
A structural equation model of food security promotion among rice-farming households in Nakhon Nayok Province, Thailand

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Abstract Results revealed that the highest level of food security dimension among rice farming households was 'food accessibility' and 'food availability,' followed by 'food utilization and safety,' and 'food stability,' respectively. Regarding food security promotion among rice-farming households, the highest level was 'intra-household understanding related to household food security,' followed by 'having a supplementary occupation,' 'enhancing social support,' and 'self-reliance'. The regression analysis using the stepwise method revealed that off-farm income had a positive effect on household food security, whereas household debt was found to be negatively associated with household food security. Moreover, the structural equation model analysis indicated that intra-household understanding related to food security directly and positively influenced household food security. Furthermore, intra-household understanding related to food security had a positive and indirect effect on household food security through social support in the local community, enhancing supplementary household occupation, and household self-reliance, respectively.

Keywords: Food security promotion, Rice-farming households, Nakhon Nayok Province

Introduction

Nowadays, the world has been facing a food crisis and insecurity, leading to malnutrition and health problems. Therefore, food security is one of the major concerns in many countries, including Thailand. Access to an adequate quantity and quality of food has been considered a significant dilemma at local, regional, and national levels in many countries. The report by FAO, IFAD, UNICEF, WFP, and WHO (2022) indicated that the proportion of households facing

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moderate and severe food insecurity and malnutrition has continuously and tremendously increased at both the global and regional levels due to significant drivers related to climate change, economic conflicts, financial shocks, and inequalities.

Although Thailand has known known as one of the major food producers and food surplus countries, food insecurity, especially in terms of food accessibility, is still problematic, even among rice-farming households, who are major food producers (Tiwasing *et al.*, 2018). In addition, Tiwasing *et al.* (2018) also indicated that numerous rice-farming households in Thailand experienced lower caloric consumption than the minimum required for daily dietary energy and consumed un-nutritious or insecure food.

Therefore, the objectives were to investigate the determinants of food security and to construct the structural equation model for food security among rice-farming households in Ko Pho Subdistrict, Pak Phli District, Nakhon Nayok Province which this community relies on rice cultivation as their livelihood.

Materials and methods

Research setting

The research was conducted in Ko Pho Subdistrict, Pak Phli District, Nakhon Nayok Province, Thailand. This community is situated in the central region of Thailand and is approximately 4 kilometers away from Pak Phli district. It covers a total area of 23,125 rais (or 3,700 hectares) and comprises ten villages with 823 households and a population of 2,860 people. The majority of the land in this area is alluvial plain. During the rainy season, the area is prone to short-term flooding. There are no mountains or forests in this region. The site features an irrigation canal running through the middle of Ko Pho Subdistrict, and the climate experiences alternating dry and wet periods. Ko Pho Subdistrict is primarily a rice-farming community. After the rice harvest, farmers engage in additional income-generating activities, such as vegetable gardening and wage labor. Most households in the area have access to electricity.

Population and samples

The population in this study was rice-farming households in Ko Pho Subdistrict, Pak Phli District, Nakhon Nayok Province. According to administrative data from the Pak Phli Agricultural Extension Office for the crop year 2016/2017, there were 823 registered rice-farming households in the area. Using Yamane's formula (1973), the calculated sample size was 281 rice-farming

households. Household samples were selected by using systematic random sampling.

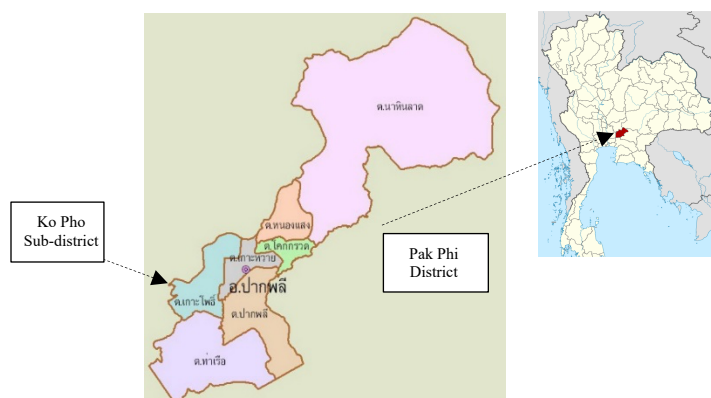


Figure 1. Map of Ko Pho Sub-district, Pak Phli District, Nakhon Nayok Province, Thailand

Source: Land Development Department of Thailand (nd.) and Wikipedia (nd.)

