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Cover Story

Yucun Village in Anji County, Zhejiang Province is known for its lucid waters and lush mountains. At the entrance of a local park stands a towering monument bearing the inscription "Lucid waters and lush mountains are invaluable assets."

Yucun is rich in quality limestone resources, and more than half of its locals relied on quarrying in the 1980s and '90s. It was covered in dust and smoke all year round. At the beginning of the 21st century, the village shut down limestone quarries and cement factories.

In August 2005, Xi Jinping, then Party chief of Zhejiang, visited Yucun. With changes already well and truly underway, he was impressed by what the village had achieved. He said: "We used to say that we wanted both lucid waters and lush mountains, as well as mountains of gold and silver. In fact, lucid waters and lush mountains are invaluable assets."

Guided by this concept, Yucun boosted eco-tourism industry and has today become a model of China's beautiful countryside. In 2021, Yucun was named one of the "Best Tourism Villages" by the United Nations World Tourism Organization.

The concept of "lucid waters and lush mountains are invaluable assets" has exerted a far-reaching impact on China's development.

(Liqin Zhang, President of Common Prosperity Yangtze River Delta Forestry National Innovation Alliance, State Forestry and Grassland Administration of the People's Republic of China.)

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About the Journal

Agricultural & Rural Studies (**A&R**, **ISSN 2959-9784**) is a quarterly journal to be an international, multi-/inter-disciplinary platform for communicating advances in fundamental and applied studies on contemporary agricultural, rural and farmers' issues and policies, as broadly defined by the disciplines of economics, sociology, human geography and cognate subjects.

A&R is a digital-only, double-blind peer-reviewed, open-access (OA) journal. Article Publishing Charges (APC) are waived in the first four years. The journal publishes various materials – perspective, review, original research, and commentary articles – and it is dedicated to serving as an efficient, professional, and innovative platform for scholars in the field of agricultural and rural studies.

In a nutshell, the A&R Journal:

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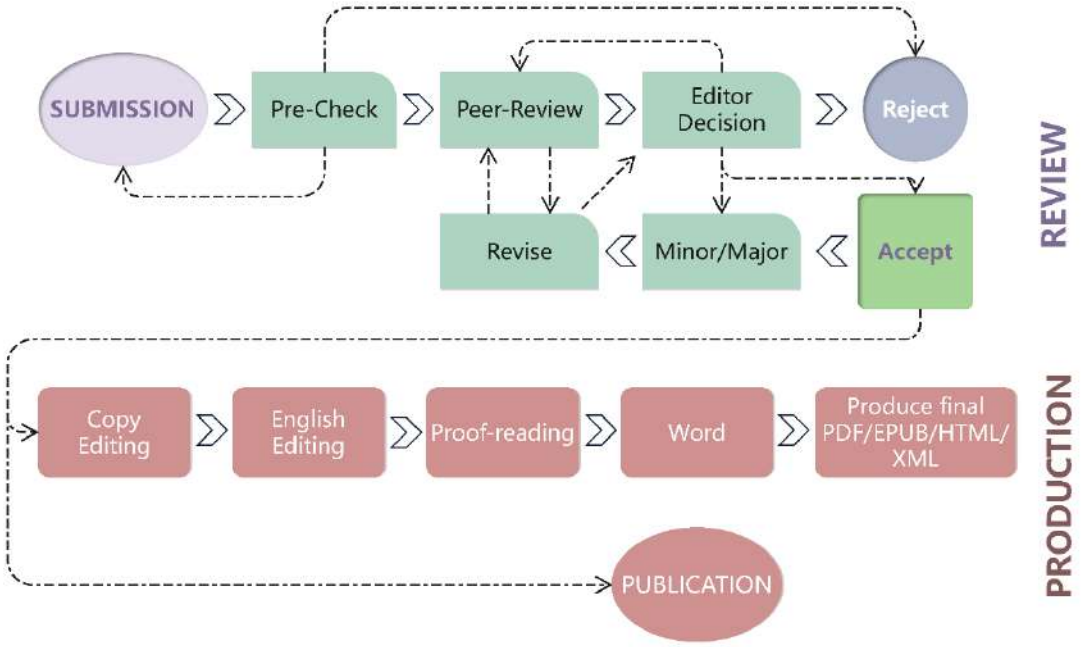

Agricultural & Rural Studies

Article

Determining Factors Effecting the Population Growth Rate of Villages in Turkey: An Econometric Perspective

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Abstract: Assuming core (permanent) population to be vital to the maintenance of the village and rural life, this study investigates the population growth rate (PGR) of villages in Turkey. PGR is used as a dependent variable in the analysis, using a sample of 201 villages. The independent variables are ascertained through face-to-face interviews with village heads (mukhtars). Hypothesis tests, correlation analysis and econometric models are used to examine the development/decline trends of the PGR of the village. The results show that total land property of the village and land property per household are the strongest variables supporting the continuity of population. Agricultural income remains the biggest income item in most villages, and this increases according to land size. Beyond this, opportunities for paid work outside the village while living in it (extra-village employment) positively affect the rate of increase of the village population.

Keywords: Econometric analysis of village survival; village population changes; land property; extra-village income; viability of villages

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1. Introduction

The territory nowadays comprising Turkey, in Anatolia and Thrace, has one of the oldest histories of sedentary life, dating back around 12,000 years to circa 10,000 BCE. Although the first settlements were quite different from those of today, they were still in the form of a village settlement and the main economic occupation of people was agriculture. The survival of these villages as communities also depended on meeting the needs of the population with the products obtained via agricultural activities, either directly (farm-based production) or indirectly (exchanging farming produce for items made outside). In other words, as long as the total agricultural product and the total needs of the population were in balance, and assuming no environmental disaster, people would continue to live in that place. When this balance was not achieved, some or all of the population would eventually migrate out and establish new villages. As Mayozer and Roudart (2009, p. 266) state, "many Mediterranean regions (Palestine, Anatolia, Cyprus, Malta), which included Anatolia in the Neolithic age, witnessed successive abandonment and resettlement periods of peoples". The same source also states that village populations could not exceed 300 people in this period due to transportation problems. Today, Turkey has a rapidly decreasing population in the countryside as a whole, with falling average populations by village and a growing population in just 10 percent of villages. This study looks at the weakening and developing population of villages of Turkish villages in the context of contemporary socio-economic conditions. Comprehensive quantitative data and similar analyses using them are rarely found in the literature. In this respect, this study aims to contribute to the change in rural areas and quantitative rural analysis beyond just providing information about villages in Turkey. It will make more clear some recent developments in the Turkey rural like villages are declining and disappearing or return from cities to villages in the last 40 years. While the rural population is decreasing in general, non-agricultural activities and incomes are increasing in the villages, and tourism and industry are developing in some regions. Therefore, this study also aims to contribute to understanding the recent changes about Turkish villages.

Resilience and the disappearance or development of rural settlements is a complex subject related to ecological, economic and cultural systems (Anthopoulou et al., 2017). According to Li, Westlund and Liu (2019, p. 137), "Generally, the development of rural communities consists of

both the material and immaterial content", where the "material" content includes "physical space, geographic characteristics, population and resource endowments", and the "immaterial" content involves such things as "personal relationships, values, attitudes, culture and institutions". Li and his colleagues draw attention to the growth, decline, and even death of rural communities as depending on interaction between rural settlements and areas and the external environment. Rural development in the knowledge economy is determined by linked endogenous and exogenous factors. Important factors for rural settlement resilience range from climate conditions and natural resources through location and land opportunities to regional development and agricultural policies. Moreover, rural resilience "reflects the capacity to adapt to interruptions and changes" which is itself the result of a "long process of transformations and reconstructions, adaptations and integration of intrinsic resources and forces operating in the social and ecological system" (Folke et al., 2010; Pike et al., 2010, cited in Anthopoulou et al., 2017, p. 3).

In the literature, studies examining the sustainability of rural areas on the basis of rural households have included the following variables in their analyses: productivity of the agricultural sector, farmer incomes, and loss of livelihoods (Ratnasari et al., 2023), economic ability (Miller, 2023), the ability of "... use urban opportunities and assets to diversify income sources and thereby avoid the uncertainties..." (Baker,1995, p. 117), resources like financial reserves, social resources, organizational resources, and community resources.(Scharlach et al., 2019, P. 708), sanitation conditions of the community, household expenditure, income satisfaction (Xie et al. 2023, pp. 15–16). While Ali Boloor and Asima Nusrath point out that villages close to the city can attract more population (Boloor & Nusrath, 2015, p. 1162), and Salisbury et al. argue "Village population change and city distance are negatively correlated" (Salisbury et al., 2005, p. 149).

In summary, the adaptation and expansion, survival and extinction of rural settlements is determined by a variety of conditions and factors that are influenced by changes in historical, socio-economic, geographical situations and governmental policies at both national and international levels. Therefore, to understand evolution of the rural settlements need to research each specific condition in its context. Because there are huge numbers of rural settlements with many different characteristics as well as common ones, quantitative approaches to the issue of rural survival are implied. However, "with academic and professional attention increasingly focusing on the quantitative analysis of urban and regional change, the rural had been relegated from being at the core of geography to an inferior position" (Phillips & Smith, 2018, p. 4). Such analysis focusing on the village is thus at once an important subject in its own right and also constitutive of a redressing the balance. Expressed in another way, the mass population shift of recent times known as "urban migration" is equally "rural migration" – what is into one is out from the other. Thus, consideration of the continued viability of the countryside as a space for living communities – in Turkish, villages are literally "alive/living" (canlı) or otherwise – acts as a corrective to what may be dubbed the urban centric assumption.

The urban centric assumption is an analytical perspective that prioritizes the city (urban space and its places) and others the village (rurality) (Jongerden, 2021). This is grounded in the historical transformation of economies, in which value became increasingly added by industry as opposed to agriculture as a function of technological and systems development (mass production, financial capital) – along with the situation of researchers, it might be added, who are typically based in urban centers, attached to institutions with a similarly urban perspective or interest bias. Currently, tertiary sector developments (radically stimulated by communication exchange facilitated by the Internet) indicate the possibility of a new transformation – perhaps even going beyond the rural-urban binary, eventually. For the moment, however, Turkey remains mostly in the "developing world" position – notwithstanding its designation as a newly industrialized country" (NIC) – with respect to population balance.

There are many historical and socio-economic dimensions of the villages population changes, agricultural activities, such as mechanization, general government economy policies, birth and death rate, in and out-migration both domestic and international, political reasons, rural development policies, rural population adaptation strategies i.e. All these subjects are analyzed more detailed in previous research and publications, see Öztürk (2012, 2019), Öztürk et al. (2014, 2017, 2020).Turkey has seen a demographic shift of historical proportions – quite literally – during the last period of economic neoliberalism, essentially with an inversion of the traditional 3:1 rural-to-urban population ratio over the last half century or so (the current reversal stands at around 1:4) (Öztürk, 2012, pp. 139 ff.). Changes in counting classification make official statistics difficult to interpret, but certainly they have also shown an overall absolute as well as relative decline in the numbers of people living in Turkey's countryside, notwithstanding the development of out-of-city suburbia (belde, banliyö), or "urban villages" (Öztürk et al., 2014).

It is in this context, therefore, that the present study is presented as a review and extension to the project Socio-Economic and Cultural Transformation of Rural Space: Modernizing and Disap-

pearing Traditional Spaces and Meanings (2014–2017). The research project employed both quantitative and qualitative research methods. Here we have utilized further quantitative data on Turkish villages and interpretations of those in addition to the original qualitative research. The qualitative part of the research project consists of 60 focus group discussions (FGDs), 30 with women and the other 30 with men, in 30 different villages across Turkey.

The project was realized in 26 (NUTS 2) statistical regions to represent the country as a whole. Face-to-face interviews were conducted with village headmen (mukhtars) in 201 villages, used to investigate the development and decline of the villages. For these mukhtar interviews, 71 questions were asked, both open-ended and closed, on a range of subjects including the village's land assets, agricultural activities, technology, food production, non-agricultural income, relations with the nearest town/city, migration and cultural issues. Some of the data obtained from these questions were accepted as independent variables, with population change being taken as the dependent variable. Then, econometric models were created based on meaningful relations of the dependent with independent variables. Increase in population is employed as the primary indicator of settlement development/decline because it is the most emphasized indicator in the literature as well as in the raw historical data.

2. Materials and Methods

Studies conducted in developed countries mostly show a positive relationship between population density and population size (Singh et al., 2008). Manifestly, the fact that a population lives more densely in a place means that the people are able to continue their lives there. However, the facilities of the settlement or region may become insufficient in the face of population growth over time; thus, "researchers draw attention to the relationship between population pressure and livelihoods and economic factors, especially between population density and quantity and location and availability of means of subsistence" (Kuijt, 2000, p. 77). At this point, in its simplest form, rural settlement evolution (survival/extinction) can be considered a phenomenon wherein livelihoods are determined by the existence and quality of land and climate conditions specific to the village, and usage rights and ownership are defined within the framework of the rules of the social system. For this reason, one of the first independent variables examined in the analyses was the land property of the village.

Table 1: Variables used in analysis and their explanations

Dependent Variable		
Variable	**Definition**	**Explanation**
PGR	Population growth rate	0=decreasing less or increasing* 1=decreasing more
Independent Variables		
Variable	**Definition**	**Explanation**
	Land Property of Village	
LAND	Land per household	
TRAC	Tractors per household	
NOH	Number of households	
HWL	Households without land	
TLV	Total land of village	
	Variables Used in Econometric Model 1	
DIST	Distance to town/city	
ILH	Land/irrigated land per household	
CCOL	Lives in the city and cultivates own land	0*=No, 1=Yes
WCOL	Has non-farming village work and cultivates own land	0*=No, 1=Yes
VWC	Lives in the village but works in the town/city	0*=No, 1=Yes
IVE	Investment/aid sent to the village after emigration	0*=No, 1=Yes
MIG	Migration from town/city to village	0*=No, 1=Yes
	Variables Used in Econometric Model 2	
WLAND	Household without land	0*=No, 1=Yes
DLAND	Decline in household land	0*=No, 1=Yes
ILAND	Increase in household land	0*=No, 1=Yes

* Categories encoded “0” are defined as the reference (base) class.

Both historical data and contemporary literature show that population size, infrastructure and social facilities have a positive effect on the survival of the rural settlement. In addition, the fact that the villages are of different types even within a country and the conditions are constantly changing over time requires that the analyses to be made on the villages include different or newly developing characteristics. According to our field research, one of the new significant factors in the differentiation of villages is the level of non-agricultural activities, employment and income; roughly, the greater the external and non-agricultural inputs, the more vibrant the village. The data on non-agricultural activities, incomes and the population living in the village and going to the town/city for daily work are also included in the econometric analysis here. These variables have been assessed at both the household and village level in the field study. This data and methodology that we used econometric analyses are distinctive characteristics of this study.

Another important factor is immigration to village, which supports the population of the village. People wanting to migrate to the village and those who want to invest should be able to acquire land from the village. For this reason, these two variables were also included in the analysis to determine whether they were effective in village development (as measured by population). According to the qualitative research observations, ease of access to urban social facilities, shopping places and entertainment venues has a decreasing effect on village out-migration and can be effective in villages receiving migration. In this context, information about the variables used in the study is given in Table 1.

In the first step of the analysis, the population change between 1965 and 2008 in the villages surveyed was calculated. For general population growth rate (PGR), villages across Turkey were allocated to two groups. The first group of villages had a population decrease at rates lower than the (−13%) national average (or an increase), and the second group had a decrease at rates faster than the average.

The population survival of a settlement is primarily due to births. If there are no young people in the village to become partners and have children together, the number of people in the village

decreases and the ability to regenerate weakens. In addition, young people staying in the community and finding a spouse (i.e., from another village or elsewhere) contributes to maintaining or increasing the human presence in the village. (Non-marital) migration from and to the village also affects the population size and the characteristics.

Living in a place requires that people have the means to meet their needs there, starting with food and shelter. This requires consideration of livelihood. In the villages within the scope of this research, agricultural income (including animal husbandry) was found to constitute the first biggest source of income in 66.6% of the villages and the second biggest source in 47.8%. Clearly, the main income in most of the villages is derived from agricultural activities. Determinants of the level of agricultural income include total land of the village, size of the land per household and, as a negative of the same indicator, households without land. In addition, as an indicator of agricultural income, the presence of a tractor and animals are also significant variables.

In this context, three main research questions were addressed:

1. Are there differences among village land/property types (land per household, tractors per household, number of households, households without land, total land of village) according to PGR?
2. Is there a correlation between land property of a village and PGR?
3. What are the factors affecting PGR according to the econometric models obtained?

3. Results and Discussion

3.1. Mann-Whitney U Test

In the first analysis, the differences among village land/properties (land per household, tractors per household, number of households, households without land, total land of village) according to PGR was tested. First, a Kolmogorov-Smirnov normality test is performed, and it was observed that the variables are not distributed normally. Thus, in order to test the differences according to PGR, a Mann-Whitney U test was applied. The results of this test are shown in Table 2

Table 2. Results of differences by PGR.

	LAND	**TRAC**	**NOH**	**HWL**	**TLV**
Mann-Whitney U	2608.500	2577.000	2998.000	503.000	3841.500
Wilcoxon W	7073.500	7137.000	8048.000	1064.000	8306.500
Z	−5.272	−4.572	−4.720	−2.671	−2.096
Asymp. Sig. (2-tailed)	.000**	.000**	.000**	.008**	.036**
** Significance at 5%					

As a result of the analysis, when it was seen that the variables were not distributed normally, a Mann Whitney U test was applied instead of the independent t-test. Since the probe values obtained were 0.000 (i.e., < 0.05), it was decided that the medians were not equal according to the PGR groups – in other words, there was a significant difference between the groups. Table 3 shows where these differences were.

Table 3. Mean-rank values.

	PGR	**N**	**Mean Rank**	**Sum of Ranks**
LAND	Decreasing less and rising	99	117.65	11647.50
	Decreasing more	94	75.25	7073.50
	Total	***193***		
TRAC	Decreasing less and rising	89	111.04	9883.00
	Decreasing more	95	75.13	7137.00
	Total	184		
NOH	Decreasing less and rising	100	80.48	8048.00
	Decreasing more	98	118.91	11653.00
	Total	***198***		
HWL	Decreasing less and rising	33	32.24	1064.00
	Decreasing more	47	46.30	2176.00
	Total	***80***		
TVL	Decreasing less and rising	99	105.20	10414.50
	Decreasing more	94	88.37	8306.50
	Total	**193**		

The mean-rank values in Table 3 show that in villages with lower than average decreases or a growing population, the total land, total land per household and the number of tractors per household was higher. In rapidly population decreasing villages, the number of households without land and the number of households was higher. These results show a significant relationship between agricultural assets, which are the most important determinants of agricultural income, and population development. Although in some villages non-agricultural income exceeds agricultural income, agricultural income is still a primary factor in village population change.

The other side of the same coin was that the population decrease rate was shown to be higher than average in villages with more landless households and with a higher number of households. If households lose their land, those households migrate, and the population decreases (faster). If the number of households is high, the amount of land per household decreases and/or landlessness increases, depending on the division of land by inheritance. In this case, people will emigrate to find better living conditions. In fact, among the reasons given for the decline in living standards in villages, that of "agricultural products do not pay off/agricultural income and/or livestock number decrease" was given most commonly (at a rate of 32%). Other reasons mainly pointed to general income decrease and livelihood difficulties. This was confirmed by the reasons for migration from the village; a little over 60% of the reasons given for leaving were unemployment, to find a job, and financial difficulties.

3.2. Correlation Analysis

In the second analysis, the correlation between land properties of villages is tested, using the same variables. This analysis method is commonly used to test the linear relationship between two variables or the relationship of a variable with two or more variables and to measure the relationship between these, if any.

Table 4. Results of Spearman correlation test.

			TLV	HWL	LAND	TRAC	NOH
Spearman's rho	TLV	Correlation coefficient	1.000	−0.133	0.680**	0.185*	0.205**
		Sig. (2-tailed)	.	0.240	0.000	0.013	0.004
		N	196	80	196	182	196
	HWL	Correlation coefficient		1.000	−0.425**	−0.295**	0.379**
		Sig. (2-tailed)		.	0.000	0.008	0.000
		N		81	80	80	81
	LAND	Correlation coefficient			1.000	0.426**	−0.526**
		Sig. (2-tailed)			.	0.000	0.000
		N			196	182	196
	TRAC	Correlation coefficient				1.000	−0.350**
		Sig. (2-tailed)				.	0.000
		N				187	187
	NOH	Correlation coefficient					1.000
		Sig. (2-tailed)					.
		N					201

** Correlation significant at 0.01 level (2-tailed).

* Correlation significant at 0.05 level (2-tailed).

The correlation coefficient can be obtained by various methods. Generally, three types of correlation coefficients are used, namely Pearson, Kendall's tau-b and Spearman's rho. If the data of the variables to be correlated are normally distributed, the Pearson correlation coefficient is preferred, and if one or more are not normally distributed, then Kendall's Tau-b or Spearman's correlation coefficient is preferred. The following definitions are made regarding the power of the correlation coefficient:

0.00 – 0.25 Very weak relationship
0.26 – 0.49 Weak relationship
0.50 – 0.69 Moderate relationship
0.70 – 0.89 High relationship
0.90 – 1.00 Very high relationship

Since the variables obtained from the research data were not distributed normally, the evaluation was made according to the Spearman correlation coefficient, from which the following eight conclusions can be drawn.

1. The relationship between LAND and TLV shows a moderate positive correlation between the coefficient value of 0.680 and the significance level of 0.01 (p = 0.0000).

Since the total land assets are fixed, the land per household will naturally decrease as the number of households increases. The positive but weak aspect of this relationship can be interpreted thus: if the total land is large, it allows the village to support more households, but the imbalance of land distribution and land assets are not the only determinants of land per household. In fact, out-migration from many villages occurs due to landless households and related livelihood difficulties.

2. TLV and TRAC have a very weak positive and significant relationship, with the coefficient value of 0.185 and the significance level of 0.05 (p = 0.013).

The availability of a large amount of land in a village does not require tractors in all or most of the households in the village. Depending on the distribution of land among households, relatively large land-owning households may own tractors, while those with less do not. For a small-scale landowner to own a tractor may not be economic. Small landowners may not have the opportunity to accumulate and borrow money to buy a tractor. In fact, small landowners typically rent a tractor when necessary.

3. TLV and NOH have a very weak positive and significant relationship, with a 0.205 *coefficient* value at the 0.01 significance level (p = 0.004).

As stated above (in the first analysis), if the total land is relatively large, the number of households is expected to be higher where there is a balanced distribution of land, but as the number of

households increases, the amount of land per household will decrease with divisions by inheritance, and the smaller land will not support the large number of households in the long run (since a certain size of land will only support a certain number of households). Considering that agricultural land reached its maximum at the end of the 1960s in Turkey, and that the total number of farms did not change much after that, there was a decrease in small landowners. The positive but weak land size-to-household relationship is thus in accordance with historical developments.

4. HWL and the LAND have a negative significant weak relationship, with a coefficient value of 0.425 at a significance level of 0.01 (p = 0.000).

It is significant that the relationship between households without land and land per household is negative. The same amount of land is divided by more households, and households with shrinking lands become landless more quickly. Conversely, the increase in the amount of land per household coincides with the migration of households without land.

5. HWL and TRAC have a negative significant weak relationship, with a coefficient value of 0.295 at a significance level of 0.01 (p = 0.004).

This can be evaluated similarly to Conclusion 4.

6. HWL and the NOH have a positive and significant weak relationship, with a coefficient value of 0.379 at the level of 0.01 significance (p = 0.000).

The increase in the number of households causes an increase in the number of households without land due to the division of the land by inheritance. However, the weakness of the relationship indicates that the landless households migrated from the village.

7. LAND and TRAC have a weak positive relationship, with the coefficient value of 0.426 at the level of 0.01 significance (p = 0.000).

It is meaningful that households that have more land own tractors.

8. LAND and the NOH have a weak and negative relationship, with the coefficient value of 0.350 at the significance level of 0.01 (p = 0.000).

Increasing total land per household implies that larger households buy some of the land of other households. A total of 21.5%. households who sold their land had either migrated or were about to take the first place, which was the largest proportion in this category. This relationship between migration and land sales supports the negative relationship between the number of households and the amount of land per household.

3.3. Econometric Models

- **Model 1**

After analysing the correlations between certain variables and population change rates, we looked at some other variables in relation to the dependent variable and conducted modelling analyses.

In these models we used, the following (three) open and (five) yes/no variables: (open) distance of village from town/city, village tractor number and amount of (irrigated) land per household; (yes/no) cultivate own land but lives in the town/city, cultivates own land but (also) has non-farming work in the village, lives in the village but works in the town/city, receives investment/aid in the village after emigration, and migration from town/city to village.

We found the following variables in the field that supported the village population: People who were cultivating their own land but were either living outside the village or who had non-farming work in the village (thus, not entirely dependent on agricultural income); villagers who were living in the village but going to work (daily) in the town/city (extra-village employment); some people who had emigrated from the village but later made investments and/or gave aid to the village; and some people who had migrated from the town/city to the village.

In a multivariate model in which dependent and independent variables are separated when the dependent variable is a nominal-scale variable, the ordinary least squares method (OLS) is inadequate as the estimation technique. In this case, discriminant and logistic regression models can be used as an alternative.

The dependent variable consists of two or more groups in the discriminative model, and the parameters of the model are calculated to best distinguish the groups from one another. However, in order for discriminative analysis to make this distinction in the best way, the independent variables should be suitable for normal distribution and the covariances of the independent variables should be equal at each group level. If nominal or ordinal scale variables are included among the independent variables, these two assumptions cannot be provided. This assumption is not sought for independent variables in logistic regression models. The general form of the logistic regression model is as follows (Gujarati, 2001, p. 555):

$$L = \ln\left[\frac{pi}{1-pi}\right] = b_0 + b_1X_i + e_i \quad (1)$$

Because analytical methods cannot be used in parameter estimations in the logistic regression model, the maximum likelihood (ML) technique, which is an iterative method, is used (Stock & Watson, 2011, p. 401). A logistics distribution function is used to explain the model. In the logit model, coefficients cannot be directly interpreted as the effect of a change in independent variables on the expected value of the dependent variable. The sign of the coefficient indicates the direction of the relationship between the argument and the probability of the event occurring.

Table 5. Descriptive statistics of the recommended variables (Model 1).

Variables	Observations (no.)	Mean	Standard Deviation	Minimum Value	Maximum Value
PGR	198	0.5050	0.5012	0	1
DIST	197	47.461	31.239	2	156
LAND	196	98.938	187.31	0	1800
ILH	193	33.929	92.588	0	740.7407
TRAC	187	0.4401	0.3495	0.00285	1.5
CCOL	201	0.6517	0.4776	0	1
WCOL	201	0.6766	0.4689	0	1
VWC	201	0.7114	0.4542	0	1
IVE	194	0.5257	0.5006	0	1
MIG	201	0.5970	0.4917	0	1

Table 5 shows the descriptive statistics of the variables used in the binary logistic regression (Model 1) and Table 6 shows the parameter estimations of Model 1

Table 6. Parameter estimations of binary logistic regression (Model 1).

Model 1	Coefficient	Standard Error	z	$P>\|z\|$	Marginal Effect
DIST	−0.0039	0.0059	− 0.67	0.504	−0.00098
LAND	0.0037	0.0024	1.53	0.126	0.00092
ILH	0.0027	0.0032	0.86	0.388	0.00069
TRAC	1.6437	0.6132	2.68	0.007	0.4091*
CCOL	0.0277	0.4323	0.06	0.949	0.00691
WCOL	−0.0409	0.4465	−0.09	0.927	−0.01019
VWC	−1.3601	0.4725	−2.88	0.004	−0.31604*
IVE	0.6566	0.3864	1.70	0.089	0.16209
MIG	−0.5429	0.4106	−1.32	0.186	−0.13371
Constant	22.6734	23.1248	0.98	0.327	
		* Significance at 5%			
		No. obs. =161			
		LR chi2 (10) = 46.09			
		Prob > chi2 = 0,000			
		Pseudo R2 = 0.2066			

According to Table 6, the variables of distance, total land per household, irrigated land per household, living in the city and cultivating own land, working in other jobs, and migration from

city to village do not have a significant effect on village population growth rate. The number of tractors per household and extra-village employment variables do have a significant effect on this.

Next, in order to interpret the model, we looked at the marginal effects. According to the model, the probability of a village having a relatively negative population growth (i.e., the population decreasing there faster than the average) was 53.35%.

Increasing the number of tractors per household by 1 increases the probability of a faster decrease in the population of the village by 0.4091%. In simple terms, an increase in the number of tractors per household correlates with a rapid decrease in the village population. This can be explained by recognizing the increase in the number of tractors in terms of the tractor function to replace human labor and, as a consequence, idle labor leaving the village and ultimately bringing about a decrease in the number of households. Tractors have been improving in quantity and quality in recent decades in Turkey. The number of tractors increased more than six-fold between 1979 and 2016 (Table 7). We observed as a frequently expressed opinion in the field that it is difficult to do agriculture without tractor. It is necessary to say that: Mechanisation started in 1950 in Turkey, with tractor numbers rising ever since; the 1950s also saw the beginnings of mass internal migration. Many social scientists explained this movement of people as having resulted from the mechanisation, but later this explanation became weak because agricultural employment increased up the 1990s, so other factors were suggested, such as the pull of cities. An important reason for internal migration in Turkey after 2000 was the closure of primary schools in villages, which prompted many villagers to migrate to urban areas for their children's education.

Table 7. Tractor Number, 1979–2020.

Year	Tractor Number
1979	318, 571
1990	769, 456
2000	1, 159, 070
2020*	1, 958, 727

Source: Turkstat https://data.tuik.gov.tr/Bulten/Index?p=Motorlu-Kara-Tasitlari-Aralik-2020-37410

The probability of a rapid decrease in the population of the village decreases by 31.6% when people go daily to work in the town/city. People living in the village but going outside to work in the town or city (extra-village employment) is an increasing phenomenon, both in Turkey and elsewhere in the world. This type of dual life is becoming more popular for a number of reasons, including the increase in ease/means of transportation, the growing preference to live in a rural environment, the lower cost of living in the countryside, better opportunities for/from non-agricultural employment and simple economics (access to income/lower living costs) for poor villagers. Extra-village employment is clearly a development that reduces the loss of village population.

Although the establishment of factories and mines alongside villages is a suggestion that has been voiced for a long time for the increase in the welfare of the villages, today's development tends to be the reverse of that, related to the increase in transportation facilities and the cheap labor supply of the villages. We observed that people going daily to work outside the village would in many cases travel some distance (up to 100 km) and take jobs with relatively low wages.

- **Model 2**

Another model trial was made with the data collected from village-based questionnaires. For this, we used data on village households becoming landless and having increasing/decreasing land as independent variables and population change as the dependent variable.

Table 8. Parameter estimation of binary logistic regression (Model 2).

Model 2	Coefficient	Standard Error	z	$P > \|z\|$	Marginal Effect
WLAND	0.9268	0.3252	2.85	0.004	0.2276*
DLAND	0.0069	0.4157	0.02	0.987	0.0017
ILAND	−0.4941	0.3331	−1.48	0.138	−0.1228
Constant	−0.2406	0.2928	−0 .82	0.411	
		* 5% significance level			
		No. obs. =198			
		LR chi2 (10) = 11.74			
		Prob > chi2 = 0,0083			
		Pseudo R2 = 0.0428			

In this model, the probability of a village's population decreasing faster than average was 49.46%.

The variables of decrease/expansion of household land do not have a significant effect on village population growth rate. The landlessness variable has a significant effect. Considering the marginal effects, when the number of households without land increases by 1, the probability of rapid decline of the village population increases by 0.2276%.

As stated in the above analyses, if a household loses its land, the family is very likely to leave the village. According to our qualitative research, the fact that those who migrate or are the most likely to sell their land confirms this result.

4. Conclusions

In the light of all these data's, ranging from the amount of land to non-agricultural activities, from the distance to the city to the size of the village population, and analyzes of them shows that it is necessary to start from the fact that the development of rural settlements is reshaped again and again by human activities. Just as there is no single reason that determines the continuation of rural life and settlement, there is no single reason for its changes. In this context, the approach to rural areas should be developed by taking into account both a multifaceted analysis of contemporary developments and local differences. Most fundamentally, it is necessary to take into account the continuity of rural life, the existence of income sources and employment opportunities, especially agriculture, and the fact that people expect welfare at the country average.

