

Results of an in-depth survey on food security to study and improve household food security using knowledge in food science, nutrition, and food production technology in 10 provinces of Thailand after the outbreak of the coronavirus disease 2019 (COVID-19)

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ABSTRACT

This study aims to analyze the factors affecting the food security of Thai households by using a food science perspective. The research employed quantitative methods, collecting data from 4,001 sample households across 10 provinces in Thailand using the Household Food Insecurity Access Scale (HFIAS) questionnaire. Results revealed that 75.38% of households were food secure, while 24.62% were food insecure. Key factors affecting food security included the household head's education level, household income, agricultural activity, and natural disasters. Additionally, it was found that food-insecure households tended to consume food of lower quality and nutritional value. This study highlights the importance of developing food production and processing technologies and providing nutritional education to promote food security, leading to improved food quality, nutrition, and production technologies in the ten pilot provinces following the COVID-19 pandemic, utilizing advancements in food production and processing technologies and providing knowledge in nutrition and marketing to the public.

Introduction

The crisis caused by the spread of the COVID-19 virus in 2019 has led to economic structural problems, resulting in increased poverty and inequality (Panneer et al., 2022). This crisis mainly affects the agricultural sector, the general workforce, and populations with low and unstable incomes. In 2020, most people engaged in agriculture faced difficulties accessing various resources, including land for cultivation, access to capital, a lack of knowledge relevant to development planning and product improvement, and a tendency towards a lack of savings and debt accumulation (Rasul et al., 2021). Rooting economic development is expected to be a solution for addressing poverty and inequality correctly and sustainably. This finding aligns with the government's policy of driving the country forward using the mechanism of a welfare state to develop grassroots economics, in line with the philosophy of His Majesty the King in raising the quality of life and self-reliance of the people (Janmaimool & Denpaiboon, 2016). Critical problems include low-income occupations, instability, a lack of savings, and debt accumulation. Developing grassroots economics is, therefore, an expectation to address these problems and manage poverty effectively and sustainably, or it could be summarized as creating "sustainable stability" at the community level in developing pilot areas and raising household incomes by linking the potential of the specific regions to support and reduce the

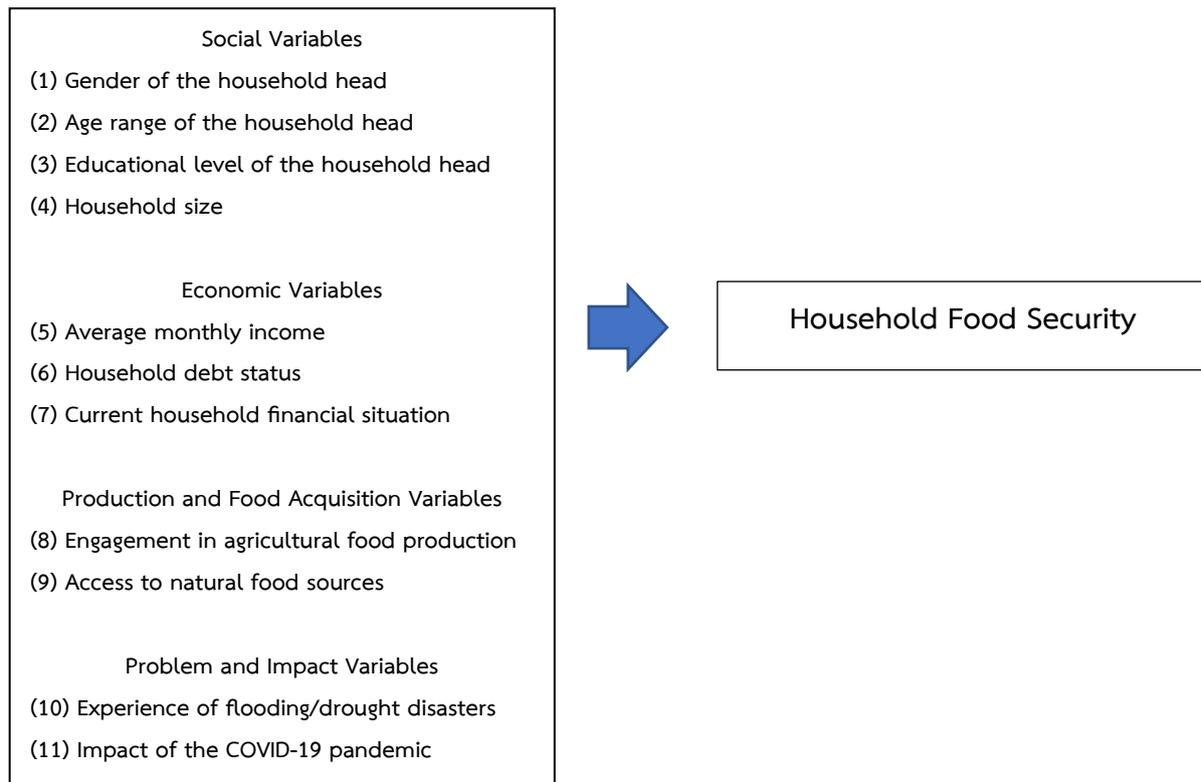
impact of the spread of the COVID-19 virus. This method has been previously shown to promote the development of community-based food security and income enhancement by utilizing community resources sustainably (Limnirankul et al., 2015).

