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Determinants of Food Security Among Rice Farming Households in the Province of Bali : An Ordered Logistic Model

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Abstract

This study aims to investigate food security at household level and to identify the socio-economic factors that affect the levels of food security among households of lowland rice farmers. Research was conducted in three district centers of rice production in the province of Bali, i.e. Buleleng, Gianyar and Tabanan. Samples were taken by multistage sampling of 216 respondents consisting of 122 ICM alumni and 94 non-ICM alumni. The data for the study were obtained with the aid of a structured questionnaire survey randomly administered to rural farming households in the districts. Household food security was measured by cross classification of the share of food expenditure and consumption of energy. The socio-economic factors that affected household food security levels were estimated using ordered logistic regression. The result showed that in the aggregate 49.07% of the households were categorized as secure, 37.9% as vulnerable, 8.79% as insufficient, and 4.17% as insecure. The analysis showed that housewives education, incomes and household food reserves had a significantly positive effect on the level of food security whereas family size, the prices of rice and instant noodles had a significantly negative effect. The food security level of the ICM alumni was higher than that of the non-ICM alumni.

Keywords : *food security, households, lowland rice, integrated crop management (ICM)*

1. Introduction

The dominant staple diet in Indonesia is rice, and it plays a major role in the Indonesian economy. Many households are engaged in the lowland rice farming sector, and the demand for rice continues to increase although rice production tends to fluctuate. Mariyono *et al*., (2010) states that rice is a politically strategic commodity, and either a shortage in the domestic rice market or highly fluctuating prices have the potential to create political instability. Since the early 1970s, Indonesian rice policy has sought to attain food self-sufficiency through price support, price stabilisation and public investment. This policy has made the central government a player in the rice market.

The province of Bali has a relatively small acreage of farmland for lowland rice in comparison with some other provinces in Indonesia, but its productivity is higher than the national productivity. In fact, its productivity could be enormously increased to achieve its full potential. Among the various problems connected with farming operation of lowland rice are as follows : (a) ownership of farmland that is relatively small and scattered and even tends to shrink due to land fragmentation resulting from the legacy system patterns, (b) the occurrence of lowland conversion to other uses as a result of the development of the local economy such as for tourism and housing, (c) limited discharge of irrigation water particularly during the dry season caused by competition in the use of water, (d) labor shortages especially during harvest, and (e) the level of pest attack and incidence of disease that is still likely to be high and varies between regions and between planting seasons.

One of the efforts to overcome these problems is through the implementation of Integrated Crop Management (ICM) by relying on the application of technological innovation. Sembiring and Widiarta (2008) stated that the success in increasing rice production from 20.2 million tons to 54 million tons in 2006 was due to an increase in productivity rather than an increase in the number of harvested areas. In an effort to increase rice production in the short term, the application of technological innovation is more realistic than expansion of paddy-fields.

The majority of farmers in Indonesia practice subsistence agriculture in the sense that they act as both producers and consumers of rice. Therefore, the quantity of rice sold in the marker relies heavily on the surplus of household consumption and the prices of rice and commodities from other industries that they need. If these

subsistence formers sell their products in ways that reduce the quantity of household consumption in order to afford to buy other products, their food security will dwindle. Darwanto (2005) stated that the program of increasing food security is still dependent on rice as a basic strategic commodity. This program is directed toward the independence of the community or the local resource-based farmers to be achieved through increased productivity of food.

In the long run improvements in food security in Indonesia have generally been driven by pro-poor economic growth and a successful Green Revolution, led by high-yielding rice varieties, massive investments in rural infrastructure, including irrigation, and ready availability of fertilizer. In the short run, food security in the country has been intimately connected to rice prices. High rice prices have a major impact on the number of individuals living below the poverty line and on the quality of their diet (Timmer, 2004).

Food security that is achieved at regional level does not necessarily guarantee food security at household level. According to Saliem *et al*. (2002), although food security is guaranteed at regional level, there are still vulnerable households with a quite high percentage so that it is necessary to measure food security at household level. This is because the food problem in a region can only be understood by analyzing the food problem at household level, which is the mainstay of the condition of food security. The purpose of this study is to analyze the level of food security among farming households and to identify the socio-economic factors and characteristics of the households that affect their food security.

