in rural areas consume more food sources of plant protein than animal origin both from the results of their purchases and their own production. Meanwhile, households living in urban areas consume more food sources of animal protein. This could also indicate that more wealthy households live in urban areas and they can meet the needs of high protein intake from relatively more expensive sources. Based on the income group, the poorest households consume more food sources of plant protein in both sources. In addition, the poorest households also consume more meat and fish from their own produce. While the richest households consume more food sources of animal protein both from the results of the purchase and from their own production.
3.2. QUAIDS estimation
Figure 1 presents the proportion of expenditure on the consumption of protein-source food based on different sources from which it is obtained. The figure shows that the food consumption of the Indonesian populace is still dominated by food purchases in the market. It is seen that only tofu and tempeh are consumed more as commodities of their own production. However, in the case of Poultry and fish commodities, the matter is quite balanced. Meanwhile, the biggest difference is found in the case of meat commodities where the purchased-food consumption is far greater than the consumption of food of their own production. Certainly, it is not surprising because meat consumption in Indonesia is still relatively low in frequency and farmers might prefer selling the meat rather than using it for their own consumption.

Results of the estimation of the QUAIDS model from the observation of the sample members that consume food of their own production (Table 3) show that the squared expenditure parameters for commodities of the bean, meat, poultry, and milk groups are significant. If the quadratic expenditure parameter is not significant it means that there is an indication that the expenditure elasticity value would be relatively constant in each income group [17]. If the expenditure parameter has a positive sign and the squared expenditure parameter is negative then the nature of the good is as a luxury good at a lower level of household expenditure and as a necessity good at a higher level of it. Meat commodities have the character of being luxury goods at all levels of household expenditure as indicated by positive parametric signs on expenditure and squared expenditure.
Table 3. Estimation of the quails demand system (own production)

| Groups                        | Beans   | Tofu and tempeh | Meat    | Poultry | Fish   | Milk    |
|-------------------------------|---------|-----------------|---------|---------|--------|---------|
| Constant                      | 0.41707** | -0.15416       | 1.76146** | -0.43934** | -0.24249 | -0.34254** |
| Ln price                      | 0.12176*** | 0.00037        | 0.06332 | -0.11774*** | -0.03285  | -0.03486 |
| Beans                         |         |                 |         |         |        |         |
| Tofu and Tempeh               | 0.00037 | 0.00225         | 0.01495 | -0.00336 | -0.02039* | 0.00618 |
| Meat                          | 0.06332 | 0.01495         | 0.24640** | -0.20222** | -0.03563  | -0.08681** |
| Poultry                       | -       |                 | -0.00336 | -0.20222** | 0.20695** | 0.07127** |
| Fish                          | -0.03285 | -0.02039       | -0.03563 | 0.07127  | -0.03426 | 0.05187** |
| Milk                          | -0.03486 | 0.00618        | -0.08681** | 0.04511  | 0.05187 | 0.01852 |
| Ln expenditure                | 0.13380*** | 0.00476***     | 0.19742*** | -0.18536*** | -0.08314** | 0.05796*** |
| Ln expenditure^2              | 0.00934*** | 0.00147       | 0.00395** | -0.01117*** | -0.00170 | -0.00188*** |
| Demographics characteristic   |         |                 |         |         |        |         |
| Number of Under-Five Children | 0.00031 | 0.00090         | 0.00070 | -0.00107 | -0.00125 | 0.00042 |
| Number of Teenagers           | 0.00141 | -0.00008        | 0.00002 | -0.00129 | -0.00012 | 0.00006 |
| Number of Adults              | 0.00025 | 0.00002         | -0.00130 | 0.00099  | -0.00024 | 0.00011 |
| Household Size                | -0.00121 | 0.00004        | 0.00075 | 0.00053  | -0.00003 | -0.00007 |
| Farm-Owning Status (1=yes)    | 0.00889*** | 0.00215**      | -0.00253** | -0.00131 | 0.00866*** | 0.00193*** |
| Number of Wage Earners        | -0.00063 | 0.00171**       | -0.00047 | -0.00126 | 0.00199  | -0.00134 |
| HH's Sex (1=male)             | -0.00132 | 0.00108         | 0.00081 | 0.00047  | -0.00372 | 0.00268** |
| HH's Age                      | 0.00016*** | -0.00006*      | 0.00000 | 0.00013** | 0.00014** | -0.00004 |
| HH's Years of Education       | -0.00025 | -0.00015        | -0.00027** | 0.00016  | 0.00074*** | -0.00023** |
| Distance to Traditional Market| 0.00088*** | 0.00005       | 0.00014 | 0.00002  | 0.00053** | 0.00014 |
| Island (1=Java)               | 0.01528*** | 0.00461***     | -0.00252** | 0.01374*** | 0.00906*** | 0.00039*** |

