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Research Article

Determinants of Household Food Security in Northern Province, Sri Lanka

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Abstract

The study focused on determining the key factors influencing food security in Sri Lanka's Northern Province. It employed a multi-stage sampling method involving 93 Grama Niladhari (GN) divisions selected through stratified random sampling. Subsequently, 909 households were randomly chosen for data collection between November 2021 and February 2022. A meticulously designed questionnaire was utilized to gather information from households in the study region. Various analytical methods were employed, such as descriptive statistics, correlation analysis, Lin-log, and Tobit models. The Lin-log model findings highlighted that the growth in food expenditure was comparatively lower than the increase in total Expenditure. Additionally, the food security index revealed that only about one-third of households experienced high food security in the area. The Tobit regression model results indicated that factors like age, family size, total income, gender, and place of residence had a negative impact on the food security index. Conversely, the level of savings demonstrated a positive correlation with the food security index. These findings shed light on the complex interplay of socio-economic factors affecting regional food security.

Keywords: food expenditure, food security index, Northern Province
JEL classification: A13, E21, I32

Introduction

Food security is a significant issue in developing countries; governments focus more on eliminating food insecurity and hunger worldwide, even though global hunger and malnutrition have increased due to the COVID-19 pandemic, conflict, economic shocks, climate changes, and soaring fertilizer prices. Worldwide, more than 333 million people suffer from high food insecurity and do not know where food is available for their families (WFP, 2023).

The concept of food security originated in the middle of the 1970s and is now a burning issue worldwide because of the global food crisis and food problems. The Food and Agriculture Organization (FAO) estimated that nearly 9.9% of the worldwide population was affected by undernourishment in 2020. Sustainable Development Goals (SDGs) give more attention to reducing poverty (Goal 1) and no hunger in 2030 (Goal 2) worldwide. In addition to these goals, food security ensures people's good health and well-being (Goal 3), including availability, access, and food utilization. Without any of these conditions, it can be considered food insecurity.

Food security has become a fundamental problem worldwide because of the long lockdowns and war between Ukraine and Russia. Food security is a flexible concept, as reflected in many attempts at definition in research and policy usage. The concept of food security addresses people's risks of not having access to the required food. Food insecurity can occur at household, regional, and national levels.

In the past, before 1977, Sri Lanka focused on self-sufficiency in food commodities. Therefore, the government has taken significant strides in enhancing food security by adopting policies prioritizing the development of diverse sectors, including agriculture, livestock, irrigation, fisheries, nutrition, and health. Developing these sectors aims to guarantee access to food, maintain stability in food availability, and optimize food utilization within every household (Institutes of Policy Studies of Sri Lanka, 2022).

Due to COVID-19 and the economic crisis in Sri Lanka, high food prices, scarcity of imported food commodities, and low yield in the agriculture sector push more risks on food security. Food security disproportionately aggravated vulnerable groups of the population already facing food insecurity before its onset (Central Bank Annual Report, 2020). According to the World Food Programme, *"6.3 million people, or over 30 percent of Sri Lanka's population, are "food insecure" and require humanitarian assistance. Of these, around 5.3 million people are either reducing meals or skipping meals, and at least 65,600 people are severely food insecure."*

In the context of Sri Lanka, the Global Hunger Index (GHI) ranked Sri Lanka in 64th Rank out of 121 countries, and the Global Food Security Index (GFSI) ranked Sri Lanka in 79th Rank (55.2/100) in 2022 (Global Food Security Index, 2022). Based on the FAO (2017) statistics, the level of calorie deficit in Sri Lanka, 192 Kcal/capita/day on average in 2014-2016, is the highest in South Asia.