2. Method

2.1 Theoretical Framework

In order to measure food security at household level, cross classification of two indicators of food security was used, i.e. food expenditure and energy consumption adequacy (kcal) (Jonsson and Toole, 1991 in Maxwell and Frankenberger, 1992) as shown in Table 1 in which 80 percent of energy consumption (per unit of adult equivalent) is combined with food expenditure > 60 percent of the total expenditure of a household, thus producing the following criteria :

Table 1. Food security indicators using cross classification of energy sufficiency and food expenditure

Energy consumption per adult equivalent	Food Expenditure	
	Low	High
	(<60% of total expenditure)	(≥60% of total expenditure)
Sufficient	Secure (4)	Vulnerable (3)
(>80% energy requirement)		
Insufficient	Less secure (2)	Insecure (1)
(≤80% of energy requirement)		

Share of food expenditure categories: (1) low if < 60% and (2) high if ≥60%. Consumption of energy categories: (1) sufficient if >80% of standard requirements and (2) no sufficient if ≤ 80% of standard requirements. According to Indonesian food and nutrition symposium in 2004, the standard requirements of energy consumption in Indonesia is 2.000/cap/day.

Food security categories : (1) insecure is households have low access to food both physically and economically, and don't meet the standard of nutritional adequacy, (2) households with less food, have economic access to food but a low quality of food consumption, (3) vulnerable households have met the standard condition of energy sufficiency but the household income is relatively low so that it is equally harmful to food shortages (low access to food economically) and (4) secure households have the ability to meet adequate energy intake in addition to having economic access to sufficient food, and also a good quality of consumption.

Maxwell *et al*. (1999) tested the Coping Strategy Index against various benchmarks of food security, and found significant correlation with other indicators of food security including dietary intake (kilocalories per adult equivalent per day), per capita expenditure and the proportion of expenditure on food (food budget shares), and various anthropometric measures in one specific case.

The assumption is that condition expected from category 2 is higher or better than category 1, and category 3 is better than category 2, and category 4 is better than category 3. Thus these four categories are naturally ordered because category 4 > 3 > 2 > 1. Because of this interrelation between categories, estimation of the factors that affect food security is based on an ordered logistic regression model, in which the meaning a score is supposed to be a linear function of dependent variables and an aggregate of cut points/limits (Greene, 2003). The probability of choice for category i:

$$\Pr(\text{outcome}_j = i) = \Pr(K_{i-1} < \beta_1 x_{1j} + \beta_2 x_{2j} ..... + \beta_k x_{kj} + u_j \leq Ki) \quad \text{..... (1)}$$

is assumed to be distributed logistically in ordered logistic, where :

β_i = parameters coefficient i = 1,… k

Ki = cut points/limits-i, i = 1,…k

x_{ij} = dependent variable category-i observations-j

k = number of categories

As pointed out earlier, category i = 1 is defined as the lowest value, i = 2 as the next level and so forth. The probability of an individual to choose category i is :

$$p_{ij} = \Pr(y_j = i) = \Pr(K_{i-1} < x_j \beta + u \leq Ki$$

$$= \frac{1}{1+\exp(-Ki+x_j\beta)} - \frac{1}{1+\exp(-Ki-1+x_j\beta)} \quad \text{..... (2)}$$

where K_0 is defined as very small (- ∞) and K_k very big (+ ∞)

$$\text{Log likelihood is } L = \sum_{j=1}^{N} w_j \sum_{i=1}^{k} I_i(y_i) \ln p_{ij} \quad \text{..... (3)}$$

where w_j is an optional weighting, and

$$I_i(y_j) = \begin{cases} 1, \text{ if } y_j = 1 \\ 0, \text{ others} \end{cases}$$

2.2 Location

The research was conducted in Buleleng, Gianyar, and Tabanan with the consideration that the three districts are the centers of rice production in the province of Bali and the populations of farming households are relatively large than those of other districts.