According to the FAO's definition of food security, it can be summarized as "a state in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and one preference for an active and healthy life." (Prajunban, 2015). Based on the FAO's concept, food security comprises four key elements: availability, access, utilization, and stability. Food availability is the state in which enough food items are suitable for ingestion in terms of quality, variety, and nutritional content. Food aid, domestically produced, and imported from other nations may all fall under this category.

Resources and food production areas, biodiversity and local ecosystems, and scientific and technological developments in food production, processing, and storage affect food availability. The ability of people to have sufficient and suitable resources to purchase wholesome food is referred to as food access. In the legal, political, economic, and social environments in which people live, as well as cultural customs like resource sharing within the community, these resources cover people's capacities and skills to obtain food. Food access encompasses a range of ways to get food for everyday consumption, including producing or growing it, purchasing it, trading it, or receiving it. This could be direct access to food from natural sources or indirect access that mostly depends on market mechanisms, where consumers do not have much influence over food safety, quality, and kind. To offer the best possible nutritional advantages, food science and technology are used to produce, process, and store food and provide sufficient, hygienic, safe, and nutritionally suitable diets for consumers. The link with non-food inputs is also included. To do this, one must follow the guidelines of good nutrition, which include: (1) dietary diversity; (2) appropriate portion sizes; (3) minimal processing or addition of food additives; and (4) cleanliness and safety, free from harmful chemical contaminants. This entails consuming food that is safe, nutritious, and beneficial to the body in appropriate quantities. Finally, the ability of consumers—individuals, households, and communities—to always have access to enough food is known as food stability. It tackles the risk of food insecurity brought on by emergencies or occurrences that could result in unexpected food shortages, like economic downturns, changes in the weather or seasons, or other associated causes (Masawas et al., 2016).

The Rajabhat University network recognized the importance of collaborating to propose research projects with the cooperation of 38 Rajabhat universities. We have cooperatively developed the research project on community-based food security and income enhancement by linking the potential of specific areas to support and reduce the impact of the spread of COVID-19. This project aimed to study the factors relating to Thailand's Household Food Security situation (HFIAS) during the COVID-19 pandemic, including the coping strategies index (CSI) for food security during the COVID-19 pandemic and the development of food production and processing technology and nutritional education to the public to promote food security for Thai households.

Conceptual Framework



Research methodology

This quantitative research involves households across ten provinces covering various regions of Thailand. A sample of 400 households was selected from each section, with a quota encompassing municipal and non-municipal areas within each district. The sampling was done using a simple random sampling method. Data was collected through interviews with household heads or their representatives using a questionnaire. The questionnaire included sections for basic information, economic data, production and consumption data, and the USAID Household Food Insecurity Access Prevalence (HFIAP) questionnaire (Coates et al., 2007). Data collection took place between 21 November and 30 December 2022, when the COVID-19 virus began to ease, and government measures were being relaxed.

The household food security index analysis used the calculation method previously outlined (Coates et al., 2007). The index distinguishes between food security and households using the Household Food Insecurity Access Prevalence (HFIAP). The analysis categorizes households into four levels: (1) food-secure households, (2) mild food insecurity, (3) moderate food insecurity, and (4) severe food insecurity. This study considers household statuses in two groups: (1) food-secure households and (2) food-insecure households. Ethical approval was obtained from the Human Research Ethics Committee of Rajabhat Rajanagarindra University, with approval number RSUERB2022-114.

