HOUSEHOLD INCOME DIVERSIFICATION AND FOOD SECURITY IN SRI LANKA

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Abstract

Diversifying income sources is recognized as a crucial strategy to boost earnings, mitigate risk, and reduce economic vulnerability. Despite its importance, the relationship between food security and income diversification in Sri Lanka hasn't received sufficient attention. Therefore, this study investigates how Sri Lankan food security is impacted by income diversification by analyzing 19,783 national representative households' data taken from the 2019 Household Income and Expenditure Survey (HIES). The nutrition-based Food Security Index (FSI) was used to assess food security. Food security is measured by dividing the daily calorie intake by the recommended per capita daily calorie intake of all household members. An FSI value below 1.0 indicates food insecurity, while values at or above 1.0 indicate food security. Income diversification was measured using Simpson's Index of Diversity (SID), with households possessing multiple income sources classified as having diversified income portfolios. Descriptive statistics, multiple linear regression and probit regression were used to analyze the data. The results reveal that over half of households have a variety of sources of income, indicating that households typically rely on multiple sources of income rather than just one, and FSI, with a mean of 1.11, suggests that households are food secure on average. Ultimately, the analysis revealed that the household food security in Sri Lanka is positively and significantly impacted by income diversification. Sectoral analysis indicates that rural and urban households have wider income sources compared to households in the estate sector, while the estate and rural sector households are generally food secure, compared to the households in the urban sector. These

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findings highlight the importance of promoting income diversification strategies among Sri Lankan households to enhance food security and build resilience against economic shocks in Sri Lanka.

Keywords: Food security; Household income; Income diversification; Rural-urban disparities; Sri Lanka

1. Introduction

As a developing country, Sri Lankan households deal with considerable income risk and food security challenges. Moreover, income streams within Sri Lanka are highly depend on the geography, agricultural climate, and socio-economic factors. In response to these challenges, households across the country are pursuing diversification strategies and exploring multiple income sources instead of relying on a single, favored source (Senevirathna and Dharmadasa, 2021).

Food security continues to be one of the most fundamental development issues that Sri Lanka and the world face. According to the Food and Agriculture Organization (FAO, 1996), Food security is when all people in a household can access sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Even though global food production has increased, millions of people are still suffering from food insecurity around the world, exacerbated by problems such as decreasing agricultural land and water for agricultural activity, and environmental changes (Bashir and Schilizzi, 2012). In Sri Lanka specifically, food insecurity impacts a significant proportion of the population, given recent evidence of increased vulnerability at the household level, noting an escalation in unhealthy coping strategies, such as eating less and relying more on social services (Asian Development Bank, 2023). While wealthier countries are somewhat insulated from economic shocks, developing nations like Sri Lanka can suffer tremendously from seemingly small economic fluctuations or price increases.

Diversification of income sources is increasingly viewed as a solution for household income fluctuation, to fight poverty, and promote economic stability. When a household has multiple income sources, it increases household income and helps cover essential needs such as food, education, and healthcare. Income diversification has been particularly recognized as a potential strategy to enhance food security and household resilience, as it helps reduce the risks linked to overreliance on agriculture, especially in rural areas where households often face poverty and environmental challenges (Jayasinghe et al., 2017). These dynamics are especially important in the Sri Lankan context, where agriculture remains a dominant livelihood activity yet is increasingly vulnerable to climate variability and market fluctuations.

Despite the importance of income diversification increasing food security, there remains a lack of empirical studies on how these two are interconnected in Sri Lanka. This study attempts to narrow this gap by analyzing the relationship between

diversified income sources and household food security outcomes. This could provide valuable insights for policymakers and stakeholders working to improve food security and economic resilience among Sri Lankan households.

1.1 Objectives of the study

Main Objective:

To examine how income diversification relates to food security status in Sri Lankan households.

Specific Objectives:

- To assess the extent of income diversification practiced by households in Sri Lanka.
- To examine the association between income diversification and food security outcomes at the household level.
- To determine the key factors influencing income diversification strategies and evaluate their effects on household food security.

2. Literature Review

Income can originate from conventional as well as unconventional channels, and its consistency and amount greatly influence the financial stability and standard of living of people and families (Zouaoui and Zoghlami, 2023). When households expand household income through various sources such as wages, agriculture, non-agricultural sources, and miscellaneous cash receipts, it's classified as having diversified income (Senevirathne and Dharmadasa, 2021). When the household diversifies its income, it boosts its overall monthly earnings and positively impacts its access to food (Bekele et al., 2018; Zoungrana and Amelie, 2022; Tithy et. al., 2016). Moreover, expanding the sources of income will relieve budgeting constraints for households and allow more resources to go toward the necessities of food, clothing, education, and health (Bekele et al., 2019).

