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RESEARCH ARTICLE

Is Climate Change Posing a Challenge to Food Security? Empirical Evidence from a Small Island Developing Country

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ABSTRACT

Food security remains one of the main goals for all countries worldwide. While several agencies have mobilized resources to achieve this goal, food insecurity remains a significant livelihood challenge in many developing countries. Therefore, in this paper, we examine some critical factors affecting the food security of rural agricultural households in Fiji using the latest Agricultural Census data. This study reveals that farmers' access to fishing grounds and non-timber forest resources can improve farming households' food security. The study also shows that while the government vigorously pursues a transition from subsistence agriculture towards commercial agriculture, improving market access and reducing transportation costs will significantly improve food security. Given the importance of regular cash income, the study also demonstrates that off-farm employment of household members, particularly larger-sized households, will substantially help to improve food security. Lastly, and most importantly, the government must quickly examine how it could mitigate challenges posed by climate change, as this could devastate food security via reduced food production.

Keywords: Agriculture, climate change, food security, ordered logit model.

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1. Introduction

Small developing states have some stylized issues, including high debt levels, poor governance and high pilferage, narrow resource base, high unemployment, high prevalence of non-communicable diseases, and concerns for food security. These issues are further exacerbated when these countries are subjected to external shocks such as the last COVID-19 pandemic, natural disasters, and climate change.

A recurring concern is food insecurity. Food and Agriculture Origination (FAO, 1996) defines *food insecurity* as the inability of households to access adequate amounts of nutritionally balanced food to enjoy a healthy lifestyle. Noting the importance, the 2015 United Nations summit came up with 17 Sustainable Development Goals to be addressed, amongst which Food Security was one (UN, 2015). These goals were to be achieved by 2030.

Past research in developing countries demonstrates that poor households have inadequate food as a significant consequence (Khaleque, 2023). Children drop out of school, and as they grow up, they also remain in subsistence agriculture or engage in low-paid jobs, and poverty and food insecurity pass on from one generation to another, thus undermining the very goal of the global body of the UN. In this regard, noting the gravity of the issue, several agencies have mobilized resources to achieve this goal; food insecurity remains a significant livelihood challenge in many developing countries (Iortyom & Kargbo, 2023; Tanyanyiwa, 2021). Bodies such as the United Nations Children's Fund (UNICEF), FAO, World Food Program (WFP), International Fund for Agricultural Development (IFAD), World Health Organization (WHO), non-government agencies (NGOs), and regional development partners such as the Department of Foreign Affairs and Trade (DFAT), NewZealand Aid (NZAid) and others are mobilizing their resources to tackle this issue worldwide.

A report recently published by FAO, IFAD, UNICEF, WFP, & WHO, 2022 provides a startling picture of food security worldwide. The report notes that by 2021, the number of people affected by hunger will rise to 828 million, an increase of 46 million since 2020. This data demonstrates that we may need more time to meet the 2030 target. While the above statistics are about the situation on the ground now, the future also looks very worrying. As Ranganathan *et al.* (2018) note, there is a large gap between what we produce today and what is needed to feed everyone in 2050. They argue that by 2050, while the world's population will be around 10 billion, an increase of 3 billion from the 2010 population, there will be a 56% gap in crop calories for the same period if the status quo is maintained and a land gap of a 593-million-hectare over the same period.

Fiji and the small island nation-states of the Pacific are not an exception. The countries vary widely in topography and culture but are similar due to the small physical size, remoteness from the center, pristine but fragile biodiversity, and narrow resource base. The island nations, known throughout the world for their pristine environment, friendly people, and eco-friendly tourist spots, are now under the spotlight due to climate change, which is threatening the very survival of these Pacific communities. The last ADB report on Food Security noted that climate change and its effects in the Pacific can compromise island nations' prosperity, stability, and security. The loss of arable coastal land and its impact on productivity and production, damage to coastal and inland infrastructure and river bank erosion and flooding, and loss of fertile land and watersheds can create significant development challenges and put additional pressure on government resources and contribute to mounting debt (ADB, 2011).