Data processing and analysis used statistical software to perform descriptive statistics, including frequencies, percentages, means, and cross-tabulations to explain the data overall. The Chi-square statistic was used to analyze the correlation between household variables and food security. Logistic regression was employed to test the influence of factors on household food security.

This research establishes a conceptual framework investigating various household characteristics influencing household food security. These characteristics include social variables, such as gender, age, education level of the head of the household, household size, and membership in groups/networks; economic variables, such as income, debt, expenses, financial situation, welfare, and government assistance; food production and acquisition variables, such as land ownership, agricultural food production, and foraging for food from natural sources, and challenges and impact variables, such as experiencing floods/droughts, encountering outbreaks of animal diseases in agriculture/pests/plant diseases, and being affected by the COVID-19 pandemic.

Based on the food security survey in the area, the researchers will introduce knowledge about food processing, such as proper fish drying techniques, including making dried fish, sun-dried fish, chili paste, and preservation methods. Processing crispy fish mango jam for extended storage, making crispy fried bananas, chewy bananas, banana jam, candied coconut, and various processed fruits. Processing mangoes, including pickled, dried, and organic pandan tea. These diverse food processing methods aim to enhance variety and enable safe, long-term storage. The research also emphasizes extending product shelf life, food preservation techniques, packaging, and food nutrition and applying the researchers' knowledge of biology and food technology to food processing and preservation. It also provides knowledge on how to store various products, integrating scientific knowledge with local data and context.

The researchers presented the food security data to provincial meetings in each province to highlight the local context and factors for prevention and mitigation. They also explored the use of food technology to prevent potential disease outbreaks. For example, in Chachoengsao Province, the research findings and solutions using scientific knowledge were reported in a provincial meeting. The Governor of Chachoengsao Province acknowledged the report and utilized the information for sustainable purposes.

This research presents data at the provincial level and to funding sources for their information. Importantly, this research has established a national database that collects research findings and can be used to study food security, with potential for long-term national impact, as illustrated in Figure 1.