Research instrument

The research utilized a questionnaire as the primary data collection instrument. Interviews were conducted with the household heads, who represented their respective households. Before collecting data in the field, the questionnaire underwent content validity and reliability checks. Five experts in agriculture or agricultural economics examined the questionnaire. The results of the content validity assessment, based on the index of item-objective congruence (IOC), indicated that all items were well-satisfied. Subsequently, a pilot test was conducted with thirty rice-farming households in Nong Saeng Sub-district, Nakhon Nayok Province, which shared a similar context with Ko Pho Sub-district.

To examine factors affecting household food security, the dependent variable was the level of food security, calculated from four dimensions: food accessibility, food availability, food utilization and food safety, and food stability. Independent variables consisted of twelve factors, including sex of the household head, age of the household head, education level of the household head, marital status of the household head, type of household, household size, on-farm income, off-farm income, household food expenses, land size, household debt, and household savings.

In constructing the structural equation model for food security promotion among rice-farming households, latent variables were introduced. These

consisted of five variables: household food security, intra-household understanding relating to household food security (BIU), social support (SOC), supplementary occupation (SUC), and self-reliance (SER). Each latent variable was measured using five items or observed variables. An analysis of reliability in terms of internal consistency demonstrated that Cronbach's alpha coefficients for all latent variables exceeded 0.70, indicating well reliability.

Data analysis

Data were analyzed using frequency, percentage, mean and standard deviation, stepwise multiple regression analysis, confirmatory factor analysis (CFA), and structural equation modeling (SEM).

Results

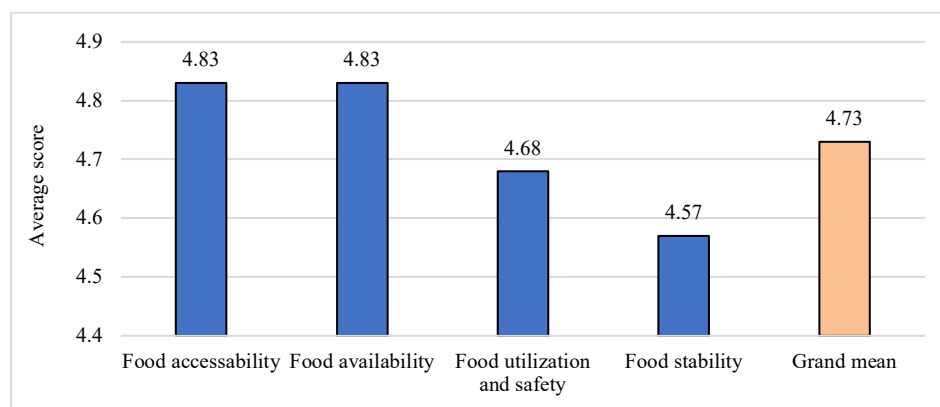
Socio-demographic characteristics of rice-farming household samples

Approximately half of the respondents (50.53%) were female, with an average respondent age of 54.52 years. The majority of respondents (88.61%) had completed primary education. The average household size was 3.43 persons per household. The average annual household farm income was 264,679.56 Thai Baht, while the average yearly household off-farm income was 26,011 Thai Baht. Approximately one-fourth of the household expenditure was allocated to food, with an average spending of 35,000.71 Thai Baht. The respondent had approximately 26 years of farming experience. The average size of household land was 83.54 rais (13.37 hectares), with an average agricultural area of 65.66 rais (10.51 hectares). The average household labor force was two persons. Nearly half of the sampled households (49.82%) reported agriculture or farming as the primary occupation of the household. Approximately three-quarters (72.24%) had incurred debt, with an average household debt amounting to 1,262,502.46 Thai Baht. Nearly half of the sampled households (49.47%) had household savings, with an average savings amount of 14,751.42 Thai Baht. The majority of farmers (76.30%) produced rice for sale. All household samples (100%) consumed bottled water or purchased drinking water. For agricultural activities, all rice-farming households utilized rainwater.