Food security has also been subjected to many studies, particularly to identify region-specific factors contributing to it. The following list has been identified as the main factors associated with household food insecurity:

- Age of the household head (Adeyanju *et al*., 2023; Ahmed *et al*., 2017; Akbar *et al*., 2023; Leza & Kuma, 2015; Shone *et al*., 2015),
- Marital status of the household head (Adeyanju *et al*., 2023; Mensah *et al*., 2013; Shone *et al*., 2015),
- Sex of household head (Adeyanju *et al*., 2023; Akbar *et al*., 2023; Endale *et al*., 2014; Hashmiu *et al*., 2022; Shone *et al*., 2015),
- Educational status of the household head (Adeyanju *et al*., 2023; Ahmed *et al*., 2017; Akbar *et al*., 2023; Endale *et al*., 2014; Hashmiu *et al*., 2022; Mota *et al*., 2019),
- Family size (Ahmed *et al*., 2017; Akbar *et al*., 2023; Endale *et al*., 2014; Endalew *et al*., 2015; Mensah *et al*., 2013; Mota *et al*., 2019; Naser *et al*., 2015; Shone *et al*., 2015; Toma *et al*., 2023),
- Household wealth index (Leza & Kuma, 2015; Toma *et al*., 2023),
- Agricultural extension service (Endalew *et al*., 2015; Hashmiu *et al*., 2022; Leza & Kuma, 2015; Toma *et al*., 2023),
- Productive safety net program service (Gecho *et al*., 2014; Toma *et al*., 2023),
- Agricultural inputs use (Gecho *et al*., 2014; Mota *et al*., 2019),
- Access to credit (Adeyanju *et al*., 2023; Gecho *et al*., 2014; Hashmiu *et al*., 2022; Leza & Kuma, 2015),
- Livestock ownership (Endale *et al*., 2014; Endalew *et al*., 2015; Hashmiu *et al*., 2022),
- Oxen ownership (Leza & Kuma, 2015),
- Farm size (Adeyanju *et al*., 2023; Gecho *et al*., 2014; Leza & Kuma, 2015; Shone *et al*., 2015),
- Dependency ratio (Akukwe, 2020; Toma *et al*., 2023).

However, there needs to be an empirical study on the determinants of food security in the Pacific, more so examining the impact of climate change.

In this paper, we examine some critical factors affecting the food security of rural agricultural households in Fiji using the latest Agricultural Census data. These factors, once identified, could be subject to mitigation strategies to improve Food security in the country. Lessons learned can be used in the other small states in the Pacific, the Caribbean, and small African regions. The second section of this paper provides an overview of Food Security issues in Fiji and the Pacific. The third section of the paper provides a methodology for this research, the fourth section provides results and discussions, and the last section provides a summary and conclusion.

2. Food Security in Fiji and the Pacific

The Pacific Island countries are all subjected to the effects of climate change but at varying degrees. The low-lying atoll islands such as Kiribati, Tuvalu, Tokelau, and Niue will be the worst affected, particularly by sea level rise, as some of these countries have the highest point of 5 meters from the mean sea level (Tokelau). Noting this challenge, the Pacific leaders organized the first-ever Pacific Food

Summit in Port Vila, Vanuatu, on April 21–23, 2010. This was attended by the respective Ministers of health, agriculture, and trade to discuss various actions that needed to be undertaken to deal with this crisis. The Summit identified and examined various threats to food security, discussed strategies to improve it, and endorsed a *Framework for Action on Food Security* to guide multi-sectoral and coordinated responses in improving food security within the Pacific countries and across the region. The Framework noted the importance of traditional agriculture systems, community involvement, climate resilience, and emergency systems and safety nets in ensuring food security during climate change.

Fiji, one of the low-risk countries (see Table I), took the lead role in ensuring the food security of its population is not compromised as its coastal population is subjected to coastal erosion, loss of fertile agricultural land, saltwater intrusion and its inland population is facing extreme weather conditions, flooding, river bank erosion, and frequent droughts.

TABLE I: Vulnerability of Food Security (Source: McGregor *et al*., 2009)

Country	Proportion of imported food exp (%) (year)[a]	FAO food import capability index[b] (FIC) 1990–2001	Vulnerability of food security based on FAO FIC[c]
Cook islands	–	1.84	Extremely vulnerable
Fiji	–	0.17	Low
Kiribati	36 (2006)	1.56	Extremely vulnerable
Federated states of Micronesia	39 (2005)	–	
Palau	81–84 (2006)	–	
Papua new Guinea	–	0.12	Low
Samoa	56 (2002)	2.59	Extremely vulnerable
Solomon islands	35–44 (2006)	0.15	Low
Tonga	45 (2001)	1.10	Highly vulnerable
Tuvalu	–	5.48	Extremely vulnerable
Vanuatu	–	0.46	Moderately vulnerable

Notes: -: no data available; FAO: Food and Agriculture Organization. [a] From country household income and expenditure surveys, various years. [b] FICI: proportion of the total value of food imports in the total value of food exports. [c] FICI "plus": proportion of the total value of food imports in the total value of food exports, including services, remittances, and servicing of foreign debts.