The households in Sri Lanka's Northern province bore significant repercussions from the 30-year civil war, which concluded in

2009. Despite the passage of time, many affected individuals and families have yet to achieve complete economic recovery. In the aftermath of the conflict, resettlement efforts, the influx of financial institutions, and the introduction of new commodities like vehicles and electronics have increased cash flow, influencing income and expenditure patterns. In the meantime, Covid-19 and the economic crisis worsen their economic well-being again. Nearly 30% of households in the Batticaloa district and 54% of rural households in Sri Lanka were in food insecurity (Rathnayake et al., 2019; Thirumarpan, 2015). However, there is a lack of recent studies regarding identifying the level of food security and determinants of food security in the Northern province of Sri Lanka. Therefore, the research focuses on measuring the food security index and identifying the food security determinant among the households in the Northern province of Sri Lanka.

The rest of the paper consisted of the following: Section 2 discusses the theoretical background and empirical evidence. Section 3 deliberates the methodology, population, sample, variables, and method of data analysis used in this study. Section 4 delivers results and discussion. Finally, section 5 concludes the study.

Literature Review

Theoretical foundation

Several theories discuss food security, and this section focuses on the dominant theories, such as climate, political economy, and sustainable development theories.

The Climate Theory of food security posits that environmental factors, specifically climate-related events such as droughts, floods, erratic rainfall patterns, and extreme weather events, play a significant role in determining food availability and access. This theory suggests that these climatic phenomena directly impact agricultural productivity, leading to reduced crop yields, livestock losses, and disruption of food supply chains. It emphasizes the relationship between climatic conditions and food production, highlighting how changes in weather patterns can result in food shortages, price fluctuations, and decreased access to nutritious food. Climate Theory underscores the vulnerability of agricultural systems to climatic variations and the subsequent implications for food security, especially in regions heavily reliant on rain-fed agriculture (Ospovat, 1977).

Political Economy Theory regarding food security analyzes the broader socio-political and economic structures influencing food access, availability, and distribution. This theory emphasizes that food insecurity is not solely a result of insufficient food production but is intricately linked to power dynamics, economic policies, trade relations,

governance systems, and resource allocation (Caporaso & Vevine, 1992).

Sustainable development theory revolves around meeting the needs of the present without compromising the ability of future generations to meet their own needs. It was popularized by the Brundtland Commission report, which defined sustainable development as development that "*meets the needs of the present without compromising the ability of future generations to meet their own needs*." The theory encompasses three pillars: economic sustainability, social sustainability, and environmental sustainability. The intersection of sustainable development theory and food security highlights the importance of not only producing enough food but also doing so in a way that preserves the environment, supports communities, and ensures long-term access to nutritious food for everyone. Achieving sustainable food security involves a holistic approach considering environmental, social, and economic factors in food production and distribution (Brundtland, 1987).

Empirical Evidence

One of the basic needs of humankind is food; the World Food Summit (1996) states, "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Nearly 1.2 billion people worldwide cannot get sufficient food for a healthy life, and rural farmers in developing countries especially suffer from insecure food (IFAD, 2009).

The determinants of food security differ between developed and developing countries and rural and urban areas. Empirical studies identified social, economic, demographic, and environmental factors as significant determinants of food security in all countries and places. Sub-categories of significant determinants of food security in developing countries are household family size, level of education, employment opportunities, ownership of assets, and age (Sani & Kemaw, 2019). In addition, farming, livestock, access to credit, distance to market, and access to irrigation are the additional factors identified in rural household food security (Negash & Alemu, 2013).

Santos et al. (2022) conducted a thorough investigation into the nexus between the gender of household heads, employment status of household members, and food insecurity within households with children in a low-income district of Lima, Peru. Employing a cross-sectional study design, the researchers gathered data through a household questionnaire administered to a stratified random sample. This questionnaire included a validated food security tool, the Household Food Insecurity Access Scale (HFIAS). This study utilized multivariate logistic regression models to predict household food insecurity, considering several independent variables such as the

gender of the household head, education level of the head, employment status, household-level employment dynamics, age, and weekly food expenses per person. Outcomes indicated that households headed by women had nearly three times higher odds of experiencing food insecurity compared to those headed by men. Moreover, the household head's education level surfaced as a significant factor influencing food insecurity. Specifically, households with a head who had not completed high school were 3.4 times more likely to face food insecurity compared to those with some post-secondary education.