According to the FAO food security arises when everyone has the physical and financial means to obtain sufficient nutritious food that satisfies their dietary needs (FAO, 2010). Poverty is a significant marker of food security, particularly regarding food access (Yuniarti et al., 2022). In Sri Lanka, around 4.5 million people suffer from food insecurity (Eshanm et al., 2017).

FAO's concept of food security comprises four primary dimensions: food access, food availability, food utilization, and the long-term sustainability and stability of food resources (Kakwani and Son, 2016). To calculate food security at the household level, most studies commonly use calorie adequacy (Manikas and Sundarakani, 2023). In addition, dietary diversity and experience-based indicators are also used. However, food utilization and stability are less frequently measured, and

only three studies considered all four dimensions of food security (Manikas and Sundarakani, 2023).

Numerous studies have proven that income diversification plays a crucial role in enhancing food security (Zoungrana and Amelie, 2022; Atuoye et al., 2019; Bekele et. al., 2019; Tithy et. al., 2016; Agbola et al., 2008). The evidence suggests that more than 61% of households in Sri Lanka have made significant improvements to their welfare and resilience to economic shocks by diversifying their income sources (Senevirathne and Dharmadasa, 2021). Moreover, various studies suggest that income diversification plays a crucial role in enhancing food security. For example, households' participation in rural off-farm activities is essential for mitigating their food insecurity (Gebre et al., 2023).

Similarly, over the past two decades, significant interest has developed in understanding the connection between diversifying income sources and ensuring food security, particularly among small-scale farmers (Anang and Apedo, 2023). According to Babatunde and Qaim (2010), farmers who earn income from sources outside of farming experience lower rates of child stunting and underweight compared to households without off-farm incomes. Food accessibility relies on both household income availability and its distribution within households, with food pricing and the stability and consistency of income sources being crucial for maintaining food security (Akeem et al., 2020).

Kilic et al. (2009) observed that the income earned from agricultural activities is insufficient to support them for the entire year, leading them to seek additional off-farm income during critical periods between food shortages and subsequent harvests. According to Agbola et al. (2008) families engage in activities such as cultivating crops, collecting wild produce, and offering agricultural labor to supplement their income and mitigate food shortages.

Chang and Mishra (2008) proposed that households with greater access to revenue-creating opportunities or better-paying employment tend to exhibit higher income levels and greater food security compare to households lacking such advantages. Income from off-farm activities tends to stabilize income streams, as wages from off-farm work are typically less volatile than those from on-farm sources (Mishra and Sandretto, 2002).

A study conducted in Burkina Faso, focusing on rural and urban households' income diversification and food security, revealed that the majority of households suffer from food security(Zoungrana and Amelie, 2022). Etea et al. (2019) investigated diversification of household income and food security in Ethiopia, using a sample of 350 semi-urban and urban households and four revenue sources. The evidence indicated that diversification of income was positively related to food security within the area of study. Mamman et al. (2019) analyzed income diversification and socioeconomic determinants affecting farm households' food security in Nigeria's state of Jigawa using data from 200 sampled households. The study concluded that livelihood diversification and income diversification reduce the incidences of food poverty among farm households in the state. Additionally, most such households are food secure. Dev et al. (2017) examined the manner in which income diversification strategies affect household food security in rural households in Bangladesh. The research indicated that income diversification was positively

associated with household food security but not at a significant level. Agbola et al. (2008) examined the manner in which income diversification strategies affect food insecurity in Nigeria. It concluded that income diversification strategies were vital in determining the level of food insecurity observed.

Although various studies have examined the relationship between income diversification and food security in developing countries, empirical research focused specifically on Sri Lanka is limited. Despite approximately 4.5 million people in the country experiencing food insecurity (Eshanm et al., 2017) and the rising adoption of income diversification strategies among households (Senevirathne and Dharmadasa, 2021), their relationship has not been accorded sufficient priority. It is in filling this gap that this study proposes to contribute by examining nationally representative data from the 2019 HIES to explore how income diversification impacts food security among households in Sri Lanka's rural, urban, and estate regions.