2.3 Sampling Technique and Data Collection

Samples were taken by stratified random sampling in which each population has an equal chance to be used as a sample. The sample size was determined by employing the Slovin method with a ten percent margin of error. Respondents were 216 farming households consisting of 122 ICM alumni and 94 non-ICM alumni comprising 72 respondents in Buleleng, 66 in Gianyar, and 78 in Tabanan. The data were obtained with the aid of a structured questionnaire survey randomly administered to rural farming households in the districts in the 2012 planting season, i.e. during the dry season (July-October) and the wet season (November-February).

2.4 Empirical Model

The Empirical model used to estimate the factors that affect the food security levels of the farming household is an ordered logistic model as shown in equation 4 :

$$\text{Ln Pr}(y_j = i) = \ln\alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + \beta_{10} \ln X_{10} + \delta_{PTT} D_{PTT} + \mu \quad \ldots\ldots (4)$$

where Pr (y_j = i) is the probability of household food security level category (1 is insecure, 2 is less secure, 3 is vulnerable, and 4 is secure). X_1 is age of housewife (years), X_2 is formal education of housewife (years), X_3 is family size, X_4 is rice price (IDR/kg), X_5 is the price of instant noodles (IDR/pack), X_6 is price of vegetables (IDR/kg), X_7 is fish price (IDR/kg), X_8 is the price of cooking oil (IDR/kg), X_9 is household income (IDR/month), X_{10} is household food reserves by proxy in (IDR/month) and D_{PTT} is a dummy variable (0 is non-ICM alumni and 1 is ICM Alumni).

3. Empirical Result

3.1 Share of food Expenditure and Household Energy Suffiency

Generally speaking, household needs can be grouped into two categories : food and non-food. At a particular income level, households will allocate their incomes to meet both these needs. The structure of household expenditure is one of the indicators of household welfare level (Ilham and Sinaga, 2007); Purwaningsih et al, 2010). Increased prosperity will raise food consumption because of increasing purchasing power.

In Table 2, it is shown that the overall household food expenditure share of rice farmers in Bali consists of 58.33 percent belonging to low level and 41.67 percent high level. From the viewpoint of the farmers' status, it is found that most of the ICM alumni (41.67%) have a low food expenditure and 14.81% of them have a high food expenditure, whereas most of the non-ICM alumni (26.85%) have a high food expenditure and 16.67% have a low food expenditure.

Table 2. Percentages of rice farming households in terms of the total share of food expenditures in Bali.

Category	Farmer Status		Total
	ICM Alumni	Non-ICM Alumni	
Low (≤ 60%)	90 (41.67)	36 (16.67)	126 (58.33)
High (> 60%)	32 (14.81)	58 (26.85)	90 (41.67)
Total	122 (56.48)	94 (43.52)	216 (100)

Performance of energy consumption by the farming households in Bali can be seen in Table 3. In the aggregate the farming households energy consumption is sufficient, i.e. 187 households (86.57%) consume above 80% of energy and 29 households (13.43%) consume less.

Table 3. Percentages of farming households in terms of energy consumption in Bali, 2012

Category	Farmer Status		Total
	ICM Alumni	Non-ICM Alumni	
Insufficient (< 80%)	14 (6.48)	15 (6.94)	29 (13.43)
Sufficient (≥ 80%)	108 (50.00)	79 (36.57)	187 (86.57)
Total	122 (56.48)	94 (43.52)	216 (100)

Farming households in the rural areas generally have modest consumption patterns. Rice remains a staple food although they also consume other carbohydrates such as corn, tubers, and noodles. Food expenditure on carbohydrates tends to dominate in the household expenditure structure. Since carbohydrates greatly contribute to energy consumption, the level of food sufficiency status can be reflected in household energy consumption.

Table 4 shows the distribution of food security levels among the farming households in Bali. In the aggregate, 49.07% are classified as secure, 37.96% vulnerable, 8.80% less secure, and 4.17% insecure.

Table 4. Percentages of household security levels in terms of farmer status in Bali.