Danso-Abbeam et al. (2021) conducted a comprehensive investigation into household food security within the rural areas of Rwanda's Southern and Northern provinces. Collecting cross-sectional data from 534 farming households, the study assessed household food security status using the Food Consumption Score (FCS) and the Food Insecurity Experience Scale (FIES). To pinpoint the factors influencing household food security, the study applied an ordered Probit model. The findings revealed that a substantial proportion (74.4%) of households demonstrated acceptable FCS. However, when evaluated through the FIES, 36.52% of farming households experienced moderate to severe food insecurity. Notably, livestock ownership emerged as a crucial determinant of food security, as indicated by both assessment metrics. These results underscore the significance of Rwanda's 'one cow per household policy' in combating hunger and food insecurity. Moreover, the study recommends reinforcing this policy, considering its evident impact on improving household food security within the region.

Simelane and Worth (2020) identified the theoretical framework for food and nutrition security (FNS). The theoretical framework was established by referencing prior food security and nutrition security publications. Through this review, it became evident that defining FNS (Food and Nutrition Security) requires careful consideration to address food security and nutrition security effectively in formulating food policies and strategies. It is crucial to strike a balance between these two concepts without prioritizing one at the expense of the other. This equilibrium can be attained by conducting a comprehensive needs assessment analysis that integrates livelihood and vulnerability approaches to FNS. This analysis should encompass the four essential conceptual dimensions of FNS, ensuring a comprehensive coverage of every aspect involved in achieving food and nutrition security.

Rathnayake et al. (2019) analyzed the food security status within rural households in Sri Lanka, drawing data from the households' income and Expenditure survey. This study utilized a two-stage approach: initially assessing the food insecurity index and subsequently employing an ordered logistic

regression model to gauge the food insecurity status of households based on various independent variables. The food insecurity index was established using a proxy variable derived from the percentage of each household's total expenditures allocated to food. Through statistical tests like the two-sample t-test and proportion test, notable differences in means were observed in human capital variables between households categorized as food secure and food insecure. The outcomes derived from the ordered logistic regression model highlighted significant factors influencing household food insecurity. Specifically, households with female and educated heads exhibited decreased vulnerability to food insecurity. Additionally, households with more members who completed secondary education, more working members, fewer young dependents, and fewer elderly dependents were associated with reduced food insecurity among rural households in Sri Lanka.

According to the global food security ranking, Asian and African countries' position is shallow compared to developed countries (Global Food Security Index, 2022). The prevalence of food insecurity in Ethiopia is very high (Mengistu & Kassie, 2022). Southern Ethiopia's 70.6% of households suffer from food insecurity (Bahiru et.al., 2022). In Sri Lanka, the risk of food insecurity, especially among the most vulnerable people, increased after COVID-19 (Central Bank of Sri Lanka, 2020). Before the pandemic, very high-level food insecurity in rural households in Sri Lanka was 22%, and above the threshold point was 33%, respectively (Rathnayake et al., 2019). Nevertheless, the Northern Province households earn the second lowest household income per month and the highest percentage of poor households (6.3%) in Sri Lanka (Household Income and Expenditure Survey, 2016). Based on prior research, most studies focused on food security in African countries, highlighting a significant gap in understanding the food security levels and their determining factors in post-COVID-19 and economic crisis Sri Lanka. Additionally, there is an absence of studies assessing food security in the Northern Province of Sri Lanka.