3. Methodology

3.1. Data Source

This study used 2019 Household Income and Expenditure Survey (HIES) data conducted by Sri Lanka's Department of Census and Statistics (DCS, 2019). It provides a nationally representative dataset that captures detailed information on household income sources, expenditure patterns and food consumption. The study focused on how different income streams influence household access to adequate nutrition, as reflected in calorie intake. In the HIES dataset, food consumption data were collected over a weekly period, detailing the quantity of each food consumed by households. To examine calorie intake per person, the Sri Lanka Food Composition table, published by the Department of Nutrition, Medical Research Institute in 2021, was used (Jayatissa et al. 2017). And the average daily minimum calorie intake was considered to be 2030 kilocalories, as suggested by the Sri Lanka Medical Research Institute and the Department of Census and Statistics calculations (Thilani, 2022). Due to the exclusion of households with zero total income, the analysis was based on a sample of 19,783 households.

3.2. Data Analysis

3.2.1.Measuring the Income Diversification

The extent of this income diversification is measured using the Simpson's Index of Diversity (SID), one of the most commonly used methods for assessing income diversification in empirical studies (Akamo et al,2020; Dev et al., 2017; Etea et al. 2019).

$$\text{SID} = 1 - \sum_{i=1}^{n} pi^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

n = Total income sources and Pi = proportion of household income derived from individual sources. Table 1 shows the criteria used to determine the extent of income diversification, based on the classification of Dev et al. (2017).

Table 1; Level of Income Diversification Criteria

SID value	Group
0<SID<=0.3	Low-income diversification
0.31=<SID<=0.6	Moderate income diversification
0.61=<SID<=1	High-income diversification

3.2.2.Measuring the Determinants of Income Diversification

A probit model is used to measure the determinants of income diversification.

$P(Y) = ß_0 + ß_1X_1 + ß_2X_2 + ß_3X_3 + \ldots ß_{12}X_{12} + u$ ..... (2)

- (Y =1) income diversified (income sources >1)
- (Y= 0) otherwise (income sources = 1)

Table 2 shows the independent variables in the probit model for determinants of income diversification.

Table 2; Model specification – determinant of income diversification

Dependent Variable	**Explanation**
Income diversification	Dummy = 1 diversified, 0 = otherwise
Independent Variables	**Explanation**
Characteristics of household head	
Age (X_1)	Year
Education (X_2)	Year
Gender (X_3)	Dummy = 1 male, 0 = otherwise
Marital status (X_4)	Dummy = 1 married, 0= otherwise
Characteristics of household	
Size of household (X_5)	Number of household members
Total elder dependents (X_6)	Number of members > 60 years
Total younger dependents (X_7)	Number of members < 15 years
Number of individuals aged over 15 with primary education (X_8)	Number of members grade 1-5
Number of individuals aged over 15 with secondary education (X_9)	Number of members grade 6 -13
Number of individuals aged over 15 with tertiary education (X_{10})	Number of members in higher education (GAQ, diploma, degree, PhD)
Regional dummies	
Urban (X_{11})	Dummy =1 Urban, 0 = otherwise
Rural (X_{12})	Dummy =1 Rural, 0 = otherwise

3.2.3.Measuring the Food Security

The food security index (FSI) is used to measure food security. When the FSI is more than or equal to one, the household is categorized as food secure; otherwise, it is categorized as food insecure (Etea et al. 2019).

$$FSI = Y_i / R \quad \text{.....} \quad (3)$$

- Y i = Real daily calorie intake of the i^{th} household per person
- R = Recommended daily calorie intake per person

3.2.4.Measuring the Impact of Income Diversification on Food Security

The probit model is used to measure how income diversification impacts food security.

$$P(Y) = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \ldots \gamma_{18} X_{18} + e \quad \text{.....} \quad (4)$$

- (Y =1) food secure (FSI >=1)
- (Y= 0) otherwise (FSI< 1)

γ_0 is the intercept, X1-X18 represent the independent variables, γ_1 - γ_{18} are coefficients of the independent variables, and e is the error term. Multiple linear regression is used to measure the impact of income diversification on the food security index using same independent variables (Etea et al. (2019)

$$Yi = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \ldots \alpha_{18} X_{18} + \varepsilon_i \quad \text{.....} \quad (5)$$

Yi represents the data on food security index and X_1 - X_{18} represent the independent variables. α_0 is the intercept, α_1 - α_{18} are the coefficients of the independent variables and ε_i is the error term.

Table 3 present the independent variables in the both models. These variables were selected based on the availability of HIES (2019) data, (DCS, 2019) Senevirathna and Dharmadasa (2021), Zoungrana and Amelia (2022), Dev et al., (2017) previous studies.