N = 3,624

Note: *, ** & *** are significant level at 10%, 5% & 1% respectively
Source: Authors calculation based on IFLS data

With regards to demographic characteristics, the estimation result denotes that the number of under-five children in the household has no influence on consumption of the household’s own products. This could be seen from the insignificant coefficient value for almost each of the food groups. However, the existence of under-five children has a positive effect on purchased-milk consumption with the coefficient of 0.00377. This means that the addition of one under-five child in the household, consumption of purchased milk will increase by 0.00377%. This shows that milk consumption for under-five children is obtained more from purchase results than from self-production. The most-consumed milk in Indonesia is packaged milk produced by factories in the form of formula milk powder and sweetened condensed milk while the consumption of pure milk is still limited [18]. The household head’s age significantly has a negative effect on beans and tofu and tempeh consumption but it has an opposite effect on the consumption of animal protein such as poultry and fish. This finding emphasized that the consumption of animal protein which normally more expensive is higher for younger household head than that of plant protein. The estimation result concerning purchased-food consumption also shows that there is a positive and significant effect on fish only which confirms that the older the age of the household, the higher the consumption of animal protein from self-produced food. Despite that this
result is a good sign because the consumption of animal protein is getting better, one should be wary of some of the risks of heart and cardiovascular diseases that older people are susceptible to.[19]

The estimation results on the education variable of the head of the household turned out to show relatively the same results for the two sources (namely, being purchased and being self-produced) of goods for consumption. Generally, the education of the household head has a positive effect on the consumption of beans and fish commodities (0.00016 & 0.00053) but a negative effect on meat and milk consumption (0.00015 & 0.00040). It means that the addition of one year of household head’s education, consumption of beans and fish will increase by 0.00016% and 0.00053%, in contrast for meat and milk will decline by 0.00015% and 0.00040%. This also indicates that the consumption as seen from the level of household head’s education is consistent and not affected by the two source types of the food obtaining. Furthermore, in the variable of ownership status of farming, there are opposite results from the two samples in the commodities of beans, tofu and tempeh, and fish which point out that the consumption of food from these two sources is complementary. For example, households that own a farm would consume more fish of their own production and reduce fish purchases, as confirmed by Vigani et al. in their study, which also states that households owning farm business consume more food from their own farm products [20]. The distance of households to traditional markets has a positive effect on the consumption of fish obtained from among their own farm products. This means that the closer the distance of the household to the traditional market, the lower the consumption of fish of their own production and vice versa.