Farmer status	Food Security Levels				Total
	secure	vulnerable	less secure	insecure	
ICM alumni	79	28	11	4	122
	(36.57)	(12.96)	(5.09)	(1.85)	(56.48)
Non-ICM alumni	27	54	8	5	94
	(12.50)	(25.00)	(3.70)	(2.31)	(43.52)
Total	106	82	19	9	216
	(49.07)	(37.97)	(8.79)	(4.17)	(100.00)

Vulnerable households are those that have a high share of food expenditure but they do consume a fair amount of energy. This condition indicates the low income received by the group. The large number of non-ICM alumni that belong to the vulnerable criterion is presumably connected with lower incomes, particularly those earned from wet-field farming operation. This can be seen from the household income structure, in which the contribution of a farming operation among the ICM alumni is 41 percent in comparison with 38 percent among the non-ICM alumni. On the whole, the main source of income of most respondents is rice farming. Therefore, efforts to increase production in order to increase farmers' income should be sustained. With their limited income, vulnerable households can allocate food expenditure in ways that meet energy sufficiency. In this group, income is a major factor in the achievement of food security.

3.2 Determinants of Food Security Levels

The results of ordered logistic regression models in Table 5 show that the Pseudo R^2 value is 0.6407. This indicates that the independent variables can account for the 64.07 percent of the dependent variables in the model. The LR test values were significantly different at α 1%, which means that jointly the independent variables including age, education, family size, household income, food reserves, food prices and farmer status significantly affect the farmers' food security levels.

While in usual regression there is an intercept that functions as a constant, in the ordered logistic models there are cut points or limits that serve as barriers between the value of each dependent variable. In the results of regression analysis the four levels of food security indicated by three LIMIT categories, namely LIMIT_2 is insecure, LIMIT_3 is less secure, and LIMIT_4 is vulnerable, therefore the standard of comparison is the secure level. Assuming cetaris paribus, the probability levels of household food security at various levels are as follow : (1) the probability of food security (insecure) : Pr (insecure $\leq$15.1429), (2) the probability of food security (less secure) : Pr 15.1429< less secure $\leq$16.3054, (3) the probability of food security (vulnerable) : Pr16.3054< vulnerable $\leq$18.5241), (4) the probability of food security (secure) : Pr (secure > 18.5241).

Table 5. Results of ordered logistic analysis factors affecting household food security level of rice farmers in Bali province

Variable	Exp sign	Coefficient	Standard Error	z-Stat	Prob	Odds-Ratio
LIMIT_2	+/-	15,1429*	8,0793	1,8742	0,0609	
LIMIT_3	+/-	16,3054*	8,8091	2,0150	0,0439	
LIMIT_4	+/-	18,5241**	8,1182	2,2817	0,0225	
Housewife age	+/-	0,9028^{ns}	0,6168	1,4636	0,1433	2,4665
Housewife education	+	0,9894***	0,2878	3,4371	0,0006	2,6896
Family size	-	-1,1552***	0,4026	-2,8690	0,0041	0,3149
Household income	+	1,9918***	0,6572	3,0306	0,0024	7,3286
Household food reserves	+	2,2635***	0,7748	2,9213	0,0035	9,6166
Rice price	-	-1,6976**	0,7726	-2,1971	0,0280	0,1831
Instant noddle price	-	-2,5520*	1,4176	-1,8002	0,0718	0,0779
Fish price	-	-0,0096^{ns}	0,5799	-0,1657	0,8684	0,9083
Vegetable price	-	-1,0257^{ns}	0,7215	-1,4215	0,1552	0,3585
Cooking oil price	-	-1,5090^{ns}	1,5964	-0,9446	0,3449	0,2214
Dummy ICM	+	0,9208***	0,2828	3,2552	0,0011	2,5113
LR Index (Pseudo-R^2)		0,6407				
LR statistic		236,0572***				
Probability (LR stat)		0,0000				

Note : *** Significant at α=1%, ** Significant at α=5% and * Significant at α=10%

Based on the results of z statistics in Table 5,it can be stated that housewife education, family size, income, household food reserves, the prices of rice and instant noodles as well as farmer status significantly affect household food security particularly at α 1%, 5% and 10%.