Table 3; Independent variables and their explanations for measuring how income diversification impacts food security

Variables	Explanation
Income diversification (X_1)	Dummy = 1 diversified, 0 = otherwise
Characteristics of household head	
Age (X_2)	Year
Education (X_3)	Year
Gender (X_4)	Dummy = 1 male, 0 = otherwise
Marital status (X_5)	Dummy = 1 married, 0= otherwise
Characteristics of household	
Size of household (X_6)	Number of household members
Total elder dependents (X_7)	Number of members > 60 years
Total younger dependents (X_8)	Number of members < 15 years
Number of individuals aged over 15 with primary education (X_9)	Number of members grade 1-5
Number of individuals aged over 15 with secondary education (X_{10})	Number of members grade 6 -13
Number of individuals aged over 15 with tertiary education (X_{11})	Number of members in higher education (GAQ, diploma, degree, PhD)
Religion – Buddhism (X_{12})	Dummy = 1 Buddhism, 0 = otherwise
Religion – Hindu (X_{13})	Dummy = 1 Hindu, 0 = otherwise
Religion – Islam (X_{14})	Dummy = 1 Islam, 0 = otherwise
Cultivating seasonal crops (X_{15})	Dummy = 1 cultivating, 0 = otherwise
Ratio of monthly food expenditure (X_{16})	Monthly food expenditure / Monthly total expenditure
Regional dummies	
Urban (X_{17})	Dummy =1 Urban, 0 = otherwise
Rural (X_{18})	Dummy =1 Rural, 0 = otherwise

4. Results And Discussion

4.1. Means of Selected Variables

According to the descriptive statistics in Table 4, the mean income diversification of 59% indicates that over half of the households in Sri Lanka have expanded their income by engaging in multiple sources of income. This diversification varies among sectors due to differences in market accessibility, employment opportunities and suitability for agriculture across regions. The rural sector shows the highest mean of income while the estate sector shows the lowest. These results are consistent with studies conducted by Senevirathne and Dharmadasa (Senevirathne and Dharmadasa, 2021). The Food Security Index (FSI) with a mean of 1.11 suggests a moderate level of food security on average. The highest FSI value is found in the estate sector, while the lowest is in the urban sector. These findings are also in line with the study by Deyshappriya (2019). The FSI values in the estate and rural areas are nearly identical and above 1, suggesting better food security conditions. This is because people in the

rural and estate sectors predominantly invest in energy-rich staple foods, which enhances their chances of attaining food security compared to urban areas (Deyshappriya, 2019). In the urban sector, the value is just under 1, indicating potential food insecurity concerns. Specially in the Estate sector, households have relatively low-income diversification (0.44) but maintain a high FSI (1.18). This apparent paradox can be explained by their direct engagement in tea plantation work and subsistence agriculture, which provides consistent access to food sources (Senevirathne and Dharmadasa, 2021).