3. Threats to Food Security in Fiji, the Pacific

3.1. Rural to Urban Migration and Pacific Labor Mobility Schemes and Its Impact on Rural Labor Availability

There is a significant exodus of young, able-bodied people from rural to urban areas to engage in daily and weekly waged employment as the commercial, tourism, industrial, and manufacturing sectors expand. This movement is having a significant impact on labor availability in rural areas, thus holding back agricultural expansion. The problem is further compounded by the Pacific Labour Mobility Schemes implemented by Australia and New Zealand, allowing for youths from Fiji and the Pacific to work in their country. This has again seen an exodus of rural youths to Australia and New Zealand, thus putting pressure on rural labor markets in Fiji and the Pacific. Gibson and Bailey (2021), in their study on the Pacific Labour Mobility Scheme, demonstrate that the host countries have benefited immensely from the scheme. However, they suggest that the sending countries must undertake a rigorous study to ascertain the possible impact on their rural agriculture labor markets as well as the economic and social impact on the laborers' households.

3.2. Lack of Efficiency and Productivity Gains

Pacific agricultural expansion for food security should focus more on increasing productivity than area expansion. Unfortunately, this has not been the case. ADB (2011) notes that Pacific food production increases have largely been due to area expansion. A concerted effort should be made towards increasing productivity as area expansion will result in deforestation, which will devastate the environment. Reddy and Duncan (2006), using data from 1961 to 2004 for six countries, Fiji, Samoa, PNG, Kiribati, Vanuatu, and Tonga, demonstrated that productivity in these countries' agriculture sectors has yet to make any gains and efficiency has declined.

3.3. Climate Change Impact

Fiji and the Pacific, with the vast number of remotely connected islands, some very low-lying atolls, and a large proportion of its population living and farming along coastal lines and waterways, face

severe threats to their livelihoods and survival. Quality arable land along the coast and waterways is being washed away or subjected to saltwater intrusion. The ADB (2011) report on Fiji, noting findings from the Intergovernmental Panel on Climate Change (IPCC), argues that climate change will directly and indirectly affect food security. The most direct effect, particularly in the smaller atoll countries, will be a further reduction of already declining agricultural output per capita as a result of increasing natural disasters and rising sea levels in the longer term.

3.4. Increasing Consumption of Imported Food

Across the Pacific, there is a gradual shift towards increasing consumption of imported food products, a shift away from traditional, locally produced food. This could devastate the rural agricultural sector as reduced demand and lack of market will push farmers and laborers out of the rural agricultural sector. Secondly, relying on imported foods could have a catastrophic effect on food security during export bans and global food shortages, as was experienced during the COVID-19 pandemic. McGregor *et al*. (2009) noted that dependency on imported food in the Pacific ranges from 35% in Solomons to 81% in Palau.

Noting these issues, Fiji, since 2018, has made significant announcements and budgetary allocations towards raising food production, not based on subsidies and grants, but as a response to market signals. While encouraging the farmers to expand commercial agriculture, the former Minister for Agriculture in Fiji, Hon. Dr. Reddy, noted a call for the country's farmers to control primary agricultural commodities rather than depend on imported produce. He noted that importing goods and services also leads to the importation of inflation, and thus, raising domestic production is the best way of controlling inflation. He called upon the farmers and landowners to utilize the available land for their benefit and the country (Reddy, 2022).

Since then, although during the brief pandemic, Fiji's agriculture production has grown significantly. Overall production increased while food imports started to decline. The importance of raising the guard about food security again came to the forefront during the last COVID-19 pandemic when the entire world's economy stopped. At the same time, countries still needed to feed their population. Countries with large urban populations who lost their jobs desperately needed essential food items. Fiji's Ministry of Agriculture called for a national movement for home gardening to ensure households have food to consume. In 2020 and 2021, 470,000 and 265,000 free vegetable seed packs were distributed, respectively. Each seed pack had seeds of six different short-term vegetables. For a country with around 178,000 households, this number of seed packs implies that several households were given seed packs several times, implying increased interest in home gardening.