Methodology

Population and Sample

The study identifies the food security status among households in the Northern province of Sri Lanka. The structured questionnaire was used to gather the required information from November 2021 to February 2022. There are five districts in Northern Province, and from each district, 10% of the Grama Niladhari (GN) divisions were selected using the systematic random sampling method. Ten households were randomly selected from each GN division. Therefore, the total number of households was 930. Finally, 909 respondents provided the required

information. The following Table 1 shows the sampling framework:

Table 1 -Sampling Framework

District	No. of DS Divisions	No. of GN Divisions	Sample GN Divisions (10%)	Sample Households	Sample respondents
Jaffna	15	435	44	440	440
Kilinochchi	4	95	10	100	98
Mullaitivu	6	136	14	140	121
Vavuniya	4	102	10	100	100
Mannar	5	153	15	150	150
Total	**34**	**921**	**93**	**930**	**909**

Method of Data Analysis

Descriptive statistics, Lin–log, and Tobit regression models were applied to analyze the data. The following equation provides Lin–log model application:

$$Y_i = \beta_0 + \beta_1 Ln\ X_1 + \varepsilon_I$$

Where:

Y_i = Expenditure on food

$Ln\ X_1 = \text{Log of total Expenditure}$

β_0 = Constant

β_1 = Coefficient of X_1

ε_I = Error term

The food security index is calculated to measure the status of food security. Previous studies used different measures to identify food security status, such as calories and Expenditure on food, which are the significant proxies that indicate the food security level. According to Smith & Subandoro (2007), Expenditure on food to total Expenditure is the primary measure used to calculate the food security index. The food security index is equal to or closer to zero, indicating that particular households spent less on food than other expenditures; therefore, the level of food security is high. On the other hand, the index is closer to one that specifies that households spending more on food means that they still have not attained the food security level. Thus, the movement of this index from zero to one represents the movements of households from high food security to high food insecurity.

Tobit regression model and marginal effects

The Tobit regression model, also called a censored regression model, is a suitable technique for identifying the determinants of food security. This model is designed to estimate linear relationships between variables when there is either left - or right-censoring in the dependent variable, also known as censoring from below and above, respectively. Since the sample population is the censored type, an index that varies from

0 to 100, the Ordinary Least Square (OLS) estimation generates biased and inconsistent parameter estimates. Therefore, the Tobit model was used to examine the factors influencing household food security status in the study. To analyze the determinants of food security status, the limited dependent variable model and its implicit form were expressed as

$y_i^* = \beta' x_i + \varepsilon_i$

$y_i = 0$ if $y_i^* \leq 0$

$y_i = y_i^* \; if \; y_i^* > 0$

where y^* is a limited dependent variable that is unobserved for values less than 0 and greater than 1 and x_i is a matrix of the explanatory variables that include factors affecting a household's food security index. β' is a vector of unknown parameter i to be estimated and ε_i is an independent normally distributed error term with zero mean and constant variance (σ^2).

The Tobit model has an advantage in that its coefficients can be further disaggregated to determine the effects of a change in the i^{th} variable on change in the probability of being food security. The sign of the marginal effect coefficient indicates the directional effect of each variable; in contrast, the magnitude of the effect can be judged from the value of the estimated Coefficient. The value of the marginal effect coefficient implies the changes in the percentage of a household being food secure brought about by one unit change in explanatory variable ceteris paribus. The t-statistic was used to judge the significance of each explanatory variable. At the same time, the Log-likelihood Ratio (LR) test was employed to judge the effect of all variables included in the model or the overall fit of the model on the proportion of households being food secure. The measurement of variables is as follows:

Table 2: Measurement of Variables

Variable	Measurement
Food Security Index	Food expenditure to Total Expenditure (Smith & Subandoro,2007; Rathnayake, Sivashankar & De Silva, 2019)
Age	Age of head of the household in years.
Family size	The number of family members living in the particular house during the study period.
Monthly Monetary income	Amount of monthly income of family members.
Gender	Gender of a head of the family. If female 1, male 0.
Area of residence	A residential area is urban or rural; if urban 1; otherwise 0.
Monthly savings	Amount of monthly savings of family members during the study period.