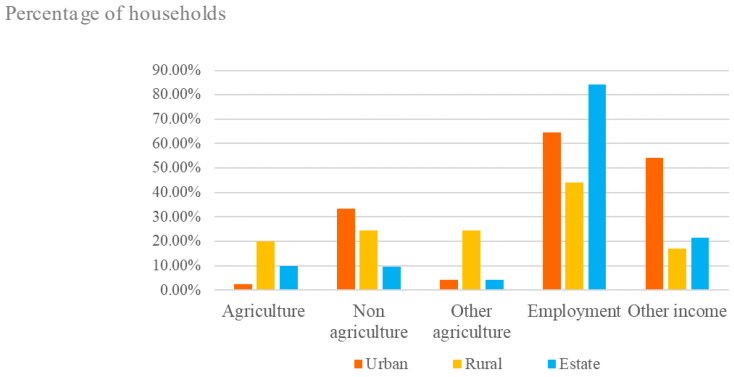
Table 4; means of selected variables

Variables	Obs	Mean (Urban)	Mean (Estate)	Mean (Rural)	Mean (All)
Characteristics of household head					
Age	19,783	54.60	53.86	54.29	54.17
Education	19,783	10.00	5.57	8.46	8.49
Gender	19,783	0.75	0.74	0.75	0.75
Marital status	19,783	0.97	0.98	0.98	0.98
Characteristics of household					
Size of household	19,783	3.85	4.03	3.69	3.74
Total elder dependents	19,783	0.66	0.61	0.63	0.62
Total younger dependents	19,783	0.82	0.99	0.86	0.87
Number of individuals aged over 15 with primary education	19,783	0.54	1.34	0.70	0.72
Number of individuals aged over 15 with secondary education	19,783	2.93	2.47	2.74	2.76
Number of individuals aged over 15 with tertiary education	19,783	0.22	0.02	0.10	0.12
Religion – Buddhism	19,783	0.58	0.09	0.78	0.67
Religion – Hindu	19,783	0.13	0.81	0.08	0.16
Religion – Islam	19,783	0.14	0.02	0.06	0.09
Having seasonal crops	19,783	0.02	0.08	0.16	0.14
Ratio of monthly food expenditure	19,783	0.38	0.55	0.46	0.46
Income diversification					
Income diversification	19783	0.51	0.44	0.62	0.59
Food Security Index (FSI)					
FSI	19783	0.99	1.18	1.12	1.11

Figure 1 shows the percentage of households deriving income from various sources by sectors. According to the graph, the highest income in all sectors comes from employment sources. Even the rural sector derives its income mainly from employment. According to Samaraweera et al. (2022) the agricultural workforce has seen a consistent yearly decrease of approximately 1.15% between 2013 and 2018.

Additionally, from 2006 to 2014, figures show that non farming jobs expanded more rapidly than agricultural employment in Sri Lanka (Samaraweera et al., 2022)

Figure 1; Percentage of households deriving income from various sources by sectors



4.2. Income Diversification Status in Study Area

Table 5; Percentage of income diversified households

Sector	Total households	Income diversified households	Percentage of income diversified households
All	19783	11,720	59.2%
Rural	15753	9,737	61.8%
Urban	3185	1,609	50.5%
Estate	845	374	44.3%

The findings from Table 5 demonstrate that income diversification is higher in the rural sector compared to the other two sectors. Specifically, 61.8% of rural households have diversified their sources of income. Similar findings were reported by Senevirathne and Dharmadasa (2021), who indicated that rural households exhibit greater levels of income diversification than urban and estate households. According to them, this suggests a strategy for managing challenges in agriculture, particularly for Sri Lanka's rural population, which is heavily involved in farming. These households face risks due to unpredictable shifts in weather patterns, especially fluctuations in rainfall. Further, Ersado (2006) observes that rural households generally have a wider range of income sources than their urban counterparts, and this diversification tends to decline as urbanization increases. The estate sector shows the lowest level of income diversification since there are suffering from a lack of job opportunities and constraints towards access to education and training, which ultimately leads to the hindrance of developing alternative income sources (Dharmadasa and Polkotuwa, 2016). And the urban sector shows lower income diversification compared to the rural sector. according to Senevirathne and

Dharmadamsa (2021) this can be happening due to the urban household earning sufficient income from their primary income sources compared to the rural sector.

Table 6 shows the level of income diversification among households. The outcomes indicate that a large proportion of urban and rural sector households show moderate income diversification. Suggesting that the majority of those households try to diversify their income to withstand economic vulnerabilities while improving their living standards. But in the estate sector, it shows low diversification reflecting the availability of a limited number of income sources and potentially increasing their susceptibility to unexpected hardships and pressures.

Table 6; Results of the level of income diversification in Sri Lanka

Degree of diversification	Sector	No. of income diversified households	Percentage of income diversified households
Low diversification	Rural	4,446	28.2%
	Urban	742	23.3%
	Estate	191	23%
Moderate diversification	Rural	4,830	31%
	Urban	827	26%
	Estate	173	20.5%
High diversification	Rural	461	3%
	Urban	40	1.3%
	Estate	10	1.2%

4.3. Determinants of Income Diversification

A probit model was used to examine the factors affecting income diversification, and the results revealed that several factors significantly affect income diversification. According to the results in Table 7, household heads' age significantly affects household income diversification. Similar results were found by Dharmadasa and Polkotuwa (2016) and Senevirathne and Dharmadasa (2021), stating that the age of the household head is a primary factor influencing income diversification in households. According to these studies, the likelihood of a household diversifying its sources of income increases with the age of the household head due to the accumulation of work experience and knowledge over time. However, the household head's education level is negatively associated with income diversification. This may be because higher education often leads to specialization in a particular field, causing individuals to focus primarily on that area and limiting their engagement in diverse income-generating activities.