4. Methodology

4.1. Data Source and Survey Period

This study will utilize data from the latest Fiji Agriculture Census (FAC) 2020 (FAO, 2021). The FAC 2020 was designed, pilot-tested, and administered under the purview of the author of this paper. In 2019, the survey instrument, the survey questionnaire, was designed, pilot tested, and enumerators selected and trained. The questionnaire had 13 sections: Household Composition, Housing Particulars, Land, Crops on Farmland, Livestock, Forestry, Fishing, Aquaculture, Climate Change and Challenges, Equipment, Agriculture Services, Food Security and Labor.

Fiji Agriculture Census was undertaken between February 10–29, 2020, covering 70,991 agricultural households in the rural sector and selected peri-urban boundary areas where agricultural activities are commonly practiced (FAO, 2021). This comprises 99.1% of the households interviewed in rural and peri-urban areas where agriculture is commonly practiced. This was the first time that all four subsectors of agriculture: crop, livestock, fisheries, and forestry were covered on a complete enumeration basis. For this survey, a household is defined as a small group of persons who share the same living accommodation, contribute their income and wealth to acquire certain goods and services, and share the same eating arrangement. An *agricultural household* is a household where the main economic activity identified is farming, i.e., it practices any agricultural activity (such as crop, livestock, fisheries, and/or forestry) during the reference period of the 2020 Fiji Agriculture Census (2020FAC).

4.2. Theoretical Model

In this study, we wish to estimate and explore the relationship between a dependent variable and a number of explanatory variables, as depicted in the following formula:

$$y_i = \beta_i x_i + \varepsilon_i \ldots \quad (1)$$

where:

y_i: response variable, which can take any value, and the subscript i refers to the observation number,
β_i: refers to a vector of parameters to be estimated,
x_i: refers to a set of explanatory variables,
ε_i: refers to the disturbance assumed to be independent across observations.

When the dependent variable is normally distributed, standard Ordinary Least Squares (OLS) model estimation can be undertaken. This, however, is not the case for this study. The dependent variable is not normally distributed but ordinal in nature. Where the dependent variable is in two categories only, a Binary Choice model, Logit, or Probit model could be estimated. Where the dependent variable is of more than two categories, then the Ordinal Logit or Probit models can be estimated to ascertain the values of the vector of parameters.

Following Zhang *et al*. (2015), the basic form of the Ordered Logit model is as follows:

$$P\,(y = j/x_i) = \frac{1}{1 + exp[-\,(\alpha + \beta X_i)]} \tag{2}$$

where:

y: a dependent variable, and the value is assigned to y ($j = 1, 2, \ldots, n$),
n: sample size,
x_i: a factor,
i (I = 1, 2, …, m): explanatory variables,
m: number of the variables.

As noted by Zhang *et al*. (2015), the cumulative model is established as follows:

$$Logit\left(P_j\right) = ln[P(y \leq j)/P(y \geq i + 1)] - \alpha_i + \beta x \tag{3}$$

where:

P_j: the probability of occurrence of the dependent variable,
$P_j = P\,(y = j), j = 1, 2, 3; x_1, x_2, \ldots, x_m{}^T$: a set of independent variables,
α_j: the intercept of the model,
β: a set of corresponding regression coefficients.

As noted by Zhang *et al*. (2015), after the parameter estimation, the probability of occurrence in some specific cases can be obtained by the following formula:

$$P\,(y <= j/x) = \frac{exp[-\left(\alpha_j + \beta X_i\right)]}{1 + exp[-\left(\alpha_j + \beta_x\right)]} \tag{4}$$

The vector of β parameters is estimated by the Maximum Likelihood method, and generally, the goodness-of-fit of the OL model is verified by Nagelkerke R^2 (Eboli & Mazzulla, 2009). The statistical impact of variables is based on the p values of the Wald tests (Eboli *et al*., 2016). Early papers on regression models for ordinal data include McKelvey and Zavoina (1975), McCullagh (1980), and Winship and Mare (1984). The paper of Fullerton (2009) reviews ordered logistic regression models and their use in sociology. The textbook of Agresti (2010) gives a thorough treatment of ordinal data, while O'Connell (2006) provides applied researchers in the social sciences with accessible and comprehensive coverage of analyses for ordinal outcomes. Other valuable books fully devoted to ordinal outcomes are Johnson and Albert (1999) in a Bayesian perspective and Greene and Hensher (2010) in the setting of choice theory. Books on statistical modeling often have a chapter on ordinal regression models, for example, Long (1997), Skrondal and Rabe-Hesketh (2004), and Hilbe (2009).