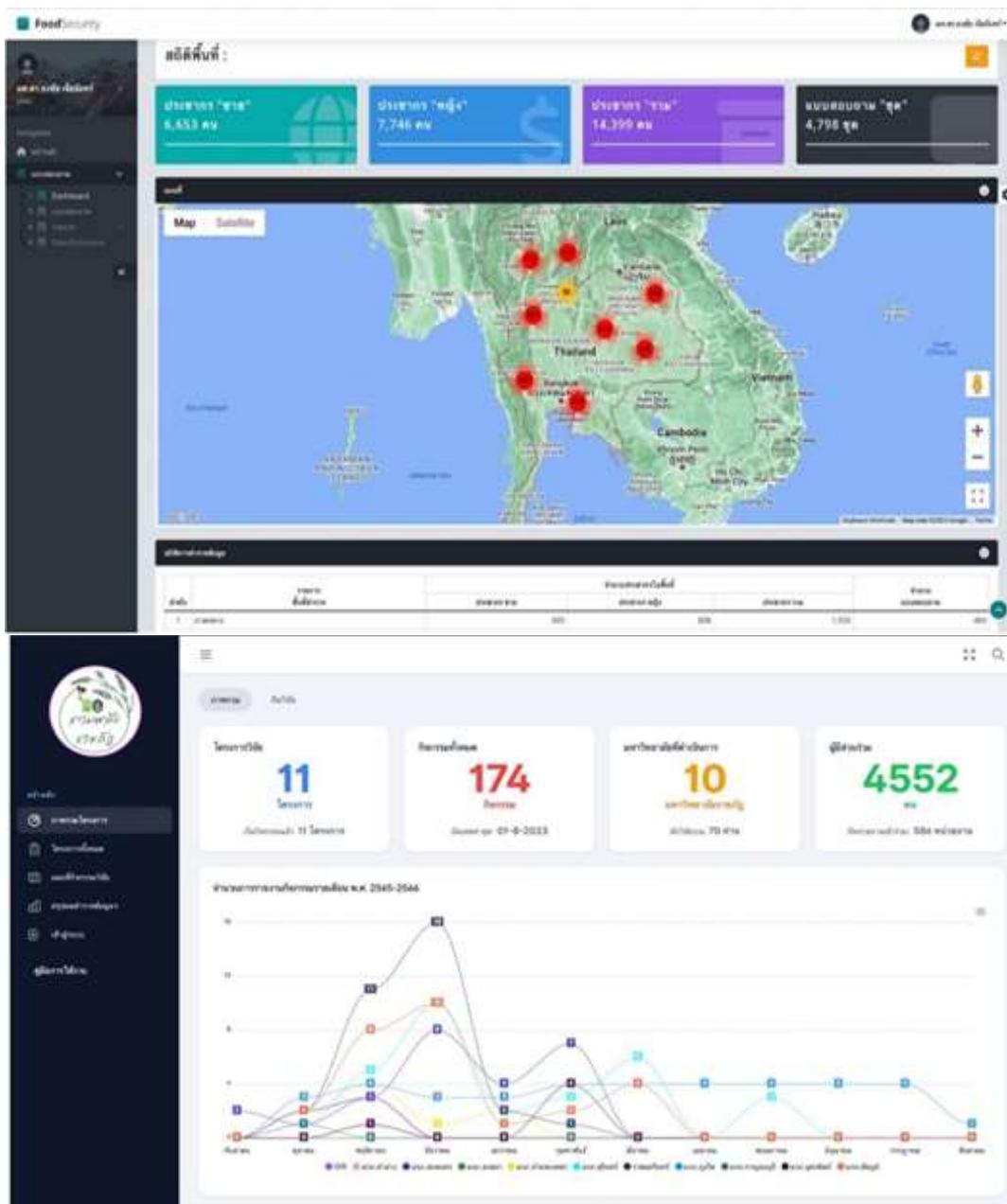


Figure 1 Development of a household data management information system platform to enhance food security using Geographic Information Systems (GIS) from research findings to obtain guidelines for analyzing and applying food technology knowledge for development in each area.

Results and Discussion

Economic and social household information

Results show a survey of 4,001 households in various regions, with the distribution of sample households in the North, Northeast, Central, and South at 30.1%, 29.9%, 20.0%, and 20.0%, respectively. The average household size is three people. Most household members are female, accounting for 53.65%, while males comprise 46.35%. Most household members are

of working age, followed by those aged 60 and above and those under 15 years, at 64.57%, 21.71%, and 13.72%, respectively. Regarding the working-age population in households, at 44.01%, the majority have 1-3 members, while 34.42% have four or more members, and 21.57% have no working-age population. Regarding the household head's information, the majority are male, accounting for 56.50%, with an average age of 52.94 years. Education levels are primarily lower than junior high school, followed by high school and junior high school, at 45.76%, 16.82%, and 12.97%, respectively.

Economic Data of Households: In most households, the average total income falls within the range of 5,001-15,000 and 15,001-30,000 Baht per month, at 33.82% and 29.74%, respectively. When the average household income is divided by the number of household members, it is found that the majority have an average income per person in the range of 5,001-15,000 and not exceeding 3,000 Baht per month, at 44.16% and 26.59%, respectively. When considering households categorized into two groups, general families and agricultural households, it is found that these two groups have similar proportions, at 47.94% and 52.06%, respectively, with average household incomes of 21,068.31 and 20,734.60 Baht per month. In general, the overall average household income is 20,894.57 Baht per month. As for household expenses, the total average monthly expenses amount to 19,147.21 Baht. The expense categories with the highest average costs are occupational investment expenses, transportation rental/purchase expenses, education expenses, and household food expenses, at 13,468.09, 7,432.88, 6,005.49, and 5,639.10 Baht per month, respectively. When considering the number of households with various expense categories, it is found that most families have expenses related to food, public utilities, and transportation, at 99.83%, 91.53%, and 84.68%, respectively.