Moreover, male-headed households tend to have more income diversification compared to female-headed households. This may reason of female-headed households frequently face problems related to education, limited access to credit,

and fewer employment opportunities. (Vimefall et al. 2015) which leads to a reduction in income sources to one or a few. There is also a positive and significant relationship between marital status and income diversification, indicating that households with a married household head tend to have more income sources compared to households with an unmarried household head. This is likely because marriage provides increased economic resources and opportunities for risk-sharing, enabling households to diversify their income sources. Moreover, married partners can combine their labor and capital, allowing them to participate in a broader range of income-generating activities (Phay and Sokcheng, 2014).

Household size also shows a positive and significant relationship with income, diversifying, suggesting that having more family members enables households to earn income from multiple sources (Adem and Tesafa 2020). Additionally, younger dependents show a negative but significant relationship with income diversification, while older dependent show a positive and significant relationship with the income diversification. A similar result was observed by Senevirathne and Dharmadasa, (2021). Martin and Preston (1994) also reveal that elderly households have seen real income growth over the years.

Furthermore, the number of household members with higher education shows a positive and significant relationship with income diversification. Highlighting that the number of members with education improves the opportunity for earning income, indicating that education improves opportunities to access lucrative non-agricultural income streams, thereby boosting income diversification. Similar results were found by Babatunde and Qaim (2009) and Loison (2015). The finding also reveals that income diversification in the rural sector exceeds compared of the other two sectors. This aligns with the findings of (Senevirathne and Dharmadasa, 2021).

Table 7; Determinants of income diversification – result of probit model

Variables	Marginal effect (dy/dx)	Z	P>|z|
Characteristics of household head			
Age	0.003	2.90	0.004**
Education	-0.031	8.82	0.000***
Gender	0.010	4.27	0.000***
Marital status	0.118	1.81	0.071*
Characteristics of household			
Size of household	0.144	9.20	0.000***
Total elder dependents	0.029	1.66	0.097*
Total younger dependents	-0.119	7.27	0.000***
Number of individuals aged over 15 with primary education	0.081	4.68	0.000***

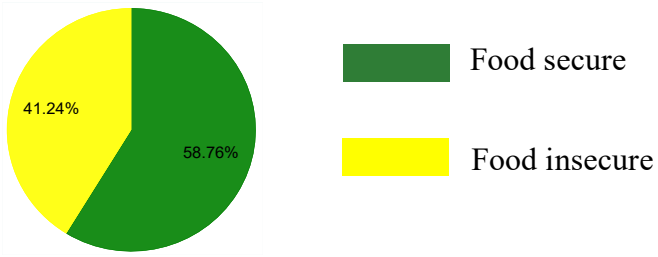
Number of individuals aged over 15 with secondary education	0.096	6.96	0.000***
Number of individuals aged over 15 with tertiary education	0.268	8.74	0.000***
Regional dummies			
Rural	0.579	11.82	0.000***
Urban	0.269	4.96	0.000***
Number of obs	**19,783**		
Wald chi2(12)	**1188.69**		
Prob > chi2	**0.0000**		
Pseudo R2	**0.0580**		

Note: *** statistically significant at 1%, ** statistically significant at 5%,* statistically significant at 10%

4.4. Food Security status in Study Area

Figure 2 illustrates the status of food security among households, showing that more than 50% of households in Sri Lanka are food secure. A recent study revealed that the incidence of food insecurity is 41.9% among Sri Lankan households (Deyshappriya, 2019). That means that more than 50% of households are food secure.

Fig. 2 Food security status in study area



Figures 3,4, and 5 illustrate the percentage of food-secure households by sector. The findings suggest that the majority of households in urban areas are food insecure, while most households in rural and estate areas are food secure. These results align with a study conducted by Deyshappriya (Deyshappriya, 2019). In urban areas such as Colombo, Gampaha, and Kalutara districts, the cost of living is high, leading to less money being spent on food items in comparison with non-food expenditures like housing, education, transportation, and healthcare. Additionally, urban households tend to spend on ready-made meals due to long working hours, but they consume very little energy-dense foods like rice, wheat, and yams (Deyshappriya, 2019). In contrast, households in estate and rural areas are more involved in food production and agriculture, either as small-scale farmers or plantation laborers, which gives them better access to and control over their food sources. Furthermore, rural and estate areas generally have more land and natural resources, enabling households to cultivate essential foods and engage in agricultural activities. However, the estate

sector is more food secure than the rural sector. Similar findings were reported by Deyshappriya (2019).]. Based on our findings, the ratio of monthly food expenditure is 55% in the estate sector, the urban sector 38% and 46% in the rural sector. Therefore, estate sector households spend more on food than other sectors. According to Dharmadasa and Polkotuwa (2016), the estate sector experiences a significantly lower socioeconomic status than the other two sectors, with poverty posing a substantial challenge. This may make them more dependent on affordable, energy-rich staple foods to meet their caloric needs.