We used the PGR as dependent variable and in order to look at independent variables for 201 villages, for which we ran hypothesis tests, correlation analysis and econometric models based on a set of questions asked of the village *mukhtar*s in order to examine the development/decline trends of the village. The following two points summarise the main outcomes.

The total land assets of the village and the land assets per household are the strongest variables indicated as supporting the continuity of the village population. Agricultural income is still the biggest income item in most of the villages, and clearly, agricultural income will broadly increase according to the land size. If a farmer cultivates the land, perhaps together with livestock breeding (when feed production for livestock is produced, which is common in Turkey), the size of the land positively affects the amount of agricultural income. This constitutes the material basis for the people living in the village. In this respect, continuity of village life is strengthened insofar as the people living there have sufficient agricultural assets, especially land, to earn their livelihood from farming.

Although land reform has fallen from the agenda in Turkey (and the world generally), its historical as well as socio-economic importance of is keenly shown here. In the light of contemporary developments, the issue becomes especially meaningful within the framework of the survival of the village, impacting on villager livelihoods, poverty reduction, food security, environmental

protection and sustainability. Hopes for a more balanced distribution of land among farmers may not be realistic in the current climate, in which largescale agriculture is encouraged. However, within the framework of the advantages of peasant agriculture and small production, it is clear that agricultural subsistence and sustainability are on the world agenda, with successful practices in countries with large agricultural populations, such as China and Brazil. Undoubtedly, the inability of urban service and industry sectors to find solutions to employment as well as the inconveniences of food security and industrial agriculture are also effective promoters of the small-scale in farming.

Having the opportunity to work in a job outside of village while living in the village positively affects the rate of increase of village population. This development can be evaluated from at least two angles. The first is that extra-village/non-agricultural employment may bolster insufficient agricultural earnings or, generally, to increase the overall household income while living in the village enables the continuation of the family farming life on family-held land. A sufficiently high income level mitigates the push to migrate from the village, and the village population can be maintained.

Second, this development is based on a sufficient development of the opportunities that allow living in the village and working outside the village. The development in transportation and communication technologies and infrastructure especially enable people to meet their needs in both their business and social and private lives without having to change the move from where they live. Again, this supports the survival of the village.

On the one hand, the research findings once again reveal the importance of agriculture and livelihood opportunities for the viability of rural settlements. And, on the other hand, it is obvious that rural residents want to both earn a relatively high income and access the opportunities available in the urban areas. This fact actually manifests itself in the rural population doing agricultural and non-agricultural work together and living both in the village and in the city. Therefore, policies regarding the general development and development of agriculture and rural areas have to take into account these two basic facts and the spontaneous tendency that develops accordingly.

Considering the strengthening trend of urban-rural migration in recent years and the increase in traffic, housing and livelihood problems in cities, villages constitute an alternative for those who want to get away from cities. If it is known which features a village can maintain its population or attract population from elsewhere, it will be easier to direct those who move from the city to the village. This study indicates that villages close to the city can protect or increase their population. This information becomes even more important in the context of reverse migration, considering that those who come from the city to the countryside are unable to completely break away from the city.

In recent years, rural settlements have been turned into neighbourhoods and rural services have been centralized in provinces with metropolitan municipalities. This policy reduced the development opportunities of some villages, which had the potential to increase their population, on their own initiative. Improving the opportunities of villages which have development potential, would not only increase the welfare of these settlements, but also contribute to reducing the problems of cities by encouraging migration from cities to these villages.

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Agricultural & Rural Studies

Article

A Study on Startup Policy Toolkit of Off-Farm Workers Returning Hometown in China

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Abstract: The study aims to explore how policies affect the behavior of rural off-farm workers on whether to return hometown to start their own businesses in China. In the trend of "Internet + e-commerce" economy, the supply-oriented policy tools need to be optimized to adapt to economic development, especially the aspects of the entrepreneurial technology and entrepreneurial information, which provide support for off-farm worker entrepreneurs. The formulation of policy tools is scientific and reasonable, but the distribution in each stage of entrepreneurship is slightly unbalanced, especially in the pre-startup stage, policy tools are rarely used, and the importance of this stage has not been paid enough attention. Overall, the policy design for off-farm workers returning hometown to start a business is reasonable, but the details need to be further adjusted. The results of the Policy Modelling Consistency (PMC) policy index evaluation model show that the performance of the overall entrepreneurship policy from 2015 to 2020 is good or excellent, but the characteristics of the primary and secondary indicators show that the use of various policy tools needs to be further strengthened, and the use of policy tools such as government procurement, public-private cooperation, intellectual property rights and overseas institutions should be increased. Based on the above conclusions, it is suggested to further promote the design and foresight of the policies for off-farm workers, to strengthen the use of capacity building policy tools from the pre-startup stage of entrepreneurship, and to carry out the overall evaluation of relevant policies.

Keywords: off-farm workers returning hometown; policy tool; China's rural revitalization policy; PMC model

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1. Literature Review

The Strategic Plan for Rural Revitalization (2018–2022) proposed that the rural area should seek its development mainly through the path of independent entrepreneurship, which provides policy support for Chinese off-farm workers to return to their hometown and start businesses. In 2021, the Central Document No. 1 proposed the launch of rural revitalization, and the Report of the 19th National Congress of the Communist Party of China proposed the macro strategy of rural revitalization, stating that the rural area is in the critical stage of "great change and great transformation", and the rural industry should develop vigorously. To this end, the central and local governments have issued a number of documents related to the return of migrant workers to their hometown for entrepreneurship, including the three-year action plan proposed by the General Office of the State Council in 2015, and the optimization of the business environment proposed by the National Development and Reform Commission in 2020. Under the premise of a favorable macroeconomic environment, it can be predicted that more and more entrepreneurial talents will emerge in the wave of returning hometown for entrepreneurship, and off-farm workers will become the backbone and driving force of the rural revitalization strategy (Li & Lin, 2023). The government provides subsidies, tax incentives, land support, and bank loans to off-farm workers returning to their hometown for entrepreneurship, which constantly increases their enthusiasm to return to their hometown to start businesses (Wang & lu, 2022). Therefore, rural off-farm workers welcome a good opportunity to return to their hometown to start businesses. Various policies enable them to catch the "express train" of rural development and quickly receive entrepreneurial support in terms of capital, technology, resources, education and training, which is conducive to the establishment of new enterprises.

At present, the most urgent needs of rural development and revitalization are finance, talent

and technology, which are the biggest bottlenecks of rural revitalization (Bai & Liu, 2019). Attracting off-farm workers to return home is one of the ways to solve the problem of rural talent shortage. Yan and Wang (2010) analyze the role of off-farm workers returning hometown to start businesses in narrowing the urban-rural gap, building a new countryside, combining entrepreneurship with urbanization, and promoting the process of economic urbanization. The process of off-farm workers returning hometown to start a business is a process of knowledge and skills to return home and also a talent revitalization process of promoting rural industry revitalization. Naminse and Zhuang (2018) consider entrepreneurship as an endogenous factor of rural development, and Darmadji (2016) believes that farmers' entrepreneurship will bring about a new way of rural development, and relevant policies will be conducive to turning farmers into entrepreneurs. Off-farm workers who return to their hometown to start businesses can enhance their information gathering advantages through e-commerce and other forms, transfer the experience of urban work and life to rural areas, reduce the cost of entrepreneurship (Nieves et al., 2016), and expand their market- relationship networks (Stam, 2010). In fact, the return of off-farm workers to their hometown is conducive to the aggregation of various resources and plays a leading role in entrepreneurship.

The driving factors and the main obstacles for off-farm workers returning hometown are the key points on which entrepreneurship policy should focus. Entrepreneurship policy can better achieve policy goals by 'actively' guiding off-farm workers to return home to start a business. Li (2020), in her survey of 204 off-farm workers, found that the driving factors for migrant workers to return home included personal achievement motivation, demonstration role of other entrepreneurs', and so on. Luo (2012) argues that the entrepreneurship of off-farm workers returning hometown is influenced by individual characteristics, family resource endowment, employment pressure, macro policies, and is a reasonable choice under the combined effect of multiple factors. Chen et al. (2022) proposed that the entrepreneurship of off-farm workers returning hometown is influenced by both social and economic factors, the former including employment and residential welfare and social integration, and the latter including entrepreneurial environment, capital endowment and family responsibility. Su and Guo (2017) empirically demonstrate the impact of the Belt and Road policy on the entrepreneurship of off-farm workers returning to their hometown in the northwest, while the inhibiting factors include the entrepreneurial environment, access to market information, and their own risk tolerance. Shen (2018) finds that the off-farm workers are mainly the result of triple effects, including 'professional reputation promotion effect', 'family happiness enhancement effect', and 'rural revitalization direction effect'. In view of this, taking quantitative policy analysis as a method and observing whether the policy content helps to solve the practical problems of off-farm workers should be a realistic way of thinking about the effectiveness of national policies.

There are several ways of categorizing entrepreneurship policies. For example, Lundström and Stevenson (2005) divided entrepreneurship policies into areas such as entrepreneurship education, entrepreneurship promotion, entrepreneurship financing, and entrepreneurship support through specific research on 10 countries. Henrekson and Stenkula (2010) categorized entrepreneurship policies into entry controls, capital constraints, labor markets, social guarantees, commercialization of research and development, and tax incentives. In the current entrepreneurship policy research, scholars at home and abroad mostly use content analysis method for text analysis and establish an index system through the econometric model. Content analysis of policy texts provides an effective way for researchers to examine policy content, policy instruments, and policy goal (Gao & Tisdell, 2004). Content analysis method includes a variety of analysis tools, such as the policy tool analysis method, the policy semantic network analysis method, and building policy evaluation model. Taking the policy tool analysis method as an example, policy tools refer to the methods, measures and means that the government can take to achieve its policy goals (Huang et al., 2018), and policy tool theory is based on the 'structural theory' of public policy, which views policies as consisting of 'elements' or 'modules'. Therefore, the analysis of policy tools can be used as one of the paths of policy research to reveal the internal structure of entrepreneurship policies (policy tools). Regarding the classification of policy tools, Lowi (1964) divides them into regulatory and non-regulatory instruments; Rothwell and Zegveld (1985) divide them into supply-side, environmental-side, and demand-side tools; Stigler (1971) divides policy instruments into 2 categories: enabling and inducing. Susan Borrás and Edquist (2013) divide innovation policy tools into 3 categories: mandatory tools, economic transfers, and "soft" tools. Scholars use the above research tools to analyze entrepreneurship policy. For example, from the perspective of policy text analysis, Gao and Peng (2019) conduct policy tool mining on 172 entrepreneurship policies of ministries and commissions and show the evolution trend of hot topics and policy characteristics. From the perspective of econometric model analysis, Dye (1995) proposed three principles for policy models: "should be simple and simplify political life", "should identify the most important aspects of the policy area", and "should be consistent with reality". And the PMC index model is widely used. For example, Zhang and Ying (2018) construct 10 unitary indicators and 44 binary indicators for

the 10 entrepreneurship and innovation policies in 2017 with PMC index model and complete the quantitative evaluation with a curve chart. Sansone et al. (2020) analyzed the impact of three different types of incubators (commercial, hybrid, and social) on enterprises, indicating that policymakers can cultivate social incubators. Nugroho et al. (2015) developed a model framework to compare public data openness policies in different countries through a literature review and case studies, comparing policies in the United States, the United Kingdom, the Netherlands, and other countries.

Based on the above analysis, this paper constructs a two-dimensional framework of "policy tool-entrepreneurship process", quantifies the policy of off-farm workers returning hometown, explores the path of policy optimization, finds the 'correction' and 'incorrection' of the policy in multidimensional quantitative analysis, and provides the decision-making reference for perfecting and predicting the policy of off-farm workers returning hometown to start entrepreneurship.

2. Analysis Framework and Research Design

2.1. Data Sources

This paper selects eight policies issued by the Central Government, Ministries and Commissions on off-farm workers returning to their hometown to start businesses, including three basic policies issued by the State Council and the General Office (P1, P2, P6) and five targeted policies issued by ministries and commissions at two levels (P3, P4, P5, P7, P8). The policies are searched and sorted through the website of www.pkulaw.cn and the policy column of the official websites of all the ministries and commissions, and the search period is of almost five years. The collection principles are as follows: (1) in addition to the 'Opinions of the State Council on Further Improving Employment and Entrepreneurship in the New Situation' in 2015 as the root policy, there is a category of off-farm workers returning home to start a business in the policy text, other policies are all the text titles, that is, the policy text containing the keywords of "off-farm workers returning home to start a business". (2) The policy selection period is from 2015, when the State Council issued the policy on off-farm workers returning to their hometown to start their own business and conducted a five-year pilot project, to 2020, when the national pilot project on supporting off-farm workers and other people returning to their hometown to start their own business in connection with new urbanization ends, and the policy texts are selected at the central level from 2015 to 2020. The eight selected policy texts are typical and representative, and the textual analysis can reflect the top-level national policy design ideas on off-farm workers returning hometown.

Table 1. A summary of representative policies on off-farm workers returning hometown to start a business.

Serial No.	Policy Code	Policy Names	Issuing Authority	Date of Issue
1	P1	Opinions of the State Council on Further Improving Employment and Entrepreneurship in the New Situation	the State Council	2015
2	P2	Opinions of the General Office of the State Council on Supporting the Returning of Migrant Workers and Other Personnel to Their Hometown and Start Businesses	General Office of the State Council	2015
3	P3	The Notice on Implementing the Pilot Work of Supporting Migrant Workers and Other Personnel Returning Home and Undertaking Entrepreneurship on the base of New Urbanization	National Development and Reform Commission	2015
4	P4	The Notice on Implementing the Action Plan of Developing Agricultural and Rural Resources to Support Migrant Workers and Other Personnel to Return Home and Start a Business	Six ministries including Ministry of Agriculture	2015
5	P5	Notice on Implementing a Five–year Action Plan for the Training of Migrant Workers and Other Personnel Returning Home for Entrepreneurship (2016–2020)	Five ministries including Ministry of Human Resources and Social Security	2016
6	P6	Opinions of the General Office of the State Council on Supporting the Entrepreneurship and Innovation of People Returning Home and to the Countryside to Promote the Integrated Development of Rural Primary, Secondary and Tertiary Industries	General Office of the State Council	2016
7	P7	Opinions on Further Promoting the Work of Returning Home and Starting Businesses	Three ministries including Ministry of Human Resources and Social Security	2019
8	P8	Opinions on Promoting the High–quality Development of Returning Home and to the Countryside for Entrepreneurship	19 departments including National Development and Reform Commission	2020

2.2. Construction of Two-Dimensional Analysis Framework

Policy tools are the 'modules' that make up the entrepreneurship policy, and the content of the policy is a composite system composed of a number of policy tools (Huang, 2016). Therefore, the internal composition of the policy, the proportion of policy tools, the main purpose of the policy and the effectiveness of the policy can be analyzed by decomposing the entrepreneurship policy into policy tools. In the 1950s, Hood proposed the research method of policy tools in Tools of Government. As a component of the policy framework and research tools, policy tools have been widely used in the field of public policy research since then. Since Kirschen (1964) proposed 64 types of policy tools, scholars began to divide policy tools into different categories. For example, Stigler (1971) and Barro (1978) divided policy tools into two types of authorization and induction. The three types of policy tools classified by Rothwell and Zegveld (1985): Supply type, demand type and environmental type, are the most widely used in policy analysis.

The introduction of policy tools into entrepreneurship research by domestic scholars has begun to take shape. Ding et al. (2020) conducts a quantitative analysis on entrepreneurship policies from 1994 to 2017, and explores the policy differences in various regions using demand type, supply type and environment type tools; Yang et al. (2019) conducts a research on the policies of the State Council and 16 ministries to support innovation and entrepreneurship development policies, and finds four basic characteristics, such as the use of policy tools and thematic relevance characteristics. Some scholars have also conducted quantitative research on the farmer entrepreneurship policies. Li and Li (2019) conduct a quantitative analysis on the policy text of farmers' employment and entrepreneurship in 2004–2008 and find out the problems of structural distribution imbalance of policy tools and insufficient departmental coordination. In view of this, taking 8 policies of off-farm workers' return home for entrepreneurship as an example, the paper sets up an analysis framework of policy tool-entrepreneurship process to observe whether the policy tools are reasonably applied in the process of off-farm workers' return hometown for entrepreneurship.

2.2.1. X-dimension: The Perspective of Policy Tools

Based on the three types of supply, demand and environmental policy tools classified by Roy Rothwell and Walter Zegveld and combined with the two-level classification of entrepreneurship policy tools by Bai and Zhang (2016), a second type of analytical tool for the policy tool dimension is merged.

2.2.2. Y-dimension: The Perspective of Entrepreneurial Process

Lundström and Stevenson (2005) divide the entrepreneurial process targeted by entrepreneurial policy into three stages: pre-start, start-up and early-start. Yi and Xia (2008) divide them into two stages: new venture formation and new venture growth. At the stage of new venture formation, the system of entrepreneurial instruments mainly consists of six items: tax policy, incubation service, entrepreneurship education, entrepreneurship skill training, entrepreneurship financing projects, and electronic registration. At the stage of enterprise growth, the system of entrepreneurial policy tool mainly includes venture capital, private fund, growth financing, innovation fund and capital market. Bai et al. (2013) divide it into three supporting stages: seed stage and start-up stage (transformation stage of project achievements to industrialization), development stage and mature stage (rapid development stage of enterprises after industrialization of achievements), and the whole stage. In each stage of entrepreneurship, the key supportive policies needed are different, and the number and frequency of policy instruments used in each stage are also different. Therefore, the entrepreneurial process perspective is introduced into the policy research framework, and the entrepreneurial process of off-farm workers is divided into four stages: pre-start, start-up, development and the whole stage. Together, a two-dimensional analytical framework with X-dimensional entrepreneurship policy tools is built.

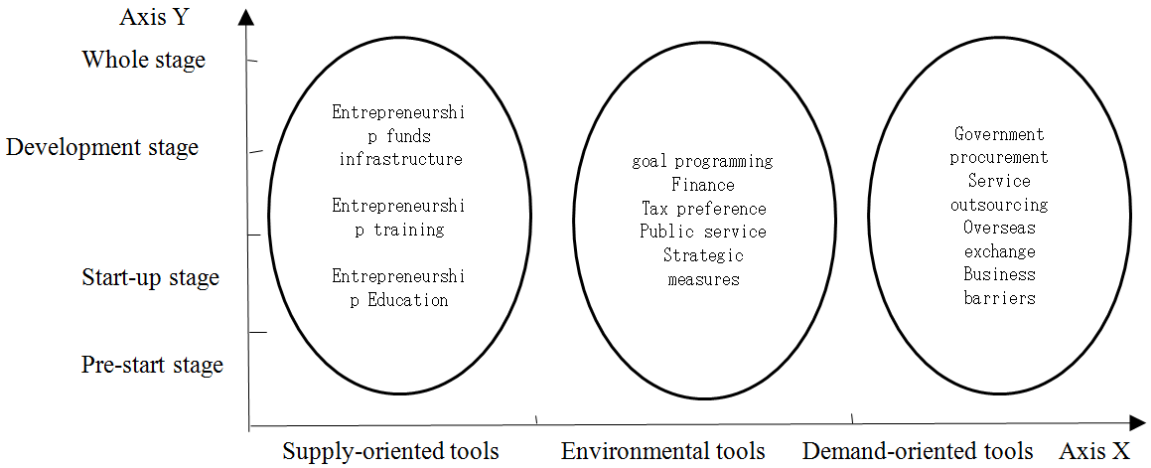

Figure 1. Two-dimensional framework of policy analysis.

2.3. Research Methods

Following the framework of two-dimensional analysis, 118 policy clauses from 8 policy texts are coded. The basic principle of coding is to read the policy clauses one by one, and to consider the order of the policy text as a Level 1 code number; the relevant clauses of the policy texts are considered as basic policy units, and secondary numbering is carried out according to the order. The coder is a research group of three experts who perform independent coding to ensure the coding reliability. The coding results were then reviewed by two industry experts to ensure the reliability of the conclusions. The coding results are processed as '1' (yes) and '0' (no), the coding consistency coefficient of the analysis category is calculated as $\alpha = \left[\sum_{i=1}^{118} \alpha_i\right] / 118$, and the overall consistency coefficient β = (α) is calculated as $\beta = \left(\alpha_1 + \alpha_2 + \ldots + \alpha_n\right) / n$.

After two rounds of adjustment, each round is adjusted according to the coding method with the highest consistency coefficient. The overall consistency coefficient of the final coding is up to 85.1%, the coding reliability passes the test (> 80%), and the coding table of the policy text (Table 2) is produced.

Table 2. Coding table of the content analysis of policy text for off-farm workers returning hometown for entrepreneurship.

Serial No.	Policy Document No.	Policy Text Analysis Unit	Code
1	NDRC[2015]2811	1 To carry out the pilot work of supporting migrant workers and other people to return home for entrepreneurship on the base of new urbanization is to thoroughly implement the national plan of new urbanization... it is an important practice to promote mass entrepreneurship and innovation and is of a very important and positive significance in terms of promoting the construction of new urbanization and supporting the returning home for entrepreneurship.	1–1
		2 (1) To create an environment, stimulate vitality and adhere to market orientation	1–2
		(2) To optimize the layout, start businesses in clusters, adopt measures suiting local conditions, and deeply develop characteristic and advantageous resources	1–3
	…	…	…
2	Ministry of Human Resources and Social Security [2019]129	1 (1) To implement entrepreneurship supporting policies. Individuals returning home for entrepreneurship can enjoy the same entrepreneurship support policies as local workers in terms of tax reduction and exemption, site arrangements and so on…	2–1
		1 (2) To implement the policy of entrepreneurship guarantee loan, and promote the financing mode of 'government + bank + insurance' …	2–2
…	…	…	…
8	Ministry of Agriculture and Rural Areas [2015]8	7 (2) To strengthen the implementation of responsibilities... included in the work assessment, to specify the time schedule, formulate detailed implementation rules, implement the division of responsibilities, and ensure work effectiveness.	8–23
		7(3) To strengthen publicity and guidance... constantly stimulate the enthusiasm, initiative and inherent potential of returning home to start a business.	8–24

3. To Analyze the Policy of Off-Farm Workers' Returning Hometown for Entrepreneurship

3.1. Overall Characteristics of the Policy

3.1.1. The Emphasis of Policy Texts Issued by Governments at all Levels Is of Dissimilarity and Similarity

This paper processes and visualizes the policy text using Rostcm6 software: extracting high-frequency characteristic words, observing the high-frequency words in the policy text of off-farm workers' returning hometown for entrepreneurship, eliminating the characteristics of the policy itself, such as the words of 'entrepreneurship', 'returning hometown', 'off-farm workers', and so on, and revealing the policy concerns. The results of the analysis show that the concerns of the State Council are slightly different from those of the ministries and commissions. The former pays more attention to the services and resources provided for returning migrant workers; while the latter pays more attention to the training and employment opportunities provided for off-farm workers. However, according to the overall observation and analysis results, the policy concerns of off-farm workers returning their hometown for entrepreneurship include three aspects: (1) the support provided by the government and society, including services and training. These services include platform services, government services, in-depth services provided by market-oriented intermediary services, financial services, etc. For example, the 'Opinions on Promoting the High-Quality Development of Returning Home or to the Countryside for Entrepreneurship' (NDRC Employment [2020] No. 104) proposes "Internet plus government services", and encourages areas at or above country level to establish a "One-stop service on the Internet", and encourages areas at or above the county levels to establish a "one-stop" comprehensive service platform for returning hometown for entrepreneurship, in order to create a favorable environment for development. The training includes an entrepreneurship training plan, entrepreneurial ability training, etc., and vigorously cultivates high-quality labor talents to meet the needs of the returning hometown. (2) Promoting entrepreneurship and innovation in agriculture. The "Opinions on Supporting the Workers Returning Home for Entrepreneurship and Innovation, and Promoting the Integrated Development of Rural Primary, Secondary and Tertiary Industries" proposes to give priority to the development of characteristic agriculture and facility agriculture by virtue of new technologies, new ideas and new channels; "Opinions on Further Promoting the Workers of Returning Home for Entrepreneurship' (HRSSD [2019] No. 129) encourages "rural talents", "local experts" and "rural entrepreneurs" to attract skilled talents to return hometown for entrepreneurship and innovation; supports innovation in terms of technology, management and business model with policies. (3) Returning to hometown to start a business is to achieve the ultimate goal of development, such as the integrated development of primary,

secondary and tertiary industries.

3.1.2. The Emphasis of the Policy Is Characterized by Phases

In 2015, the State Council issued the 'Opinions on Further Improving Employment and Entrepreneurship in the New Situation' (SC [2015] No. 23), proposing to support rural migrant workers to return home and start businesses, and advocating integration with county economic development and the integration of primary, secondary and tertiary industries. The above idea is the policy embodiment of General Secretary of the Communist Party of China Central Committee Xi Jinping's thoughts on rural development and rural revitalization. In the five-year period from 2015 to 2020, the policy focus has shifted from specific transactional training and services for returning off-farm workers to development issues.

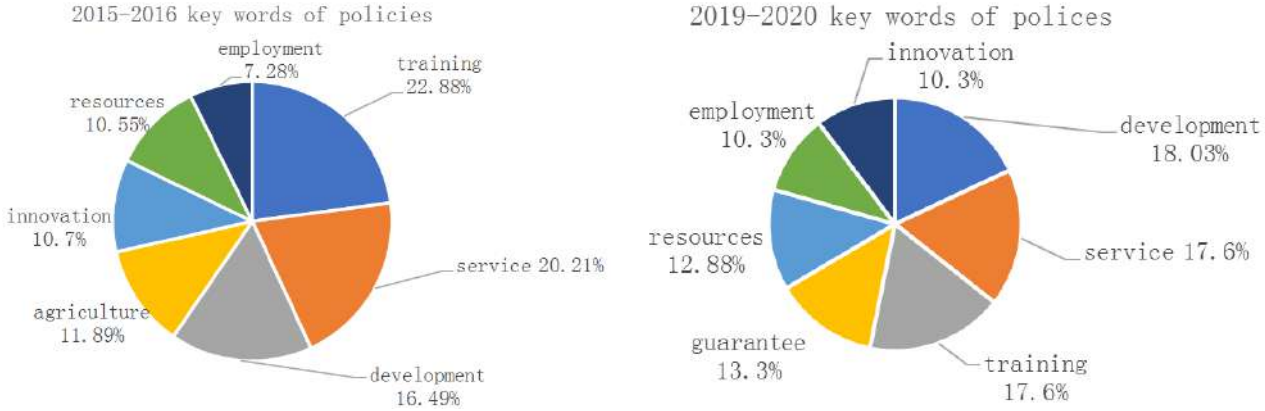

Figure 2. Policy emphasis by phases for off-farm workers returning hometown for entrepreneurship**.**

3.2. Two-Dimensional Framework Analysis of the Policy for Off-Farm Workers Returning Hometown for Entrepreneurship

3.2.1. Policy Analysis of Off-Farm Workers Returning Hometown for Entrepreneurship from the Perspective of Policy Tools

The policy texts are coded one by one to form a coding table (Table 3) using Roy Rothwell & Walter Zegveld's policy tool analysis framework. The frequency of use of the policy tools were categorized as environmental type (61.1%), supply type (35.7%) and demand type (3.2%). Previous studies have shown that the usage frequency characteristics of off-farm workers' returning hometown for entrepreneurship are in line with those of national entrepreneurship policy tools. This indicates that the state is more inclined to create a good business atmosphere and use policy tools such as regulations and public services to provide more convenience for small and micro enterprises in terms of entrepreneurship policy design. According to the World Bank's Business Environment Report and GEM's Global Entrepreneurship Observation Report 2017/2018, both show the progress and improvement of China's business environment and the effectiveness of the national entrepreneurship policy. The use of supply-side policy instruments plays a direct role in promoting the entrepreneurial activities of off-farm workers returning to their hometown. It provides support directly from the factor market through entrepreneurial technology support, entrepreneurial education and training, entrepreneurial capital support, etc. In China, 35.7% of the policy instruments for off-farm workers returning to hometown for entrepreneurship are supply-oriented.

Table 3. Roy Rothwell & Walter Zegveld coding table of policy tools.

Policy Tools	Policy Unit Code	Frequency	Proportion (%)
Supply-oriented	1–7, 1–11, 2–3, 2–4, 2–9, 2–13, 3–2, 3–3, 3–6, 4–12, 4–13, 4–14, 4–15, 4–16, …, 8–14, 8–15, 8–16, 8–17, 8–18, 8–19, 8–20, 8–21	45	35.7%
Demand-oriented	2–5, 2–10, 3–4, 4–2	4	3.2%
Environment-oriented	1–1, 1–2, 1–3, 1–4, 1–5, 1–6, 1–8, 1–9, 1–10, 1–12, 1–13, 2–1, 2–2, 2–5, 2–6, 2–7, …6–1, 6–2, 6–3, 6–7, 6–9, 6–10, 6–12, 6–13, 6–14, 6–16, 6–19, 7–1, 8–2, 8–3, 8–4, 8–7, 8–8, 8–9, 8–10, 8–11, 8–14, 8–20, 8–21, 8–22, 8–23, 8–24	77	61.1%
Total		126	100%

The first-level policy instrument of dimension X is then divided into two-level policy instruments. It is found that the construction of entrepreneurship infrastructure (40%) and entrepreneurship training (35.6%) account for a relatively high proportion of supply-oriented policy tools. For off-farm workers returning hometown, entrepreneurship technology and entrepreneurship information (13.3%), venture capital investment (6.7%) and entrepreneurship education (4.4%) account for less. This suggests that the off-farm workers are still in the early stages of entrepreneurship. On the whole, the state provides stronger policies to facilitate entrepreneurship in terms of perfecting infrastructure and providing off-farm workers with knowledge and skills training. The key point of the policy is to solve the urgent problems in the initial stage of off-farm workers' entrepreneurship. Among the environmental policy instruments, the improving of public services (39.7%) and the providing financial support (23.1%) have a relatively high share. For off-farm workers returning hometown, target planning (15.4%), strategic measures (11.5%), talent and other regulations (6.5%), and preferential taxation (3.8%) have a lower share. This shows that the government must first provide various services and support measures to create a good business environment for off-farm workers to start their businesses. Second, the government should solve the financial problems of off-farm workers through subsidies, loans and other financial support. In a word, the overall analysis of secondary policy tools shows that the policy of off-farm workers' returning hometown for entrepreneurship in China at present has more of a "help on the horse" element. In the future, the introduction of policy tools into the prospective idea of policy, such as the introduction of entrepreneurship technology, the introduction of talent and other long-term production rates, and the introduction of regulating market behavior should be carried out more. At the same time, more attention should be paid to demand-oriented policy instruments to achieve more policy goals by using diversified policy instruments such as public procurement and foreign exchange.

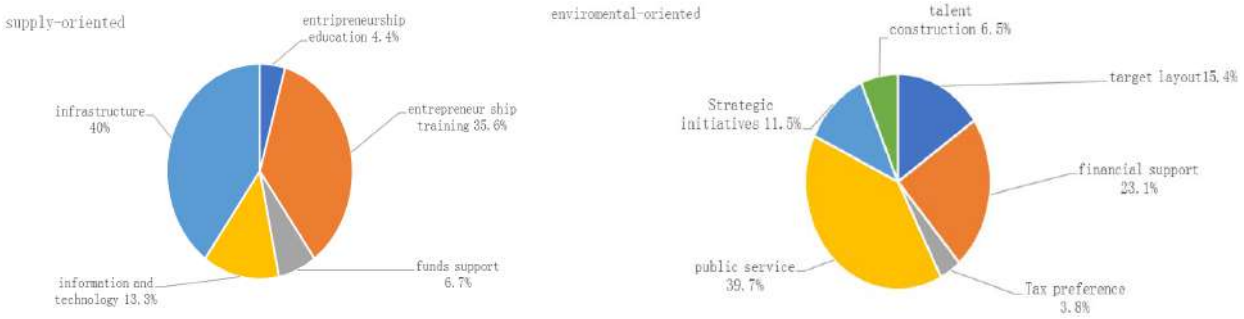

Figure 3. Analysis results of supply-oriented and environment-oriented policy tools.