Situations related to food security of rice-farming household samples

The overall level of food security among rice-farming households was very high ($\bar{x} = 4.73$). When considering each dimension of household food security,

both 'food accessibility' and 'food availability' had the highest score ($\bar{x} = 4.83$), followed by 'food utilization and safety' ($\bar{x} = 4.68$) and 'food stability' ($\bar{x} = 4.57$) (Figure 2).



Note: 1.00-1.80= very poor, 1.81-2.60=poor, 2.61-3.41=moderate, 3.42-4.20=high, 4.21-5.00=very high

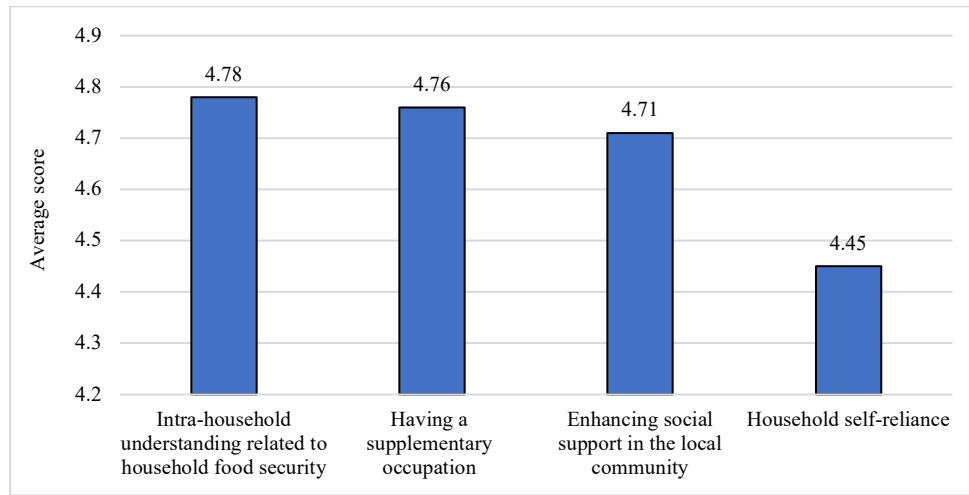
Figure 2. Food security of rice-farming households in the Ko Pho sub-district, Pak Phli district, Nakhon Nayok province

Situations Related to Food Security Promotion among Rice-Farming Household Samples

When considering each dimension of household food security promotion, the highest level was 'intra-household understanding related to household food security' ($\bar{x} = 4.78$), followed by 'having a supplementary occupation' ($\bar{x} = 4.76$), 'enhancing social support in the local community' ($\bar{x} = 4.71$), and 'self-reliance' ($\bar{x} = 4.45$). All dimensions were at a very high level (Figure 3).

Determinants of household food security among rice-farming households

The result based on multiple regression analysis using the stepwise method revealed that only two independent variables, off-farm income and household debt, significantly influenced household food security among rice-farming households in Ko Pho Sub-district, Pak Phli District, Nakhon Nayok Province. Off-farm income had a significant and positive effect on the level of household food security ($b=2.968$; $p<0.01$). In contrast, household debt significantly and negatively affected the level of household food security ($b=-0.208$; $p=0.022$). These two variables together explained 51.30% of the variation in the level of food security ($R\text{-Square} = 0.513$).



Note: 1.00-1.80= very low, 1.81-2.60=low, 2.61-3.41=moderate, 3.42-4.20=high, 4.21-5.00=very high

Figure 3. The level of food security promotion among rice-farming households in Ko Pho Sub-district, Pak Phli District, Nakhon Nayok Province

Table 1. Factors affecting the food security among rice farming households

Independent variables	b	SE	B	t	p
Off-farm income	2.968	.000	.737	4.464	<.001
Household debt	-0.280	.000	-.409	-2.481	.022
Constant	4.089	.021		198.682	<.001

R² = 0.513, Adjusted R² = 0.465

A structural equation model for promoting food security among rice-farming households

Before constructing the SEM, confirmatory factor analysis was used to test the measurement model of each latent variable employed in the model. The findings indicated that all latent variables were well-fitted to the empirical data. Therefore, each measurement model was utilized in constructing the SEM in the subsequent data analysis step.