The Tobit Regression model is as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon_i$$

Where:

Y_i = Food security index

$\beta_0 = \text{Constant}$

$\beta_1 - \beta_6$ = Coefficients of each independent variable

$X_1 - X_6$ = Explanatory variables

ε_i = Error term

Results and discussion

This section provides results and a discussion of the analyzed data. Table 1 presents the summary statistics of the variables.

According to the results, the average age of the households is 42 years, and the average number of family members is three (03). Before COVID-19 in Nothern Province, the average household total Expenditure was Rs.44,020, and food expenditure was Rs.20,639 (Household Income and Expenditure Survey-2019). However, the study results show an income of Rs.78,516 and a total expenditure of Rs.55,560. After COVID-19, expenditures increased due to the price increase. Further, the food expenditures were Rs.17,990, revealing that people spent more on other things than food and less on food. These results prove that due to COVID-19, people have changed their consumption patterns. The computed mean value of the Food Security Index, standing at 33.02, indicates a moderate level of food security among the households in Northern Province, Sri Lanka.

Table 3: Descriptive statistics of the variables

Variable	Minimum	Maximum	Mean	Standard deviation
Age	20	72	42.40	12.54
Family size	1	7	3.28	1.20
Total income (Rs.)	5,000	400,000	78,516	39,277
Total Expenditure (Rs.)	7,700	134,240	55,560	17,296
Expenditure on food (Rs.)	1,900	45,000	17,990	6,009
Amount of savings (Rs.)	00	351,400	26,325	29,796
Food security index	12	64	33.02	7.167

Source: Computed by authors, 2022

The correlation analysis indicates a notable negative relationship between the food security index, family size, and age, signifying a 1% level of statistical significance.

Table 4: Correlation analysis

Variables	Family size	Age	Total Income	Food Expenditure	Savings	Total Expenditure
Age	0.17**					
Total Income	0.33**	0.17**				
Food Expenditure	0.35**	0.14**	0.52**			
Savings	0.18**	0.14**	0.93**	0.37**		
Total Expenditure	0.56**	0.23**	0.49**	0.71**	0.22**	
Food Security Index	-0.26**	-0.12**	0.03	0.42**	0.17**	-0.29**

** Significant at 1% level

Conversely, it reveals a positive correlation between the food security index, food expenditure, and savings. Remarkably, a significant positive correlation exists between total income and total Expenditure, while a significant negative correlation is observed between total Expenditure and the food security index. This outcome distinctly emphasizes that food security is directly linked to Expenditure and indirectly associated with the food security index. However, the study finds the correlation between the food security index and total income to be insignificant.

Results of the Lin–log model

The Lin- Log was used to estimate the impact of total Expenditure on food expenditure. It has been applied in Engel expenditure functions, named after the German statistician Ernst Engel (1821–1896). Engel postulated that "the total expenditure that is devoted to food tends to increase in arithmetic progression as total expenditure increases in geometric proportion." Another way of expressing this is that the share of Expenditure on food decreases as total expenditure decreases (Gujarati, 2012).

The relationship between food expenditure and total expenditure is illustrated graphically below:

Figure 1 shows the relationship between food expenditure and total expenditure, which recommends that food expenditure increase more slowly as total expenditure increases, perhaps giving credence to Engel's law.

Food security status is measured as the ratio of food expenditure to total Expenditure. It was categorized into three groups of households based on the minimum and maximum values of the index suggested by Smith & Subandoro (2007). According to the food security index, less than 30, between 30 and 40, and above 40 indicate high, moderate, and low food security, respectively. The results prove that 32.5% of sample respondents' food security level is high, 53.9% of respondents' is moderate, and the rest of the 13.6% suffer from food insecurity.