4.3. Empirical Model: Ordered Logit Regression Model (OLR)

As explained in the preceding section, the ordered logit regression model (OLR) was applied to determine the relationship and determinants of Food security by a number of explanatory variables.

$$\begin{aligned} \text{Logit FoS}_i \;=\; & \beta_0 + \beta_1 \text{Gen}_1 + \beta_2 \text{HHS}_2 + \beta_3 \text{LAA}_3 + \beta_4 \text{FREx}_4 + \beta_5 \text{FIEx}_5 + \beta_6 \text{CCObs}_6 \\ & + \beta_7 \text{SAG}_7 + \beta_8 \text{MAD}_8 + \beta_9 \text{OfEmp}_9 \end{aligned} \tag{5}$$

where:

- FoS: Food Security Index, which is scored from 0 = Highly Insecure/Vulnerable to 4 = Excellent Food Security. The FoS score is calculated by summing the scores given to two questions (see Table II),
- Gen = Gender, measured as 0 = Female and 1 = Male,

- HHS = Household Size, measured as the number of persons living and eating together,
- LAA = Land area under agriculture measured in acres,
- FIEx = Fisheries Access Index measured as 0 = Not engaging in part-time fishing and 1 = Engaging in part-time fishing,
- MAD = Market Access Index measured as:

  0 = Walk/horse ride or drive own transport to market at very close proximity (less than 30 mins),
  1 = Take public transport to the market in close proximity,
  2 = Hiring private transport to market approximately 1 to 2 hours away,
  3 = Hiring private transport or using maritime vessels with a market more than 2 hours away,
  4 = Market very far away, too costly, and not accessible.

- FREx: Forest Resource Extraction, measured as 0 = No extraction or 1= Extraction undertaken,
- CCObs: Number of changes/impacts noted on the farm over the last 12 months from the list below:

  i) Loss of soil fertility,
  ii) Decline in crop yield,
  iii) New pests and diseases,
  iv) Increased soil erosion,
  v) Reduced water quality and supply,
  vi) Change in the cropping season,
  vii) Increased weather uncertainty,
  viii) Increased drought,
  ix) Saltwater intrusion.

- SAGI: Sustainable agriculture (SA) practices, measured as the number of practices carried on the farm over the 12 months from the list below:

  i) Agroforestry/planting climate-resilient crop varieties,
  ii) Climate-resilient livestock breeds,
  iii) Use of recommended agriculture inputs,
  iv) Crop rotation,
  v) Planting of mucuna cover (nitrogen fixing) crops,
  vi) Contour farming,
  vii) Use of organic manure.

- OfEmp: Number of household members engaged in full-time off-farm employment.

TABLE II: Questions and Calculation of the Food Security Index (FoS)

		During the past 12 months, was there a time when your household ran out of food because of a lack of money or other resources?		
		Always = 0	Sometimes = 1	Never = 2
In the past 12 months, did your household have balanced 3 meals a day?	Never = 0	0 + 0 = 0	0 + 1 = 1	0 + 2 = 2
	Sometimes = 1	1 + 0 = 1	1 + 1 = 2	1 + 2 = 3
	Always = 2	2 + 0 = 2	2 + 1 = 3	2 + 2 = 4

TABLE III: Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max
Gen	0.9023	0.2968	0.0	1.0
HHS	4.2086	2.1629	1.0	25.0
LAA	2.2614	55.2896	0.800000D-06	8890.9
FREx	0.2814	0.4497	0.0	1.0
FIEx	0.1500	0.3571	0.0	1.0
CCObs	4.3944	2.8679	0.0	9.0
SAgrP	0.4404	0.7763	0.0	5.0
MAD	1.4928	1.6866	0.0	4.0
FoS	2.9781	0.9126	0.0	4.0
OfEmp	0.5942	0.9714	0.0	5.0

The descriptive statistics of the variables are provided in Table III.