The results based on the structural equation model (after model adjustment) revealed that the model fitted the empirical data, as indicated by the following statistical indices: chi-square/the degree of freedom (χ^2/df) or CMIN=1.192, GFI=0.953, AGFI=0.921, CFI=0.981, RMR=0.009, and RMSEA=0.026. Therefore, it can be concluded that the structural equation model for promoting household food security among rice-farming households in the Koh Pho Sub-district is well-fitted to the empirical data.

Table 2. Fitted indices of the structural equation model

Statistical indices	Criteria	Findings based on the empirical result
CMIN	≤ 3.00	1.192
GFI	≥ 0.90	0.953
AGFI	≥ 0.90	0.921
CFI	≥ 0.90	0.981
RMR	< 0.05	0.009
RMSEA	≤ 0.05	0.026

It indicated that the variables with a notable direct impact on household food security were social support (DE=0.235), self-reliance (DE=0.266), and intra-household understanding related to household food security (DE=0.335 (Figure 4 and Table 3). Furthermore, the finding demonstrated that variables with a significant indirectly influence on food security promotion included a supplementary occupation (IE=0.160) and intra-household understanding related to household food security (IE=0.144).

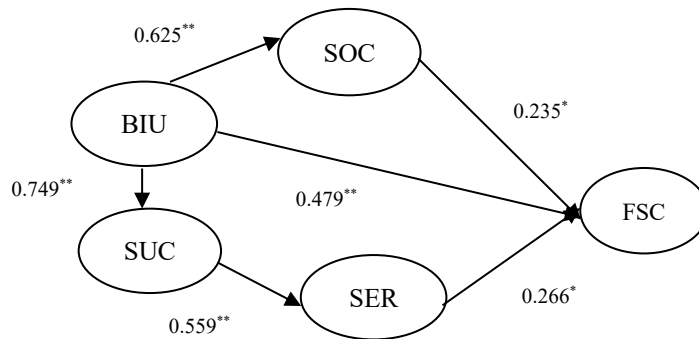


Figure 4. A structural equation model of household food security promotion among rice-farming households in Ko Pho sub-district, Pak Phli district, Nakhon Nayok Province

Table 3. Direct and indirect effects of the structural equation model for promoting food security among rice-farming households

Variables	R ²	Effect	Variables			
			Promoting food security			
			SOC	SER	SUC	BIU
SOC	0.391	DE	-	-	-	0.625
		IE	-	-	-	-
		TE	-	-	-	0.625
SUC	0.562	DE	-	-	-	0.749
		IE	-	-	-	-
		TE	-	-	-	0.749
SER	0.359	DE	-	-	0.599	-
		IE	-	-	-	0.449
		TE	-	-	0.599	0.449
FSC	0.479	DE	0.235	0.266	-	0.335
		IE	-	-	0.160	0.144
		TE	0.235	0.266	0.160	0.479

Note: DE=Direct effect; IE=Indirect effect

Discussion

Determinants of household food security among rice-farming households

The result revealed that off-farm income positively correlated with household food security. This finding was consistent with the study by Masawat *et al.* (2016), which found that Thai farming households with income from both on-farm and off-farm sources experienced improved household food security. Additionally, this finding aligned with the study of Sinyolo *et al.* (2014), which indicated that off-farm income positively influences food security in rural South African farm households. Off-farm income enhanced household investments to expand agricultural productivity. Furthermore, it served as household capital during periods when the household faced challenges in harvesting agricultural production, especially in cases of drought or flooding.

Household debt had a negative relationship with the level of food security. This result suggested that an increase in the amount of debt led to a decrease in the food security status of households. This finding was consistent with the study by Masawat *et al.* (2016), which found that farming households with debt were more likely to experience lower levels of food security than those without debt. Farmers' indebtedness could be led to food security problems at the household level due to difficulties in accessing food. This was also supported by the study of Ahmed *et al.* (2017), which showed that debt had a negative impact on the food security of small farming households in Pakistan.

A structural equation model of food security promotion among rice-farming households

The finding indicated that intra-household understanding related to household food security directly and positively influenced household food security. This finding was consistent with the study by Mohammed (2020), which suggests that households with joint decision-making among household members were more likely to be higher food security than those with sole decision-makers. Therefore, promoting household food security should begin with fostering better intra-household understanding.