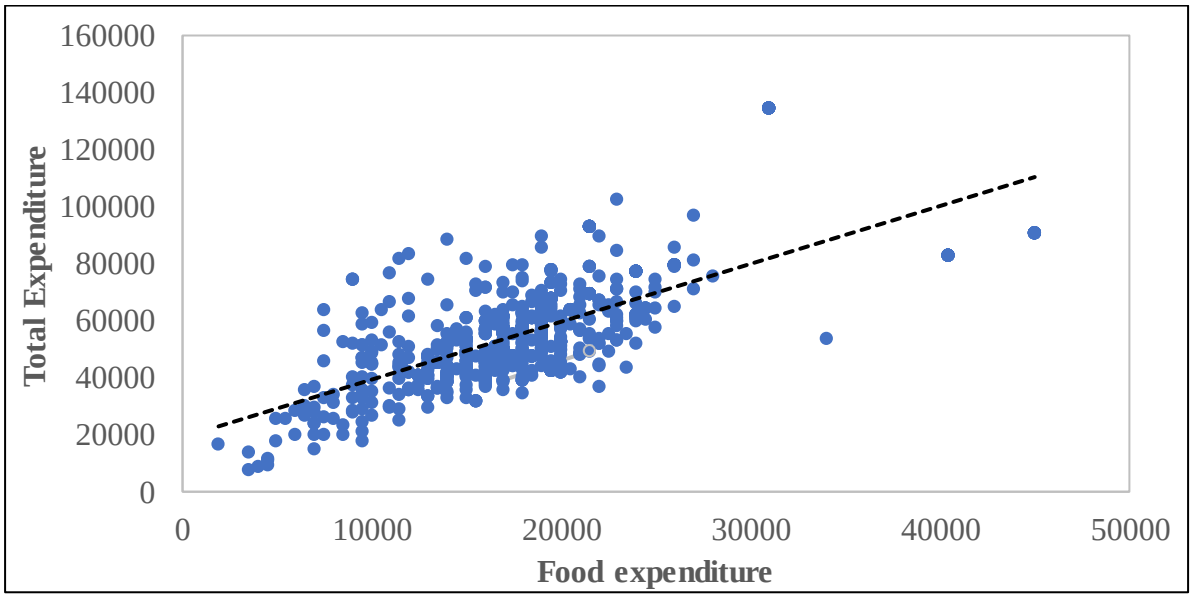

Figure 1: Relationship between food expenditure and total Expenditure

Table 4: Results of the Lin–log model

Variable	Coefficient	Standard error	Standardized Coefficient	t - value
Log of Total Expenditure	12883.56***	446.95	0.69	28.83
Constant	-122143.04	4863.54		-25.11
F – value	830.92***			
R-Value	0.69			
R^2Value	0.48			

Note: *** represents the 1% level of significant

Table 4 provides the Lin–log model results. The slope coefficient value 12,883.56 specifies that changes in the total Expenditure of one percent (1%) lead to about Rs.128.83 changes in the food expenditure. This result is statistically significant at the 1% level. Thus, the findings of this study support the Engel expenditure models, which represent that the household will spend a lower rate on food as their total expenses increase.

Table 5 shows the Tobit regression model results. According to the results, the overall model is significant at a 1% level, as indicated by the Log-likelihood ratio test (Prob > $\chi 2$ = 0.0000). The estimated model reveals that age, family size, total income, and amount of savings are highly significant at a 1% level of the six explanatory variables. At the same time, gender and place of residence were significant at a 5% level.

The Coefficient of age shows a negative sign, indicating the older household head has a

higher probability of achieving food security than young-headed households because an increased level of the age of the household head supports more food security due to the age maturity. Increasing the level of age of the household head motivates dependents to find a job and increase their earning capacity, which stimulates more security in food. Marginal effects of age in the model represent that older people have 0.00022% or less probability of being food insecure than younger people. This result is consistent with the findings of Sekhampu (2013).