3.2.2. Y-dimension: Policy Analysis of Off-Farm Workers Returning Hometown for Entrepreneurship from the Perspective of Entrepreneurship Process

As found in the coding analysis of the policy for off-farm workers returning hometown for entrepreneurship, almost half of the policies for off-farm workers returning hometown for entrepreneurship cover the whole stage (48.5%), followed by the coverage of the development stage (22.3%) and of the start-up stage (21.5%). This shows that the policy coverage is broad, not only considering the initial stage of off-farm workers, but also considering the support that should be given to the development of the entrepreneurial enterprises, and there are also policy provisions dealing with the issues of equity of listed enterprises and listed financing of rural off-farm workers. There are also many policy provisions that focus on the development and start-up phases of entrepreneurial enterprises. Policy support and benefits are available to address the particular difficulties faced by entrepreneurs during these two periods. It is worth noting that the policy distribution focused on the pre-start stage of off-farm workers returning hometown for entrepreneurship accounts for a relatively small proportion (7.7%), the pre-start belongs to the early stage of entrepreneurship, which is the process when off-farm workers conceive the awareness of returning hometown for entrepreneurship and consciously search for resources. Special attention should be paid to the policy design at this stage. On the one hand, the policy needs to solve the universal problems of this stage, on the other hand, it is also necessary to make off-farm workers fully aware of the difficulties and challenges they will face after starting their business, make them have a clear and complete understanding of their returning hometown for entrepreneurship, and avoid blindness.

Table 4. Policy code table of entrepreneurship process dimension.

Entrepreneurial Cycle	Policy Unit Code	Frequency	Proportion (%)
Pre-start Stage	1–1, 3–1, 4–2, 4–6, 4–7, 4–17, 5–2, 5–3, 6–1, 8–4,	10	7.7%
Initial Stage	1–6, 1–8, 1–9, 1–10, 1–11, 2–1, 2–2, 2–3, 2–4, 2–5, 2–6, 2–7, 2–9, …, 4–5, 4–8, 4–12, 4–13, 4–14, 4–17, 4–21, 5–10, 6–16,	28	21.5%
Development Stage	1–3, 1–4, 1–12, 1–13, 2–7, 2–9, 2–11, 2–12, 2–14, 3–4, 3–5, 3–8, 3–9, …, 4–14, 4–15, 4–16, 4–18, 4–19, 6–2, 6–10, 6–17,	29	22.3%
Whole Stage	1–2, 1–5, 1–7, 2–8, 2–10, 2–13, 3–6, 3–7, 3–11, 4–1, 4–3, 4–20, 4–21, 4–22, 4–23, 4–24, 5–1, 5–4, 5–5, 5–6, 5–7, 5–8, 5–9, 5–11, 5–12, 5–13, …, 8–12, 8–13, 8–14, 8–15, 8–16, 8–17, 8–18, 8–19, 8–20, 8–21, 8–22, 8–23, 8–24,	63	48.5%
Total		130	100%

3.2.3. Two-Dimensional Framework Analysis of Policies for Off-Farm Workers Returning Hometown for Entrepreneurship

The Analysis at X and Y Dimensions: the Characteristics of Using Policy Tools in Each Entrepreneurial Stage. The cross-analysis of Roy Rothwell & Walter Zegveld's policy tool analysis framework and the entrepreneurial process yields the result that the frequency of use of environmental policy tools is highest in each stage of off-farm workers' returning hometown for entrepreneurship, indicating that the state creates a favorable environment for returning off-farm workers through financial, tax incentives, public services and other policy tools, thus indirectly promoting off-farm workers' entrepreneurial activities. It is worth noting that the supply-oriented policy instruments are used less used by off-farm workers in the pre-start phase (0.8%), i.e., there is a lack of policy support in terms of entrepreneurship education, entrepreneurial skills training, entrepreneurial capital support and entrepreneurial technology support. However, the above-mentioned policy support is very necessary in the start-up phase and the lack of relevant policies is not conducive to entrepreneurial start-up activities. In addition, special attention should be paid to pre-start training and related education of entrepreneurs, which will not only provide them with skills and knowledge capital, but also help them to broaden their entrepreneurial horizons. And it will help the entrepreneurial activity to go well afterwards.

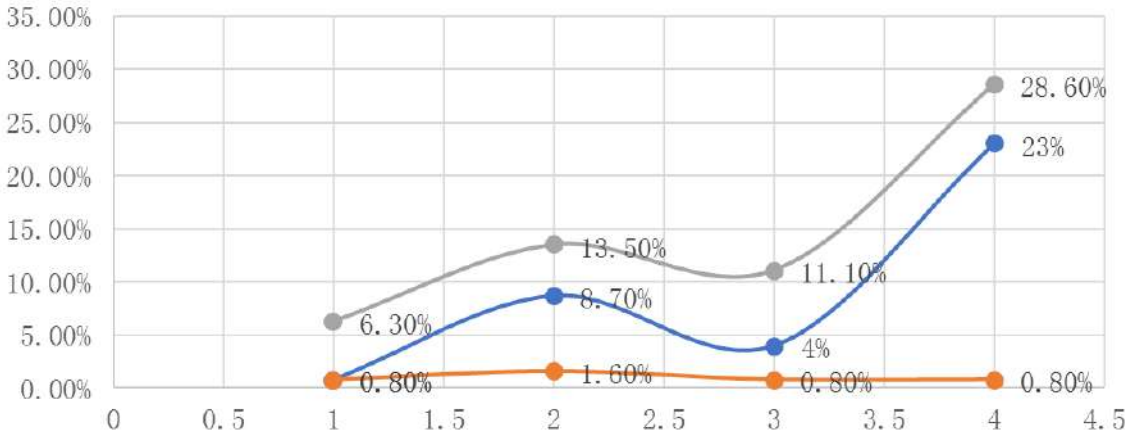

Figure 4. Policy tools two-dimensional distribution statistics of entrepreneurship process.

4. The PMC Model of Policies for Rural Off-Farm Workers Returning Hometown

Based on Ruiz Estrada (2011) policy evaluation study, the Policy Modelling Consistency (PMC) index model is used to measure the excellence of the migrant worker return to hometown entrepreneurship policy. The advantage of the PMC method is that there is no limit to the number of secondary variables and the weights of the variables are the same, thus avoiding subjective weighting (Ruiz Estrada et al., 2007). The rural off-farm worker policies are evaluated using the PMC index model, which includes 9 primary index and 35 secondary indicators. According to the requirements of the theoretical mobility hypothesis, the estimation of the secondary indicators follows the binary [0,1] setting (i.e., 0,1 assignment), and 35 secondary indicators are evaluated for each policy as follows:

Table 5. PMC index for rural off-farm worker policies.

X_1(Nature of Policy)	$X_{1:1}$ Forecast (prospect prediction); $X_{1:2}$ supervision (supervision and management of returning home for entrepreneurship process); $X_{1:3}$ suggestions (Development Countermeasures); $X_{1:4}$ guidance (development-oriented goal); $X_{1:5}$ support (support for returning home and starting a business)
X_2(Policy Prescription)	$X_{2:1}$ long term (policy prescription over 10 years); $X_{2:2}$ Phase 2 (policy prescription: 6–10 years); $X_{2:3}$ short term policy (1–5 years)
X_3(Policy Level)	$X_{3:1}$ The State Council (issuing agency); $X_{3:2}$ ministries and commissions of the State Council (issuing agency)
X_4(Policy Function)	$X_{4:1}$ Government procurement (political procurement); $X_{4:2}$ guidance (guidance); $X_{4:3}$ institutional constraints (regulatory constraints); $X_{4:4}$ technological innovation (technological innovation)
X_5(Action Level)	$X_{5:1}$ industry (industry aspect); $X_{5:2}$ support platform (platform aspect); $X_{5:3}$ enterprises (enterprise aspect); $X_{5:4}$ universities and scientific research institutes (research aspect); $X_{5:5}$ maker group (individual aspect)
X_6(Policy Tools)	$X_{6:1}$ technology R&D (technology, R&D Research); $X_{6:2}$ talent team (talent, training and education); $X_{6:3}$ basic resources (infrastructure, etc.); $X_{6:4}$ cultural atmosphere (cultural atmosphere); $X_{6:5}$ government procurement (government procurement); $X_{6:6}$ overseas institutions (overseas contacts); $X_{6:7}$ finance and taxation (economy and finance); $X_{6:8}$ public private cooperation (cooperation and sharing); $X_{6:9}$ intellectual property (intellectual property)
X_7(Policy Operability)	$X_{7:1}$ specific implementation scheme (specific steps); $X_{7:2}$ supporting policies (element allocation)
X_8(Policy Evaluation)	$X_{8:1}$ sufficient basis (basis for policy formulation); $X_{8:2}$ clear objectives (clear policy objectives); $X_{8:3}$ program science (program science)
X_9(Incentive Constraint)	$X_{9:1}$ supervision and assessment (industry supervision); $X_{9:2}$ legal protection (legal protection)

According to the formula (1)–(3), the PMC index can be calculated as:

$$X \sim N\,[0,\,1] \tag{1}$$

$$X_t \left(\sum_{j=1}^{n} \frac{X_{ij}}{T\left(X_{ij}\right)}\right)\ (t = 1, 2, 3, 4, 5\ldots\ldots) \tag{2}$$

t is the primary index; j is the secondary index.

$$PMC=\left\{\begin{array}{l} Xt\sum_{j=1}^{n}\frac{X_{1j}}{5}+Xt\sum_{j=1}^{n}\frac{X_{2j}}{3}+Xt\sum_{j=1}^{n}\frac{X_{3j}}{2}+ \\ Xt\sum_{j=1}^{n}\frac{X_{4j}}{4}+Xt\sum_{j=1}^{n}\frac{X_{5j}}{5}+Xt\sum_{j=1}^{n}\frac{X_{6j}}{9}+ \\ Xt\sum_{j=1}^{n}\frac{X_{7j}}{2}+Xt\sum_{j=1}^{n}\frac{X_{8j}}{3}+Xt\left(\sum_{j=1}^{n}\frac{X_{9j}}{2}\right) \end{array}\right\} \tag{3}$$

Then take the policy 1 (P1), policy 2 (P2), policy 6 (P6) as an example, all of them are issued by the State Council, and the PMC index is 7.14, 5.87 and 6.19, the rank is No.1, No. 3 and No. 2 among the policies.

Table 6. PMC index calculation table of entrepreneurship policy from the State Council.

Policy Code	Nature of Policy	Policy Prescription	Policy Level	Policy Function	Action Level	Policy Tools	Policy Operability	Policy Evaluation	Incentive Constraint	PMc Index	Ranking
P_1	1	0.33	0.5	0.75	1	0.56	1	1	1	7.14	1
P_2	0.8	0.33	0.5	0.5	0.8	0.44	1	1	0.5	5.87	3
P_6	0.8	0.33	0.5	0.5	1	0.56	1	1	0.5	6.19	2

Overall, the policies on off-farm workers returning hometown to start a business in China are good or better. Among them, the "Opinions of the State Council on Further Perfecting Employment and Entrepreneurship in New Situation" (2015) has reached an excellent level. The path of policy optimization can be started from two aspects: policy function and policy instruments. In terms of policy function, institutional constraints should be strengthened, and in terms of policy tools, the use of policy tools such as government procurement, public-private cooperation, intellectual property rights and overseas institutions, can be increased.

5. Conclusions and Suggestions

5.1. Research Conclusion

Through the use of two types of entrepreneurial tools and an entrepreneurial process analysis framework, this paper examines eight typical policy texts on off-farm workers returning hometown for entrepreneurship from 2015 to 2020 from different perspectives, and draws the following main conclusions:

(1) As found in the analysis of the overall characteristics of the policy, the overall focus of the policy is to provide more services and support for off-farm workers returning to their hometown to achieve the long-term development goals. Therefore, the key point of the policy design is to provide in-depth support services from the perspective of government, society and platforms, promote the development of rural industries and create a good business atmosphere. As shown in the results of further unearthing the keywords of policy text and the policy release time, the State Council and the General Office pay more attention to providing services and resources for off-farm workers returning hometown, while the ministries and commissions pay more attention to specific links such as entrepreneurship training and entrepreneurship employment opportunities. Over time, the policy of off-farm workers returning hometown pays more attention to development issues, which is well related to the Strategic Plan for Rural Development (2018–2022) and incorporates off-farm workers' entrepreneurship into the rural development and revitalization strategy.

(2) The policy tools in Roy Rothwell & Walter Zegveld's policy tool analysis framework also tends to create a good business climate and the internal consistency of entrepreneurship policy is good. Further analysis suggests that the use of secondary policy tools is somewhat inadequate and that there is a need to develop diversified policy tools and to exploit the potential of balanced policy tools to achieve more policy objectives.

(3) From the perspective of the entrepreneurial process, it is found that the policy for off-farm workers returning hometown for entrepreneurship covers a wide range from the pre-start, start-up stage, development stage to the whole stage, which is covered by relevant supporting policies. At the same time, the depth of the policy content is also great. Considering the problems that may arise in the process of off-farm workers' entrepreneurship, such as equity financing, listing financing and so on, it provides a forward-looking policy for the expanded development of off-farm workers' entrepreneurship.

(4) From the perspective of the two-dimensional framework of policy tools and the entrepreneurship process, the analysis presents that the use of policy tools is relatively uneven at all stages of the return of off-farm workers to hometown for entrepreneurship. Among them, the policy tools are less used in the pre-start stage and should be given further attention; the demand-oriented policy tools are less used and need to be further involved in policy design.

5.2. Policy Suggestions

(1) The frequency of policy tools used in the pre-start phase should be strengthened accordingly. The research indicates that the current policy tools are more spread out in the early and development stages of enterprises and that the policy tools are under-utilized in the pre-start phase. However, it should be recognized that the pre-start phase needs more policy support to access potential resources, information and skills and to create the conditions for a successful transformation of entrepreneurial awareness into entrepreneurial enterprises. Policy design should therefore pay more attention to the entrepreneurial characteristics of this stage and provide targeted policy tools to help. Furthermore, within the framework of Roy Rothwell & Walter Zegveld policy tools, special attention should be paid to the use of supply policy tools, and the necessary public services and

talent information support should be provided for migrant workers in the pre-start stage of entrepreneurship.

Firstly, during the start-up period, we should pay special attention to improving the overall quality of off-farm workers returning hometown, providing technical assistance for various problems that arise during the start-up period by training them in technical skills, teaching them vocational skills, passing on the latest policies and guiding them to understand market dynamics. Secondly, to provide financial support and pre-employment training opportunities for off-farm workers during the start-up period, the lack of funds during the start-up period is the norm for entrepreneurship, and it is more difficult for small and micro enterprises to get financial support due to qualification problems, so we should pay attention to financial support and tax incentives in the start-up period, and government-led investment attraction and private capital investment are feasible options. In addition, providing special support funds to off-farm workers to start businesses in their hometown, accepting awards in lieu of subsidies to support entrepreneurial projects in their hometown, and fully subsidizing sanitation and water bills are all favorable policies. At the same time, more pre-employment training opportunities will be provided for off-farm workers so that they can understand the difficulties and challenges they may encounter in starting their own businesses and acquire the relevant knowledge in a timely manner. Thirdly, to promote the reform of land system, returning off-farm workers need to have land as their business base, so they need to be supported in land use and property rights allocation, etc. Try the system of linking the increase and decrease of urban and rural construction land, the limited use of rural idle house bases and village construction land remediation and reclamation into arable land for the construction of agricultural and by-product processing projects, etc. Allow the establishment of production houses within the house bases and other measures to realize the entrepreneurship of off-farm workers the guarantee of land use.

Optimize the internal structure of supply policy tools and strengthen the application of entrepreneurship technology and entrepreneurship information tools. At present, the use of entrepreneurship infrastructure construction and entrepreneurship training tools account for a relatively high proportion, but it's not so urgent to select entrepreneurship technology and entrepreneurship information and set up as policy terms alone. At present, rural construction has entered the digital era. In 2020, the Ministry of Agriculture and Rural Affairs issued the "Digital Agriculture and Rural Development Plan (2019–2025)", the launch of digital rural construction requires off-farm workers to start businesses through digital technology and information. Its expression in the policy design to provide conditions and support for off-farm workers returning hometown at the national level is what the policy should focus on in the future. In addition, the current rural entrepreneurship clusters are concentrated in the "Taobao village", and the agricultural products are rising in the form of "Internet plus" e-commerce platforms. In the rather mature operation mode of the Taobao village, entrepreneurial technology and entrepreneurial information play a key role in the entry and development of returning migrant workers. However, off-farm workers are still lack of technology and information, and they need to think about the policy support points in terms of technology, information and entrepreneurship. To solve the problem of information access, we can set up special windows for business consultation and Internet service platforms to publish timely information on business projects, market conditions and production technologies, and cooperate with research institutes and universities to introduce professionals to provide legal advice and technical training for off-farm workers and form a regular mechanism. As for the entrepreneurial technology, strengthening skills training is an important way to invite "foreign brains" to give lectures and management consultation and diagnosis to off-farm workers from time to time, to teach advanced knowledge and skills, and to provide opportunities for off-farm workers to visit and study in advanced enterprises, so as to diversify the sources of information and increase technical skills of off-farm workers returning to their hometown through various forms. Through various forms, the information sources of returning off-farm workers are diversified and their technical skills are increased.

(3) The application of demand-oriented policy tools in developed enterprises should be strengthened accordingly. Demand-oriented policy tools mainly include government procurement, service outsourcing, trade deregulation, foreign exchange, etc., which should be generally applied to developed and mature enterprises. As far as off-farm workers returning hometown to start businesses are concerned, properly, demand-oriented policy tools are distributed less in policies. However, it should also be taken into account that some returned off-farm workers have a short business cycle of successful entrepreneurship and may face rapid expansion soon after starting their own businesses, when it is necessary to provide them with demand-oriented policy tools. Moreover, the Belt and Road initiative is a long-term national plan that will not be affected by short-term international situations. Cross-border trade is very common in the wave of "Internet plus" and digital economy. Overseas exchanges are not far away from off-farm workers returning hometown for entrepreneurship. It is necessary to take into account the characteristics of their entrepreneurship and the business cycle, and to strengthen the application of such policy tools. For example, Nanle

County in Henan Province has implemented the "One Belt, One Road, One Park" demonstration project to build a hometown entrepreneurship cluster demonstration area and an international business square business incubation park, all of which are powerful measures to encourage off-farm workers to start outward-oriented businesses. In addition, tax preferences are given to export and foreign trade enterprises, the development of cross-border e-commerce in rural areas is strengthened, domestic and international infrastructure is enhanced, and training on cross-border trade is provided to off-farm workers returning to their hometown to guide them to benefit more from foreign business.

In short, as the results of the analysis of the policy for off-farm workers' returning hometown for entrepreneurship show, the current national policy enjoys the integration of internal consistency with scientific, short-term and long-term effectiveness, and is also linked to rural development and revitalization too. However, the research results also show that there is room and opportunity to further optimize the current policy. In the context of national macro-industrial development and rural revitalization, it's necessary to further explore the special policy for off-farm workers returning hometown for entrepreneurship and provide more policy perspectives and suggestions.

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Article

Quantification of Bioclimatic Performance of Rural Coastal Low-Cost Dwellings in the Sundarbans

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Abstract: As we are aware that climate change poses a significant threat to environmental quality, human health, and well-being, etc., it is important to mitigate the environmental adverse impacts on human health. To do this, a necessary step forward is a bioclimatic analysis that includes a quantitative understanding of eco-human-energy friendliness. The study evaluates the environmental performance of low-cost coastal dwellings by analyzing bioclimatic components. Primary data was collected from field investigation and the perception response of 1332 dwellers from the selected blocks of coastal Sundarban region, West Bengal including remote rural, rural, and semi-urban areas was recorded. The statistical analysis indicated the upper 95% confidence limit for each subgroup and a normalization of the upper confidence limit with a unity score of 10 for each subset of parameters. The total score of the five categories of bioclimatic components was rounded to 150. A comprehensive evaluation of bioclimatic aspects of low-cost dwellings and scoring of features (design strategies, indoor environmental quality, thermal comfort, and energy efficiency) significantly yielded a quantitative rating of the performance of a rural built environment. Overall, this study successfully quantified the evaluation of the bioclimatic performance of low-cost coastal rural dwellings, which may be useful to develop strategies or building codes for the passive design of dwellings in the coastal, rural areas of India.

Keywords: bioclimatic quantification; environmental quality; rural and semi-urban settings; low-cost coastal dwellings; scoring criteria

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1. Introduction

Buildings and all kinds of built environments contribute substantially to greenhouse gas (GHG) emissions, energy consumption (Li et al., 2019), and resource consumption, causing environmental changes and global warming (Balasbaneh & Bin 2017, 2018). Worldwide, greenhouse gases, i.e., Methane (CH_4), Carbon dioxide (CO_2), and Nitrous oxide (N_2O) continued to increase with the consequent rise in the global mean temperature by about 1.2 ± 0.1°C above the baseline 1850–1900, concerning the preindustrial level estimate (World Meteorological Organization [WMO], 2021). Rural India represents nearly 2/3rd of its total population, and the scenario predominates with low-cost dwellings (mud houses and huts). The rural populace largely depends on conventional energy sources like wood, animal dung, and agricultural residues for household chores, with scanty electricity consumption for lighting systems and other requirements (Misra, 2023; Tiwari, 2023). Low-cost dwellings carry many environmental concerns, including CO_2 and other GHG emissions from burning fuels (firewood, cow dung cakes), congested room structures, and cattle sheds. To reduce emissions, it is necessary to improve dwelling characteristics, eco-friendliness, human-friendliness, and energy-friendliness (Bera & Nag, 2022; Henderson et al., 2020). These may help minimize the adverse impacts on the environment and improve human health, comfort, safety, and enhance energy efficiency (Nag, 2019; Zr & Mochtar, 2013). Research evidence (Bal & Matzarakis, 2022; Bazzato et al., 2021; Bera & Nag, 2021; Bera & Nag, 2022; Bhamare et al., 2020; Liu et al., 2020; Mohammadi et al., 2018; Subhashini & Thirumaran, 2018; Watson, 2020) are overwhelming to elucidate effectiveness bioclimatic concepts in building and landscape designs and human comfort. Appropriate design intervention makes buildings comfortable with a due understanding of the regional climate and implementing passive design practices, such as natural ventilation, day lighting, passive heating and cooling, and using suitable local

building materials for thermal storage (Attia et al., 2019; Loftness, 2020; Semahi et al., 2019; Zahiri & Altan, 2020; Zhen et al., 2016).

Attia et al., (2019) developed a bioclimatic analysis tool to identify proper bioclimatic design strategies for hot and humid climatic zones based on temperature and humidity levels. In addition, the identification of suitable passive design strategies in the specific climatic zone is based on temperature, relative humidity, wind speed, and rainfall (Hwang & Chen, 2022; Putra et al., 2022). Furthermore, the bioclimatic design strategies influence the building's environmental performance such as improving indoor thermal comfort, indoor environmental quality, and energy efficiency (Aghimien et al., 2022; Chandel et al., 2016). Few studies highlighted the various tools for evaluating the bioclimatic design strategies in specific climatic regions such as Givoni and Olgyay bioclimatic charts as well as Mahoney tables and ASHRAE standard 55 (Tamaskani Esfehankalateh et al., 2022). Bera and Nag (2022) highlighted the assessment of the bioclimatic design of low-cost rural dwellings based on the surrounding environment, indoor environment quality, residential health, energy consumption, building design and materials use, and building innovation. Table 1 shows a summary of the quantification of the bioclimatic performance of the buildings based on various parameters across different regions.

Table 1. Studies on the assessment/identification of bioclimatic design strategies of the built environment in different regions.

Study description	Research aim	Parameters used	Regions	References
Identification of bioclimatic design of low-cost rural dwellings.	To identify the passive design strategies to achieve the maximum thermal comfort and energy efficiency in the buildings.	Site and location; energy consumption; health and safety; building materials and innovation.	India	(Bera & Nag, 2022)
Assessment of bioclimatic design strategies based on Mahoney table in Esfahak village.	To investigate the possible relationship between climatic characteristics and the built environment of Esfahak, a village located in the hot desert region of Iran.	Use of Mahoney table based on different climatic parameters such as Temperature, Relative humidity, Rainfall	Hot desert region, Iran	(Hosseini, 2022)
The affordability of energy determines the sustainability of building-integrated bioclimatic design solutions.	This study investigates how climate factors and energy affordability levels relate to the use of bioclimatic design techniques.	Climatic conditions, gross domestic products, and electricity prices Use of simulation tools-*EnergyPlus, SketchUp, Meteonorm*	hot climates (Doha and Timbuktu)	(Elaouzy & El Fadar, 2023)
Identify the architectural design strategies for the dwellings of low-income people under bioclimatic criteria in Monte Sinahí, at Guayaquil.	To find out the appropriate bioclimatic design strategies for low-cost dwellings of Monte Sinahí.	Architectural morphology, urban form, building elements, and solar and wind flow control devices	Monte Sinahí, Guayaquil	(Forero et al., 2020)
Assessment and identification of bioclimatic architectural strategies for the building design of the tropical climatic zone.	To identify and evaluate the proper bioclimatic design strategies based on the guidelines proposed by Givony, and Olgyay, among others.	Use of dynamic simulation software Design-Builder to evaluate the building's passive strategies based on operative temperature, relative humidity, PMV, PPD, and discomfort hours.	Tropical climatic region of Panama	(Austin et al., 2020)
Assessment of the cooling potential of different passive design strategies using the bioclimatic aspects.	To develop an analysis tool for the evaluation of the cooling potential of different passive design strategies for different climatic zones of India.	Bioclimatic chart	18 cities of India of different climatic zones such as hot-dry, hot-humid, temperate, cold, and composite	(Bhamare et al., 2020)

Relevance exists in adopting the concept of bioclimate to building environmental performance rating systems. The bioclimatic strategies include the optimum use of natural energy sources, reducing the need for artificial sources of energy, and promoting natural ventilation to avoid the need

for air conditioning for cooling (Elaouzy & El Fadar, 2023; Xhexhi, 2023). In addition, bioclimatic design strategies are a crucial architectural approach to improve indoor thermal comfort, and energy efficiency, and reduce buildings' carbon footprint (Bera & Nag, 2021; Elaouzy & El Fadar, 2022; Gupta et al., 2023). Various national and international green building rating systems (e.g., BREEAM, LEED, HQE, DGNB, CASBEE, Green Globes, SBTool, and other national schemes) apply to different built environments, including residential settings (Nag, 2019; Pontes et al., 2022). Depending on the criteria and assessment maturity, the performance rating schemes have their relative presence in building accreditation across the countries. The national and international building rating system depends on different criteria, such as site and location, health and safety, energy efficiency, indoor environmental quality, water efficiency, building materials, innovation like rainwater harvesting, use of green energy, etc. (Assefa et al., 2022; Braulio-Gonzalo et al., 2022; Menna et al., 2022).

Furthermore, no national or international organization has yet published any guidelines criteria, and ratings to evaluate the building environmental performance of low-cost rural dwellings. Scope remains in exploiting the rating systems for evaluating the environmental performance of low-cost dwellings in rural coastal settings. Dwellings in coastal regions of eastern India are tornado and flood-prone, bringing devastation every consecutive year. The present field-based study evaluated indoor environmental quality, thermal comfort, energy efficiency, and passive designs of the low-cost coastal dwellings of the stated regions.

The study aims to develop a comprehensive assessment of the environmental/bioclimatic performance of coastal, rural low-cost settings concerning national and international rating systems. The study included different parameters associated with building environmental performance rating systems to assess the bioclimatic and environmental performances of coastal and rural seaside dwellings. The components are (a) site and location, (b) energy consumption and efficiency, (c) health and safety, (d) building materials, and (e) building innovation in indoor and outdoor environments. Based on the above parameters, the study focused on standardized scoring and assessment of rural settings of the dwellings in the aspects of bioclimatic performance. This is a maiden attempt at the quantification of rural coastal dwellings from the bioclimatic perspective.

2. Materials and Methods

2.1. Site Selection and Study Area

The study focuses on the quantification of the bioclimatic performance of low-cost rural coastal dwellings of Sundarban. Primarily, South 24 Parganas district was selected for the study and considered four coastal blocks such as Patharpratima (21.7941°N, 88.3555°E), Kakdwip (21° 52' 59.88" N, 88° 10' 59.88" E), Sagar (21°39' 10" N, 88°04' 31" E) and Mathurapur-1 (22° 07' 13" N, 88° 23' 39" E) (Figure 1). Approximately 10 million people live in the study area, which is dispersed over 29 blocks with isolated rural, rural, and semi-urban environments. Of the country, mangrove cover makes up around 42% of this region. The four village blocks included in the study all have mostly hot and humid climates. Every year, temperatures are measured to be as high as 40°C and as low as 10°C. In the region, the monsoon season which includes mid-June to mid-September, receives around 75% of the annual rainfall, or about 140 cm on average (Bera & Nag, 2022). A majority of the rural populations in this region reside in low-cost dwellings made up of earthen materials, such as mud, wood, mud mixed with straw, etc. (Figure 2).

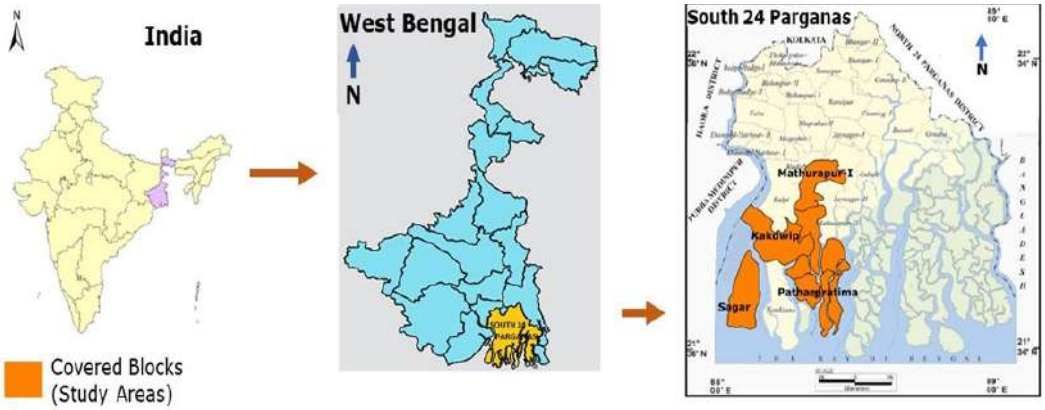

Figure 1. Location map of the study area.

Figure 2. Low-cost dwellings of the rural, coastal Sunderbans region in India.

2.2. Field Survey and Primary Data Collection

The bioclimatic components of remote rural, rural, and semi-urban community dwellings from 97 checkpoints of the selected blocks (Patharpratima, Kakdwip, Sagar, Mathurapur-I) under coastal households setting in the Sundarban region of West Bengal state in Eastern India were evaluated using a field-based questionnaire survey from 1332 individuals across the year. The questionnaire was designed meticulously to compare dwellers' perceptions across seasons and study sites (remote rural, rural, and semi-urban settings). Random sampling was followed to collect the primary questionnaire survey data from a diversified, widespread location of 97 checkpoints within the study area. The selection of parameters for assessing the environmental performance of rural houses mainly aligns with internationally recognized building rating systems, including IGBC, LEED, BREEAM, and national building codes (GRIHA, India). The questionnaire survey sheet consists (Table S1) of information about the surrounding environment, the design of the built environment, energy consumption, health and safety (including indoor environmental quality and thermal comfort), building material, and building innovation due to selected parameters influence the bioclimatic dimension of the built environment. The residents of dwellings responded about their perception and satisfaction based on POE (Post-occupancy evaluation) (Khalil & Husin, 2009). Data were gathered by a standardized single-digit score on a five-point Likert scale (Likert, 1932), referred to as strong disagreement (1) to a strong agreement (5) to a defined requirement and condition. The analysis consists of an approach to quantitatively determine the balance between climatic conditions and the built environment, considering the necessity of the dwellers' health and safety and architectural and technological solutions (Amiri et al., 2020; Madhumathi & Sundarraja, 2014; Mohammadi et al., 2018; Nag, 2019). Furthermore, Table 2 depicts the methodology and a comprehensive criterion for scoring the parameters.

Table 2. Parameters for bioclimatic analysis and scoring methodology.