Figure 3 Food security status in urban sector

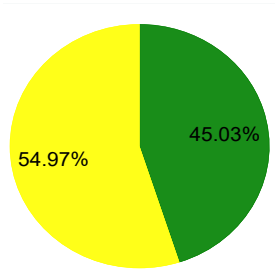


Figure 4 Food security status in rural sector

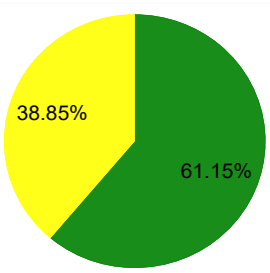
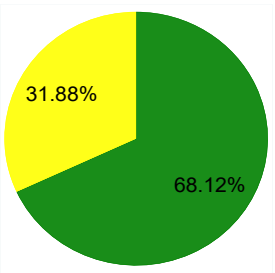


Figure 5 Food security status in estate sector



4.5. Results of How Income Diversification Impacts of Food Security

Probit model and multiple linear regression models were utilized to determine how the diversification of household income impacts food security. To enhance the accuracy and relevance of the conclusion from the probit model, multiple linear regression was applied to the entire dataset to evaluate the relationship between income diversification and the food security index (FSI) in Sri Lanka (Etea et al. 2019).

Table 8; How income diversification impacts on food security

	Probit Model			Multiple Linear Regression		
Variables	**Marginal effect (dy/dx)**	**Z**	**P>|z|**	**Coefficients**	**t**	**P>|t|**
Dependent variable – food security				**Dependent variable – food security index (FSI)**		
Characteristics of household head						
Age	-0.0000	-3.44	0.001**	-0.0000	-4.65	0.000***
Education	0.0075	2.03	0.043**	0.0035	3.49	0.000***
Gender	-0.0017	-0.07	0.944	-0.0110	-1.59	0.111
Marital status	0.4752	6.82	0.000***	0.2082	6.81	0.000***
Characteristics of household						
Size of household	-0.3604	21.72	0.000***	-0.1163	-26.61	0.000***
Total elder dependents	-0.0642	3.67	0.000***	-0.0073	-1.72	0.086*
Total younger dependents	-0.1372	8.47	0.000***	-0.0268	-7.15	0.000***
Number of primary education members (age >15)	0.1677	9.44	0.000***	0.0521	12.21	0.000***
Number of secondary education members (age >15)	0.2666	18.04	0.000***	0.0801	20.92	0.000***
Number of tertiary education members (age >15)	0.3246	10.59	0.000***	0.1038	13.71	0.000***
Religion – Buddhism	0.1446	3.76	0.000***	0.0528	5.25	0.000***
Religion – Hindu	0.0975	2.13	0.033**	-0.0534	4.34	0.000***
Religion – Islam	-0.3059	-6.12	0.000***	-0.0500	-4.04	0.000***
Having seasonal crops	0.2743	8.68	0.000***	0.0819	10.66	0.000***
Ratio of monthly	0.9837	14.46	0.000***	0.3219	16.27	0.000***

food expenditure						
			Regional dummies			
Rural	0.2942	10.34	0.000***	0.0772	10.22	0.000***
Estate	0.6266	10.50	0.000***	0.1622	10.45	0.000***
			Income diversification			
Income diversification	0.1575	7.27	0.000***	0.0422	7.22	0.000***
constant	-0.4923	-4.88	0.000***	0.8239	22.36	0.000***
Number of observation		=	19,783	Number of observation	=	19,783
Wald chi2(18)		=	2112.73	F(18, 19764)	=	188.03
Prob > chi2		=	0.0000	Prob > F	=	0.0000
Pseudo R2		=	0.1055	R-squared	=	0.1592
				Root MSE	=	.34929

Note: *** statistically significant at 1%, ** statistically significant at 5%, *statistically significant at 10%

According to the results in Table 8 all the variables except gender show significant impact on food security. The finding reveal a strong, positive and significant relationship between household income diversification, and household food security, indicating that having multiple income sources leads to to more food secure household. This may reason of diversifying household income sources provides sufficient resources to invest in their dietary needs. This finding aligns with previous studies by Ekele et al. (2019), Oyewole and Isah (2012), and Degefa and Nyariki et al. (2002). The consistency of these findings across the world contexts underscores the universal importance of income diversification as a strategy for enhancing household resilience and food security.