A priori, the following signs are expected from the explanatory variables. The Gender (Gen) variable is expected to have a positive sign indicating that female households are more likely to be insecure regarding food insecurity. The Household Size (HHS) variable is expected to have a positive sign indicating that larger households will be more likely to have food security as some more members can produce more or bring in more income. The Land Area under Agriculture (LA) is expected to have a positive sign indicating that larger farms will provide more likelihood of food security. The Forest Resource Extraction (FREx) variable is expected to have a positive sign indicating that larger farms will provide more likelihood of food security. The Fish Extraction (FIEx) variable is expected to have a positive sign indicating that access to fishing will provide additional food sources, thus contributing to food security. The Climate Change Effects (CCObs) are expected to have a negative sign, indicating that more effects observed on the farm will imply less production and, thus, poor food security. The Sustainable Agriculture Practices (SAgrP) variable is expected to have a positive sign indicating that the more sustainable agriculture practices the farmer engages in, the more likelihood of having improved food security. The Market Access Difficulty (MAD) variable is expected to have a negative sign indicating that the more difficult it gets to get to market and sell off your products, the more insecure the farm household will be with regard to food security and lastly, the Off-Farm-Employment (OfEmp) is expected to have a positive sign indicating that the more household members work in the formal sector, the more significant income earned will provide more likelihood of better food security.

5. Results and Discussion

The estimates of the Food Security model for Fiji's Agricultural households are presented in Table IV. Most of the results conform to expectations. The Chi sq test demonstrates the model has a good fit.

TABLE IV: Ordered Logit Model for Food Security

Variable (Dependent variable: FoSec)	Coefficient	Standard error	Marginal effects (at prob Y = 04)
Constant	3.41279***	0.0184	
HHS	−0.07466***	0.0021	−0.02782***
LAA	0.01827***	0.0013	0.00681***
FREx	0.04021***	0.0105	0.01503***
FIEx	0.27968***	0.0132	0.10722***
MAD	−0.08125***	0.0027	−0.03028***
Gen	0.04949***	0.0150	0.01830***
CCObs	−0.04592***	0.0016	−0.01711***
SAgrP	0.10735***	0.0061	0.04000***
OFEmp	0.54640***	0.0054	0.20362***

Note: 1. ***$p < 0.01$. 2. Estimation based on N = 63601. 3. Log likelihood function = −69828.89; Restricted log-likelihood = −76688.73; Chi-squared [9] ($p < 0.001$) = 13719.70577; and Significance level < 0.001.

The HHS variable does not conform to a priori expectations. The negative sign implies that larger households are more likely to have food insecurity. The reasons could be that additional members are not engaged in any productive work, thus putting pressure on household food requirements. The land area variable indicates that larger farms are more likely to contribute to food security. This implies that given Fiji's farm sizes are small, a long-term effort to improve food security is to provide additional leases to smallholder farmers so that their food security can improve.

Access to fishing and forest resources by full-time farmers also contributes to a high likelihood of better food security. In particular, during droughts and cyclones, farmers living closer to forest reserves and the sea resort to fishing to provide food to the table. Market Access variable is also highly significant, implying that if farmers can sell off their produce with minimum transportation cost and difficulty, the likelihood of ensuring food security of their household is high. The significant Gender variable indicates that female-headed households have a higher probability of food insecurity. On average, it's 1.8% likely that the food security of female-headed households will be lower than that of their male counterparts. The climate change variable indicates that farm households' food security is negatively affected by climate change effects on the farm. That is, with every impact type, it is 1.7% likely that food security will fall. So, in the medium to long term, mitigating the effects of climate change will significantly help in raising household food security. The results also demonstrate that sustainable agricultural practices also increase the probability of food security of farm households. For

every additional sustainable agriculture practice undertaken by the household, there is a 4% likelihood of improving food security. Lastly, the results also demonstrate that if any farm household member works off the farm, then there is a higher likelihood that that household will have better food security. The results show that with every additional member working off-farm, there is a 20% likelihood of improving food security.

6. Summary and Conclusion

This paper examines one of the major policy objectives of all governments: food security. While larger, well-developed countries have resorted to providing food vouchers and cash transfers to help the poor, small, developing countries are struggling to meet the various demands on their meager budgets. Therefore, a more sustainable solution must be sought to address the issue of food insecurity in households.

This study examines this issue for rural agricultural households, and the results go beyond suggesting that increased food production via increasing farm sizes can solve the issue of food insecurity. This study reveals that food insecurity is a more complex problem now as new problems have emerged affecting farm households.