Household Indebtedness: 53.06% of households are in debt. The leading causes of debt are primarily related to agricultural expenses, vehicle purchases, and food costs, at 25.49%, 14.90%, and 14.10%, respectively. In terms of financial situations, households either have income just sufficient for expenses, have extra income for savings, face occasional financial problems, or experience recurring economic issues, at percentages of 54.96%, 23.39%, 18.22%, and 3.42%, respectively. A majority of households, 90.20%, receive welfare or assistance from the government, including Universal Coverage Scheme (UCS), Government Welfare, Government Economic Stimulus/Aid, and Elderly Citizen Cards, at 67.48%, 44.09%, 33.49%, and 27.47% of the sample households.

Regarding the challenges faced by households in the past year, it was found that 65.38% of families continue to be impacted by the COVID-19 virus, affecting their physical and mental health, as well as increasing their debt burden, at 40.14%, 26.87%, and 18.80%, respectively. Concerning challenges from epidemic diseases, households experienced problems with human diseases, plant/pest diseases, animal diseases, and aquatic animal diseases, at 62.56%, 12.52%, 3.12%, and 1.07%, respectively. As for natural disasters, most households did not face any problems, 75.43%, while 10.25% had issues with flooding, 8.30% with drought, and 6.02% with both flooding and drought.

Regarding food sources, the majority of households, 66.73%, primarily purchase food from fresh markets or flea markets, with 20.59% mainly buying from grocery stores. About 34.52% of households can access food from natural sources, with the majority finding it from rivers, canals, forests, and wetlands.

Correlation between variables and food security

The assessment of household food security using the HFIAP index revealed that 75.38% of households are food secure, while 24.62% are food insecure. Food insecurity can be categorized into mild, moderate, and severe levels at 14.22%, 5.50%, and 4.90%, respectively. These households face varying degrees of anxiety, uncertainty about food, problems with food quality, food diversity, or inadequate nutrition (Coates et al., 2007).

In the analysis of the correlation between independent variables and household food security, it was found that within the social variables, household size, age range, and education level of the household head have a statistically significant correlation with food security at the 0.05 level. Households with a head between 21 and 40 have the highest food security, with proportions decreasing with age. Additionally, an increase in the education level of the household head results in a higher proportion of food-secure households, ranging from 66.37% for those with no formal education to 88.57% for those with a bachelor's degree or higher. This finding is consistent with the previous research (Piaseu & Mitchell, 2004).

Regarding economic variables, every economic variable, including average monthly income, household indebtedness, current financial situation, and agricultural activities, significantly correlates with food security at 0.05 (Mango et al., 2014). When considering the data on middle-income and the proportion of food-secure households by region, it was found that the two are positively correlated. In other words, the southern part has the highest average monthly income of 28,212.41 Baht and the highest proportion of food-secure households at 84.38%, followed by the central region, the northeastern region, and the northern part, with average incomes of 21,987.40, 18,401.41, and 17,784.25 Baht per month, and proportions of food-secure households at 80.25%, 76.71%, and 64.84%, respectively. Based on the analysis of household data, it was found that higher levels of monthly average income and monthly average income per capita led to an increase in the proportion of households with food security. This proportion increased from a minimum of 60.39% and 66.45% to a maximum of 83.31% and 95.40%, respectively. It is noteworthy that in the analysis of the income data, households in the income range of 5,001-15,000 Baht had a proportion of 77.14%, and those in the income range of 15,001-30,000 Baht had a balance of 90.94%. This difference is significant compared to other income groups.

Regarding the current financial situation of households, the proportion of food-secured households decreased as income increased (Dev et al., 2016). The balance of families with adequate income and savings decreased to 86.54%, while the ratio was as low as 43.07% among households with recurring financial problems. In terms of debt, households with debt had a lower proportion of food security at 71.74%, compared to homes without obligation, with a balance of 79.50%.

An analysis of food production and acquisition variables revealed a statistically significant relationship between agricultural food production and obtaining food from natural sources within households. When comparing families that could receive food from natural sources, there was a lower proportion of food security, with percentages of 70.55% and 77.93%, respectively. When combined with the variable of monthly income, households with higher incomes tended to obtain less food from natural sources. This result could be due to natural food sources being an alternative for low-income families (Brouwer et al., 2007).

It was found that experiencing flooding or drought had a statistically significant relationship with household food security. Variables related to challenges and their impact on food security were analyzed. Households affected by such disasters had a lower proportion of food security than those who did not face these challenges. Among families affected by flooding and drought, the balance with food security was the lowest at 58.09%. However, when comparing flooding and drought, deficit appeared to have a more significant impact on household food security, with percentages of 65.66% and 70.73%, respectively.