Parameters	Scoring criteria
Site and location	
Transportation (Local transportation - bicycle stand, green vehicle motor van stand) (Long-distance transportation - bus stand, railway station)	The score (1 to 5) depends on the distance from the house, where 1 (minimum) represents non-availability, that is, less human-friendly to residents, and 5 (maximum) indicates nearby, which is most human-friendly.
Surrounding area (Building surroundings - watershed, green area, outdoor space) (Area surroundings -construction activities, bazaar, schools/colleges)	The score (1 to 5) is based on availability and distance, where 1 (minimum) represents non-availability or absence, and 5 (maximum) indicates nearby and more influence on the resident's lifestyle.
Settlement (Housing settlement, cluster settlement)	The score (1 to 5) is based on the impact of settlement on the environment, 1 represents a more negative impact (less eco-friendly), and 5 indicates no or less impact (most eco-friendly).
Building design (Type of building, window, roof and inner design, kitchen, outer design)	The score (1 to 5) is based on the impact of the built facility on the environment, health, safety and comfort; 1 (minimum) indicates less eco-, human-, and energy-friendliness; 5 (maximum) represents most eco-, human-, and energy-friendliness.
Energy efficiency	
Indoor environmental conditions (Air movement, natural ventilation, and sunlight penetration) **Resident's behaviour and satisfaction** (Use of light and fan in the daytime, electricity expense, awareness about the misuse of electricity, and use of solar energy) **Use of cooking fuel or aids** (Cow dung cake, firewood, LPG, kerosene stove, etc.)	The energy efficiency includes (a) environmental conditions, (b) residents' behaviour and satisfaction, and (c) use of the cooking fuel or aids. The comprehensive score of the section (1 to 5) relates to residents' perception and satisfaction, where 1 (minimum) indicates strongly disagree or dissatisfied, whereas 5 (maximum) explains strongly agree or satisfied.

Table 2. *Cont.*

Parameters	Scoring criteria
Health and Safety	
Indoor environmental quality (Visual comfort, acoustic comfort, cleanliness, smell/odor, indoor thermal comfort, indoor air quality, indoor work productivity)	The section includes (a) indoor environmental quality, (b) heat-related illness, (c) SBS, and (d) thermal and humidity sensation and preference votes. A comprehensive score (1–5) is based on residents' perceptions and satisfaction, ranging from strongly disagreeing or dissatisfaction (score 1) to strong agreement with satisfaction (score 5).
Heat-related illness	
Sick building syndrome (SBS)	For heat-related illnesses and SBS syndrome, a score (1–5) is based on perception; a score (1) would indicate the absence of the problem (not at all). A score (5) relates to the presence of the problem (very much so).
Building material	
Floor, wall, and roof (Type and materials of floor and wall, roof, and partition materials)	The score (1 to 5) depends on the impact on the environment (eco-friendliness) and energy efficiency (energy-friendliness), where (1) corresponds to the minimum score that is less eco-friendly and energy-friendly. In contrast, a score (5) indicates the most eco-friendly and energy-friendly.
Door, window, and ceiling (Materials of door, window, glaze of window, and ceiling)	
Recycling, reuse, and waste management	
Building innovation	
(Garden, insulation, sanitation, and building envelope)	The score (1 to 5) refers to the occupants' perception; 1 indicates less eco-friendly, human-friendly, and energy-friendly; 5 relates to most eco-friendly, human-friendly, and energy-friendly.

2.3. Statistical Analysis

All statistical analyses were performed using the IBM® SPSS® software platform on both the original data and generated variables. The integrated upper 95% confidence limit value of five category parameters (site and location, energy efficiency, health and safety, and building innovation) was calculated to quantify the maximum and minimum total score for analyzing the building environmental performance of low-cost coastal dwellings in the bioclimatic aspect's dimensions. In addition, Cronbach's alpha reliability testing was performed to evaluate the internal consistency or reliability of the interactions among different bioclimatic components used in this study. Stated differently, the degree to which a measurement consistently captures an idea is its dependability, and one way to gauge this level of consistency is by the use of Cronbach's alpha (α).

3. Results

The perception and scoring of bioclimatic components by dwellers varied based on the area, type, and characteristics of the dwellings. The villagers' perception response of 97 different checkpoints and the dwelling characteristics parameters were presented in subsets of parameters based on different parameters of remote rural, rural, and semi-urban dwellings as stated above in Table 2. The statistical analysis of the subsets showed (Table 3) an upper confidence limit of 95%. For instance, local transportation has three parameters with the lowest and highest scores of 3 (1x3) and 15 (3x5). The upper 95% confidence limit is 12 out of 15, and 8 out of 10 as normalization against the unity score of 10. However, compared to long-distance transportation, which has two parameters with the lowest and highest scores of 2 and 10, the normalization score is 4 due to the unavailability and partial availability of rural and semi-urban areas. The highest and lowest scores of

building surroundings are 3 (1x3) and 15 (5x3), having 10.8 of the upper 95% confidence limits (7 is the normalization value against a unity score of 10). In contrast, area surroundings have a score of 8 out of 10 as the upper value of 95% confidence limit. Types of settlement have two parameters with the lowest and highest scores of 2 (1x2) and 10 (5x2), and 7 is the upper value (normalization against a unity score of 10). The total of 12 parameters under the building design has an upper value of 95% confidence limit of 8, 8, 6, 5, and 7 out of 10. Furthermore, 16 parameters were considered under energy efficiency evaluation, and the upper values of 95% confidence limits are 7, 6, and 5. Similarly, 40 parameters under health and safety have values for 95% upper confidence limits of 8, 6, 5, 8, 5, and 5 accordingly. In addition, 13 parameters are included under building materials, and scores are 6, 8, and 7 out of 10 accordingly. Only 4 parameters are considered under building innovation and have a limit of upper 95% confidence limit of 6 (normalization against a unity score of 10) (Table 3). As the number of parameters differs in each subset, a normalization of the upper confidence limit was applied against a unity score of 10. Thus, the integrated total upper 95% confidence limit value of 285 of five categories was rounded to a normalized value of 150, with the relative influence of subsets of characteristics for different types of dwellings, categorized as remote rural, rural, and semi-urban.

Figure 3 depicts household communities' relative weightage (%) of different bioclimatic parameters. The availability of local transportation facilities is highest in rural communities compared to other communities due to the availability of bicycle stand, green vehicle, and motor van stand, whereas long-distance transportation facilities are available in semi-urban areas due to the presence of a railway station and bus stand. Various building design parameters in different household communities are highlighted in Figure 3 influenced by economic conditions, lifestyle, and community structure. The indoor environmental conditions of remote rural areas are higher than other communities due to natural ventilation, sunlight penetration, etc. Moreover, various comforts such as visual, acoustic, thermal, cleanliness, and human health-related disorders vary with different communities due to building structure, outdoor environment, etc. Building materials and innovations also vary with the household communities. This analysis indicates that the building's environmental performance in the bioclimatic dimension varied with the household communities. The composite scoring and the relative coverage of the enclosed graphical area helped compare the bioclimatic performance of houses of similar community environments.

Table 3. Normalized scoring of bioclimatic parameters for evaluation and comparison of rural coastal dwellings.

		Upper 95% Confidence limit	Normalization (against a unity score of 10)	The relative weightage (%)
Site and location				
Transportation	Local transportation (3 parameters - bicycle stand, green vehicle, motor van stand)	12	8	5.4
	Long-distance transportation (2 parameters - bus stand, railway station)	4.4	4	2.6
Surrounding area	Building surroundings (3 parameters - watershed, green area, outdoor space)	10.8	7	4.7
	Area surroundings (2 parameters – construction, bazaar, educational institute)	7.7	8	5.3
Settlement	Settlement (2 parameters - housing settlement, cluster settlement)	6.8	7	4.6
Building design	Type of building (2 parameters - form and layout of building)	8.4	8	5.4
	Window (3 parameters - location, opening, and design of window)	11.2	8	5.3
	Roof and inner design (3 parameters - roof, corridor, staircase)	8.6	6	4.0
	Kitchen (2 parameters - kitchen pattern and chimney use)	4.7	5	3.3
	Outer design (2 parameters – farmhouse/cattle shed, toilet)	7.2	7	4.0

Table 3. *Cont.*

		Upper 95% Confidence limit	Normalization (against a unity score of 10)	The relative weightage (%)
Energy efficiency				
Indoor environmental condition	Indoor environmental conditions (4 parameters - air movement, indoor ventilation, residents satisfied with air movement, sunlight penetration)	14.1	7	4.6
Residents' behavior and satisfaction	Residents' behavior and satisfaction (4 parameters - use of light and fan in the daytime, expense of electricity, use of solar energy, awareness about the misuse of electricity)	11.5	6	4.0
Cooking fuels	Cooking fuels (8 parameters - LPG, coal, cow dung cake, dry leaf, kerosene stove, firewood, gul (cooking fuel), others)	20.3	5	3.4
Health and Safety				
Indoor environmental quality	Visual comfort (3 parameters - natural day lighting, artificial lighting, and the overall quality of lighting)	12.3	8	5.4
	Acoustic comfort (2 parameters - noise or vibration and the overall quality of noise control)	6.4	6	4.0
	Cleanliness and smell (6 parameters - level of cleanliness, the smell from drainage or sewer, dumping ground, cow dung, chemicals, smoke in the room during cooking)	13.3	5	3.4
	Indoor quality (3 parameters - thermal comfort, air quality, work productivity)	12.4	8	5.4
Heat-related symptoms	Heat-related symptoms (18 parameters)	39.9	5	3.4
Sick building syndrome	Sick building syndrome (8 parameters)	16.9	5	3.3

Table 3. *Cont.*

		Upper 95% Confidence limit	Normalization (against a unity score of 10)	The relative weightage (%)
Building material				
Floor, wall, and roof	Floor, wall, and ceiling (6 parameters - type and materials of floor and wall, roof and partition materials)	17.7	6	4.0
Door, window, and ceiling	Door, window, and ceiling (4 parameters - materials of door, window, glaze of window, ceiling)	15.7	8	5.3
Recycling and reuse, waste management	Materials recycling and reuse, types and waste management facility (3 parameters)	9.7	7	4.5
Building innovation				
	Building innovation (4 parameters - garden, insulation, sanitation, building envelope)	12.6	6	4.0
Total		285	**150**	100

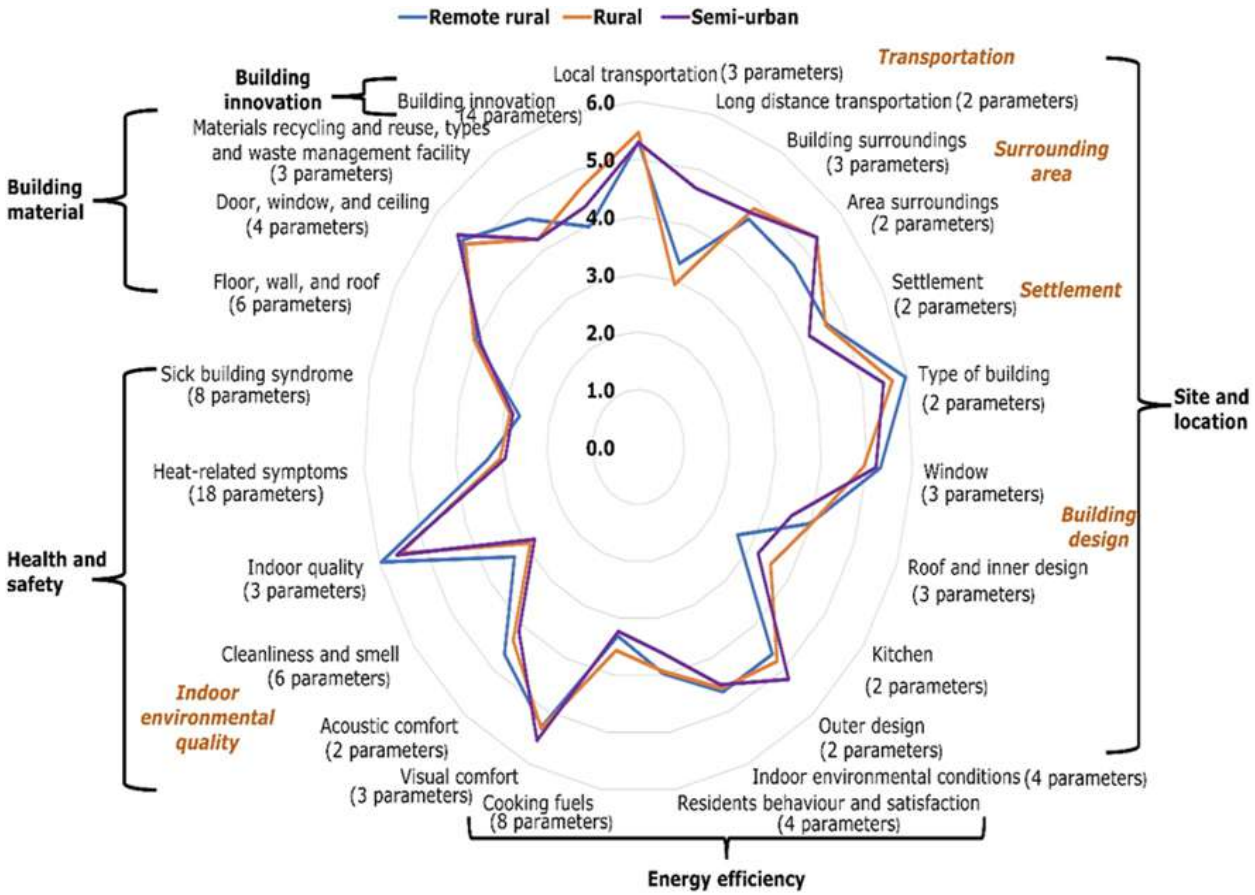

Figure 3. The relative weightage (%) of various bioclimatic parameters of remote rural, rural, and semi-urban dwellings.

4. Discussion

Previous studies reported guidelines for implementing green building concepts in large residential complexes, particularly in urban areas (De Masi et al., 2021; Doan et al., 2017; Faqih & Zayed, 2021; Nag, 2019). However, there is a knowledge gap in our existing understanding of the characterization of low-cost rural dwellings. This maiden endeavor explores bioclimatic elements of impoverished low-cost homes, with a representative analysis of coastal houses in Eastern India. The poor socioeconomic backgrounds of the households primarily determine the nature and structure of the settlements in the studied rural settings. Based on sample surveying, the perception response of the villagers and the performance characteristics of the dwellings were evaluated by normalization of weightage of different subsets of parameters of dwellings. A large matrix of parameters comprising 1332 households and 97 checkpoints was clustered into 23 subsets for different categories of homes. The analysis yielded some differences in internal consistency, as reflected in Cronbach's alpha reliability testing of 23 subsets. The reliability coefficients of room window features (location, opening, and design), cleanliness and smell, materials of the door, window and ceiling, sick building syndrome, settlement, building innovation, heat-related symptoms, transportation, acoustic and visual comfort, indoor environmental condition, ranged between $\alpha = 0.499$ and 0.859. The reliability level of Cronbach alpha (α) value was classified as 0.0–0.20 (less reliable), > 0.20–0.40 (rather reliable), > 0.40–0.60 (pretty reliable), > 0.60–0.80 (reliable), and > 0.80–1.00 as 'very reliable' (Wahyudi, 2016). Hence, our analysis indicates a pretty reliable ($\alpha = 0.49$ to 0.6), reliable ($\alpha = 0.6$ to 0.8), and very reliable ($\alpha > 0.80$) outcomes of the interaction between different components as stated above. Despite a consistent 'reliable' to 'very reliable' α obtained for most of the parameters and their interactions, very few 'pretty reliable' α values for some of the parameters might have resulted from the heterogeneous construct of the checkpoint or exogenous factors, such as site or location and/or seasonal variations. Overall, this study successfully quantifies the bioclimatic performance of low-cost coastal rural dwellings. This may help develop building regulations or guidelines for the passive design of dwellings in rural coastal regions of India.

The primary aim of the bioclimatic design strategy is to mitigate the impact of climate change on occupants of indoor environments (Bera & Nag, 2022). The passive design strategies of the buildings are based on the local climate, and surrounding environment to improve the quality of the indoor built environment, energy efficiency, and thermal comfort (Bera & Nag, 2022). This

study highlighted the different criteria of individual parameters for the assessment of building environmental performance in the bioclimatic dimension and developed the composite scoring to evaluate the bioclimatic parameters of the built environment of the different climatic regions. As stated, the prevailing environmental performance ratings systems have their application domain primarily to the well-structured built environment of geographical priority. The present contribution brought out a comprehensive evaluation of bioclimatic aspects of low-cost dwellings and accordingly suggested an approach to scoring components (design strategies, indoor environmental quality, thermal comfort, and energy efficiency). The premise of the evaluation is to ascertain (a) the impact of the dwellings on the environment and related components (eco-friendly), (b) human health, safety, and comfort (human-friendly), and (c) the energy efficiency of the dwelling structure (energy-friendly). Large-scale validation of the suggested evaluation process and scoring of bioclimatic dimensions may further evolve a new quantitative approach to rating the performance of a rural built environment.

In addition, ensuring the safety of low-cost coastal dwellings is of utmost importance, especially in areas prone to natural disasters such as floods, cyclones, storm surges, tornados, and tsunamis (Zisan et al., 2013). To mitigate the risks associated with coastal living, certain safety measures can be incorporated into low-cost coastal dwellings. These measures include: (a) using durable and weather-resistant materials that can withstand the corrosive effects of saltwater and the impact of high winds, (b) designing the dwelling with proper ventilation to reduce the risk of mold growth in humid coastal environments, (c) opting for simple and streamlined architectural designs to minimize wind resistance and reduce the risk of structural damage during storms, (d) implementing effective drainage systems to manage heavy rainfall and prevent water accumulation around the dwelling, (e) establishing community-based early warning systems to alert residents about approaching storms, allowing them to evacuate promptly, and (f) ensuring adequate airflow to help dry out the building after flooding.

Coastal areas are vulnerable to climate change and need affordable and durable housing solutions. Research in this area is crucial to finding innovative and sustainable solutions for low-cost coastal dwellings. This research should address the unique challenges posed by coastal environments and contribute to overall resilience in the face of climate change. Some recommendations for future research are given below:

- Develop building materials that are low-cost, climate-responsive, and capable of withstanding saltwater exposure, high winds, and storm surges.
- Explore innovative materials that offer both durability and environmental benefits such as bamboo, recycled plastics, or sustainable composites.
- Implement passive design strategies that optimize natural ventilation, day lighting, and thermal performance to reduce the reliance on energy-intensive climate control systems.
- Integrate renewable energy systems, such as solar panels, wind turbines, or tidal energy, to power low-cost coastal dwellings. Research ways to make these systems more affordable, accessible, and adaptable to diverse coastal environments.
- Use ecological infrastructure, such as mangrove restoration, dune stabilization, and wetland preservation, as natural buffers against coastal erosion and storm impacts.
- Explore landscaping and green roofing options that enhance the aesthetics of low-cost coastal dwellings.
- Promote community engagement in the design and construction processes to ensure that local knowledge and needs are considered.
- Integrate traditional building techniques and indigenous knowledge into modern, low-cost coastal dwelling solutions.
- Advocate for policy frameworks that incentivize the adoption of sustainable and resilient building practices for low-cost coastal dwellings.
- Modify or enhance existing policies to promote eco-friendly coastal housing initiatives.

5. Conclusions

This study provides a scoring criteria-based quantitative approach to evaluate bioclimatic components of coastal rural dwellings, including remote rural, rural, and semi-urban low-cost houses of coastal regions of the Sundarbans, eastern India (West Bengal). The bioclimatic aspects are associated with building environmental performance, such as energy efficiency, thermal comfort, and indoor environmental quality. The proposed scoring process and evaluation criteria may demand emendation with regions (like urban environment) and building types (commercial, office, industries). Overall, this study significantly addressed the bioclimatic performance i.e., eco-human-energy friendliness of low-cost coastal rural dwellings, which may be useful to develop strategies or building codes for the passive design of rural dwellings in the coastal areas of India. This method

and analysis in this study may extend the evaluation of dwellings' environmental performance in other coastal regions based on the selected criteria.

Supplementary Materials: The following supporting information can be downloaded at: https://sccpress-my.sharepoint.com/:b:/p/travismalone/EWQCWdvaTFdBn5_uuFwG6yYBSzaP1NSUsvm-PE2f4Uid5Q?e=Rox5sr&download=1, Table S1: Design of the questionnaire datasheet for the perception survey of the dwellers.

CRediT Author Statement: Mahadev Bera: Conceptualization, Methodology, Software, Validation, Resources, Formal analysis, Investigation, Data curation, Writing – Original draft; **Pranab Kumar Nag:** Conceptualization, Methodology, Resources, Supervision, Project administration, Funding acquisition, Writing – Review & Editing; **Sumanta Das:** Conceptualization, Methodology, Validation, Supervision, Writing – Review & Editing.

Data Availability Statement: The data presented in this study are available within the article or supplementary material [Table S1: Design of the questionnaire datasheet for the perception survey of the dwellers].

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Conflicts of Interest: The authors declare no conflict of interest.

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Agricultural & Rural Studies

Article

Extension Services and Household Food Security of Women Rice Farmers in the Delta Region of Myanmar

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Abstract: The study aimed to analyze women's households' farming practices towards household food security, particularly in six villages of the Ayeyarwaddy region. Data were collected from 126 randomized respondents. Descriptive analysis, Non-parametric Spearman's rank correlation coefficient and stepwise regression methods were applied to analyze the degree of association for extension services upon household food security. Results of the KII and FGD were used to further explain in survey. The respondents are mostly middle-aged women, married, natives of the study sites, and have achieved primary education with the average of five family members. Their earnings from farming are below the poverty threshold of Myanmar. The extension support organizations such as GOs, NGOs, INGOs, and private sectors support extension in this area and government as the primary support by providing and demonstrations. The result of food availability shows rice, fish, eggs, meats, vegetables, legumes are the usual food present in the homes of the respondents. All respondents mostly have rice, vegetables, and fish for a certain period of time in the food accessibility. When it comes to food utilization, most respondents cook their food except lime which they eat raw. In food stability, almost all respondents have enough food in their homes. Access to the extension services as to credit, market infrastructure, and transport accessibility proved to have huge effects on food security. Farm organizations also support food security. In view of all of these, the study recommended the adoption of extension strategies. These techniques are grounded on the respondents' farming practices and extension strategies identified.

Keywords: women households; access to extension services; food security

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1. Introduction

Agriculture is one of the most important sectors in the economy of Myanmar. In 2014-15, the agriculture sector contributed one-fifth of the GDP and total export earnings. Myanmar has more than 22 million hectares, of which more than 8% million hectares are devoted to rice (Shwe & Hlaing, 2011). Almost three-fourths of the farmers' income comes from rice farming (Larry, 2013). Besides Ayeyarwaddy, Bago, Mandalay, Yangon, and Sagaing regions are Myanmar's main paddy growing areas.

Ayeyarwaddy in the Delta region, which is rich in fisheries and the traditional rice bowl of the country. The main source of income is derived from farming in the Ayeyarwaddy region. Livestock and fisheries are the significant food sources and primary sources of income for farmers (Win et al., 2016). Ayeyarwaddy is the most climate-affected region. It loses an average of 11.4 percent of harvest annually to storms, floods, and pests, which is higher than the national average of 7.8 percent (United Nation Development Programme [UNDP], 2014). In 2008, Cyclone Nargis devastated much of the area of the Delta region (Win et al., 2016).

This study was a pioneering investigation on food security related to the farming practices of women households. Women's studies are still lacking in the Delta region. The linkage between women's role and food security is still weak due to the lack of agricultural technologies and extension support (ADB, 2016). No detailed studies were conducted in the Delta region, particularly on food security among the local people and specifically among women households. Moreover, there is no study or research about women in agricultural extension services related to food security. The study's general objective is to analyze the extension practices of female-headed households, and their households' food security in the Delta region of Myanmar. Specifically, the study aimed to:

1.1. Objectives

1. Describe the socio-economic profile of the respondents.
2. Discuss the agricultural extension services in the study townships, Delta region.
3. Determine the factors that affect food security and analyze the relationship between extension services, and food security of female-headed households.
4. Propose an extension framework.

2. Materials and Methods

2.1. Analytic Framework

The analytic framework developed for this research is presented in Figure 1. The framework lays out the various factors that were covered by this study. Therefore, the measurements of the food security status of households, and the four components of food security as identified by FAO served as the guide in the creation of the framework, and as such, was utilized by the researcher as a guide for data gathering and analysis. Following the literature review and the study's objectives, the researcher analyzed whether certain socio-economic factors, rice farming practices, and access to extension services influence the household food security of female-headed farmers. The socio-economic factors including age, household size, income, and farming practices are believed to be associated with the components of food security.

Women are actively engaging in farming activities, and their labor participation is necessary to attain food security. Therefore, access to extension is crucial and the given extension services allow people to improve food security.

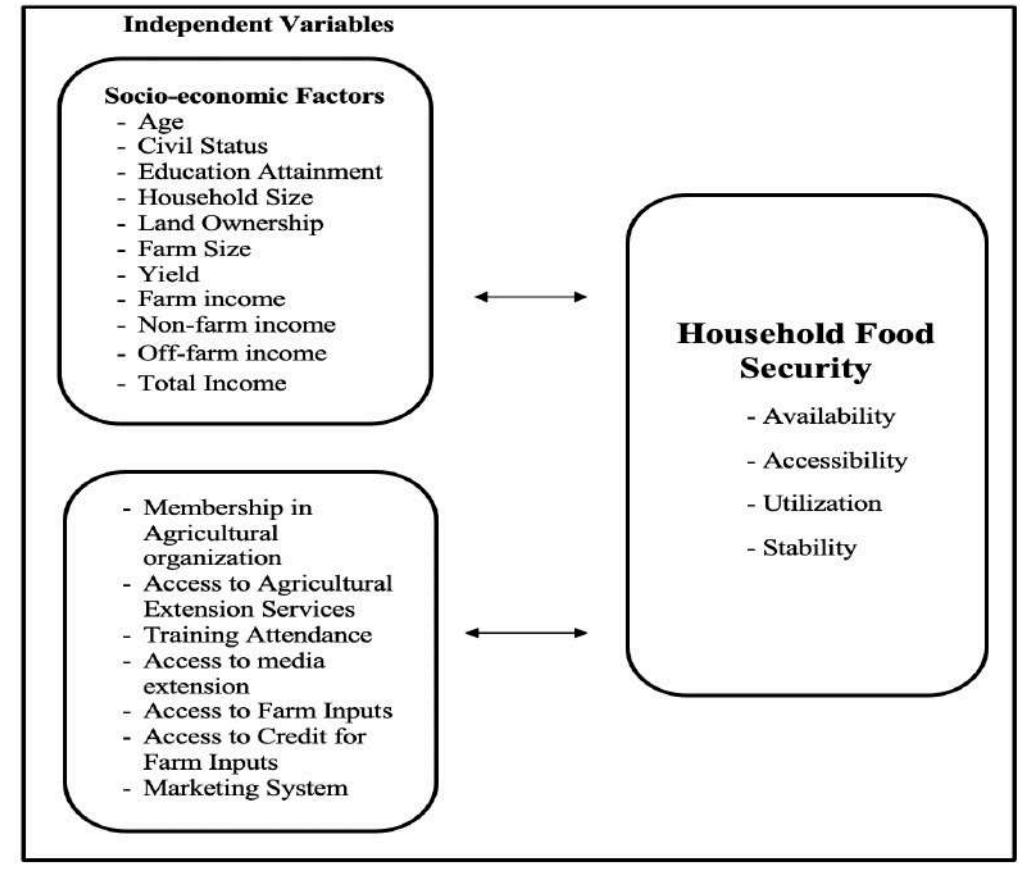
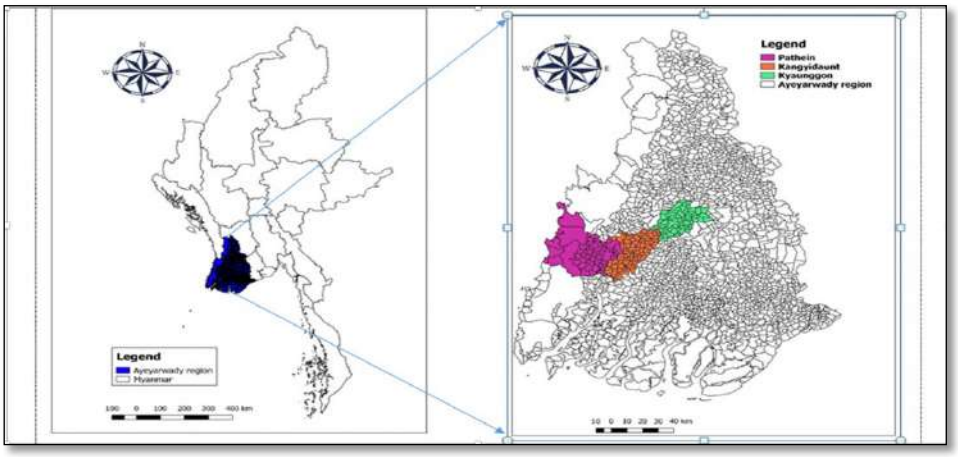


Figure 1. Analytic framework of the locale of the study.

The study was conducted in the six villages of three townships in the Delta region of Pathein District, Myanmar. The study villages are Kan Ni Phyar and Zayat Kwin in Pathein township, Ywa Thit Kone and Kwin Yar Kyi villages in Kangyidaut township, and Hlae Seik and Zayat Seik in Kyaunggon township. The Ayeyarwaddy region has an area of 35,140 km^2 and lies between 16°50″north and longitudes 95°10″ east. It has a population of 6,184,829 people. Delta region was chosen as Myanmar's rice bowl, and the villages selected are rice villages. After the devastation of Cyclone Nargis in 2008, most farmers became landless, and men-headed farmers moved on to other

regions for another livelihood and left their jobs with their wives. Therefore, the areas are the most appropriate sites for this study, considering 42% of the women labor force and impoverished communities that need help for food security. Figure 2 shows this study's research locale.



(a) Myanmar (b) Ayeyarwady region

Figure 2. Location of the Study Area.

3. Results

3.1. Data Collection and Analysis

A total of six villages from three townships was collected. The data was collected from 21 women farmers from each village and thus, the total number of women respondents were 126. Data gathering activities were conducted from November to December 2018. Key informant interview (KIIs) and focus group discussion (FGD) guides were developed based on the flow and content of the survey. Simple Linear Regression and Multiple Linear Regression were used to determine the relationship among the agricultural extension services, and women and their household food security. Non-parametric Spearman's rank correlation coefficient or Spearman's Rho was used to determine the relationship between the independent variables (extension services) and the dependent variables (food availability, food accessibility, food utilization, and food stability).

4. Discussion

4.1. Socio-demographic Profile of the Respondents

4.1.1. Age

Age of the respondents ranged from 23–65 years. The mean age is 45, and a third of the respondents were around mean 41–50 years (Table 1). According to Eisenstein (2020), farmers within 41–50 years are still productive and can devote their time and energy to farm development activities. This finding indicates that most respondents are at a good age to conduct farm activities.

4.1.2. Civil Status

Most of the respondents (76%) are married, while only 3% are separated (Table 1). Kao (2009) reported that women farmers are now actively engaged in supporting their families because they are busy at work or looking after their children and have no access to information. Thus, it is very important and urgent to help women farmers overcome their learning barriers. This finding agrees with the statement of Kao (2009) that most women are married and are actively engaged in farming.

Table 1. Socio-demographic profile of respondents.

	Frequency	Percentage
Age		
30 and below	9	7.11
31–40	37	29.43
41–50	39	31.08
51–60	31	24.60
61 and above	10	7.41
Range=	23–65	
Mean=	45	
St.Dev.=	10	
Civil Status		
Single	19	15.13
Married	95	75.46
Widower	8	6.31
Separated	4	3.22
Educational Attainment		
No Education	8	6.31
Primary School	58	46.02
Middle School	33	26.23
High School	15	12.01
College/University	7	5.51
No Response	5	4.09
Household Size		
Small (Equal or below mean)	77	61
Large (Above mean)	49	39
Range=	2–12	
Mean=	4	
St.Dev.=	2	

4.1.3. Educational Attainment

About 46% of the respondents had attended primary school education, while 6% had not attended formal schooling. Other 48% said they had other forms of education (Table 1). The findings indicated that half of the respondents had low education and literacy rates because they did not get the chance to learn through formal education. In this regard, Chanthavong (2012) reported that women in Asia are poorly educated because boys' schooling is customarily preferred since girls are trained to assist the mother in household chores and help earn income.

4.1.4. Household Size

More than 60% of the households are small household size, while others (39%) are large household size. As per Table 1, the average household size is 4. According to the 2014 Myanmar Population and Housing Census Thematic Report on Housing Conditions and Household Amenities, the average Myanmar national household size is 4.4 (United Nations Population Fund, 2017). Therefore, most of the respondents fall within Myanmar's national household size.

4.1.5. Income

The following discussion presents the average income and sources of the respondents. As per Table 2, most of their income comes from farm-related activities, other get from livestock raising, off-farm income and non-farm activities were noted.

Table 2. Total income sources of the respondents.