Rural farm households have increased household needs compared to the days of subsistence living, and thus, while increasing food production is being advocated, market access is a critical binding constraint. With market access, the farm household can purchase additional household requirements which are not provided by the farm. Thus, the government must strategically investigate how it could, directly or through the private sector, improve access to the market so that farm produce is easily sold off at a reasonable price without being a victim of an imperfect market. Secondly, climate change is posing a serious challenge to food security, and the government must speed up mitigation programs while, at the same time, continuing with a global campaign to address this issue as it is caused by the larger nations, and thus it must be addressed at that level. Lastly, long-term food security can be guaranteed if household members work outside that farm to bring in cash income. This could be enhanced through education and setting up commercial and industrial ventures closer to the rural areas so that cash employment is possible for surplus household members.

Access to fishing and forest resources by full-time farmers also contributes to a high likelihood of better food security. In particular, during droughts and cyclones, farmers living closer to forest reserves and the sea resort to fishing to provide food to the table. Market Access variable is also highly significant, implying that if farmers can sell off their produce with minimum transportation cost and difficulty, the likelihood of ensuring food security of their household is high. The significant Gender variable indicates that female-headed households have a higher probability of food insecurity. The climate change variable indicates that farm households' food security is negatively affected by climate change effects on the farm. So, in the medium to long term, mitigating the effects of climate change will significantly help in raising household food security. The results also demonstrate that sustainable agricultural practices also increase the probability of food security for farm households. Lastly, the results also demonstrate that if any farm household member works off the farm, then there is a higher likelihood that that household will have better food security.

Conflict of Interest

The author declares that they do not have any conflict of interest.

References

ADB (2011). *Food security and climate change in the Pacific: Rethinking the options* (Report). Asian development bank. https://www.adb.org/publications/food-security-and-climate-change-pacific-rethinking-options.

Adeyanju, D., Mburu, J., Gituro, W., Chumo, C., Mignouna, D., Ogunniyi, A., *et al.* (2023). Assessing food security among young farmers in Africa: Evidence from Kenya, Nigeria, and Uganda. *Agricultural and Food Economics*, *11*(1), 4–20.

Agresti, A. (2010), *Analysis of Ordinal Categorical Data* (2nd ed.). Wiley.

Ahmed, U. I., Ying, L., Bashir, M. K., Abid, M., & Zulfiqar, F. (2017). Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PLoS One*, *12*(10), 1–15.

Akbar, A., Darma, R., Fahmid, I. M., & Irawan, A. (2023). Determinants of household food security during the COVID-19 pandemic in Indonesia. *Sustainability*, *15*(5), 1–16.

Akukwe, T. I. (2020). Household food security and its determinants in agrarian communities of south-eastern Nigeria. *Agro-Science*, *19*(1), 54–60.

Eboli, L., Forciniti, C., Mazzulla, G., & Calvo, F. (2016). Exploring the factors that impact on transit use through an ordered probit model: The case of metro of Madrid. *Transportation Research Procedia*, *18*, 35–43.

Eboli, L., & Mazzulla, G. (2009). An ordinal logistic regression model for analysing airport passenger satisfaction. *EuroMed Journal of Business*, *4*(1), 40–57.