Housewife education affects food security levels significantly. This is consistent with the results of a study by Demeke and Zeller (2010); Bashir et al. (2012), which confirms that education determines household food security. Education level of housewife is also important in a household's food security level as the food purchasing, preparation and serving etc. is most of the time concerned to housewife.

Family size has a significantly negative effect on the level of household food security. An addition of one member to the family will reduce the chances of a household to achieve food security as much as 0.3150 times compared to a household with no additional members. The greater the family size, the greater the portion of an income spent on food, which will result in a more insecure condition. This condition accords with the studies by Demeke and Zeller (2010); Bashir et al (2012) which affirm that a large family size will reduce the level of food security.

Household income is an economic variable that has a significantly positive effect on food security. This is because an increased income will boost the purchasing power necessary to satisfy food requirements. With an adequate income, a household can afford all the necessities of life (education, housing, medical care, etc) which may affect the nutritional status (Suhardjo, 1986). The odds ratio value of household income is 7.3286, which indicates that any increase in household income per month will result in increased chances for food security.

The basic unit for food security within a poor community is a family. Their food supply must be secure at all times, not simply on average, thereby implying that local storage facilities must be effective, that staples are available out of season, and that distribution systems are uninterrupted by weather, political or budgetary cycles (Falvey, 2001). Keeping food reserves in store is an important aspect in ensuring the availability of food. Food reserves can be kept in the form of hulled rice, un hulled rice, and other stuffs for consumption in the

future. The result of analysis shows that food reserves have a significantly positive effect on the level of food security. Rusastra et al., (2008) states that one of effort to increase household food reserves by delayed selling system development. Development of delayed selling systems is aimed at supporting the farmers who reside in production centers, to avoid price plunges under the fixed government price, at peak harvest season. Such activity can also be controlled through the food barn system development and the provision of capital enhancement funds for rural business institutions.

Constraint on efforts to develop the practice of keeping food reserves individually demands a special space with a particular size that can be used to store un hulled rice until the next harvest. This problem is sometimes difficult for farming households to deal with. On the other hand, the farming community's tradition of storing food reserves collectively in rice barns has not been functioning optimally. Another threat is the widespread adoption of a system of crop transaction in which a farmer sells the crops long before harvest to a middleman, who contracts for the whole rice harvest while it is still unripe, so that the farmer has nothing left to store as food reserves.

Most Indonesians residing in rural areas are net buyers of rice. This includes all landless labourers and a surprisingly large number of small farmers, who produce some rice but sell other commodities to purchase additional rice for their own consumption (Warr, 2011).Household purchasing power is a factor that greatly affects the affordability of food, and their purchasing power is strongly influenced by the amount of income and food prices. Assuming that the income level remains constant while food prices increase, income will decline in real terms. This decline will impose constraint on food consumption or on maintaining a particularly quantity of consumed food, thereby reducing the consumption of other kinds of food in terms of variety and quantity.Hence, the declining food security.

Lokollo et al (2007) states that fluctuations in food prices have a negative impact on the consumers' purchasing power and inhibit households from access to food they need. To the producers the fluctuations and the reduced prices of un hulled rice during harvest lower their incomes, thereby reduce their purchasing power and access to food (especially for the net consumers).

4. Conclusion and Recommendations

4.1 Conclusion

The food security levels of the wet field rice farmers in the province of Bali range between secure condition and vulnerable condition. The main source of income of these households is wet field farming operation. The levels of education, income, and food reserves have a positive effect on household food security, whereas family size, the prices of rice and instant noodles have a negative effect. The food security level of ICM alumni is higher than that of non-ICM alumni. The probability of food security of the rice farmers in the province of Bali is the highest among other categories of food security.

4.2 Recommendations

Problems relating to insufficiency in the consumption of energy lie in the farmers' low income and their knowledge about nutrition. Therefore, the government's programs should be directed towards a sustainable increase in rice production, expansion of employment opportunities, and increase in household income besides increase in household food reserves and availability of good quality foodstuffs evenly distributed at affordable prices, as well as counseling on knowledge about nutrition.

In view of the potential of food storage in supporting the supply of food reserves, increased income, and food security at household level, it is recommended that government and non-government institutions intensify their participation in constructing granaries for the communities in their areas.

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