Source of Income ($)	Mean	Median	Mode	Std. Dev	Range
Farm income	4,756	3,051	2,101	5,444	23–43424
Off-farm income	842	630	5	940	2–3502
Non-farm income	1,873	420	70	5,501	1–28016
Total income	7,471				2–43424

Note: $1 = Kyats (K) 1427.77

The average farm income, off-farm income and non-farm income are K6,790,050 (4756 USD), K1,201,571 (842 USD) and K2,673,808 (1873 USD), respectively. Results also show that the minimum and maximum farm incomes are at K33,000 (23 USD) and K61,999,484 (43424 USD) and the total average gross income is $7,471. This finding agrees with Myanmar Living Conditions Survey (2017), which described that Myanmar farmers' total gross farm income per year is $4772 (Myanmar Living Conditions Survey, 2017 as cited by International Food Policy Research Institute (2022). Besides, this finding agrees with United States Agency for International Development (USAID, 2013)'s results, which described that Myanmar farmers' total gross income per year is $7984.

4.2. Access to Extension Services of the Respondents

Table 3 shows that 97% of the respondents get extension support from extension workers while the remaining percentage miss out on this aspect because their homes are not easy to visit.

Table 3. Access to individual extension method.

Variables	**Frequency** (n = 126)	Percentage
Visited by extension workers		
Yes	122	97.12
No	4	3.41
Times visited by extension workers		
Once a month	21	17.43
Twice a month	53	43.00
Thrice a month	13	11.21
Once in 2–3 months	2	2.46
1–6 times a year	20	16.09
Others	9	7.41
No Response	4	3.21

There are too many farmers to contact and visit their fields in the study region, therefore, there is not enough time to do so for the extension workers. Key informant interviews revealed that the extension workers support could not provide enough support for the whole study area due to the insufficient extension workers and farmers ratio. Thus, these problems became the top current extension problems and difficulties in this study. Traveling is also a problem since traveling to distant locations is time-consuming. Even the stringent regulations of Myanmar on extension support are also seen as an issue (Oo & Ando, 2012).

Table 4 shows the respondents' participation in extension programs and training in Table 5. About 52% of respondents reported having attended extension trainings, while 48% of respondents reported to have missed them. As to reasons for not attending, 62% reported they were not aware of these trainings while a good 30% said they have no time to join such.

Table 4. Attendance to group extension training.

Variables	**Frequency** (n = 126)	Percentage
Attendance a training or demonstration		
Yes	65	52.41
No	61	48.19
Reasons for not attendance		
Not aware	38	62.31
No time	18	30.12
Living very far from residence	5	8.00

The following topic deals with the type of trainings given by extension support groups (Table 5). It appears that 43% of the respondents get their extension training on rice production and vegetable production from the Department of Agriculture (DoA). About 44% of them likewise said that they have attended extension programs in relation to livestock also from the DoA. The respondents also got low support from cooperative development organizations except in terms of livestock production (33%). In contrast, NGOs have not extended any assistance on livestock production in this area just like the private organizations who provide no support in terms of vegetable production. The results of key informant interviews and focus group discussions agreed to reveal that the Government provided the greatest number of trainings than other organizations.

Table 5. Type of trainings and training providers.

Training Provider	**Rice Production (n = 65)**		**Vegetable Production (n = 7)**		**Livestock (n = 9)**	
	f	**%**	**f**	**%**	**f**	**%**
Government Organizations						
Department of Agriculture	28	43.02	3	43.17	4	44.41
Cooperative Department	1	2.41	0	0	3	33.00
Saemaul Undong	18	28.16	1	14.00	1	11.15
Non-government Organizations						
Non-government	3	5.32	2	29.38	0	0
Private sector	19	29.44	0	0	1	11.08
No Response	8	12.31	1	14.42	0	0
Average number of times attended the training	2 times		2 times		2 times	
Training Satisfaction						
Slightly satisfied	1	2.08	0	0	0	0
Moderately satisfied	13	20.31	2	29.31	4	44.31
Highly satisfied	42	65.41	2	29.31	3	33.41
No Response	9	14.31	3	43.16	2	22.39

It was also found that all respondents have, on average, twice attended these trainings. In fact, 65% of the respondents were highly satisfied when it comes to these rice production workshops while 29% and 33% of them, respectively, were also much pleased with the extension trainings given to them.

The next part discussed the respondents' access to media extension in terms of rice varieties, inputs, and marketing strategies. As per Table 6, 33% of the respondents get rice variety information from television. About 32% said they get rice variety knowledge from radio while 14% and 18% of them get input and marketing information also from this media. Aside from the findings of FGD, the respondents' access to media extension includes the radio and television. Note that, the respondents receive low to zero information from their co-farmers, extension workers, farm journals, and other farmer channels.

Table 6. Access to media extension.

Access to Media	Rice Varieties (n = 126)		Inputs (n = 126)		Marketing (n = 126)	
	f	%	f	%	f	%
Source of Information						
Television	42	33.12	21	17.14	20	16.31
Radio	40	32.45	18	14.33	22	18.15
Leaflets	27	21.26	12	10.27	6	5.48
Farmer channel	6	5.31	3	2.49	2	2.27
Newspaper	4	3.49	1	1.36	0	0
Farm journal	2	2.32	3	2.44	1	1.14
Sources of Interpersonal Information						
Extension worker	2	2	0	0	0	0
Co-farmer	1	1.14	1	1.14	0	0
None/Not aware	33	26.07	82	65.31	87	69.46
Printed materials that have read by respondents						
Brochure	45	36.04	22	18.00	20	16.14
Leaflets	8	6.45	1	1.14	2	2.08
Newspaper	6	5.12	0	0	1	1.47
Farm journal	0	0	1	1.14	0	0
Others	2	2.39	0	0	0	0

Data also showed that brochure is the top printed material that respondents read to know more about rice varieties (36%), inputs (18%) and marketing (16%). In the case of Myanmar, Livelihoods & Food Security Trust Fund (LIFT, 2015a) reported that the Ministry of Agriculture, Livestock and Irrigation (MOALI) is undertaking farmers' education activities through the mass media (e.g., newspaper, radio, television, and channels), distribution of education pamphlets, leaflets and brochures individual and group training and visits by extension workers.

The results revealed that the respondents receive two loans per year (Table 7). The same data also states that 45% of them borrowed money to pay farm inputs while 2% said they loaned to repay their previous loans. It also appears that 77% of the respondents applied for second loans in order to pay off other farm-related expenses. About 6% of them, also admitted that they did so to repay their first loans. The data shows that respondents get credit from many sources such as agricultural banks, the Cooperative Department, Saemaul Undong, private money lenders, group savings, non-institutional sources, relatives and others within loan 1 and loan 2. In this study, agricultural banks and cooperatives and Saemaul Undong are government organizations. To be precise, 67% of them get their first loans from agricultural banks while 47% of them get from the cooperative department. The average loan amount of the respondents for the first loan is $444 while the average amount for the second is $341. The results of FGD revealed that access to credit can support the farm operation costs and the farmers from the study area need to get more amount of loans for other farm-related expenses.

Table 7. Details of credit support.

Details of Credit	Loan 1 (n = 117)		Loan 2 (n = 17)	
	F	%	F	%
Purpose of Loan				
Payment for farm inputs	53	45.16	8	47.13
Other farm-related expense	46	39.45	13	77.41
Payment for farm labor	31	27.31	3	18.47
Loan payment	2	2.27	1	6.36
No Response	4	3.18	0	0
Provider of Loan				
Governmental Organizations				
Agricultural Bank	78	67.00	2	12.37
Cooperative Department	23	20.12	8	47.41
Non-governmental Organizations				
Saemaul Undong[a]	16	14.45	4	24.39
Non-institutional sources	2	2.36	0	0
Private Organizations				
Private money lenders	9	8.49	1	6.15
Group savings in the village	4	3.27	0	0
Others	4	3.27	1	6.36
Relatives	1	1.07	0	0
No Response	0	0	1	6.36
Amount of Loan				
Average amount (in K)	$444		$341	
Std. Deviation	$752		$282	
Lowest loan	$70		$105	
Highest loan	$5603		$1051	

Note: [a] (The Saemaul Undong (SMU) program was initiated and run in Myanmar since 2012. Although the project period is over the SMU villages continue their villages development by themselves.)

LIFT (2015a) reported most farmers do not necessarily borrow money from government, agricultural development companies, traders, and middlemen because they assume that their interest rates are high but they do. Information on loans from government banks such as the Myanmar Agriculture and Development Bank (MADB) is disseminated through village leaders.

As the respondents cultivated mainly rice and the second was growing other crops, the raising livestock was found to be very rare in the study area. They mostly sell out their crops and livestock to local assemblers. In fact, 56% of them trade their rice to local assemblers. About 75% of them are sent their vegetables to the local assemblers. However, 63% of respondents sell poultry directly to the public market (Table 8). These data are agreed with the report of Livelihoods & Food Security Trust Fund (LIFT, 2015b), that each district in the Delta region has a local market center where the local commodities produced were sold.

Table 8. Market support.

Market Support	Commodity							
	Rice (n = 126)		Vegetables (n = 12)		Livestock (n = 9)		Poultry (n = 8)	
	F	%	F	%	F	%	F	%
Market Outlet								
Local assembler	71	56.00	9	75.31	7	78.19	2	25.14
Retailer	17	14.52	0	0	0	0	1	13.36
Middleman	29	23.16	1	8.23	0	0	0	0
Public market	0	0	0	0	2	22.36	5	63.31
Others	1	1.13	2	17.18	0	0	0	0
No Response	8	6.36	0	0	0	0	0	0
Ave. distance of market from farm	11 km		6 km		No Response		2 km	
Marketing Problems								
Low price	38	30.43	3	25.21	1	11	0	0
Transport cost	3	2.27	0	0	0	0	0	0
Postharvest losses	2	2.27	1	8.27	0	0	0	0
None	83	66.00	8	67.31	8	89.14	8	100

Transportation to these local markets, appear to also affect the smooth delivery of products. According to the rice farmers, the distance between the field and the market could be as far as 11km while vegetable growers said that theirs is at an average of 6km. LIFT (2015a) recommended that the significant distance from the field of the farmers should be given a solution especially when farmers have to travel that long in order to sell their crops, and get the necessary supplies for their next cropping. Aside from transportation, another market-related problem is the selling of rice way below its normal price (30%). The discussions of focus group members (FGD) revealed that their crops get low price in the market. LIFT (2015a) described that the market system in Ayeyarwaddy Delta as a "dendritic market system" or a hierarchy of streets in a branching out pattern. For this, much infrastructure support from the government was necessary.

Table 9 presents the methods by which the respondents transport their crop, this being an aspect of infrastructure support. Note that respondents transport their crops and livestock by motorcycle, trucks, and others in the study area. On that aspect, data shows that 70% of the respondents transported their crops and livestock from the farm to the market by trucks while the rest transported them by other means.

Table 9. Infrastructure support.

Details	Crops (n = 85)					
	Truck		Motorcycle		Others	
	F	%	F	%	F	%
Means of transportation from farm to market	59	69.12	3	4.38	28	33.28
Ownership						
Owned	12	20.45	2	67.17	4	14.38
Borrowed	0	0	0	0	2	7.39
Rented	41	70.44	0	0	17	61.39
No Response	6	10.13	1	33.37	5	18.47
Total	59	100	3	100	28	100
If rented, arrangement for payment						
Per trip	29	71.21	0	0	8	47.46
Contracted price	3	7.53	0	0	0	0
Others	0	0	0	0	1	6.36
No Response	9	22.46	0	0	8	47.08
Total	41	100	0	0	17	100

The results show that 67% of the respondents have their own motorcycles while only 20% have their own trucks. To be precise, 70% of the respondents rent trucks called "Gon-daung" when

they want to sell their fresh produce to the market. A little below this percentage (61%) also rents out Bullock-carts. It is noted that from FGD, the group members described that the renting cost of Gon-daung is relatively high in the study villages.

Table 10 shows the aspects pertaining to support received by farmer-members. The results show full active participation of the respondents in farmers, women, and religious organizations.

Table 10. Membership in organization.

Market Support	Type of Organization									
	Farmer's Organization (n = 30)		Women's Organization (n = 3)		Religious Organization (n = 1)		Social Organization (n = 37)		Others [a] (n = 11)	
	f	%	g	%	g	%	f	%	f	%
Status of Membership										
Active	30	100	3	100	1	100	35	95.48	3	27.31
Inactive	0	0	0	0	0	0	1	3.39	4	36.07
No Response	0	0	0	0	0	0	1	3.39	4	36.07
Position in the Organization										
Member	30	100	3	100	1	100	34	92.43	6	55.19
Officer	0	0	0	0	0	0	1	3.39	0	0
No Response	0	0	0	0	0	0	2	5.36	5	46.27

Note: [a]Others include Pyae Mahar, Cooperative Department, and Company

Almost (95%) are also active members of social organizations, however, some who do not actively participate due to busy life and schedule. All respondents are bonafide members of various farmers', women's, and religious organizations while only 92% are members of social organizations. About 55% of them are also members of other groups. It was found that agricultural banks, cooperatives, and Saemaul Undong coordinate with the village tracts in order to provide credits, loans, farm inputs and others to the farmers in the study area. Women households were found to actively participate in these organizations. According to the key informant leaders' interviews, the women-headed farmers are active participants in the organizations and they are also good members. LIFT (2015b) recommended that GOs, NGOs, and the private organizations share about the knowledge of agricultural technology, farm diversification, and home economics through village leaders, information distributors, or village meetings to the villagers.

4.3. Food Security of the Respondents

4.3.1. Food Availability

Food availability is measured by the presence of food inside the farmers' houses. Fruits, vegetables, legumes, dairy products, meat, and cereals are included within the houses as the food availability measurements. Boles et al. (2014) reported that food availability is measured through the presence of food inside homes. Most of them keep only 1 to 2 kinds of food and have fruits (59%), vegetables (50%) and meat (90%). Based on the data, the respondents have abundant food supply of different kinds of vegetables (46%) while they only have 1 to 2 kinds of dairy products (see in Table 11).

Table 11. Total food availability of the respondents.

Variety	1 to 2		3 or more		None		Total	
	F (n=126)	%	F (n=126)	%	F (n=126)	%	F (n=126)	%
Fruits	74	58.73	14	11.11	38	30.16	126	100
Vegetables	63	50.00	58	46.03	5	3.97	126	100
Frozen vegetables	6	4.76	1	0.79	119	94.44	126	100
Legumes	60	47.62	1	0.79	65	51.59	126	100
Dairy products	16	12.70	0	0	110	87.30	126	100
Meat products	114	90.47	12	9.82	0	0	126	100
Cereal products	51	40.47	3	2.38	72	57.14	126	100

As the respondents are rural, most do not have refrigerator and they do not keep frozen vegetables (94%). This finding agrees with the report of Gearhart (2013), that the households are used to keeping only 1 to 2 kinds of food in every food item such as fruits, vegetables, legumes, dairy products, meat, cereal.

4.3.2. Food Access

The Household Dietary Diversity Indicator Guide of the United States Agency International Development (USAID) was used as a tool to determine whether farmers had access to various food products. Under this endorsed by USAID in 2006, the respondents' food attitudes and behaviors were collected using the previous 24-hours as a reference period (24-hour recall). The food access data of respondents were collected based on the 12 main food items in the food box during the 24-hour period (Swindale & Bilinsky, 2006). The average food consumption of the respondents is 6 within the ranges 2 to 12. The individual results based on the 12 main food items were divided by the number of total respondents (126) then multiplied by 100. First, the Household Dietary Diversity Score (HDDS) variable was calculated for each household. The value of this variable ranged from 0 to 12.

HDDS (0-12)	Total number of food groups consumed by members of the household. Values for A through L will be either "0" or "1". Sum (A + B + C + D + E + F + G + H + I + J + K + L)

Second, the average HDDS indicator was calculated for the sample population using the following:

$$Average\ HDDS\ (\%) = \frac{Number\ of\ Households\ with\ B, D\ or\ F\ = 1 + 2 + 3}{Total\ number\ of\ households} \times 100$$

All respondents ate rice because it is the main food of the country. It is followed by vegetables at 91% (Table 12). RoUM in Myanmar Census of Agriculture in 2010 stated that the top food item of Myanmar households is cereal and the second is vegetables (Christoplos, 2010).

Table 12. Food access of households.

Food Items	Frequency (n = 126)	Percentage
A. Cereals	126	100
B. Root and tubers	40	32.23
C. Vegetables	114	91.16
D. Fruits	73	58.47
E. Meat, poultry, offal	54	43.39
F. Eggs	39	31.26
G. Fish and seafood	81	64.00
H. Pulses/legumes/nuts	27	21.37
I. Milk and milk products	9	7.09
J. Oil/fats	24	19.21
K. Sugar/honey	34	27.49
L. Miscellaneous	47	37.23
Average HDDS	6	
Minimum HDDS	2	
Maximum HDDS	12	

According to the data, the respondents had the minimum consumption food of household dietary diversity scores is 2 and the maximum HDDS is 12 while the average HDDS is 6. This means the respondents, on the average, had 6 food items while they had the minimum had 2 food items and the maximum food items 12 for 24 hours. According to Walker and Fisher (1997), a person should eat 20–30 different types of foods every day and the dietary adequacy levels are described based on food variety consumption: > 30 food items is very good; 25–29 food items is good; 20–24 food items is fair; < 20 food items is poor; and < 10 food items is very poor. This finding falls in very poor dietary adequacy level and the average food access of them are very low level.

4.3.3. Food Utilization

Total food utilization results show that the respondents mostly cooked their food before eating such as rice (84%), fish (85%), pork (100%), eggs (50%), roselle (49%), water spinach (58%), tomato (68%), cauliflower (92%), lettuce (91%), and banana (100%). They eat lettuce raw in salads and banana in the fruit category. Fried water spinach, on the other hand, is their top choice in the food section as per Table 13.

Table 13. Utilization of food.

Food Items	Method of Preparation					
	Cooked		Fried		Raw	
	F	%	F	%	F	%
Starch						
Rice	87	84.02	0	0	0	0
Sea-food						
Fish	67	85.41	0	0	0	0
Meat						
Pork	27	100	0	0	0	0
Eggs	20	50.23	0	0	0	0
Vegetables						
Roselle	19	49.16	0	0	0	0
Water Spinach	0	0	19	58.16	0	0
Tomato	13	68.07	0	0	0	0
Salad						
Cauliflower	0	0	12	92.41	0	0
Lettuce	0	0	0	0	10	91.34
Fruit						
Banana	0	0	0	0	52	100

4.3.4. Food Stability

The questionnaire used was adapted from USDA Household Dietary Diversity and Households Hunger scales was used to represent household food stability (Bickel et al., 2000).

$$\text{HHS} = \frac{\text{Survey-weighted sample of households with household hunger score} > 1}{\text{Survey-weighted sample of households in the FFP project implementation area}} \times 100$$

HHS categories

a. little to no hunger in the household (0–1)

b. moderate hunger in the household (2–3)

c. severe hunger in the household (4–6).

To summarize the data, the Household Hunger Scale (HHS) was calculated by using Food for Peace (FFP) indicators of USAID (2015). In this case, HHS score was calculated using this formula.

According to the results, 99% of the respondents fell in the moderate hungers scores while at least 1% of the respondents had little to no hunger in the households (Table 14).

Table 14. Household hunger scale (HHS) of the respondents.

Statement	Frequency (n = 126)	Percentage
1	2	1.28
2	106	84.31
3	18	15.46

This finding is similar with Deitchler et al. (2011) who reported that moderate household hunger scale is higher than other household hunger scales. Minn and Oo (2017) reported that poor diet quality has contributed to high levels of stunting and malnutrition along with high levels of anemia, iodine and vitamin A deficiency is found in Myanmar people and children in Ayeyarwady region.

4.4. Relationships

4.4.1. Relationship between Extension Services and Food Security

Table 15 shows the correlations between extension services and food security. According to the results of food availability, the training attendance (rs = 0.267, p = 0.001) has high significant correlation and the number of training programs (rs = 0.024, p = 0.176), rice production training satisfaction (rs = 0.205, p = 0.011), number of vegetable production training (rs = 0.148, p = 0.049), and be accompanied by training (rs = 0.184, p = 0.019) have significant correlations.

In terms of food access, the number of vegetable production (rs = 0.221, p = 0.006), and the training satisfaction on livestock (rs = 0.212, p = 0.009) have high significant correlations while training attendance (rs = 0.189, p = 0.017), number of training program (rs = 0.158, p = 0.039), number of rice production training (rs = 0.188, p = 0.018), rice production satisfaction (rs = 0.192, p = 0.016), training satisfaction of vegetable production (rs = 0.193, p = 0.015), number of livestock (rs = 0.204, p = 0.011), be accompanied by training (rs = 0.175, p = 0.025), have significant correlations.

Likewise, the number of vegetable production (rs = 0.275, p = 0.001), vegetable production satisfaction (rs = 0.239, p = 0.003), number of livestock training (rs = 0.210, p = 0.009), and livestock satisfaction (rs = 0.221, p = 0.007) have high significant correlations while number of rice production training (rs = 0.165, p = 0.032), rice production training satisfaction (rs = 0.190, p = 0.017), and have significant correlations with food utilization.

According to food stability, six variables: number of training programs (rs = 0.301, p = 0.000), number of rice production training (rs = 0.224, p = 0.006), and number of vegetable production training (rs = 0.309, p = 0.000), vegetable production training satisfaction (rs = 0.258, p = 0.002), number of livestock training (rs = 0.519, p = 0.000), livestock training satisfaction (rs = 0.519, p = 0.000) have high significant correlations while the rest: training attendance (rs = 0.198, p = 0.013), rice production training satisfaction (rs = 0.196, p = 0.014), and be accompanied by a training program (rs = 0.175, p = 0.025) have significant correlations with food stability. The key informant leaders revealed that the training sessions are effective support for farmers in agriculture and the respondents need to provide training related to food security.

Table 15. Correlation between extension services & food security

Extension Services	FAV	FAC	FU	FS
Visited by Extension Workers	0.068^{ns}	−0.029^{ns}	0.070^{ns}	−0.039^{ns}
	0.226	0.371	0.217	0.330
Attendance of training	0.267**	0.189*	0.129^{ns}	0.198*
	0.001	0.017	0.075	0.013
Number of training programs	0.176*	0.158*	0.117^{ns}	0.301**
	0.024	0.039	0.096	0.000
Number of rice production training	0.137^{ns}	0.188*	0.165*	0.224**
	0.063	0.018	0.032	0.006
Rice production training satisfaction	0.205*	0.192*	0.190*	0.196*
	0.011	0.016	0.017	0.014
Number of vegetable production training	0.148*	0.221**	0.275**	0.309**
	0.049	0.006	0.001	0.000
Vegetable production training satisfaction	0.108^{ns}	0.193*	0.239**	0.258**
	0.113	0.015	0.003	0.002
Number of livestock training	0.079^{ns}	0.204*	0.210**	0.519**
	0.191	0.011	0.009	0.000
Livestock training stratification	0.088^{ns}	0.212**	0.221**	0.519**
	0.163	0.009	0.007	0.000
Be accompanied by training	0.184*	0.175*	−0.134^{ns}	0.175*
	0.019	0.025	0.067	0.025

Note:
* Significant at P < 0.05
**Highly significant at P < 0.01
- No significant correlation

Legend:
FAV: Food Availability
FAC: Food Accessibility
FU: Food Utilization
FS: Food Stability

Overall, visiting of extension workers in this study seems not related with food security but respondents' attendance in training and their inputted satisfaction levels in relation to these trainings are positively related with food security. The respondents can improve their knowledge related with food security and they can keep their households to be food safety and security by attending the trainings. This finding agrees with the report of the Salesain Missions (2014) which found that agriculture trainings educate farmers to know the modern techniques in agriculture and livestock farming in order to improve food security and increase income potential.

4.4.2. Relationship between Market Infrastructure and Food Security

Table 16 shows the correlations between market infrastructure and food availability, access, utilization, and stability, as a whole. There is no relationship between market infrastructure and food availability. Crops transported by other means (rs = 0.202, p = 0.012), and livestock by motorcycle (rs = 0.155, p = 0.042) have significant correlations while livestock by truck (rs = −0.153, p = 0.043) have negative significant correlation with food access.

Likewise, the three significant correlated variables of food utilization are crops transported by other means (rs = 0.182, p = 0.021), livestock by truck (rs = 0.167, p = 0.031) and livestock by motorcycle (rs = 0.157, p = 0.040) in market infrastructure.

According to food stability, crops transported by other means (rs = 0.245, p = 0.003) has high significant correlation while the crops transported by motorcycle (rs = 0.149, p = 0.048) and livestock by motorcycle (rs = 0.153, p = 0.044) have significant correlations with food stability in terms of market infrastructure.

Table 16. Correlation between market infrastructure & food security.

Market Infrastructure	FAV	FAC	FU	FS
Crops transported by truck	0.045^{ns}	−0.011^{ns}	0.34^{ns}	−0.070^{ns}
	0.310	0.450	0.352	0.217
Crops transported by motorcycle	0.014^{ns}	0.013^{ns}	0.42^{ns}	0.149*
	0.439	0.443	0.319	0.048
Crops transported by others	0.127^{ns}	0.202*	0.182*	0.245**
	0.079	0.012	0.021	0.003
Livestock transported by truck	0.069^{ns}	−0.153*	0.167*	0.049^{ns}
	0.221	0.043	0.031	0.294
Livestock transported by motorcycle	0.124^{ns}	0.155*	0.157*	0.153*
	0.083	0.042	0.040	0.044
Livestock transported by others	0.013^{ns}	0.073^{ns}	0.053^{ns}	0.104ns
	0.442	0.208	0.276	0.123

Note:
* Significant at P < 0.05
**Highly significant at P < 0.01
No significant correlation

Legend:
FAV: Food Availability
FAC: Food Accessibility
FU: Food Utilization
FS: Food Stability

Overall, this implies that infrastructure is also related with food security. Crops transported by other means and livestock transported by motorcycle are mostly correlated with FAC, FU and FS. Food availability is not related with market infrastructure. This finding coincides with statement of Hebebrand and Wedding (2010) which said that the role of trade and trade market expansion play important roles in (a) enhancing food security and highlight expanding market information; (b) improving post-harvest market infrastructure; and (c) creating a positive investment climate conducive for agribusiness growth.

4.4.3. Relationship between Membership Organizations and Food Security

The correlations between the membership organizations and food availability, access, utilization, and stability in Table 17. Among the variables on membership organizations, number of organization (r_s = 0.416, p = 0.000), membership organization (r_s = 0.368, p = 0.000), status of membership (r_s = 0.368, p = 0.000), social organization (r_s = 0.341, p = 0.000), others (r_s = 0.212, p = 0.008) showed highly significant correlations while only farm organization (r_s = 0.203, p = 0.011) illustrated significant correlation with food availability.

Table 17. Correlation between membership organizations & food security.

Extension Services	FAV	FAC	FU	FS
Membership Organization	0.368**	0.139^{ns}	0.111^{ns}	0.225**
	0.000	0.061	0.109	0.006
Status of membership	0.368**	0.139^{ns}	0.111^{ns}	0.225**
	0.000	0.061	0.109	0.006
Number of organizations	0.416**	0.135^{ns}	0.110^{ns}	0.220**
	0.000	0.065	0.111	0.007
Farm organization	0.203*	0.241**	0.182*	0.403**
	0.011	0.003	0.021	0.000
Social organization	0.341**	0.024^{ns}	0.024^{ns}	−0.087^{ns}
	0.000	0.397	0.393	0.166
Women organization	−0.141^{ns}	−0.127^{ns}	−0.082^{ns}	−0.068^{ns}
	0.058	0.078	0.180	0.224
Religious Organization	−0.98^{ns}	−0.92^{ns}	−0.073^{ns}	0.120^{ns}
	0.138	0.153	0.209	0.090
Others	0.212**	−0.02^{ns}	−0.028^{ns}	0.02^{ns}
	0.008	0.3876	0.377	0.490

Note:
* Significant at P < 0.05
**Highly significant at P < 0.01
- No significant correlation

Legend:
FAV: Food Availability
FAC: Food Accessibility
FU: Food Utilization
FS: Food Stability

Meanwhile, only farm organization is highly significantly (rs = 0.241, p = 0.003) correlated with food access and significantly correlated (rs = 0.182, p = 0.021) with food utilization in terms of market infrastructure. In food stability, membership organization (rs = 0.225, p = 0.006), status of membership (rs = 0.225, p = 0.006), number of organization (rs = 0.220, p = 0.007), farm organization (rs = 0.403, p = 0.000) have higher significantly correlations in terms of membership organizations.

To sum it up, almost all respondents are members of most organizations with some being leaders even. Among the organizations, farm organization is the most correlated with food security. For this finding, the sustainable development report of the United Nations (UN, 2013) finds application. According to that report, cooperative organizations of GOs and INGOs encourage the growth of agricultural cooperatives by easing the farmers' access to affordable financing options, appropriate risk management instruments, sustainable production techniques, decision-making forums, nutrition-related programs and policies, and other agricultural resources geared towards ensuring food security. They also encourage investment in rural infrastructure which is necessary to penetrate world trades, participation of women in economic activities.

4.4.4. Relationship between Income and Food Security

Results show the significant (P < 0.05) and highly significant (P < 0.01) correlations between income (including farm income, off-farm income, non-farm income, and household income) and food availability, access, utilization, and stability (Table 18).

Among the variables on income, farm income (rs = −0.244, p = 0.003), household income (rs = −0.211, p = 0.009) are negatively correlations while non-farm income (rs = 0.143, p = 0.055) is positively correlated with FAC.

Table 18. Correlation between total income and food security.

Income	FAV	FAC	FU	FS
Farming income	−0.137 ^{ns}	−0.244**	−0.176*	−0.278**
	0.063	0.003	0.024	0.001
Off-farm income	0.018^{ns}	0.089 ^{ns}	0.072 ^{ns}	−0.095^{ns}
	0.420	0.160	0.212	0.144
Non-farm income	0.002 ^{ns}	0.143*	0.139 ^{ns}	0.057 ^{ns}
	0.492	0.055	0.060	0.262
Household income	−0.129 ^{ns}	−0.211**	−0.134 ^{ns}	−0.307**
	0.075	0.009	0.068	0.000
Note:			Legend:	
* Significant at P < 0.05			FAV: Food Availability	
**Highly significant at P < 0.01			FAC: Food Accessibility	
- No significant correlation			FU: Food Utilization	
			FS: Food Stability	

In food utilization, only farm income (rs = −0.176, p = −0.024) is negatively correlated variable. Meanwhile, farm-income (rs = −0.278, p = 0.001) and non-farm income (rs = −0.307, p = 0.000,) are negatively correlated with FS.

Overall, farming income and household income were not saved for the costs of FAC, and FS. In detail, farm income was not saved for FAC, FU and FS. Increasing non-farm income were effect on for food consumption (FAC) while their income is not related to food availability. This finding is agreed with the reports of Chang and Mishra (2008) and Qureshi et al. (2015), increasing non-farm income could enable greater investments in agriculture leading to higher income and non-farm income could improve food security even for the households which cannot invest back in agriculture through inter-temporal food consumption smoothing or by ameliorating food shortage risks in case of unexpected crop failures. Besides, this finding is also similar with Silvestri (2015) and Gassner et al. (2019) statements, that household income is negatively effect on food security.

4.5. Multiple Regression Analysis

The statistical findings of Spearman's rho correlation were enabled not only for establishing the relationship between women households' farming practices, extension services and food security in the study area but also in making the possible predictions for the multiple regression analysis. Stepwise regression method was used to further streamline the predictors (women households' farming practices) of food security in order to guide the researcher in formulating the recommended appropriate extension strategies to achieve food security. The predictors are the women households' farming practices and extension services that have strong significance with food security. Those predictors that have p-values less than the significance level of 0.05 and less than highly significant level 0.01 have statistically significant impacts.

The multiple regression analysis results in Table 19 reflects that lowland rice manual transplanting (p = 0.028), rainfed rice manual transplanting (p = 0.012), use of mechanical in pest management (P = 0.007), no transportation in rice post-harvest operations (p = 0.001), transportation to milled market in labor pattern during summer (p = 0.011) of women households' farming practices; and farmers' organization in membership (p = 0.028) of extension services, will have the highest impact on household food accessibility. Not taking these sex predictors altogether will not have the expected high impact on improving household food security in the study area. In essence, it points out that among the farming practices of women households and their access to extension services, these six will have the highest impact on household food security in this area.