The impact of the COVID-19 coronavirus pandemic was also statistically significant in its relationship with household food security. Households still affected by the pandemic had a lower proportion of food security at 72.06%, less than households unaffected, with a balance of 81.66%. Details are shown in Table 1.

Table 1 Correlation between independent variables and household food security status

Independent Variables	Chi-Square Value	Sig.
Social Variables		
(1) Gender of the household head	.907	.341
(2) Age range of the household head	14.276	.003
(3) Educational level of the household head	86.500	.000
(4) Household size	14.241	.007
Economic Variables		
(5) Average monthly income	79.553	.000
(6) Household debt status	32.346	.000
(7) Current household financial situation	168.131	.000
Production and Food Acquisition Variables		
(8) Engagement in agricultural food production	9.869	.002
(9) Access to natural food sources	26.554	.000
Problem and Impact Variables		
(10) Experience of flooding/drought disasters	75.935	.000
(11) Impact of the COVID-19 pandemic	45.009	.000

Correlation analysis

The analysis of the correlation between independent variables and the household food security status reveals that only the gender of the household head is not significantly correlated with the food security status. However, the other independent variables are statistically significant and have very weak correlations ($r < 0.20$) with the food security status. When considering the correlation between independent variables together, the variables with the highest multicollinearity are the age of the household head and the education level of the household head ($r = -0.497$), agricultural food production, and food acquisition from natural sources ($r = 0.409$), household size and average monthly income ($r = 0.365$), and household indebtedness and financial situation ($r = 0.295$). Nevertheless, none of the pairs of independent variables correlate higher than 0.65 ($r > 0.65$) based on Burns' criteria, indicating no issues of multicollinearity (Burns, 1993). Therefore, they can be used for the subsequent multiple logistic regression analysis. The results of the correlation analysis are presented in Table 2.

Table 2: The results of the correlation analysis between independent and dependent variables.

Variables	Food Security Status	Gender of the Household Head	Age Range of the Household Head	Educational Level of the Household Head	Household Size	Average Monthly Income	Household Debt Status	Current Household Financial Situation	Engagement in Agricultural Food Production	Access to Natural Food Sources	Experience of Flooding/Drought Disasters	Impact of the COVID-19 Pandemic
	(-)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(-)	1.000											

(1)	-.015	1.000																		
(2)	-	-	1.000																	
	.058**	.042**																		
(3)	.146**	-.014	-	1.000																
			.497**																	
(4)	-	-	.083**	-.111**	1.000															
	.041**	.170**																		
(5)	.132**	-	-	.221**	.365**	1.000														
		.182**	.106**																	
(6)	-	-.004	-.002	-	.195**	.027	1.000													
	.090**			.073**																
(7)	-	.025	.027	-	.039*	-	.295**	1.000												
	.188**			.151**		.168**														
(8)	-	-	.142**	-	.202**	-.014	.214**	.055**	1.000											
	.050**	.107**		.182**																
(9)	-	-	.050**	-	.174**	-	.180**	.092**	.409**	1.000										
	.081**	.053**		.159**		.069**														
(10)	-	-.027	.022	-	.042**	.045**	.087**	.093**	.246**	.207**	1.000									
	.132**			.049**																
(11)	-	.038*	-	-.002	.037*	.035*	.144**	.182**	.011	.002	.128**	1.000								
	.106**		.047**																	

Note ** significant at the 0.01 level, * significant at the 0.05 level.

Influence of factors on food security

A study on the influence of variables affecting household food security through binary logistic regression analysis using the Enter method found that variables entered into the equation had a statistically significant correlation with the food security status. ($p < 0.05$), showed the following relationships: Households with a household head aged 21-40, 41-60, and over 61 years old were more likely to have higher food security than households with a younger household head under 20 years old (Wongmonta, 2023). The education level of the household head was related to food security. Families where the household head had received education were more likely to have higher food security than households where the household head had not received any education (Mutiah & Istiqomah, 2017). As the education level of the household head increased, the probability of food security also increased. Regarding the household size, households with more than one member had a lower likelihood of food security than households with only one member. In particular, families with three members had a lower probability of food security than households with only one member by 50%.