Table 5: Estimated results of the Tobit model and marginal effects

Variables	Coefficient	Standard error	t - value	Average marginal effects
Age	-0.05***	0.02	-2.78	-2.22e-06**
Family size	-1.60***	0.19	-8.23	-0.00***
Log of total income	-4.16***	0.64	-6.50	-0.00***
Sex	-2.41**	0.98	-2.47	-0.00**
Place of residence	-1.19**	0.49	-2.40	-0.00**
Amount of savings	0.00***	0.00	9.72	4.52e-09***
Constant	85.07	6.94	12.26	
Number of observations				909
Uncensored				909
Left - censored				0
Right - censored				0
LR Chi-square (6)				169.52
Probability > chi-square				0.00
Pseudo R- square				0.03
Log-likelihood				-2997.28

Note: *** and ** represent the significant levels at 1% and 5%, respectively

Family size negatively impacts food insecurity, revealing that households with more family members tend to be more food secure than households with fewer family members. More members in a family may compose more productive members, which imposes a lower burden on the labor force and makes more food available to each person, ultimately leading to high food security. The negative sign of the family size in marginal effect implies that a unit increase in the number of the family decreases the probability of food insecurity of the household by 0.00068% while other variables are held constant. This finding is opposite to the result of Sani & Kemaw (2019) but similar to Faustine (2016), which concludes that a larger family size helps provide more labor for production and positively associates with the food security status of a household. Total income and food insecurity show a negative impact on food security. This result is statistically significant at the 1% level, indicating that the households that earn more

income become more food secure than the low-income households. Thus, the higher the household's income persuades, the higher the probability of food security. Further, results of the marginal effect show that keeping other things unchanged, as the income of the household increases by one more rupee, will decrease the probability of being food insecure by 0.0176%. The finding was consistent with (Sekhampu, 2013; Yehuala et al., 2018).

The gender of a household head has a negative and significant effect on food security status, implying that female-headed households are more food secure than male-headed households. The marginal effect of gender indicates that female-headed families have a 0.0102% lower probability of becoming food insecure than male-headed families. This finding aligns with the results of Maziya et al. (2017).

The place of residence indicates a significant effect on food security; households residing in urban areas seem to have high food security compared to households living in rural areas. Urban households have more earning capacity, which helps them spend on adequate food and attain food security. A household living in an urban area has a 0.005% less probability of becoming food insecure than the rural households in the study. Rural households mainly depend on agricultural products, and their monetary income is less than non-monetary income; therefore, their food security index may be high. Further study needs to confirm this result.

Savings affect the status of food security through various dimensions, such as availability and access to food, representing households' ability to purchase food (Shaw & Nagarajan, 2011). The Coefficient of savings is positive and statistically significant at the 1% level, revealing that a household saving less has a higher probability of attaining high food security than a household saving more. Due to the high prices of food items and other essential goods during the COVID-19 and economic crisis, households saved less. This situation indicates that the households have to spend more money purchasing food to fulfill their current needs, giving them more security in food than their counterparts. The marginal effect of saving has a very low positive value, representing that the probability of becoming food secure will be higher among households who save less because of the higher Expenditure on food items. Therefore, it leads to low savings.

Conclusion

The study identifies the determinants of food security in Northern Province, Sri Lanka. A multi-stage sampling method was used to select the GN divisions, and a random sampling method was used to select the respondents from each GN division. Descriptive statistics, correlation analysis, the Tobit model, and the Lin-log model were used to identify the determinants of food

security. Among the households, 32.5% were at high levels of food security, 53.9% had moderate levels, and the rest of the 13.6% belonged to low food security. Results of the Tobit model revealed that the age of the household head, family size, income, and the amount of savings highly contributed to the status of food security, followed by sex and place of residence were also contributing to enhance the status of food security. Age matured heads of households are more food secure than the younger heads of households, and the households with a more significant number of members in the family are more secure in food than their counterparts. Compared to male-headed households, female-headed households are more food secure, and the households who save are less able to attain high food security than those who save more. Apart from these, income earned by the households and the residential place also play a significant role in food security in the study area. The age of the households, residential place, gender, and family size are also important in determining food security status. Therefore, more attention must be paid to these most important factors to improve food security in the study area. Further, the results support the empirical literature on the importance of human capital development in the status of food security, and this will help policymakers when formulating policies to reduce household food insecurity in the future.

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