As indicated by their regression coefficients, the respondents will get food security by reducing their use of mechanical apparatuses in pest management (β = −0.208), reducing of non-transportation of rice in post-harvest operations (β = −0.256), reducing/avoiding the summer labor pattern including transportation to market can increase crop production (β = −0.199). Results also revealed that manual transplanting in lowland rice (β = 0.174), and rainfed rice (β = 0.209), could increase crop production and farmers' organizations (β = 0.174), support for increased production.

Table 19. Regression analysis of women households' farming practices and extension services for households' food accessibility

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	6.942	0.259		26.815	0.000**
Lowland rice manual transplanting	1.124	0.506	0.174	2.221	0.028*
Rainfed rice manual transplanting	1.482	0.581	0.209	2.552	0.012*
Mechanical apparatuses in Pest-management	−2.706	0.992	−0.208	−2.727	0.007**
Non-transportation of rice in post-harvest operations	−1.858	0.553	−0.256	−3.361	0.001**
Transporting to Milled Market in summer labor pattern	−0.713	0.274	−0.199	−2.599	0.011*
Farmers' Organizations in membership	1.124	0.506	0.174	2.221	0.028*

Note: Dependent Variable: Food Accessibility
Significant*

The results imply that by avoiding mechanical apparatuses in pest management, preventing non-transportation of rice in post-harvest operations, reducing the summer labor pattern including from transportation of crops to milled market, respondents are seen to increase their crop production and their food security. Hebebrand and Wedding (2010) said that the role of trade market and transportation is to enhance food security, expand market information, improve post-harvest market infrastructure, and growth the agribusiness. But one of the findings is inconsistent with the finding of Pan et al. (2018) ,it is that using of mechanical in pest control is more effective for crops production and food security.

Specifically, manual transplanting in lowland and rainfed and membership and participation in farmers' organizations are highly encouraged. It appears that there is a higher chance for the respondents to attain their desired rice yields if they follow these farming practices and extension services. This interpretation agrees with the notion that participation in agricultural extension programmes positively affects the welfare of farmers' organizations through improvement in farm productivity, income, improved agricultural technologies, improved crop production and adoption of fertilizer (Danso-Abbeam et al., 2018).

Table 20 shows the results of multiple regression analysis on the farming practices of women households such as lowland rice broadcasting ($p = 0.005$), no rice transportation ($p = 0.017$) and rice transportation by bullock-cart in post-harvest operations ($p = 0.006$), crops transportation by other means to the market in terms of market infrastructure ($p = 0.045$), number of live-stocks training ($p = 0.002$), and livestock training satisfaction ($p = 0.000$) are extension services which were all found to have highest impacts on household food utilization. The analyzed data implies that farming practices and extension services are equal to the variables related to food utilization. This means that not all predictors will have high impact on improving household food security in the villages of the study sites. Rather, it only shows that these predictors will have the highest impact on household food security in the study area.

Table 20. Regression analysis of women households' farming practices and extension services for households' food utilization.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	5.446	0.215		25.320	0.000**
Lowland rice broadcasting	−0.736	0.259	−0.214	−2.839	0.005*
Non-transportation of rice during post-harvest operations due to combine-harvester harvesting	−0.887	0.368	−0.181	−2.412	0.017*
Rice transportation by bullock-cart in post-harvest operations	2.399	0.854	0.213	2.810	0.006*
Crops transported by others in market infrastructure	0.648	0.319	0.157	2.029	0.045*
Number of live-stocks training	−1.539	0.487	−0.460	−3.161	0.002**
Livestock training satisfaction	1.869	0.425	0.644	4.394	0.000**

Note: Dependent Variable: Food Security
*Significant**

According to the regression coefficients, lowland rice broadcasting (β = −0.214), no rice transportation in post-harvest operations (β = −0.181), and a number of livestock training (β = −0.460) will not increase crop production and not support food security. Meanwhile, rice transported by bullock-cart (β = 0.213 and crops transportation by others in market infrastructure (β = 0.157) will increase post-harvest losses and crops production. The respondents' satisfaction level for livestock training (β = 0.644) will increase food security. This coincides with the finding of Pan et al. (2018) stating that agriculture training improved farming operations and increased high yields production and food security. There seems also no contention that agricultural extension programmes which include farmers' capacity building of good agricultural practices, skill development regarding the use of improved farm technologies, exposure to general farm management practices and many input and output markets have been the fundamental principles underlying delivery of agricultural extension services. Needless to say, all of these are geared towards improvement in productivity, reduction of poverty and enhancement of food security (Danso-Abbeam et al., 2018 as cited in Ghana Statistical Service, 2010).

Overall, the respondents are projected to achieve food security if they avoid lowland rice broadcasting, use combine-harvester to reduce transportation in rice post-harvest operations, and minimize number of livestock training. On the other hand, transportation of rice with bullock-cart in post-harvest operations and transportation of good by other means in terms of market infrastructure as well as satisfactory livestock training will increase chances of achieving food security.

According to the multiple regression analysis results, rainfed rice broadcasting (p = 0.024), both using pre-emergence and post-emergence herbicide in weed management (p = 0.000), time of pest control in ripening stage (p = 0.016) are the farming practices which have the highest significant correlations with household food stability. Likewise, crop transportation by motorcycle (p = 0.026), crop transported by other means as per market infrastructure (p = 0.012), livestock training satisfaction (p = 0.000) as part of extension services also appear to have the highest significant correlations with household food stability (Table 21).

Table 21. Regression analysis of women households' farming practices and extension services for households' food in stability.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	5.446	0.215		25.320	0.000**
Rainfed rice broadcasting	−0.475	0.208	−0.147	−2.289	0.024*
Both using pre-emergence and post-emergence herbicide in weed management	1.315	0.360	0.233	3.654	0.000**
Time of pest control in ripening stage	−1.607	0.660	−0.156	−2.434	0.016*
Crops transported by motorcycle in market infrastructure	1.226	0.543	0.145	2.259	0.026*
Crop transported by others in market infrastructure	0.523	0.204	0.168	2.561	0.012*
Livestock training satisfaction	1.269	0.142	0.582	8.918	0.000**

Note: Dependent Variable: Food Security
*Significant**

This means that not all the predictors identified will have a high impact on improving household food security in the study villages and that only these predictors mentioned will have the highest impact on household food security in these villages.

These regression coefficients indicate that avoiding rainfed rice broadcasting (β = −0.147) and reducing pest control in ripening stage (β = −0.156) could increase crop production. Using both pre-emergence and post-emergence herbicide (β = 0.233) for weed management, crop transportation by motorcycle (β = 0.145) and by other means (β = 0.168) under market infrastructure could also increase crops production. Besides, the satisfaction level of the respondents in livestock training (β = 0.582) also appears to encourage food security. Pan et al. (2018) have recommended that usage inputs such as pesticides, fertilizer, etc., and proper and sufficient farming practices information provide farmers to improve their livelihood, thereby encouraging higher yield production and therefore ultimately achieving food security. Therefore, extension services could have immense benefits on building good agricultural practices which in turn could lead to increased incomes and overall improved food security status of the community and region.

Avoiding rainfed rice broadcasting and pest control during the ripening stage could increase on the crop production. Meanwhile, using both pre and post-emergence herbicide in weed management, crops transportation by motorcycle and other means in terms of market infrastructure will increase the crops production of the respondents. Additionally, their satisfaction on livestock training will support and increase food security. All of these suggested farming practices and extension services are seen to attain the respondents' desired rice yields.

4.*6 Agricultural Extension Framework*

From the results of the statistical analysis, the following framework is proposed. It reflects the need for food security to be acknowledged and included in the extension system (Figure 3).

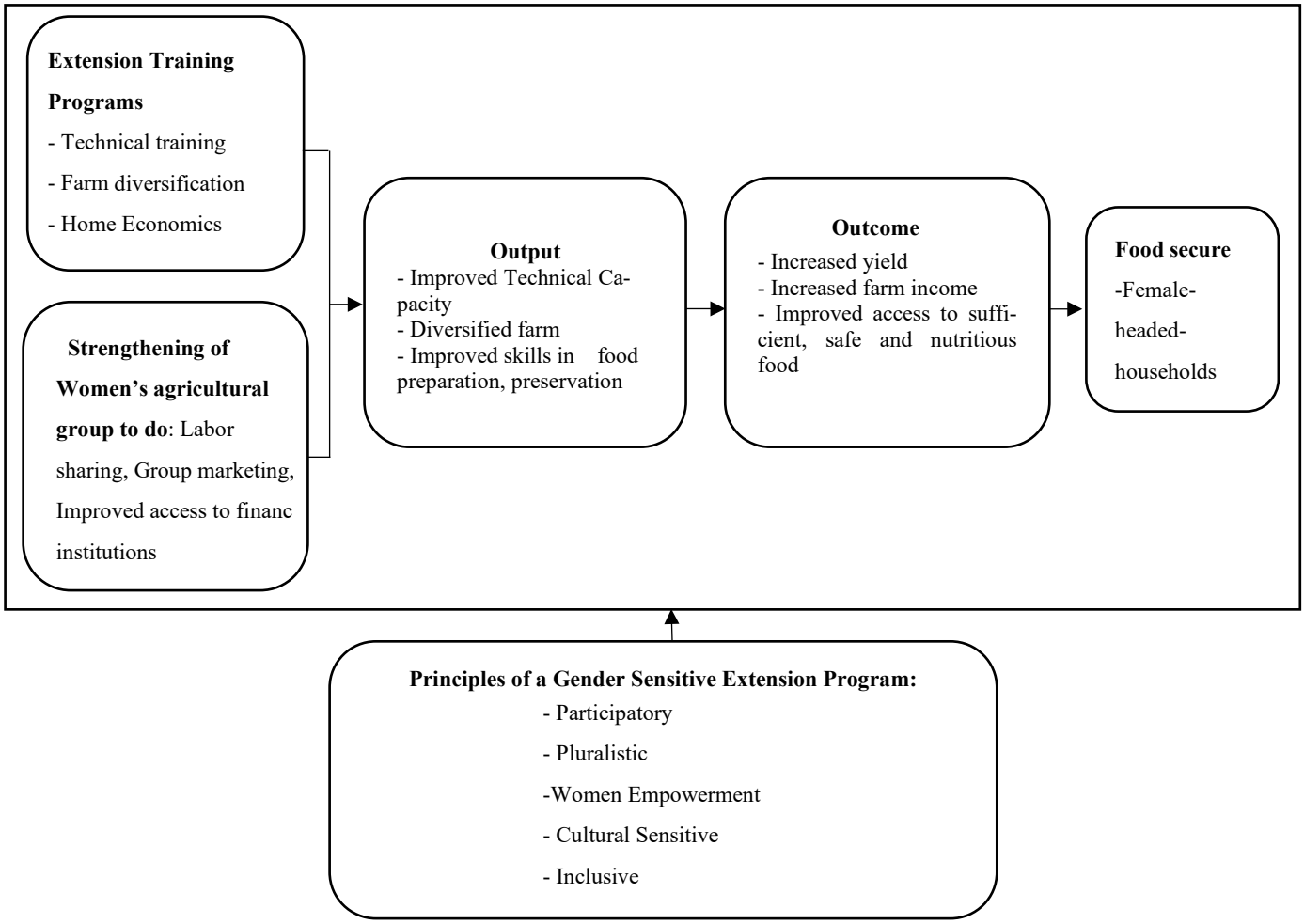


Figure 3. Proposed extension framework for women farmers.

Effective extension services and active role of women in leading farming practices are crucial in planning and implementing food security programs. The proposed extension strategies are anchored on the opportunities and challenges in the extension delivery system given the uniqueness of women farmers as revealed in the study. Through the proposed strategies, it is expected that the women farmers would be able to improve farming practice, increase self-reliance, and develop in food security.

Overall, the proposed extension framework responds to the weaknesses of the current extension system in the study area as earlier mentioned. Some of the weak points identified are insufficiency of funds, inappropriateness of technologies, low participation of women, and poor food security knowledge. Aside from identifying the weak points of the proposed extension framework, it also maximizes the strengths of the current extension system and identifies opportunities such as networks and linkages especially those in relation to women.

5. Conclusions

The average age of respondents is 45 within the range 23–65 and a large number of them have finished primary school education and the average household size is 4. The average monsoon land size is 3.2 ha while the average summer land size is 4 ha. Summer fields have higher land acres than monsoon fields because some monsoon fields are not used due to water-lodging. Most of them were farm owners whose primary source of income was derived from rice farming. Although broadcasting was the common method used, manual transplanting was seen to be more effective in terms of food security. A large number of them used post-emergence herbicide but using both pre and post-emergence herbicide appeared to be more effective for food security. Spraying was also employed but it turned out to be negatively related to food security. Likewise, irrigation which was

also commonly used, was negatively related to food security but dependence on rain was seen positively related to crop production. This has implications for irrigation facilities which currently may not be reaching many farmers who remain dependent on rain for water needs of their crops.

The respondents access the extension support from GOs, NGOs, INGOs and private sectors. GOs is the main source of extension support. According to the GOs, the agricultural extension systems, technologies, and operations of extension staff cannot fulfill its goal of catering to all the farmers' needs from the earlier extension period up to today. Besides this, connections and linkages with other services supporting professionals, technicians, and farmers at the field level are very weak thus knowledge and information developed at higher levels fail to trickle down to the grassroot levels.

The respondents did not fully access the extension support from GOs, NGOs, INGOs and the private sectors, however, GOs are found as the main source of extension support in the study area. According to the GOs, the agricultural extension systems, technologies, and operations of extension staff cannot fulfill its goal of catering to all the farmers' needs from the earlier extension period up to today. The connections and linkages with other services supporting professionals, technicians, and farmers at the field level are very weak thus knowledge and information developed at higher levels fail to trickle down to the grassroot levels.

Due to this, NGOs, INGOs, and other private sector step in to perform and provide education about technological improvement for rural livelihood, food security, and organization improvements. However, women households are still have poor access to extension services in this study region. Access to resources including trainings, market, credit, farm inputs and infrastructure support, are also related to food security. Among them, crops transported by other means and livestock transported by motorcycle are mostly correlated with FAC, FU and FS. Almost all respondents are members of most organizations with some being leaders even while only farm organization is the most correlated with food security in this study.

Surprisingly, most respondents think themselves that their households are food secure in the study area. Based on the data, they have not reached the optimum security level and they are only in the modest level of food security. In sum, the study sites in the strictest term are access to full extension support and sufficiently food security at this point thereby still posing possible risks of hunger or malnutrition upon the people in these villages.

5.1. Recommendations

The households' food security can be improved by ensuring access of female-headed households to extension training programs in topics such as technical training, farm diversification and home economics. Given the labor dependence of the households, it is likewise recommended that strengthening of women's agricultural organizations be implemented to ensure that they receive support in labor sharing, group marketing and assistance in accessing financial institutions. The proposed extension framework for female headed households is recommended to facilitate access to extension and support services and improvement of food security situation.

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Article

Sustainable and Traditional Agricultural Practices to Reinforce Income Dynamics among Tribal Communities in Rural Wayanad, Kerala, India

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Abstract: This comprehensive study conducted in Wayanad, Kerala, India, explores sustainable traditional farming practices in rural tribal households, with a primary goal of boosting income growth and agricultural productivity. The research delves into the intricate relationship between agricultural methods, income distribution, and ecological factors across household income brackets. Descriptive statistics provide a contextual understanding, while regression analysis offers insights into the relationships between Income and Agricultural Practices. The study assesses the impact of various traditional methods on agriculture, investigates the profitability and practices associated with organic, artificial, and mixed farming, and observes that mixed farming methods are more profitable than relying solely on natural practices, with income levels influencing the adoption of advanced farming technologies. The research explores the correlation between combining animal husbandry and agriculture in households, revealing an association with increased profit margins. Emphasizing the importance of sustainable agricultural practices, the study shows a preference for traditional farming techniques in the low-income bracket and a shift towards artificial methods as income rises. The research offers valuable insights into income, farming practices, and sustainability in this context.

Keywords: traditional farming; rural households; income dynamics; tribal communities

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1. Introduction

India's tribal communities, the oldest ethnic group with unique socio-cultural patterns, have faced challenges in the post-independence era, including poverty, high infant mortality, malnutrition, and low literacy rates (Lal, 2010). In Wayanad, tribal agriculture is vital for the local economy and culture, with indigenous tribes practicing traditional and subsistence farming. Challenges such as land alienation, environmental changes, and limited access to modern resources and markets impact tribal agriculture. Enhancing support for tribal agriculture is crucial for community well-being and sustainable regional development. Indigenous agricultural knowledge, known for its eco-friendliness and sustainability, is a valuable intergenerational legacy. However, the contemporary era of Liberalization, Privatization, and Globalization threatens their preservation. Primitive communities employ unique methods to safeguard and continue their indigenous knowledge for survival (Barekar, 2016). Indigenous agricultural knowledge provides a sustainable alternative to modern practices reliant on potentially harmful chemicals. Its adoption reduces the dependence on pesticides, weedicides, and fertilizers, fostering eco-friendly farming practices (Borthakur & Singh, 2021). Traditional agricultural knowledge is vital for small and marginal farmers in India, encompassing crop production, management, protection, and value-added practices. Farmers actively preserve and pass down this valuable information within rural communities, ensuring its continuity and usefulness. This traditional agricultural knowledge transforms agricultural resources, upholds biodiversity ethics, and offers historical and practical insights to present generations (Sharma et al., 2023). Modern farming practices result in genetic erosion and the extinction of crop seed germplasms, diminishing crop variety. This underscores the importance of raising awareness about healthy soils and sustainable agricultural practices to address concerns about genetically modified food and potential health risks for consumers (Srivastava, 2020). While enhancing agricultural production, the Green Revolution has incurred significant environmental costs, including climate

change and agroecosystem degradation. Local technology improvement and global sustainable intensification offer models to reduce greenhouse gas emissions by up to 30%. Achieving sustainable agriculture entails shifting management systems, adopting eco-friendly practices, and implementing integrated insect farming systems (Adegbeye et al., 2020). The key to rapid, broad-based, and self-sustaining economic development lies in enhancing rural income growth and industrialization through productivity increases in agriculture (Balisacan, 1989). Traditional agriculture is gaining global recognition as a solution for sustainable food production in a changing climate. Recognizing the link between climate change and agriculture underscores the importance of adopting a climate-smart approach to food production (Singh & Singh, 2017).

Traditional agriculture optimizes resources, upholds biodiversity principles, and imparts historical and practical wisdom to today's generation (Sharma et al., 2022). Applied in various agricultural facets, it includes crop production, management, protection, farm machinery, soil and water management, medicinal plants, animal husbandry, grain pest control, weed management, and value-added food products. Traditional farming practices like agroforestry, intercropping, crop rotation, cover cropping, organic composting, integrated crop-animal farming, shifting cultivation, and slash-and-burn farming have positive and negative implications. Positively, they enhance soil fertility, sequester carbon, optimize resource use, maintain biodiversity, promote sustainability, and protect the environment. However, certain practices like slash-and-burn techniques in shifting agriculture have negative consequences (Hamadani et al., 2021). Research indicates that upland farmers use indigenous knowledge to adapt to challenging conditions and scarce resources, guiding practices in agriculture, soil conservation, pest control, and ensuring successful harvests. Excessive nitrogen in the environment leads to health and environmental issues, including nitrate contamination in drinking water, negative impacts on freshwater bodies, estuaries, natural ecosystems, greenhouse gases, ozone depletion, acid rain, leaching of bases from soils, and biodiversity loss (Keeney, 1997). While not deemed superior to scientific knowledge, indigenous knowledge is pivotal in equipping farmers with coping mechanisms in degraded uplands (Salomon et al., 2014). Indigenous agriculture plays a vital role in rural development, nature conservation, and the preservation of local ecosystems, ensuring the sustainable use of biodiversity for the well-being of both nature and humanity (Sharma et al., 2020). Studies discuss the importance of incorporating these sustainable cropping practices with modern/corporate agricultural tools to maximize their benefits (KWG & LPHK, 2016; Saha & Bauddh, 2020; Tribe, 1993).

1.1 Sustainable Agricultural Practices and Traditional Knowledge

Research indicates that adopting multiple sustainable agricultural practices (SAPs) in Africa simultaneously results in higher farm income and improved food security for rural households, outperforming single-practice adoption or non-adoption. Households with at least three SAPs experience significantly higher farm income and enhanced food security than those implementing fewer than three practices (Abdallah et al., 2021). The research found that adopting at least three SAPs (improved seed, fertilizer, and soil and water conservation) positively impacted farm income and food security more than adopting one or two SAPs (Setsoafia et al., 2022). Indigenous farming practices within the indigenous knowledge system (IKS) are eco-friendly, sustainable, cost-effective, and crucial for vegetable and livestock cultivation among indigenous communities. Integrating modern technology with traditional methods enhances farming efficiency and reduces energy consumption (Seko et al., 2020). Denitsa Ivanova's study explores best agricultural practices in cultivating traditional and non-traditional crops within organic farming, focusing on the ancient cereal crop Eragrostis tef. The study underscores the potential advantages of employing higher seeding rates and implementing soil and foliar fertilization to enhance crop yields (Ivanova, 2018).

In Mahaulpatha, Polonnaruwa district, Sri Lanka, a survey found 57% of farmers used straw manure before planting, and all employed chemical fertilizers post-sowing paddy seeds. While 87% used machinery for efficient land preparation, some still relied on natural indicators like rainfall patterns and wind direction. Traditional eco-friendly pest control methods were less effective in modern farming, prompting many to use chemical pesticides for immediate results despite their unsustainability (KWG & LPHK, 2016). Amish agriculture, which has evolved over 300 years, is marked by low-input farming systems that have sustained the Amish as a resilient subculture in North America. It centers on traditional practices like horse farming and manual labor, in sharp contrast to high-input conventional agriculture. This distinctive approach provides a unique research opportunity for studying biological pest control, disease management, and nutrient cycling, contributing to sustainability efforts (Stinner et al., 1989).

1.2 Indigenous Agricultural Practices and Traditional Knowledge in India

The traditional knowledge practices in the region, such as wetland rice cultivation of the Apatani tribe in Arunachal Pradesh, Zabo system of farming and Alder agriculture in Nagaland, large

cardamom plantation in Sikkim, and bamboo drip irrigation in Meghalaya, are still in use and considered viable and cost-effective for organic agriculture (De, 2021). Studies have identified and described 21 traditional agricultural tools in Tamil Nadu, including ploughs made from locally available materials like stones, wood, bone, shell, teeth, plant fiber, and animal products. These tools were economical, saving labor, money, and time, operating efficiently without requiring special skills (Karthikeyan et al., 2009b). The study by Dhananjay Kumar emphasizes the need to understand the contemporary interrelationship between traditional farming systems and modern agro-technological advancements to develop sustainable agricultural practices in tribal agro-ecological zones (Kumar, 2016). The Apatani tribe in the Ziro Valley of Arunachal Pradesh has a highly evolved indigenous system of farming that involves cultivating rice and fish together. They utilize periphytoplankton and other natural resources to sustain their farming practices (Sarma & Goswami, 2015). In Meghalaya, tribals cultivate ginger, turmeric, paddy, and vegetables using the Khasi pine system, an indigenous tree-based agricultural approach that emphasizes the coexistence of edible and timber-yielding plants in a symbiotic relationship (Jeeva et al., 2006).

The traditional Mao Naga farming practice, "Jhum Cultivation," is intricately tied to their agrarian society and interconnected with socio-economic, socio-cultural, and geophysical factors. Population pressure has shifted from traditional to non-traditional crops, shortening the jhum cycle from 5–7 to 2–3 years. Integrating traditional and ecological knowledge systems is effective in sustainably managing the Jhum land use system (Pfoze et al., 2010). The Mavilan tribe in North Kerala traditionally hunted, gathered, and shifted cultivation, with extensive knowledge in paddy and seed categorization. However, their agricultural practices have undergone substantial changes, primarily due to forest regulations, evolving land use, and encroachment by non-tribal communities (Suresh, 2010). A study in Himachal Pradesh, focusing on Kinnaur and Lahaul-Spiti districts, documented 30 Indigenous Technical Knowledge (ITKs) related to tribal farming. These ITKs encompassed areas such as soil and water management, cropping systems, farm implements, post-harvest technology, storage, horticultural crops, food product development, agro-animal-based yarns and weaves, veterinary science, animal husbandry, medicinal knowledge, and cultural myths and beliefs (Swangla et al., 2021). The traditional cropping pattern in the central Himalayan region, known as ‘Baranaaja,’ includes 12 crops with low-intensity and infrequent economic intervention. This exemplifies ‘conservation agriculture,’ efficiently meeting food requirements and conserving agrobiodiversity with sustainable water and nutrient utilization (Ghosh & Dhyani, 2004). In remote Tamil Nadu villages, dryland farmers employed traditional storage techniques. These included using lime powder to repel insects and preserve pulse grains for a year. Earthen pots filled with paddy husk were used for paddy grains, and groundnut oil combined with tamarind and ash-treated sorghum seeds deterred pests. A mixture of sweet flag powder with grains and seeds acted as a six-month repellent. The study underscores the significance of indigenous storage practices in pest protection and minimizing losses (Karthikeyan et al., 2009a).

The paper begins with an introduction highlighting the importance of sustainable agriculture and income dynamics in various communities. The literature review shapes research objectives and specific questions. The methodology involves an extensive literature review, structured questionnaire-based data collection, and advanced statistical analysis. Insights into data collection, sampling, and analysis are detailed. The results section presents key findings on agricultural practices and income dynamics, with the discussion interpreting results in the context of existing literature. Recommendations offer actionable strategies for sustainable agriculture and income enhancement. The conclusion summarizes vital findings, acknowledges limitations, and suggests future research avenues, maintaining a structured and reader-friendly format.

2. Research Framework

The research context revolves around a comprehensive study conducted in Wayanad, India, focusing on the intricate dynamics between agricultural practices, income levels, and environmental sustainability. The primary aim is to understand how these elements intersect and influence each other in Wayanad’s unique socio-economic and ecological landscape.

2.1 Research Objective

To analyze the interplay between agricultural practices, income levels, and environmental sustainability in Wayanad, India, and provide insights into fostering sustainable agricultural development.

2.2 Research Questions

- How do households in Wayanad engage in different agricultural practices, including organic, artificial, and mixed methods?
- What is the correlation between Wayanad’s income levels and agricultural profit margins?

- To what extent does the practice of mixed agriculture influence agricultural profit margins in Wayanad?
- What do households in Wayanad employ the prevalent pest management strategies, and how do income levels influence the choice of these strategies?
- To what extent are households in Wayanad aware of and adopting sustainable agricultural practices, and how does this awareness vary across income categories?
- How can promoting mixed agriculture contribute to enhanced income levels and environmental sustainability in Wayanad?

The overarching research objective is accomplished through a nuanced exploration of the diverse factors influencing these dynamics, ultimately providing valuable insights for sustainable agricultural development tailored to the socio-economic context of the region.

2.3 Methodology

Initiating with an extensive review of scholarly literature, the research methodology shapes its objectives to explore relationships between income and agricultural practices within Wayanad's tribal communities. Primary data is then meticulously collected through structured questionnaires distributed among tribal households, ensuring representative data. A stringent validation process follows to uphold accuracy. Employing stratified and purposive sampling techniques, the investigation considers a sample size of 384 (400 for increased accuracy), maintaining a 95% confidence level and a 5% margin of error. The combined approach integrates a thorough literature review, primary data collection through surveys and interviews, and advanced statistical and regression analysis. Data encompassing agricultural practices, income sources, and profit margins undergoes systematic organization for analysis, employing both descriptive and inferential statistics. Descriptive statistics provide contextual understanding, while regression analysis offers insights into the relationships between income and agricultural practices. Visualizations are generated to communicate research findings effectively. From the study's insights, actionable recommendations are formulated to positively impact the sustainable agriculture and income dynamics of Wayanad's tribal communities.

2.4 Scope and Limitations

The scope of the study is that it comprehensively analyses agricultural practices, income levels, and their interplay in Wayanad, India, considering ecological and socio-economic factors. However, the limitation is that it is essential to note that the findings are specific to the Wayanad region and may only be partially applicable to other areas. The reliance on self-reported data introduces the possibility of bias, and the study's observational nature limits its ability to establish causal relationships. Additionally, there is a possibility that not all influencing factors have been considered in this research.

3. Analysis and Results

3.1 Agriculture Details

Among the 1,870 individuals across 400 households, approximately one-fourth (25.40%) engaged in daily wage labor, which included agricultural work. Additionally, 5.08% owned farmland and worked as farmers, while 4.22% were involved in animal husbandry. The households are classified into income groups depending on their monthly earnings, which include less than 5,000 Rs/month, 5,000–9,999 Rs/month, 10,000–14,999 Rs/month, 15,000–19,999 Rs/month, 20,000–24,999 Rs/month, 25,000–30,000 Rs/month, and more than 30,000 Rs/month. The analysis further indicates that around one-fifth (18.5%) of the families in the study depend entirely on agriculture to sustain their livelihoods. Within the sample, more than three-fourths (77%) of the families fall within the income range of Rs 5000 to 19999. This concentration implies a predominantly lower middle-income profile for agriculture-dependent families. It indicates that while agriculture is central to their income, these families likely engage in additional income-generating activities, contributing to their moderate economic well-being. These families engage in agricultural and non-agricultural activities, ensuring a potentially more stable income stream. The lowest income group (<5000) has limited participation in agriculture, possibly due to barriers like restricted access to resources, including land and capital or challenges related to markets and technology. Support may be needed for these households to engage in agricultural activities fully. The data highlights a noteworthy trend where the highest average earning from agriculture is observed in the income category of Rs 15,000–19,999. This suggests a significant reliance on agriculture as the primary income source in this income bracket, potentially indicating optimized agricultural practices for greater returns. However, the high average agricultural income in the highest income group is based on only one household, limiting the generalizability of this finding.

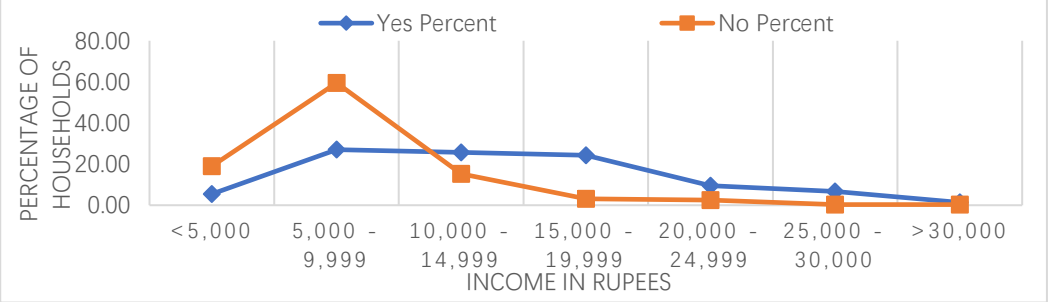

Figure 1. Income vs. families dependent on agriculture.

Analyzing primary crop choices, about one-fourth (23.5%) prioritize fruits and vegetables, 14% focus on coffee, and 10.5% on rice. Middle-income households prefer rice and coffee cultivation, while the lowest-income groups primarily cultivate fruits and vegetables. The Rs 5000–9999 income category dominates rice and coffee production, with limited contributions from the highest and lowest income categories. Pepper production is concentrated in the Rs 5000–9999 income category, with no production in the highest income categories. Tapioca is mainly produced in the Rs 5000–9999 income category, with limited involvement from the highest income categories. Fruit and vegetable production is led by the Rs 5000–9999 income category, with minimal contributions from higher income categories. Ginger production is prominent in the Rs 5000–9999 income category, with some input from the < Rs 5000 and Rs 25000–30000 categories. Chilli production centers on the Rs 10000–14999 income group, and cardamom production is chiefly within the Rs 5000–9999 and Rs 10000–14999 income categories, with no production in other categories. Other crop production is highest in the Rs 5000–9999 income category, with contributions from the < Rs 5000 and Rs 10000–14999 categories. Figure 3 shows Tapioca as the most cultivated secondary crop (22.25%), primarily grown by the Rs 5000–9999 income group. Pepper, the second most cultivated secondary crop (10.5%), is also primarily produced (47.62%) by the Rs 5000–9999 income group. Secondary rice production is found in the Rs 5000–9999 income category, and secondary wheat production is in the Rs 15000–19999 category. Significant secondary coffee production is observed in the Rs 10000–14999 income category, with contributions from the Rs 5000–9999 and Rs 15000–19999 categories. Fruit/vegetable production is significant in the Rs 5000–9999 category, with notable input from the Rs 10000–14999 and Rs 15000–19999 categories. Most secondary ginger, turmeric, chili, and cardamom production is within the Rs 5000–9999 income category, with some contribution from the Rs 10000–14999 category.