A negative but significant relationship between household head age and food security indicates that older households may face food security challenges. This finding aligns with the research of Yizengaw (2014), suggesting that as household heads age, their capacity to engage in labor-intensive activities may diminish, which leads to reduced household income and food security. In contrast, the education level of the household head positively affects food security, suggesting that when the household head is more educated, he or she will possess more knowledge and awareness regarding decisions related to food consumption in households, which will ultimately lead to improved food security for the household.

Additionally, higher education levels provide opportunities to earn higher incomes, enabling households to ensure an adequate supply of nutritious food. Similar findings were reported by Augustine and Kithu (2020), Mutiah and Istiqomah (2017), Bekele et al. (2019), and Kalansooriya and Chandrakumara (2014). Furthermore, married individuals are more likely to lead households with higher food security compared to unmarried individuals. In Sri Lanka, married households are generally more food secure than single-person households due to

factors such as combined incomes, shared financial responsibilities, social support systems, effective labor division, and long-term planning for family needs. These elements contribute to increased stability, resource accessibility, and resilience against food poverty. This finding aligns with studies by Djangmah (2016), Yusuf et al. (2015), Habyarimana (2015), and Sekhampu (2013), all of which documented the protective effect of marriage on household food security.

Household composition also plays a crucial role in determining food security outcomes. A larger family size results in a higher food requirement, which will lower the per capita food consumption in households and lead to food insecurity problems if the household income does not grow proportionally with household size. This outcome is consistent with findings from Adebayo and Ojo (2012), Sikwela (2008), and Yizengaw (2014). Similarly, households with more dependents are more likely to experience food insecurity compared to households with fewer dependents, primarily due to increased financial strain and challenges in resource allocation. As a result, households with a higher dependency ratio often struggle to maintain sufficient food security. This conclusion is supported by studies from Akukwe (2019); Bekele et al. (2019), Dawit and Zeray (2017), and Sekhampu (2013). However, having more educated members in the household leads to improved food security as education provides skills, knowledge, and opportunities that lead to better employment, earnings, and resource management. Moreover, educated household members contribute to the household's earnings by engaging in better-paying jobs and improve household decision-making related to nutrition and food management, ultimately leading to greater food security (Mutisya et al. 2016), .

Agricultural practices and economic factors also significantly influence household food security. Households that cultivate seasonal crops tend to have more food security compared to households which does not have such practices, as seasonal crops act as a buffer against price increases and market fluctuations, thereby enhancing the household's overall food security. Evidence from Aweke et al. (2022) also indicates that households that cultivated seasonal crops like Maize and beans had more food security compared to other Households. And also households with higher food-related spending tend to have more food security compared to households with lower food-related spending, since they have access to improved dietary quality, greater resilience to economic shocks, and enhanced purchasing power for a wider variety of food options. Consequently, higher monthly food expenses facilitate regular access to adequate and nutritious food resources, supporting household food security. This finding underscores the importance of adequate household income and resource allocation toward food purchases as determinants of food security outcomes. The connection between food security and religion is complex and shaped significantly by local cultural practices, economic circumstances and specific beliefs and customs within each religious group. A study

in Ghana found a positive relationship between food security and religion (Atuoye et al., 2019).

5. Conclusions

This study examined the relationship between household food security and income diversification using data from 19,783 households in Sri Lanka. The finding reveal that there is a positive and significant relationship between these two.

Even though approximately 59% of Sri Lankan households diversified their income sources, there are clear sectoral differences, with the highest income diversification (61.8%) observed in the rural sector. In comparison, the lowest level (44.3%) was recorded in the estate sector. The Food Security Index (FSI) also reflects the same patterns by showing an FSI value of 1.11, indicating overall moderate food security in Sri Lanka. While the rural and estate sectors maintain relatively food-secure conditions, the urban sector shows signs of food insecurity. Moreover, several sociodemographic factors were identified as factors affecting food security and income diversification. These include household head characteristics, household size, dependency ratios, educational attainment, seasonal crop cultivation, food expenditure ratios, religion, and regional location.

Based on these findings, the study suggests focusing on expanding vocational training and entrepreneurship support, particularly in urban and estate areas, with the intention of promoting income diversification strategies among households experiencing food insecurity. For further studies, the study recommends using longitudinal and qualitative approaches to address the limitations associated with this type of study.

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