Intra-household understanding related to household food security indirectly and positively influenced household food security through community social support. This finding aligned with the study by Mokari-Yamchi (2020), which suggested that social support played a vital role in reducing household food insecurity and preventing hunger and famine. As studied by Nyikahadzoi *et al.* (2013), social capital and interactions with neighbors in the local community promoted a higher level of social support, especially during household crises or critical situations. This highlighted that promoting household food security should extend beyond individual households to strengthen the overall community food safety net.

In addition, the finding showed that intra-household understanding related to household food security indirectly and positively influenced household food security through supplementary occupations and household self-resilience, respectively. According to the systematic review by Ansah *et al.* (2019), households with higher self-reliance capabilities were more likely to achieve a higher level of household food security as they could effectively respond to and manage household uncertainties or crises such as natural disasters, pandemics, crop failures, and price volatility. Furthermore, the finding indicated that having supplementary occupations or extra jobs significantly and positively affected household self-resilience among farm households. This was consistent with the study by Marco *et al.* (2021), which pointed out that supplementary or extra jobs were considered one of the strategies employed by households to enhance food security. Such strategies mitigated the adverse effects of household shocks and disruptions on resilience capabilities. As stated by Ansah *et al.* (2019), household strategies for promoting resilience capacities encompassed both tangible aspects, such as increased household income, savings, assets, capital, and productivity, and intangible aspects, such as self-esteem and risk attitude. Therefore, engaging in supplementary occupations or extra jobs enhanced household self-resilience, leading to improved household food security.

References

- Ahmed, U. I., Ying, L., Bashir, M. K., Abid, M., & Zulfiqar, F. (2017). Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PloS one*, 12(10). Retrieved from <https://doi.org/10.1371/journal.pone.0185466>.
- Ansah, I. G., Gardebroek, C. and Ihle, R. (2019). Resilience and household food security: a review of concepts and methodological approaches and empirical evidence. *Food Security*, 11:1187-1203.
- FAO, IFAD, UNICEF, WFP and WHO (2022). The state of food security and nutrition in the world 2022: Repurposing food and agricultural policies to make healthy diets more affordable. Rome: FAO.
- Land Development Department (nd.). Map of sub-districts in Pak Phi District, Nakhon Nayok Province. Retrieved from http://r01.ldd.go.th/dinthai/%E0%B8%99%E0%B8%84%E0%B8%A3%E0%B8%99%E0%B8%B2%E0%B8%A2%E0%B8%81/MAIN/NY/NY_02.html.
- Marco, D', Jeanne, P., Anh, L. and Ellestina, J. (2021). Drivers and stressors of resilience to food security- Evidence from 35 countries. Retrieved from <https://doi.org/10.4060/cb7411en>.
- Masawat, P., Sirisuphalak, P., Nitithan, I. and Bunyasiri, P. (2016). Factors affecting the food security of Thai agricultural households. *VRU Research and Development Journal Humanities and Social Science*, 11:347-356.
- Mohammed, K. (2020). Intra-household decision making arrangements and food security in semi-arid Ghana. *Africa Western Collaboration Day 2020*. Retrieved from https://ir.lib.uwo.ca/awc_abstracts/2.
- Mokari-Yamchi, A., Faramarzi, A., Salehi-Sahlabadi, A. Barati, M., Ghodsi, D., Jabbari, M. and Hekmatdoost, A. (2020). Food security and its association with social support in the rural households: A cross-sectional study. *Preventive Nutrition and Food Science*, 25:146-152.
- Nyikahadzoi, K., Zamasiya, B., Muchinako, G. A. and Dziro, C. (2013). Enhancing social support system for improving food security among the elderly headed household in the communal areas of Zimbabwe. *Journal of Food Research*, 2:46-54.
- Sinyolo, S., Mudhara, M. and Wale, E. (2014). The impact of smallholder irrigation on household welfare: The case of Tugela Ferry irrigation scheme in KwaZulu-Natal, South Africa. *African Journals Online (AJOL)*. 40. Retrieved from <https://www.ajol.info/index.php/wsa/article/view/105718>.
- Tiwasing, P., Dawson, P. and Garrod, G. (2018). Food security of rice-farming households in Thailand: A logit analysis. *The Journal of Developing Areas*, 52:85-98.
- Wikipedia (nd.). Nakhon Nayok Province. Retrieved from https://en.wikipedia.org/wiki/Nakhon_Nayok_province.
- Yamane, T. (1973). *Statistics and introductions analysis*. New York: Harper & Row.

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