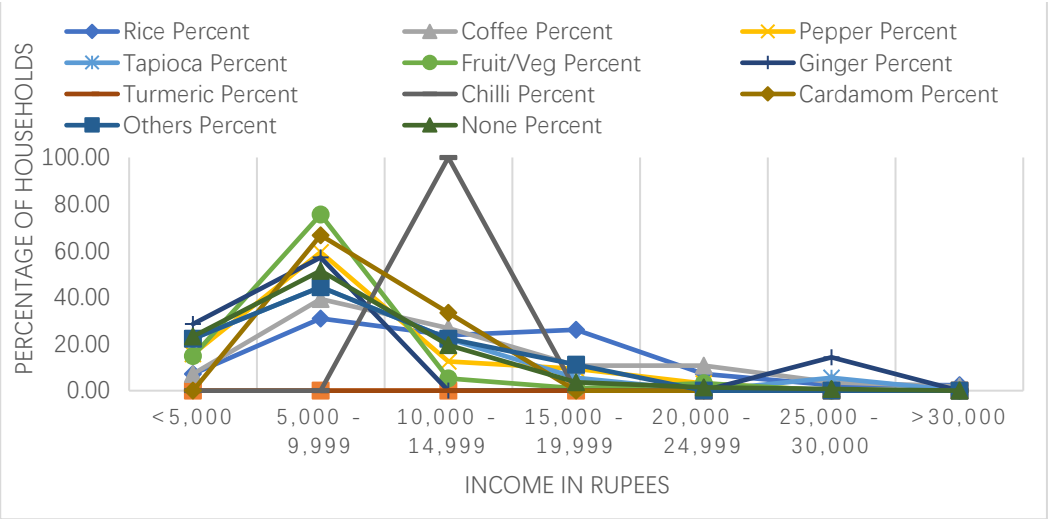

Figure 2. Income vs. primary crop type.

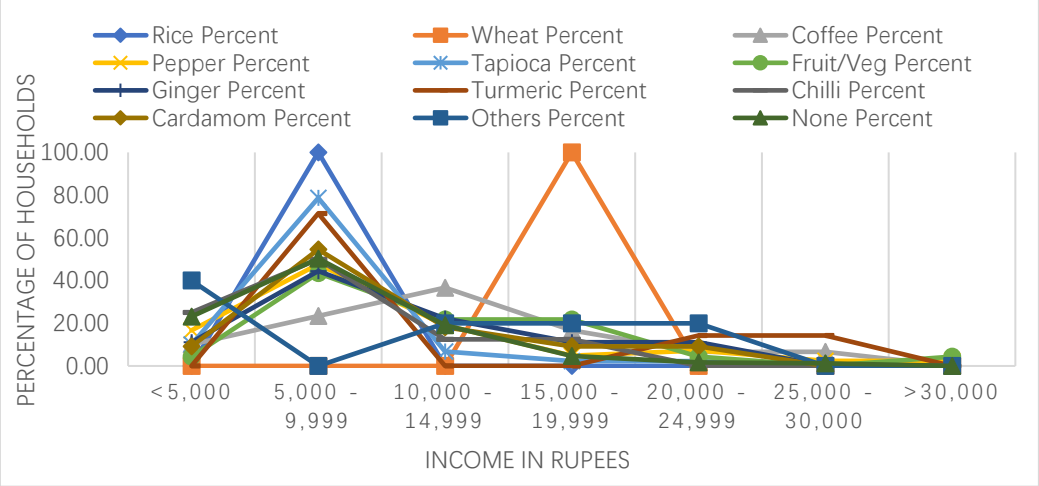

Figure 3. Income vs. secondary crop type.

The regression analysis concerning agricultural income (profit margin) in relation to primary crops reveals that these crops collectively account for about 37.01% of the variability in profit margins. Notably, the positive coefficient for rice implies that cultivating rice tends to increase profit margins. However, it is essential to note that the p-value associated with rice is close to 0.05, suggesting that the statistical significance of this effect is somewhat borderline. In the case of secondary crops, the analysis indicates that approximately 17.55% of the variability in profit margins can be attributed to these crops. However, the results are not statistically significant for crops like wheat, coffee, pepper, Tapioca, ginger, turmeric, chili, cardamom, and others. The lack of statistical significance indicates that the impact of these crops on profit margins remains undetermined. Notably, the "Fruit/Vegetable" category has the highest coefficient, but its p-value at 0.0407 achieves only marginal statistical significance.

3.2 Animal Husbandry

Animal welfare is a crucial priority in organic farming, which strives to create sustainable and eco-friendly farming systems, highlighting its commitment to both animal well-being and environmental sustainability (Lin, 2015) (Lund, 2002). Data shows that 48.25% of households practice animal husbandry, which is more common in the middle to higher income brackets than the lowest. Higher-income households may have more resources, such as land and capital, for successful animal husbandry. The data indicates that while almost half of the households practice animal husbandry, less than one-sixth (14.25%) rely entirely on it for income. This suggests that many households may have diversified income sources, engaging in additional occupations alongside animal husbandry or utilizing animal husbandry products for daily needs. The lowest-income category shows low involvement in animal husbandry due to resource limitations. In contrast, income categories between Rs 5000 and 19,999 actively engage in animal husbandry for income, with the highest participation observed in the Rs 5000–9999 and Rs 10000–14999 income categories.

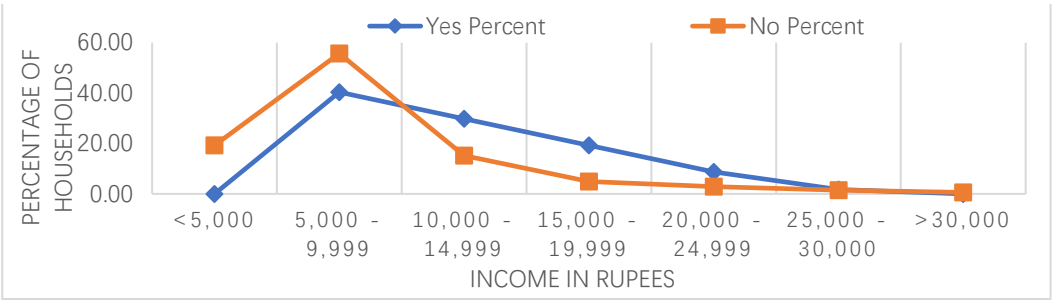

Figure 4. Income vs. families dependent on animal husbandry.

Gross income varies across income brackets, averaging Rs 5158.70 in the Rs 5000–9999 category, Rs 6955.88 in the Rs 10000–14999 category, and Rs 7745.45 in the Rs 15000–19999 category. The Rs 20000–24999 category has an average gross income of Rs 5750.00, while the highest income category (> Rs 30000) records no gross income from animal husbandry, suggesting diversified income sources. In the Rs 20000–24999 range, expenditure on feed and medicine averages

Rs 2020.00. Income from animal husbandry increases with household income, averaging Rs 3041.30 in the Rs 5000–9999 category, Rs 4047.06 in the Rs 10000–14999 category, and Rs 4454.55 in the Rs 15000–19999 category. Among agriculture-dependent households, those practicing both agriculture and animal husbandry have a higher average agricultural profit margin of 4277.5 Rs. In comparison, the 34 households solely engaged in agriculture have a slightly lower average profit margin of 3570.59 Rs. However, regression analysis indicates a minimal impact of animal husbandry on agricultural profit, supported by a low R-squared value of approximately 1.32% and an insignificant coefficient for animal husbandry, suggesting its limited influence on agricultural profit despite observed profit differences. Observations reveal that 8.25% of households own cattle, 36% rear poultry, and 4% have both cattle and poultry. Poultry rearing is more common in all income groups, while cattle and households practicing both are common in middle-income groups. The prevalence of poultry farming is attributed to its advantages, including more minor space requirements, lower investment costs, and quicker returns, making it a viable income-generating activity in rural and peri-urban areas. The 4% of households with cattle and poultry showcase diversified livestock practices for income and resource utilization. Cattle ownership analysis among families dependent on animal husbandry income reveals income-dependent patterns, concentrated in the Rs 5000–9999 (42.42%) and Rs 10000–14999 (33.33%) categories, indicating middle-income households' higher likelihood of owning cattle. The Rs 15000–19999 category exhibits 15.15% ownership, while the lowest and highest income categories have the lowest percentages, potentially due to resource limitations and different livelihood strategies. Poultry ownership analysis shows lower middle-income households' prevalence, with notably high ownership in the 5000–9999 Rs category (61.81%) and a significant percentage in the 10000–14999 Rs category (13.89%). The lowest and highest income categories have lower poultry ownership, possibly due to resource limitations and different livelihood strategies. In the Rs 10,000–14,999 and Rs 15,000–19,999 income categories, 25% of families own cattle and poultry, with the highest percentage in the Rs 5,000–9,999 income group at 37.50%. This suggests a tendency for middle-income households to engage in multiple types of animal husbandry, providing various income sources, including meat, dairy, and egg production. The average profit margin for cattle farming households is Rs 3703.13, while for poultry farming households, it is Rs 2362.5. Remarkably, households practicing cattle and poultry farming achieve the highest average profit margin of Rs 4352.94. Data indicates that these households are more profitable, potentially benefiting from complementary advantages or efficiencies. Tribes in Wayanad prioritize subsistence farming, explaining the lower emphasis on commercial poultry farming for profit.

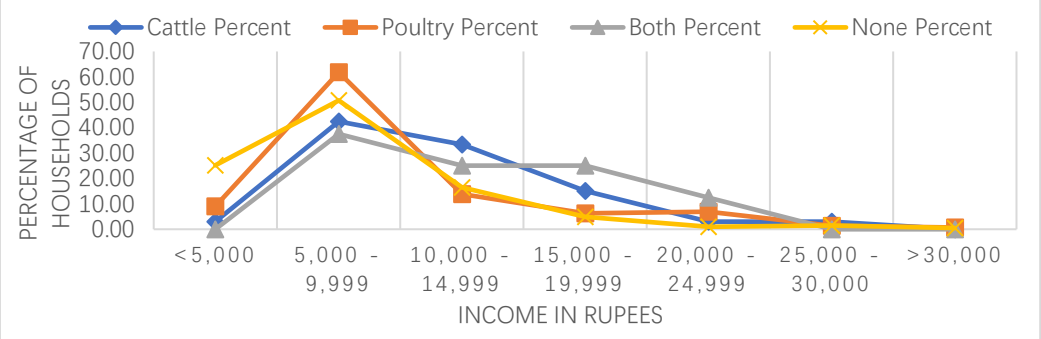

Figure 5. Income vs. type of livestock.

3.3 Fauna and Pest Management

Fauna management is crucial for tribal communities practicing agriculture and animal husbandry, involving sustainable practices to manage local wildlife and habitats. Deeply connected to nature, these communities contribute to biodiversity conservation, ecological balance, and cultural heritage preservation. Active participation empowers them in wildlife conservation decisions, supporting sustainable development and harmonious coexistence with the environment. Involvement in fauna management, seen in almost one-fourth (23.25%) of tribal families, reflects their commitment to conservation and deep understanding of maintaining a harmonious relationship with wildlife and ecosystems. As income brackets increase, participation decreases, with the highest income category at 1.08%, possibly due to other livelihood priorities. Analysis indicates reduced engagement, especially among families no longer working with forest produce and those moved away from forest settlements. Varied participation levels across income categories reveal the highest involvement in the Rs 10000–14999 category at 48.39%, reflecting a strong interest in wildlife conservation. The four lower income categories encompass 93.6% of households in fauna management.

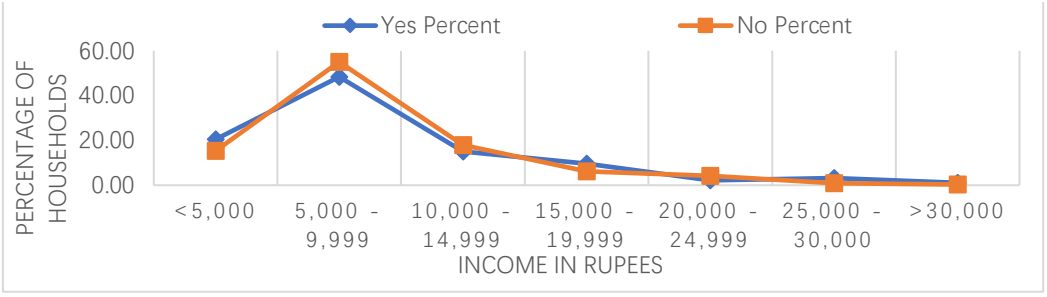

Figure 6. Income vs. fauna management (large mammals and other wildlife).

The data reveals that 8% of families use natural repellents for extensive fauna pest management, showcasing a preference for eco-friendly methods. Stun fencing is the second-highest practice, with 23.65% of households employing it, while 76.35% favor sustainable methods like natural repellents. This positive trend aligns with conservation and biodiversity preservation efforts. Promoting sustainable approaches, such as integrated pest management, minimizes harm to wildlife and the environment. The data underscores the importance of raising awareness about the drawbacks of certain pest management practices, like stun fencing and promoting sustainable alternatives. Lower income brackets prefer fencing or moats around settlements over time-consuming sustainable methods. Stun fences are most common in the Rs 5,000–9,999 category (40.91%), with no usage reported in the highest income group. Moats are predominantly used in the lowest two income categories (90%), while higher income brackets avoid this method. Traps are absent in the lowest-income category but gain prevalence in higher brackets (30.77%, 23.08%, 15.38%, and 15.38% in the Rs 5000–9999, Rs 10000–14999, 15,000–19,999, and the highest-income category, respectively). Repellents are widely used in the Rs 5000–9999 category (56.25%), 10,000–14,999 (18.75%), and the lowest income category (18.75%), with no usage in higher income brackets.

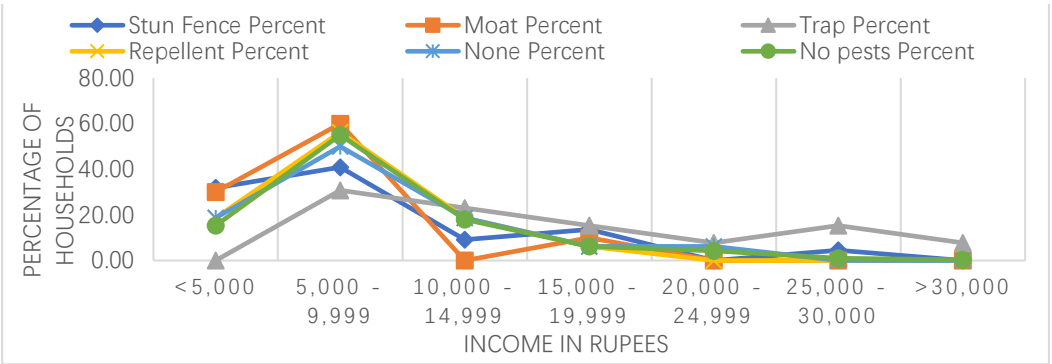

Figure 7. Income vs. pest management (large mammals and other wildlife).

Stun fences and moats show positive coefficients, suggesting potential profit margin increases, but these effects lack statistical significance. The regression analysis does not find any statistically significant correlation between pest control methods for large mammals and profit margins. In simpler terms, pest control method choice does not strongly impact profit margins from a statistical perspective. However, practical and ethical considerations should guide pest control decisions. While stun fences may offer higher profit margins, they raise ethical concerns about animal welfare and the need for safety. The data indicates that more families manage fauna for smaller pests like rodents, insects, and birds than large mammals. This is likely due to the broader issues tiny pests pose. Fauna management is less common in higher-income tribal families, who often have better preventive measures and modern housing that minimizes pest-related problems. The Rs 5000–9999 category reports the highest usage rate at 55.68%, highlighting a significant reliance on these methods for pest management.

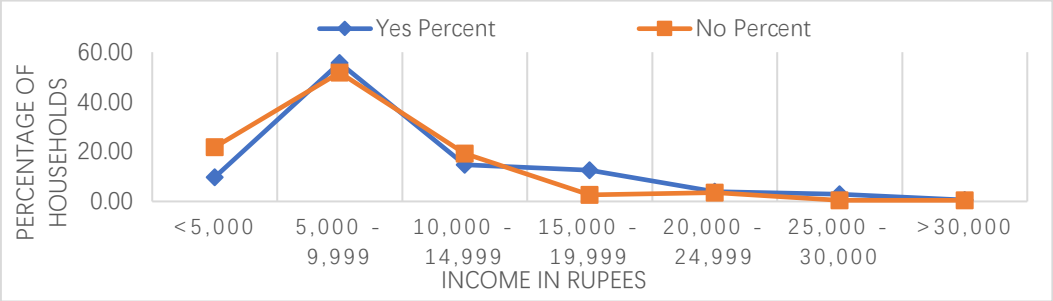

Figure 8. Income vs. fauna management (rodents, insects and birds).

The data reveals that while 76 households use sustainable homemade repellents for pest management, 92 use other fatal methods, excluding pesticides and smoke bombs. The higher use of fatal methods may stem from a lack of awareness about sustainable alternatives or perceived effectiveness. Lower-income groups focus on pest management due to their affiliation with forest produce, while middle-income families prioritize farming, aligning with rural community trends. The study in Wayanad tribes across seven income categories reveals diverse pest management strategies influenced by economic factors. Households in the 5,000–9,999 income category prioritize plowing (36.11%) and traps (29.03%). The 10,000–14,999 income group emphasizes puddling (42.86%). In contrast, the 15,000–19,999 income category does not allocate resources to puddling, indicating a different approach. Smoke bombs see substantial allocation in the 5,000–9,999 and 10,000–14,999 income categories (33.33%), while higher income categories (20,000–24,999, 25,000–30,000, and >30,000) allocate none, indicating limited prominence. Households below 5,000 income allocate moderate resources to smoke bombs (16.67%), demonstrating some reliance on this method. Traps are predominantly used in the <5,000 and 5,000–9,999 income categories, leading at 25.81% and 29.03%, while the 10,000–14,999 and 15,000–19,999 income groups stand at 16.13%. Higher-income categories (20,000–24,999, 25,000 –30,000, and >30,000) allocate fewer resources to traps (6.45%), indicating less reliance, with traps not a significant strategy for the highest-income category. Repellents are most used by the 5,000– 9,999 income category (84.21%), while the <5,000 income category stands at 5.26%. The 10,000– 14,999 and 15,000–19,999 categories show percentages of 3.95% and 2.63%, respectively. Higher-income categories (20,000–24,999, 25,000–30,000, and >30,000) also allocate relatively lower resources to repellents (ranging from 1.32% to 2.63%). The absence of resources allocated to repellents in the highest income category suggests more prominent strategies for pest management. The analysis indicates that households in the 5,000–9,999 and 10,000–14,999 income categories rely significantly on pesticides (both at 33%). However, the 15,000–19,999 category shows a more moderate use of pesticides at 16.67%. Income groups <5,000 and 20,000–24,999 show less reliance (both at 8.33%), likely due to differing financial priorities and pest-related challenges. Higher-income categories (25,000–30,000 and >30,000) do not allocate resources to pesticides, suggesting alternative strategies or fewer pest issues.

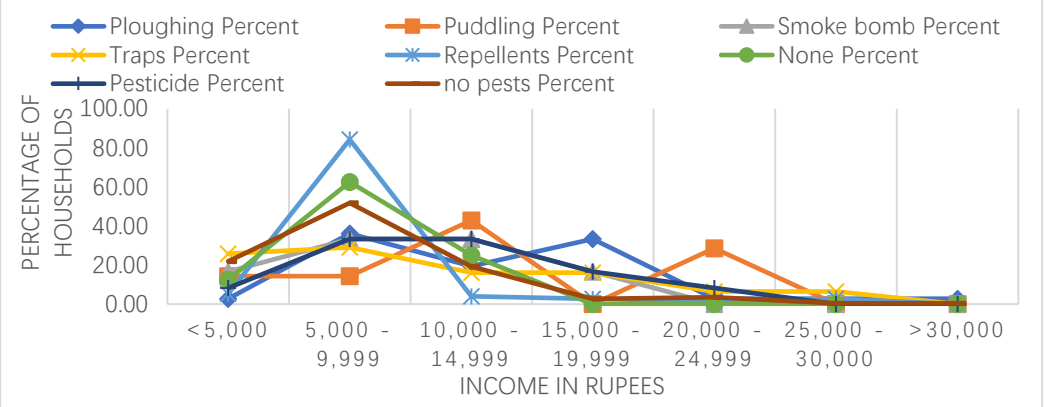

Figure 9. Income vs. pest management (rodents, insects and birds).

The regression analysis indicates that pest control methods significantly impact agricultural profit margins. Ploughing and puddling show substantial and statistically significant positive ef-

fects, contributing around 4,785.71 and 3,714.29 Rupees, respectively, to agricultural profit margins. Conversely, smoke bombs, traps, repellents, and pesticides do not affect agricultural profit margins statistically significantly. While smoke bombs and traps yield some gains, these effects lack statistical significance. Repellents and pesticides, while contributing to profit margins, lack statistical significance. Implementing plowing and puddling as pest control methods is favorable for enhancing agricultural profit margins, potentially with secondary benefits like soil quality improvement. Other methods may not provide substantial or statistically supported benefits in Rupees earned. The cost of specific pest control methods, such as pesticides or repellents, could offset gains from increased yields, limiting the improvement in net profit margins.

3.4 Crop Thrashing with Domesticated Fauna

The practice of crop thrashing with domesticated fauna, as indicated by one-seventh (13.25%) households, highlights a direct link between middle-income agricultural families and this method. Crop thrashing with domesticated fauna is a cost-effective and sustainable approach for small-scale farmers. It eliminates the need for expensive machinery or equipment, making it a viable option for those with limited financial resources. Additionally, it aligns with traditional farming practices and has cultural significance within the community. The technique is used by around three-fourths of agricultural households at 72.60%, but there is a notable decline in adoption within higher-income groups. However, it is essential to note that the effectiveness of crop thrashing with domesticated fauna may vary depending on the scale of agriculture, type of crops, and local farming practices. To improve crop production and income sustainably, it is crucial to understand how this practice can be optimized. In the 5,000–9,999 and 10,000–14,999 income categories, 33.96% and 26.42% of households, respectively, engage in crop thrashing with domesticated fauna, indicating substantial reliance on this method. The 15,000–19,999 income category has 30.19% of households practicing this method, reflecting a similar emphasis. The lower income category, < Rs 5,000, refrains from this practice due to limited access to domesticated fauna, as procuring and maintaining such assets might be financially challenging. Mechanized methods or other techniques may be more efficient, so crop thrashing with fauna decreases as the income bracket increases. The regression analysis for the profit margin in agriculture concerning the use of domesticated animals for crop thrashing reveals an R-squared value of approximately 23.02%. The coefficient for "Crop Thrashing with Domesticated Animals" is 2955.58, with a very low p-value ($1.523E^{-05}$), signifying its statistically significant and positive impact on agricultural profit margins.

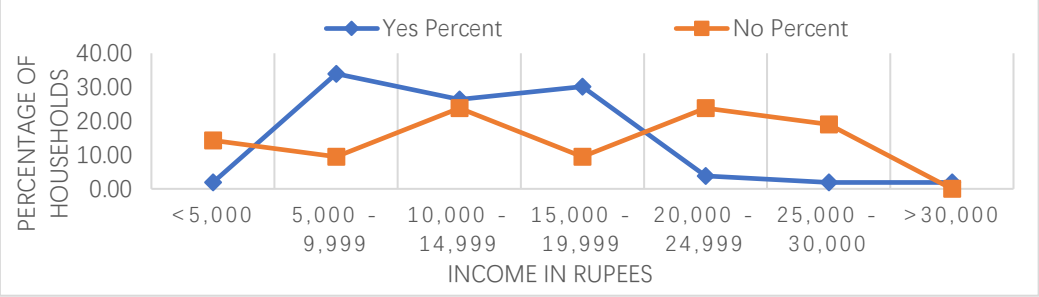

Figure 10. Income vs. crop thrashing with domesticated fauna.

3.5 Irrigation Methods

Regarding irrigation methods, the data shows that more than two-thirds of agricultural households (69.86%) use a combination of surface irrigation from nearby canals or rivers and motors for pumping water. In comparison, 23.29% rely solely on rivers, and 8.22% depend solely on small ponds. The lowest income group effectively utilizes small ponds and rivers for irrigation, showcasing their resourcefulness. Higher-income households favor modern irrigation methods like tube wells and drip irrigation, aligning with their economic capacity and resource management strategies. The income categories of 5,000–9,999 and 20,000–24,999 do not allocate resources to small pond irrigation, while the <5,000 and 10,000–14,999 income categories emphasize small pond irrigation. The lowest four income categories primarily rely on rivulet-based irrigation, with the 5,000–9,999 category significantly utilizing this method (52.94% of households). Among the 50 households that employ a combination of different irrigation methods, their average profit margins were notably higher at Rs 4238, surpassing the average profit margins achieved through natural irrigation sources. This suggests that using mixed irrigation methods yields better agricultural profit margins than relying solely on natural sources for irrigation. The regression analysis for profit in relation to the irrigation method shows a relatively low R-squared value of about 3.55%. This indicates that only a tiny proportion of the variability in profit can be explained by the choice of irrigation method.

The coefficients for "Small Pond," "Rivulet," and "Mixed" are positive, suggesting that these methods might have a positive impact on profit. However, the p-values for these coefficients are more significant than 0.05, indicating that they are not statistically significant. Therefore, the choice of irrigation method, whether a small pond, rivulet, or mixed, does not have a statistically significant effect on profit.

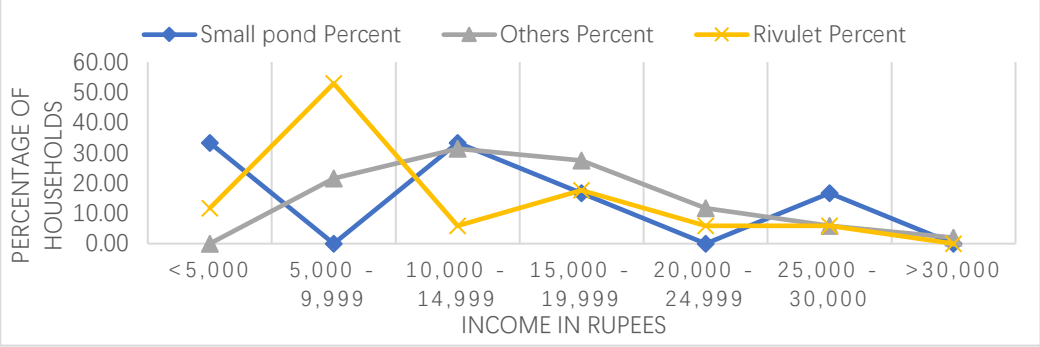

Figure 11. Income vs. water channels for irrigation.

3.6 Organic Farming

Organic farming is an agricultural approach that emphasizes using natural inputs, sustainable practices, and avoiding synthetic chemicals and genetically modified organisms. The data shows that 46.25% of households (185) practice organic farming as their primary method, including farming and subsistence households. Artificial and mixed techniques are more prevalent in the lower middle and middle-income brackets, with 18 of 21 families in these groups using such practices. The 5,000–9,999 income bracket strongly emphasizes sustainable farming, with 43.78% primarily engaged in organic agriculture. The increase in artificial practices in higher-income groups suggests that rising income levels may lead to investment in advanced farming technologies. Driven by the desire to improve productivity, optimize resource utilization, and potentially increase profits, artificial agriculture is prominent in Rs 5,000–9,999 and Rs 10,000–14,999 income households, with 42.86% and 28.57% practicing it, respectively. It is evident among both lower-middle-income and higher-income households. Meanwhile, mixed agriculture prevails in the Rs 5,000 to 19,999 income bracket, with 92.86% of households opting for this approach. This income category's strong inclination towards mixed agriculture suggests a diversified and sustainable farming approach, ensuring food security and economic stability aligned with their socio-economic and environmental context. Among households, 58 primarily practicing organic farming report an average agricultural profit margin of Rs 3668.96, while seven households using primarily artificial techniques achieved an average profit margin of Rs 3171.43. Those engaged in mixed agriculture, combining both organic and artificial methods, demonstrate the highest average profit margin of Rs 5722.2 within a group of nine families. The linear regression analysis indicates a statistically significant relationship between mixed agriculture and agricultural profit margins, with an R-squared value of approximately 8.76%. The coefficient for mixed agriculture is 2773.50, and the p-value is 0.0104, suggesting a significant influence on profit margins. However, the linear regression for organic and artificial agriculture did not show statistically significant relationships, indicating that these practices may not impact agricultural profit margins.

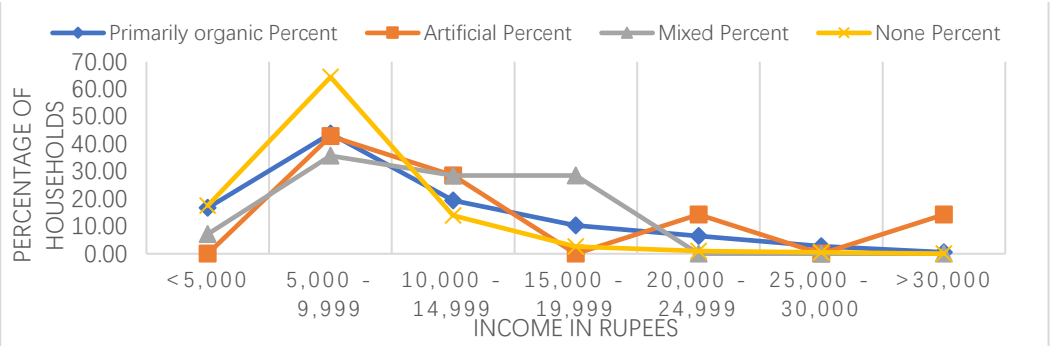

Figure 12. Income vs. practice of organic farming.

4. Findings

A significant portion of the surveyed population is involved in agriculture, with one-fifth relying solely on it for income, concentrated in the 5000–9999 Rs/month bracket. Income levels influence crop choices, with higher income focusing on rice and coffee. Rice cultivation shows a positive coefficient but a borderline significant impact on profit margins in the regression analysis. Animal husbandry is prevalent, with the highest profit margin observed when poultry and cattle are reared, and regression analysis indicates minimal impact. Fauna management is undertaken by one-fourth of tribal households, with decreasing participation as income increases but displays ethical concerns. Stun fences and moats show positive coefficients without statistical significance. Higher-income groups do not allocate resources to pesticides, and plowing/puddling is more common in the upper-middle-income bracket, showing a statistically significant positive impact on profit margins. Cost-effective and sustainable crop thrashing with domesticated fauna is observed, predominantly in middle-income households. Two-thirds of households use a combination of surface irrigation and motors, but the choice of irrigation does not show statistical significance with profit margins. Almost half of the households practice organic farming, but income increase correlates with a shift to mixed or artificial practices. Mixed agriculture demonstrates the highest average profit margin with statistically significant influence.

5. Discussion

The concentration in the middle-income bracket suggests that agriculture plays a vital role in households with moderate income levels, possibly serving as a stable income source. Provide financial incentives for low-income households to transition to sustainable and organic farming practices. Ensure fair resource access by developing customized agricultural strategies considering household income levels and regional characteristics. Diversification in crop choices among income groups indicates varying agricultural strategies and the positive impact of rice cultivation underscores its profitability. Promote crop diversification based on ecological suitability and market demand to enhance food security. The emphasis on combined poultry and cattle rearing suggests a potential for integrated farming, but the minimal impact in regression analysis warrants further investigation into the factors influencing profit margins. Those practicing agriculture and animal husbandry among agriculture-dependent households reported higher average profit margins. Encourage income diversification through combined crop cultivation and animal husbandry for economic stability and sustainability. Research suggests that declining satisfaction and income from livestock farming may lead to reduced intention to utilize improved grassland (Elahi et al., 2021). The ethical concerns associated with fauna management highlight the need for sustainable practices. Although not statistically significant, the positive coefficients of stun fences and moats indicate potential profitability, necessitating a balanced approach. Advocate for wildlife-friendly pest management to minimize ecological impact, focusing on sustainable alternatives to harmful methods. Avoiding pesticides in higher income brackets aligns with sustainable practices, but the use of pesticides in the lower income groups raises concern. Addressing policy distortions, especially in land and migration policies, can significantly reduce agricultural chemical usage (30–50%), decrease environmental impact (50%), and double farmers' total income. This aligns with strategies like enhancing access to modern technologies knowledge and enforcing environmental regulations. Larger farms consistently show lower agricultural chemical intensity, using less fertilizer and pesticide per hectare (Wu et al., 2018). Certain practices, like biofertilizers, natural pesticides, crop choice and rotations, intercropping, and agroforestry, need more agricultural integration and moderate potential for widespread adoption in the next decade. Raise awareness about sustainable farming practices through education and extension services, reducing reliance on synthetic chemicals. The positive impact of plowing/puddling emphasizes their importance in improving profit margins. The decrease in crop thrashing with increasing income levels may be due to the adoption of mechanized methods. However, the statistical significance and positive impact on profit margins underline its sustainability.