| Table 4. Estimation of the QUAIDS demand system (purchased food) |
|---------------------------------------------------------------|
| **Groups** | **Beans** | **Tofu and Tempeh** | **Meat** | **Poultry** | **Fish** | **Milk** |
| **Constant** | 0.05477 | -0.30299*** | 0.57867*** | 0.57818*** | -0.48546*** | 0.57683*** |
| **Ln Price** | 0.00138*** | 0.00180 | 0.00069 | 0.00205 | -0.01050 | 0.00457 |
| Beans | 0.00069 | 0.03872*** | -0.00348 | -0.01086* | -0.00107 | -0.02511*** |
| Tofu and Tempeh | 0.000205 | -0.01086* | 0.02824*** | -0.02335** | -0.01439 | 0.01831** |
| Meat | -0.01050 | -0.00107 | -0.05520 | -0.01439 | 0.12862*** | -0.04746*** |
| Poultry | 0.00457 | -0.02511*** | 0.02542*** | 0.01831*** | -0.04746*** | 0.0247*** |
| Fish | -0.00096 | 0.01142 | 0.07806*** | 0.02805 | -0.17669*** | 0.06012*** |
| Milk | 0.00014 | 0.00599*** | 0.00255*** | -0.00153* | -0.00811*** | 0.00096 |
| **Demographics** | **Children** | **Number of Under-Five Children** | 0.00015 | -0.00073 | -0.00039 | -0.00023 | -0.00258*** | 0.00377*** |
| **Number of Teenagers** | 0.00004 | 0.00028 | -0.00024 | -0.00130*** | -0.00121 | 0.00251*** |
| **Number of Adults** | 0.00017 | 0.00086 | -0.00044 | -0.00215*** | 0.00025 | 0.00131*** |
| **Household Size** | 0.00025 | -0.00013 | 0.00048*** | 0.00103*** | 0.00024 | -0.00188*** |
| **Owning Farming (1=Yes)** | 0.00107*** | -0.00251*** | -0.00028 | 0.00156*** | -0.00195*** | 0.00211*** |
| **Number of Wage Earners** | -0.00033 | 0.00020 | -0.00024 | 0.00018 | 0.00038 | -0.00019 |
| **HH’s Sex (1=Male)** | 0.00022 | -0.00029 | -0.00050 | -0.00029 | 0.00010 | -0.00015 |
| **HH’s Age** | 0.00000 | -0.00004 | -0.00004*** | 0.00004 | 0.00006*** | -0.00002 |
| **HH’s Years of Education** | 0.00016*** | -0.00016 | -0.00015*** | 0.00002 | 0.00053*** | -0.00040*** |
| **Distance to Traditional Market** | 0.00150*** | -0.02548*** | 0.00080 | -0.00114 | 0.02385*** | 0.00047 |
| **Island (1=Java)** | 0.00004 | 0.00043*** | 0.0004 | 0.00018 | -0.00077*** | 0.00008 |

Note: *, **, & *** are significance levels at 10%, 5%, & 1%, respectively
Source: Authors calculation based on IFLS data

### 4. Conclusion

The study aimed at analyzing the pattern of protein-based food consumption and assessing the effects on food security in rural households in Indonesia. The large sample size used was then subjected to the
application of the QUAIDS method to obtain demand elasticity. The results of the study reveal that meat commodities have the nature of luxury goods at entire expenditure levels as denoted by the positive parametric signs on expenditure and squared expenditure. The QUAIDS model shows that the pattern of protein-based food consumption varies across region. Households living in rural areas consume more food sources of plant protein than animal origin both from the results of their purchases and their own production. Meanwhile, households living in urban areas consume more food sources of animal protein. This could also indicate that more wealthy households live in urban areas and they can meet the needs of high protein intake from relatively more expensive sources. The estimation result denotes that household structures has different effect of each type of protein-based food consumption. The number of under-five children in the household has no influence on consumption of the household’s own products. Generally, the education of the household head has a positive effect on the consumption of beans and fish commodities but a negative effect on meat and milk consumption. This indicates that the consumption as seen from the level of household head’s education is consistent and not affected by the source of food production.

The finding also reveals that the consumption of plant protein is more stable in the presence of expenditure change compared to animal protein in rural households. These results suggest that self-produced food can be seen as a strategy for rural households to meet their protein-based food consumption. Self-produced food households also tend to be more food secure than the counterpart households. Consequently, the government needs to design policies that support rural households to consume more animal-protein source. The implication is that when the government sets price policies, generally the consumption of one’s own food products would be more prone to be affected. This could occur because households that have their own farms act not only as consumer but also as producer. Therefore, when there is an increase in prices, it is possible that households would prefer selling their crops to get more incentives instead of consuming them. In contrast, if the government applies an expenditure/income policy, it would be more effective in influencing the consumption of purchased food rather than self-produced food.

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