Economic factors were also analyzed. Households with higher average incomes had a higher probability of having better food security (Etea et al., 2019). Specifically, families with an income level of 15,001-30,000 and over 30,000 baht per month had a significantly higher likelihood of better food security than households with less than 3,000 baht per month, with odds ratios of 2.52 and 3.24, respectively. Households with debt were less likely to have food security than those without obligation, with a 10% lower probability. Regarding financial situations, households with barely sufficient income, occasional financial problems, and regular financial problems had a decreasing likelihood of food security, with 39%, 52%, and 81%, respectively.

Table 3 Correlation between variables and food security

Variables	Food Security Status		Chi	95% CI for OR		
	Security	Insecurity				
	Number (Percent)	Number (Percent)	p-value	OR	Lower	Upper
Age Range of Household Head	3,016 (75.38)	985 (24.62)	0.003			
Less than 20 years	35 (76.09)	11 (23.91)				
21-40 years	611 (79.87)	154 (20.13)	1.16	0.54	2.46	
41-60 years	1,473 (75.50)	478 (24.50)	1.30	0.61	2.73	
61 years and above	897 (72.40)	342 (27.60)	1.32	0.62	2.81	
Education Level of the Household Head	2,997 (75.36)	980 (24.64)	0.000			
No Formal education	134 (66.34)	68 (33.66)				
Less than junior high school	1,284 (70.13)	547 (29.87)	1.14	0.82	1.58	
Junior high school	398 (76.69)	121 (23.31)	1.40	0.95	2.05	
Senior high school/vocational certificate	537 (79.79)	136 (20.21)	1.73	1.19	2.53	
Diploma	191 (84.89)	34 (15.11)	2.08	1.26	3.43	
Bachelor's degree	422 (85.77)	70 (14.23)	2.12	1.38	3.26	
Master's degree or higher	31 (88.57)	4 (11.43)	2.32	0.75	7.17	
Household Size	3,016 (75.38)	985 (24.62)	0.007			
1 person	518 (80.56)	125 (19.44)				
2 people	757 (76.00)	239 (24.00)	0.67	0.51	0.87	
3 people	731 (72.59)	276 (27.41)	0.50	0.38	0.65	
4 people	583 (74.55)	199 (25.45)	0.55	0.41	0.73	
5 people or more	427 (74.52)	146 (25.48)	0.59	0.43	0.81	
Average Monthly Income	3,016 (75.38)	985 (24.62)	0.000			
Less than 3,000 baht	215 (60.39)	141 (39.61)				

3,001-5,000 baht	238	(69.79)	103	(30.21	1.46	1.04	2.0
			)				3
5,001-15,000 baht	1,003	(74.13)	350	(25.87	1.94	1.49	2.5
			)				3
15,001-30,000 baht	926	(77.82)	264	(22.18	2.52	1.90	3.3
			)				5
More than 30,000 baht	634	(83.31)	127	(16.69	3.24	2.32	4.5
			)				2
Household Debt Status	3,016	(75.38)	985	(24.62	0.000		
)				
No debt	1,493	(79.50)	385	(20.50			
)				
Has debt	1,523	(71.74)	600	(28.26	0.90	0.76	1.0
			)				6
Current household financial situation	3,016	(75.38)	985	(24.62	0.000		
)				
Sufficient income with savings	810	(86.54)	126	(13.46			
)				
Enough income for expenses	1,660	(75.45)	540	(24.55	0.61	0.49	0.7
			)				7
Occasional financial problems	487	(66.90)	241	(33.10	0.48	0.36	0.6
			)				2
Regular financial problems	59	(43.07)	78	(56.93	0.19	0.12	0.2
			)				8
Engagement in agricultural food production	3,016	(75.38)	985	(24.62	0.002		
)				
No	1,518	(77.57	439	(22.4			
		)	3)				
Yes	1,498	(73.29	546	(26.7	1.17	0.98	1.4
		)	1)				0
Access to natural food sources	3,016	(75.38)	985	(24.62	0.000		
)				
No	2041	77.93	578	22.07			
Yes	975	70.55	407	29.45	0.87	0.73	1.0
							4
Experience with flooding/drought disasters	3,016	(75.38)	985	(24.62	0.000		
)				
Never experienced	2,368	(78.46)	650	(21.54			
)				
Experienced flooding	290	(70.73)	120	(29.27	0.66	0.51	0.8
			)				4
Experienced drought	218	(65.66)	114	(34.34	0.59	0.45	0.7
			)				7
Experienced both flooding and drought	140	(58.09)	101	(41.91	0.37	0.27	0.4
			)				9
Impact of the COVID-19 pandemic	3,016	(75.38)	985	(24.62	0.000		
)				
Not impacted	1,131	(81.66)	254	(18.34			
)				