Endale, W., Mengesha, Z. B., Atinafu, A., & Adane, A. A. (2014). Food insecurity in farta district, Northwest Ethiopia: A community based cross-sectional study. *BMC Research Notes*, *7*(1), 1–6.
Endalew, B., Muche, M., & Tadesse, S. (2015). Assessment of food security situation in Ethiopia: A review. *Asian Journal of Agricultural Research*, *9*(2), 55–68.
FAO (1996). *The state of food and agriculture* (Report). Food and agriculture organization of the United Nations. http://www.fao.org/3/w1358e/w1358e.pdf.
FAO (2021). *Fiji 2020 Agriculture Census, Vol I-IV* (Report). Food and agriculture organization of the United Nations. https://www.agriculture.gov.fj/censusrep.php.
FAO, IFAD, UNICEF, WFP, & WHO (2022). The state of food security and nutrition in the world: Repurposing food and agricultural policies to make healthy diets more affordable (Report). Food and agriculture organization of the United Nations. https://doi.org/10.4060/cc0639en.
Fullerton, A. S. (2009). A conceptual framework for ordered logistic regression models. *Sociological Methods & Research*, *38*(2), 306–347.
Gecho, Y., Ayele, G., Lemma, T., & Alemu, D. (2014). Livelihood strategies and food security of rural households in Wolaita zone, Southern Ethiopia. *Social Sciences*, *4*(14), 123–135.
Gibson, J., & Bailey, R. -L. (2021). Seasonal labor mobility in the Pacific: Past impacts, future prospects. *Asian Development Review*, *38*(1), 1–31.
Greene, W. H., & Hensher, D. A. (2010). *Modeling Ordered Choices: A Primer*. Cambridge University Press.
Hashmiu, I., Agbenyega, O., & Dawoe, E. (2022). Cash crops and food security: Evidence from smallholder cocoa and cashew farmers in Ghana. *Agriculture & Food Security*, *11*(1), 3–22.
Hilbe, M. H. (2009). *Logistic Regression Models*. Chapman & Hall/CRC.
Iortyom, E. T., & Kargbo, P. (2023). Food and water security in the context of sustainable development. *European Journal of Development Studies*, *3*(2), 10–16.
Johnson, V. E., & Albert, J. H. (1999). *Ordinal Data Modeling*. Springer.
Khaleque, A. (2023). Food security and poverty: Searching for a linkage in the poverty prone areas in Bangladesh. *European Journal of Development Studies*, *3*(1), 85–94.
Leza, T., & Kuma, B. (2015). Determinants of rural farm household food security in Boloso Sore district of Wolaita zone in Ethiopia. *Asian Journal of Agricultural Extension*, *5*(2), 57–68.
Long, J. S. (1997). *Regression Models for Categorical and Limited Dependent Variables*. Sage Publications.
McCullagh, P. (1980). Regression models for ordinal data. *Journal of the Royal Statistical Society*, *42*(2), 109–142.
McGregor, A., Bourke, M., Manley, M., Tubuna, S., & Deo, R. (2009). Pacific island food security: Situation, challenges and opportunities. *Pacific Economic Bulletin*, *24*(2), 24–42.
McKelvey, R. D., & Zavoina, W. (1975). A statistical model for the analysis of ordinal level dependent variables. *Journal of Mathematical Sociology*, *4*(1), 103–120.
Mensah, O. J., Aidoo, R., & Tuffour, T. (2013). Determinants of household food security in the Sekyere-Afram plains district of Ghana. *Global Advanced Research Journal of Agricultural Science*, *2*, 347–353.
Mota, A. A., Lachore, S. T., & Handiso, Y. H. (2019). Assessment of food insecurity and its determinants in the rural households in Damot Gale Woreda, Wolaita zone, southern Ethiopia. *Agriculture & Food Security*, *8*, 1–11.
Naser, I. A., Jalil, R., Muda, W. M. W., Nik, W. S. W., Shariff, Z. M., & Abdullah, M. R. (2015). Assessment of food insecurity and nutritional outcomes in Bachok. *Kelantan Journal of Nutrition and Food Science*, *5*, 304–311.
O'Connell, A. A. (2006). *Logistic Regression Models for Ordinal Variables*. Sage Publications.
Ranganathan, J., Waite, R., Searchinger, T., & Hanson, C. (2018, December 5). *How to Sustainably Feed 10 Billion People by 2050*. World Resources Institute.
Reddy, M. (2022). Food security in your hands [Press Release]. https://www.agriculture.gov.fj/pressdetail.php?id=372.
Reddy, M., & Duncan, R. (2006). Agricultural productivity in the Pacific island countries: Issues and challenges. *ICFAI Journal of Agricultural Economics*, *3*(2), 16–31.
Shone, M., Demissie, T., Yohannes, B., & Yohannis, M. (2015). Household food insecurity and associated factors in West Abaya district, Southern Ethiopia. *Agriculture & Food Security*, *6*(2), 1–9.
Skrondal, A., & Rabe-Hesketh, S. (2004). *Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models*. Chapman & Hall/CRC Press.
Tanyanyiwa, S. (2021). Hunger by choice? Rethinking food security strategies. *European Journal of Development Studies*, *1*(2), 17–21.
Toma, T. M., Andargie, K. T., Alula, R. A., Kebede, B. M., & Gujo, M. M. (2023). Household food insecurity and associated factors in South Ari district, Southern Ethiopia: A community-based cross-sectional study. *PLoS One*, *18*(4), 1–15.
UN (2015). Sustainable development goals. *United Nations*. https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
Winship, C., & Mare, R. D. (1984). Regression models with ordinal variables. *American Sociological Review*, *49*(4), 512–525.
Zhang, H., Fang, J., & Bi, H. (2015). Study on the degree of rural empty nesters' satisfaction with life quality based on ordered logit model -ISM model. *Asian Agricultural Research*, *7*, 27–31.