Impacted	1,885 (72.06)	731 (27.94)	0.68	0.57	0.81
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Analyzing variables related to food production and natural food sources, households engaged in agriculture and food production had a higher probability of food security, with odds 1.17 times higher. However, families that relied on natural food sources had a 13% lower likelihood of food security. Households facing problems such as flooding, drought, or both flooding and drought had a lower probability of food security than households without such issues (Twongyirwe et al., 2019), with 34%, 41%, and 63%, respectively. Families impacted by the COVID-19 pandemic had a 32% lower likelihood of food security, as shown in Table 3.

The study on the influence of household characteristics on food security found that as the head of the household ages, the chances of the household being food secure increase. This phenomenon is because the head of the household plays a role in generating income and controlling household expenses (Prajunban, 2015). Those aged 61 and over and those aged 41-60 belong to the Baby Boomer, Gen X, and Gen Y generations. These age groups tend to be more careful with their spending and manage their finances to avoid running out of money, leading to better allocation of household expenses and increasing the chances of achieving food security.

Households with a higher level of education for the head of the household are more likely to be food secure. This finding aligns with the research by Masawas et al. (2022), which found that the education level of the head of the household is essential for production management, technology adoption, and the ability to procure food. Additionally, the education level of the head of the household is positively correlated with the household income level.

Agricultural food production is a long-standing cultural practice in each area, as is the age-old tradition of rice cultivation and the culture of preparing local dishes like those made from frogs and locally significant herbs. Mangoes, abundant in Chachoengsao Province, have been cultivated to become a cultural aspect of food and the livelihood of farmers in the area. Each area possesses unique knowledge of local food wisdom, preservation techniques, and food processing methods. The knowledge of this factor effectively contributes to addressing and managing food security issues in the area. Areas with a strong agricultural culture, where more than 70% of the population are farmers, are more likely to have food-secure households. This result is because agricultural households have their primary income from farming, and households that consume their own harvested produce reduce their food expenditure burden.

Based on the household income survey, debt burden and problematic financial situations, these two factors contribute to households being more likely to experience food insecurity. The influence of a complex economic crisis has a more significant impact on reducing the chances of food security than having a debt burden. This is because a problematic financial situation reflects a state where the household is experiencing insufficient income to cover expenses, leading to difficulties in accessing food. On the other hand, household debt can have various purposes, such as purchasing assets, investments, or consumption.

The factor of foraging food from natural sources influences household food insecurity. There are also findings related to the unsafe nutritional value of food consumption in households. This is because households that forage for food from natural sources tend to be low-income groups that rely on alternative food sources obtained without cost. Experiencing floods/droughts reduces the chances of households being food secure and impacts the unsafe nutritional value of food consumption in households. The researchers have incorporated knowledge about proper nutrition, emphasizing the need to cook food thoroughly and avoid

consuming raw or undercooked food. The survey results show that there are still people who consume raw or undercooked food, so the researchers have provided knowledge about proper food nutrition to the people in the area. Furthermore, the damage from these disasters affects farming households, a source of income. The impact of the COVID-19 pandemic has led to unemployment, layoffs, reduced income, increased medical expenses, and increased debt, resulting in a decrease in household food security.

In conclusion, this research analyzed GIS-based food security data in ten areas and found that the food insecurity rate was approximately 30%. The findings should be applied to formulate policy suggestions for improving income and fostering food security at the local, state, and federal levels. In the ten areas, knowledge in science, food production technology, food processing, food preservation, and nutritional education for the public has been developed to promote food security based on the research surveys. The process involves applying scientific knowledge and technology to promote food security in 10 areas in Thailand, using scientific knowledge appropriate to the context of each location.

Conflict of interest.

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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