Higher-income groups adopt modern irrigation methods, implying technological adoption. The lack of significance in profit margins suggests a need for nuanced understanding. Integrated water management, including a small pond and rivulet-based irrigation, can optimize water use and boost yields. The income-driven shift in farming practices may reflect a trade-off between sustainability and profitability. The significant influence of mixed agriculture highlights its potential for balancing both factors. Agroecological principles enhance sustainable farming, promoting biodiversity, diversified cultivation, organic practices, and reduced chemical inputs. Livestock integration addresses associated challenges, advocating for supportive policies fostering economic stability and environmental sustainability. Agroecology boosts farmers' incomes, with potential regional and national impact on the agricultural sector (Van der Ploeg et al., 2019). Renewable energy, including solar and wind power, is integral to various agricultural processes. It supports irrigation, cultivates solar-powered greenhouses, aids post-harvest activities through solar and geothermal

technologies, and powers transportation with biomass-based biofuels. Additionally, renewable energy is utilized for cooking, heating, and in climate-controlled sheds, promoting sustainable agricultural practices (Rahman et al., 2022). With the rise in off-farm income, rural households transition from solid, non-clean fuels like coal to more efficient and cleaner energy sources such as electricity and gas (Ma et al., 2019). It is essential to consider diverse indicators of human well-being and environmental sustainability beyond income or direct health concerns. These indicators encompass gender equality, nutrition, soil health, biodiversity, and climate forcing (Kanter et al., 2018). By distinguishing the poor, marginalized, and dispossessed dimensions, the assessment of multidimensional poverty can help design and execute poverty reduction programs and improve the persistence of alleviating poverty (Fahad et al., 2023). Economic indicators, such as profitability and productivity of inputs, are essential considerations in sustainable agricultural intensification (Shrestha et al., 2021). Promoting practices such as integrated farming systems, precision agriculture, integrated nutrient management, and integrated pest management is crucial for ensuring agricultural sustainability, food security, nutrition, and preserving natural resources for future generations (Muhie, 2022).

6. Conclusions

The research advances agricultural economics by uncovering intricate connections among income, farming practices, and profit margins. The empirical findings bolster existing theoretical frameworks on sustainable agriculture and income dynamics and offer practical insights for policymakers and practitioners. The study advocates for targeted support in the form of integrated farming systems, ethical fauna management, and awareness programs on sustainable pest control. Its interdisciplinary approach, spanning economic, ethical, and ecological dimensions, enriches our comprehension of agricultural practices and their profound implications for rural livelihoods. The emphasis on preserving culturally significant traditional farming practices underscores the importance of promoting sustainability while respecting local heritage. Moving forward, continued research is essential to comprehensively grasp the impact of traditional farming methods on profitability and sustainability in agriculture. The study underscores the profitability of mixed farming. It underscores the influence of income levels on technology adoption, emphasizing the need to tailor strategies to the local context for sustainable rural development. These invaluable insights have the potential to shape policy decisions and drive initiatives that foster more sustainable and prosperous agricultural communities.

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Article

Estimating Demand for Healthcare Facilities in Rural Developing Countries

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Abstract: Spatial analysis provides decision support for numerous public health issues such as determining locations of healthcare facilities for a given population. With limited population health data available for developing countries, spatial data analysis provides limited benefit in this regard. This paper attempts to assist public health practitioners in overcoming the health information gaps common to developing countries for determining health-related demand locations. We introduce methodologies that use generally available information from Demographic and Health Surveys (DHS). Burkina Faso, a developing country with poor health quality, is used in this paper as a case study to show how DHS data, not generally used for spatial analysis, can be used to estimate multiple area demand locations for healthcare facilities. Factors used to locate demand per administrative province included population density, proximity to major road networks, economic wealth index, birth rate, childhood stunting, and malaria rates. Major health issues in populated areas along access routes ultimately determined the estimated area demand for healthcare facility locations in this analysis.

Keywords: spatial analysis; cluster analysis; weighted factors; Getis-Ord Gi; Demographic Health Surveys; rural health; developing countries; health demand; health access; spatial accessibility

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1. Introduction

Millions of people die in developing countries due to healthcare needs not being met (Harrison, 2009). Developing countries have higher disease rates than first world countries and also have more severe resource constraints and limited access to healthcare (Adeyeye et al., 2023; Hjortsberg & Mwikisa, 2002; World Bank, 2008). Multiple studies have analyzed healthcare demand in populations that are considered in need (Comber et al., 2011; Peters et al., 2008; Schoeps et al., 2011). Identifying access to health resources is crucial in caring for disadvantaged populations in areas with high health demand (Faye et al., 2020; Yao & Murray, 2014). Defining access and demand for healthcare can be a vague concept when it comes to decision support analysis for the placement of healthcare facilities (Khan & Bhardwai, 1994; Penchansky and Thomas, 1981). Penchansky and Thomas (1981) describe a broad definition of access in five dimensions including availability, accessibility, accommodation, affordability, and acceptability. Defining access can also include the ability to receive care when needed and desired (Ricketts & Goldsmith, 2005). Rutherford et al. (2010) expands on this idea in terms of influencing factors that can impair access resulting from any intra- or extra-household influences that may hinder health service uptake.

Access to healthcare relates to the availability of healthcare resources relative to the demands of the population for services (Munoz & Källestål, 2012; Ouma et al., 2021). Availability and accessibility can be spatial in nature and it is common to refer to these dimensions as "spatial accessibility" (SA) (Delamater, 2013; Guagliardo, 2004; Luo & Wang, 2003). Spatial data related to demand and accessibility can support the process of determining the location of a healthcare facility. The placement of healthcare facilities depends on multiple factors including accessibility, population densities, and demand from major health issues (Yao & Murray, 2014). Another factor that is considered with demand is the utilization of a healthcare facility. Kiwanuka et al. (2008) observed that the poorer households utilized healthcare facilities less because of the cost. The type of health need can also determine the utilization of a healthcare facility (Kitui et al., 2013; Schellenberg et al., 2003).

The concept of a demand area, as associated with healthcare facilities, has been defined by the population within a given catchment area serviced by a healthcare facility (Munoz & Källestål, 2012; Rahman & Smith, 2000; Tanser, 2006). Studies by Guagliardo (2004) and Joseph & Bantock (1982) focus on population density using a population demand factor to spatially adjust where to locate a facility based on the population density of an area. In addition to using population density

as demand, other studies have focused on a health issue of the population in correlation to distance to healthcare facilities such as areas of infant mortality (Becher et al., 2004) or malaria (Beiersmann et al., 2007); these studies were able to examine how distance to a healthcare facility negatively affected the health of the population. Demand can also refer to the severity or potential for healthcare issues in the population. This definition supports that demand should be weighted based on the severity of the health issues and the potential usage of a healthcare facility for a population catchment area. Spatial weights between observations reflect the intensity of the geographic relationship within a certain area (Jerrett et al., 2003). Weighted spatial data for a healthcare facility from health and wealth data can provide important information about the needs of a population.

Spatial analysis has proven to be beneficial for facility site selection. Such applications as location analysis, modeling central themes, locating areas of high demand, spatial weights, distances, and SA can be completed with spatial analysis (Curtin & Church, 2006; Murray, 2010). Spatial analysis provides effective tools for measuring sample data representative of a larger population in a geographic area by performing spatial interpolation (Childs, 2004). Spatial interpolation for studies such as this provides an understanding of spatial health issues in developing countries where data may be sparse or have spatial data holes. Health risk factors, such as malaria, can be given a spatial dimension to help determine spatial patterns of high and low incidences. Spatial cluster analysis can also provide important information for finding statistically significant spatial patterns.

The purpose of this paper is to demonstrate a methodology for locating area demand for a healthcare facility in an administrative boundary by factoring in population density and other factors relative in Burkina Faso including proximity to major road networks, wealth, and health factors. This paper utilizes health data with limited geographic density from a developing country to demonstrate how spatial analysis can be used to identify areas of demand for healthcare facilities. Two exercises presented here examine areas of demand for healthcare facilities in the administrative provinces of Burkina Faso, Africa. The first analysis finds the area of demand for each healthcare facility based solely on population density. This method has common usage in the field of healthcare facility demand location research (Guagliardo, 2004; Langford & Higgs 2006; Munoz & Källestål, 2012; Rahman & Smith, 2000; Tanser, 2006). The second analysis locates an area of demand for a healthcare facility per province based on the population density outputs created from the first analysis and incorporating the additional criteria of local wealth and health factors. Including wealth and health factors in the analysis will help to better estimate the demand of healthcare facilities.

2. Methods

Healthcare facilities can provide education, resources, and preventative measures to protect against diseases, health issues, and provide medical care for communities in need (Robert et al., 2003; World Health Organization[WHO], 2020). Understanding the major health concerns in an area can help find the best location(s) that will serve the greatest portion of the population that is in demand. Spatial analysis methodologies can be utilized to assist as decision support for locating demand site selections. The process described in this section was conducted using Environmental Systems Research Institutes' (ESRI) ArcGIS software suite inclusive of ArcDesktop for the application and geo-visualization of the data. Figure 1 provides an overview of the processes used in this methodology.

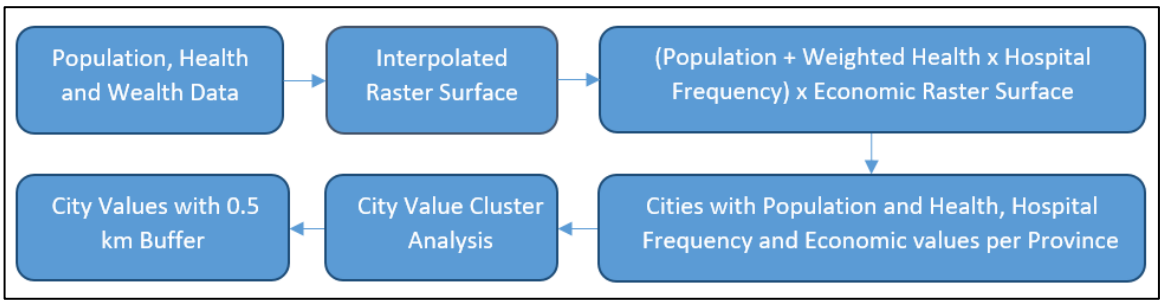

Figure 1. Workflow diagram for locating areas of demand based on the weighted population and health factors.

Burkina Faso has an estimated 19 million inhabitants with approximately 70% of Burkinabé living in rural areas (World Bank, 2015). The country has few medical professionals, with a reported 1 doctor practicing medicine per 1,000 people in the country as of 2010 (IHME, 2010). According to the WHO, Burkina Faso allocated 13% of government expenditures to health care

spending, which represented three percent of the GDP for 2010. Both figures rank low even among African countries (WHO, 2010).

2.1. Data

The Demographic and Health Surveys (DHS) collect a variety of information on the health, well-being and a variety of socioeconomic and cultural characteristics of households in most developing countries. These data provide the most comprehensive and detailed information on individual- and household-level health and well-being throughout the 45 provinces in Burkina Faso. In 2010 the DHS collected over 17,000 surveys for households clustered into 540 spatially referenced locations within Burkina Faso (Figure 2). The DHS data were sampled based on a stratified two-stage cluster design drawing first from census files, and then in each census file, a sample of households was selected (DHS, 2012). Data from households participating in the survey were grouped together into clusters and georeferenced to point locations. The cluster point locations are scattered throughout the country (Figure 2) and are randomly shifted 0–2 km in urban areas, 0–5 km in rural areas, with 1% of rural cluster locations displaced 0–10 km, to protect the privacy of respondents (DHS, 2012).

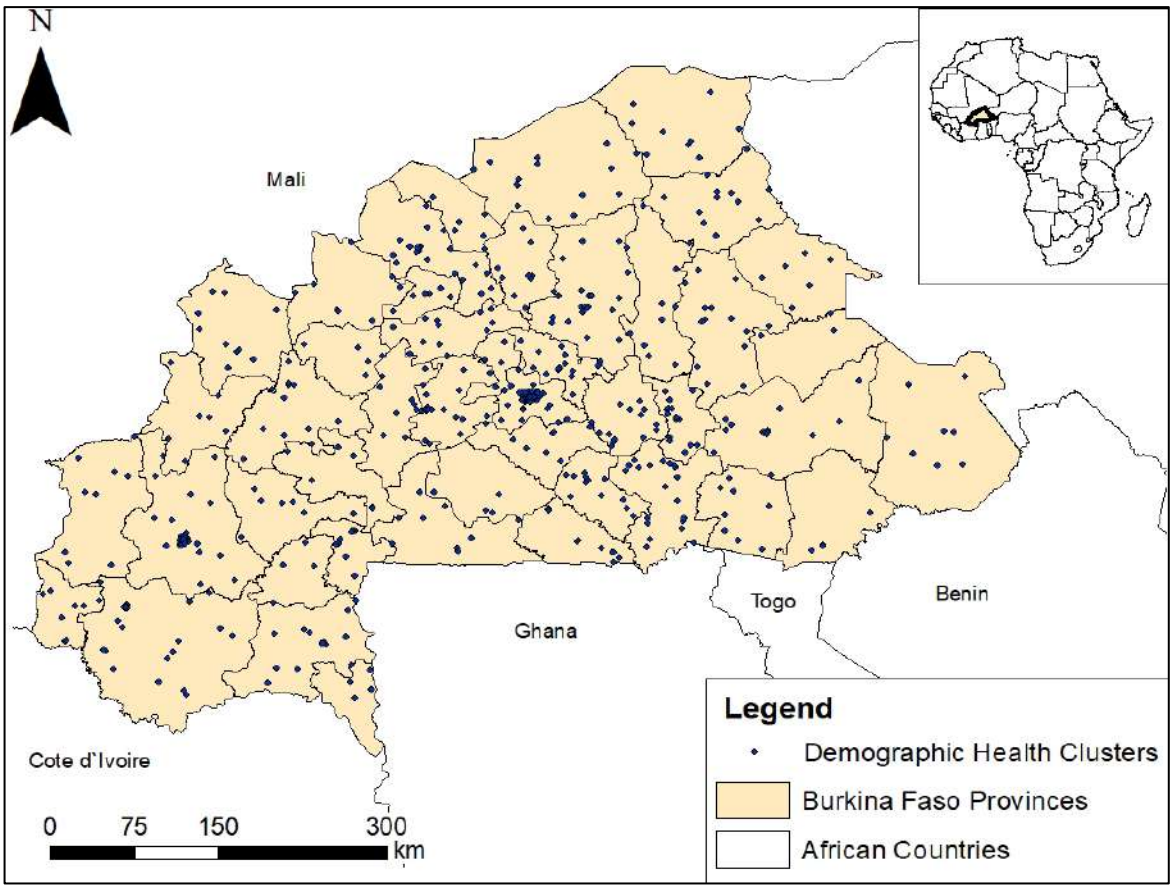

Figure 2. Burkina Faso demographic health cluster locations based on 2010 DHS data.

Factors used in this research to locate area demand per administrative province in Burkina Faso included population density, proximity to major road networks, economic wealth index, birth rate, childhood stunting, and malaria rates. These health risk factors are some of the major indicators of health and preventative care in Burkina Faso and also in Sub-Saharan Africa (SSA) (Kanamori & Pullman, 2013; Lingani et al., 2022; Tessema et al., 2022; World Bank, 2008).

Population density estimates used in this study were extracted from the WorldPop dataset (WorldPop, 2013). WorldPop works with national statistic and remote sensing satellite agencies, ministries of health, and other organizations for the construction of spatially mapped population densities. WorldPop population data is provided as a raster dataset based upon 2010 population estimates using a spatial square grid resolution of 100m.

Access to healthcare facilities in villages near a road network provides the ability for villagers to access a facility and for the provider to facilitate the healthcare facility (Kumar, 2007). Road networks are integral for transport and foot traffic in Burkina Faso (Bigman, 2000). Locations of

health facilities were selected at villages in proximity of roads providing greater access to patients and supplies in the surrounding area. Road network data were available in digital format and applied in this study as a criterion for a demand site selection (World Food Program [WFP], 2016). Road network data have been applied in previous studies of healthcare access in developing countries (Moran et al., 2006; Simarro et al., 2014).

Burkina Faso has a birth rate of 5.87 births per woman as of 2010 (Central Intelligence Agency [CIA], 2010). Developing countries in SSA see a high rate of problems related to maternal health and young children (Diallo et al., 2012). In SSA the maternal mortality ratio is ~500 per 100,000 live births, compared to 16 per 100,000 for developed countries in 2010 (WHO, 2012). Regular prenatal care checkups have shown to reduce complications with women's maternal health and increase the healthiness of children born (Bhutta et al., 2010; Moran et al., 2006; Yimer, 2000).

Malnutrition is a lack of adequate energy, protein, and micronutrients to meet basic requirements for body maintenance, growth, and development (FAO, 2014). Infants and children are most vulnerable to malnutrition because of their high nutritional requirements for growth and development (Blössner & De Onis, 2005). Stunting is often used as an indicator of malnutrition for children; when the natural growth trajectory is negatively impacted due to unmet nutritional and caloric needs (WHO, 2010). The stunting metric is the percentage of children (1–5 years of age) that are < -2 standard deviations below average in a height-for-age standard. Approximately 35% of children are stunted in Burkina Faso (DHS, 2012).

DHS data also capture the rate of malaria occurrence. Malaria is a common disease in SSA spread by mosquitos. The parasitic infectious disease causes the death of approximately 40,000 individuals every year in Burkina Faso (Murray et al., 2012). Malaria is highly endemic but is also highly seasonal in Burkina Faso based on the rainy season or shortly afterward which lasts from June to October (Müller et al, 2001). Malaria can be treated by vaccinations and antimalarial drugs. Many people use home remedies to cure fevers and other symptoms caused by malaria (Beiersmann et al., 2007). Healthcare facilities and healthcare workers provide medicine and treatments such as artemisinin-based combination therapy (ACT) and mosquito-treated nets as preventative measures. Mosquito treated nets play an important role in reducing vector-borne diseases such as malaria, yellow fever, and dengue fever (Hemingway et al., 2006; Odhiambo et al., 2013; Okrah et al., 2002).

The DHS includes survey information on the 'wealth' for each household that is used in this analysis. The 'wealth index' comprises a composite measure of selected assets by the household such as televisions, bicycles, and water access (Rutstein & Johnson, 2004). The wealth index is generated using principal component analysis and is relative to the rural areas in Burkina Faso (DHS, 2012). The wealth index reflects the assets of households and the ability to access healthcare based on transportation. The assets or wealth of households has shown to be significant in determining the utilization of healthcare facilities in multiple health studies (Fagbamigbe et al., 2015; Mugisha et al., 2002; Ononokpono & Odimegwu, 2014). Overall, Burkina Faso has a very low wealth index and is one of the poorest countries in the world (United States Department of Labor [DOL], 2014).

2.2. Interpolation

Interpolation is a method that predicts values of a surface based upon surrounding sample data points and provides a viable option based upon the assumption that spatially distributed objects are correlated (Li & Heap, 2008). DHS survey data was not collected at each of the thousands of villages in Burkina Faso resulting in unknown health and wealth information throughout most areas in Burkina Faso. Wealth and health risk factors were available at 540 geolocated point location values throughout Burkina Faso. The surveys at each clustered location were averaged for each health demand factor allowing an estimation of risk per health demand factor.

Each factor was given a value or percentage based upon survey information collected from household interviews. A wealth index percentage was based upon a composite measure of a household's cumulative living standard. The stunting metric is the percentage of children (1–5 years of age) that are < -2 standard deviations below average in a height-for-age standard. Malaria rate was based on those in the past year having symptoms of malaria. Maternity values were based upon birth rates. Each health factor was scaled as an ordinal measurement from one to three; one representing low rates while three represent high rates based upon Jenks natural breaks optimization classification method.

Due to the nature and distribution of the Burkina Faso dataset, interpolation is a suitable method for deriving a suitability weighted surface composed of the interpolated cell values for the population, wealth and health risk factors. The random shift in the geolocated DHS cluster areas should have little effect on predicting cell values as the offset is minimal and the interpolation method accounts for multiple surrounding values. The factors were interpolated using empirical Bayesian kriging (EBK). EBK is a common geostatistical interpolation algorithm for scattered point data and has been used in multiple DHS data studies (Gemperli et al., 2004; Gosoniu &

Vounatsou, 2010; Gosoniu et al., 2012). The EBK method uses an intrinsic random function accounting for the error introduced by estimating the underlying semivariogram model (Krivoruchko, 2012). The parameters chosen for the EBK model include using a k-Bessel semivariogram model with a maximum search neighborhood parameter of 10. The k-Bessel semivariogram model provides the most accurate way to interpolate data and having a small search neighborhood parameter insured health and wealth values closest to the prediction location have more influence on the predicted value than those farther away (Johnston et al., 2001). These parameters provide a way to identify local trends from the inserted DHS data while providing prediction surfaces from the interpolated values.

2.3. Weighting Values

A weighted value of the interpolated fields was created to define a field identifying the total risk. The weights were adjusted to account for each health demand, hospital frequency, and a wealth index. The first analysis of this paper was to estimate area demand for healthcare facilities based on population density. A population density map scaled from 1 to 6 using the Jenks optimization method (Jenks, 1967) was used, reducing the variance within classes and maximizing the variance between classes. The second analysis also factored in population density and included health demand variables, hospital frequency related to each health variable and wealth.

Each health factor was set to a scale value (1–3) based upon severity at each DHS cluster location. The health factors were then multiplied by the weighted frequency of survey applicants with a health risk factor accessing care in a healthcare facility based on DHS surveys collected in 2010 (DHS, 2012; Rutstein & Rojas, 2006). Each scaled demand factor was multiplied by the frequency of patients attending healthcare facilities as an approximation of healthcare facility usage recorded by DHS data (DHS, 2012). This information was collected from DHS data and literature based in SSA (Table 1). Malaria patients were those who went to a doctor to receive antimalarial treatments (DHS, 2012).

Table 1. List of demand variables and weighted frequency used as an approximation of usage of healthcare facilities for each demand variable in Burkina Faso.

Demand Variable	Weighted Frequency
Malaria	0.8
Stunting	0.67
Maternity	0.8
Wealth Index	1–0.75

Approximately two-thirds of children suffering from stunting in households seek medical attention (DHS, 2012). A maternity frequency of 0.8 refers to 80% of women who gave birth in a healthcare facility (DHS, 2012). A wealth index frequency was multiplied by the health risk factors; poorer households have been shown to attend healthcare facilities less frequently (~25%) than wealthier households (DHS, 2012).

The economic and health factor raster cells were added to the population density weighted raster value cells for all areas in Burkina Faso. The second analysis in this paper included the demand factors in the analysis and the equation is as follows:

$$D_{hi} = (D_{pi} + (\sum(H_{wi} * H_{ui}) / (\sum_i H_i))) * E_i \quad (1)$$

Where i is each individual cell value, H_i is each health factor, H_{wi} is the weight of each health value at each raster cell location, H_u is the frequency or utilization of each health demand of likelihood of using a healthcare facility, E_i is the economic wealth index for each location and D_{pi} is the population density demand from the results of the first analysis. An example of this equation is given for the village of Bondoukuy in the Mouhoun province in Table 2. This village has high stunting but a low wealth index. The village will be evaluated with the other villages in the Mouhoun province providing a weighted demand area for a healthcare facility.

Table 2. A demonstration of how population, health and wealth weighted values were assigned for the city of Bondouky, Mouhoun.

Bondoukuy, Mouhoun	Potential Values	Actual Wealth and Health Values	Frequency to hospitals	Health x Frequency Value	Value
Population	1–6	3			3
Stunting	1–3	3	0.67	2.01	2.01
Maternity	1–3	1	0.67	0.67	0.67
Malaria	1–3	2	0.8	1.6	1.6
Wealth Index	0.75–1	.75			0.75
Sum of Health Factors Weighted					4.28
Average of Health Factors					1.42
Sum of Population and Health Factors					4.42
Combined Population and Health Factors multiplied by Wealth Index					3.32

2.4. Identifying Village Values

To narrow the demand site location potential, locations of villages that fell along the road network were selected as a criterion as well. The road network data for Burkina Faso is extensive for a developing country. A road distance buffer of 0.5 km was created to narrow locational access to villages. This level of data made the analysis process easier to narrow potential healthcare demand site locations as villages within the 0.5 km distance were used as a criterion.

Villages situated in proximity to the road network each had a weight based upon population density, wealth, and health factors. Multiple villages with equally high values in each province prompted a further refinement of demand site locations. A cluster analysis using Getis-Ord Gi* statistic was applied to the village locations in each of the 45 administrative provinces to geographically identify a cluster of highest weighted demand site locations.

2.5. Getis-Ord Cluster Analysis

The population density single layer contiguous surface combined with the weighted wealth and health factor surfaces provide a way to identify areas of greatest demand based on the criteria in this paper. The calculated raster layers were then converted to geographic vector features. The vector features were then localized as weighted vector data within administrative provinces. The intersection of village data points and the newly created weighted vector polygons provided a new potential area demand site selection that identified weights with villages falling along the road network. The point data were further analyzed statistically for spatial clustering of the highest weighted locations using the Getis-Ord Gi* statistic using an inverse distance spatial relationship between points. Essentially the statistic identifies the greatest weighted points clustered in a region of each province. Getis-Ord is a spatial clustering statistic tool employed in spatial analysis as a pattern recognition tool (Chaney & Rojas-Guyler, 2016). The Getis-Ord z-score values per village displayed clustering of high demand locations where the population, wealth, and health risk factors were high. Criteria data utilized in the analysis identified each cluster point of high weight as a potential demand area for a healthcare facility. Each village along the buffer road was identified with its weighted cell output. The highest clustered cells included areas that were high in population, malaria rate, childhood stunting, and birthrate while having a high wealth index.

2.6. Weighted Measurement Tools

The Getis-Ord cluster analysis provided spatial locations of high clustering weighted points for demand site locations. Numerous clusters with statistically significant point locations were available to choose from among the final demand site choices in each province. Rather than a random selection or stopping the demand site selection process at this juncture, a Central Feature analysis using a Euclidean distance method identified a central point location within each high-value cluster dataset. Distances from each location to every other location in the province were calculated

and summed. The location associated with the shortest cumulative distance to all other locations was selected as the central weighted feature. The highest weighted points captured the intersection of population density and the economic wealth and health weighted factors. The results of this process provided the most central, highest weighted demand site point for each province.

The directional distribution is another way to measure the spatial trends in the distribution and weight of demand. The directional distribution calculates the geographic dispersion and directional trend of weighted locations within a given area. The method calculates the deviation of the x- and y-coordinates from the weighted mean center to define the axis of an ellipse. The measurement provides information on the concentration of demand through the province and the general trend of direction and shape of demand by creating a spatial ellipse covering one standard deviation, capturing approximately 68% of the weighted features. The directional weighted distribution in this analysis was able to examine the clustering of demand areas within each province by providing the spatial breadth of clustering demand of weighted locations and also the trend of direction for demand in each province.

3. Results

The inclusion of economic wealth and health factors with the population density impacted the resulting demand area site selection for many of the provinces in Burkina Faso. The Getis-Ord spatial statistic analyzed the local sum for each weighted demand village location and its neighboring weighted villages were proportionally compared to the sum of all features to find areas where population and health demand areas are the highest. Differences of significant clustered areas represented areas where Getis-Ord z-score values were significantly high compared to the proportional sum of all the villages in the province. The clustering of high z-scores using the Getis-Ord statistic provided statistically significant areas of villages where population and health risk factors are the highest in each province. The wealth and health factors resulted in percent change of 50.5% variation in scale values for 95% of the cities in each province compared to using only population data. Approximately 71% of the provinces had a change in central demand location from using only population to including wealth and health factors (Figure 3). The average distance of the health risk central feature from the population demand site was ~17 km. Most of the outcomes including the health factors displayed only a small shift to a neighboring village location from the population demand area.

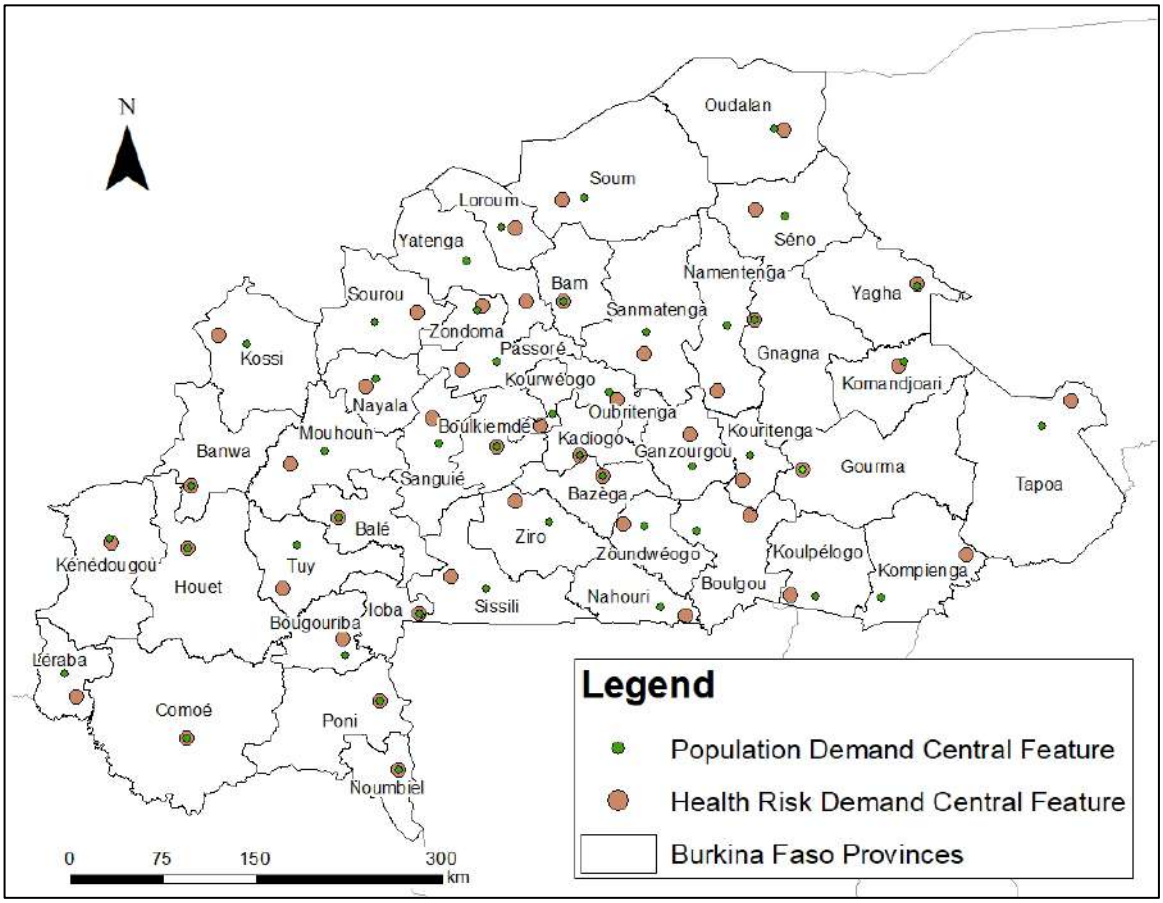

Figure 3. Central feature spatial distributions of population demand and areas that include health risk factors for provinces in Burkina Faso.

The example in the Mouhoun province in Figure 4 shows significant clustering for both population and health risk factors demand in the east of the province. Wealth and health risk factors with population further influenced demand in the Mouhoun province. Including wealth and health risk factors increased the areas of low/high clustering Getis-Ord statistical z-score ranges from -2.72-2.79 to -3.51-2.86. Including health risk factors for demand also affected the weighted directional distribution of data. In the example of the Mouhoun province, the spatial standard deviation of the distribution increased due to including areas of lower population density but high health demands. The variance of the directional distribution varied for each province and allowed the ability to quantify the spatial standard deviation and directional of demand for population and the inclusion of wealth and health factors in this analysis.

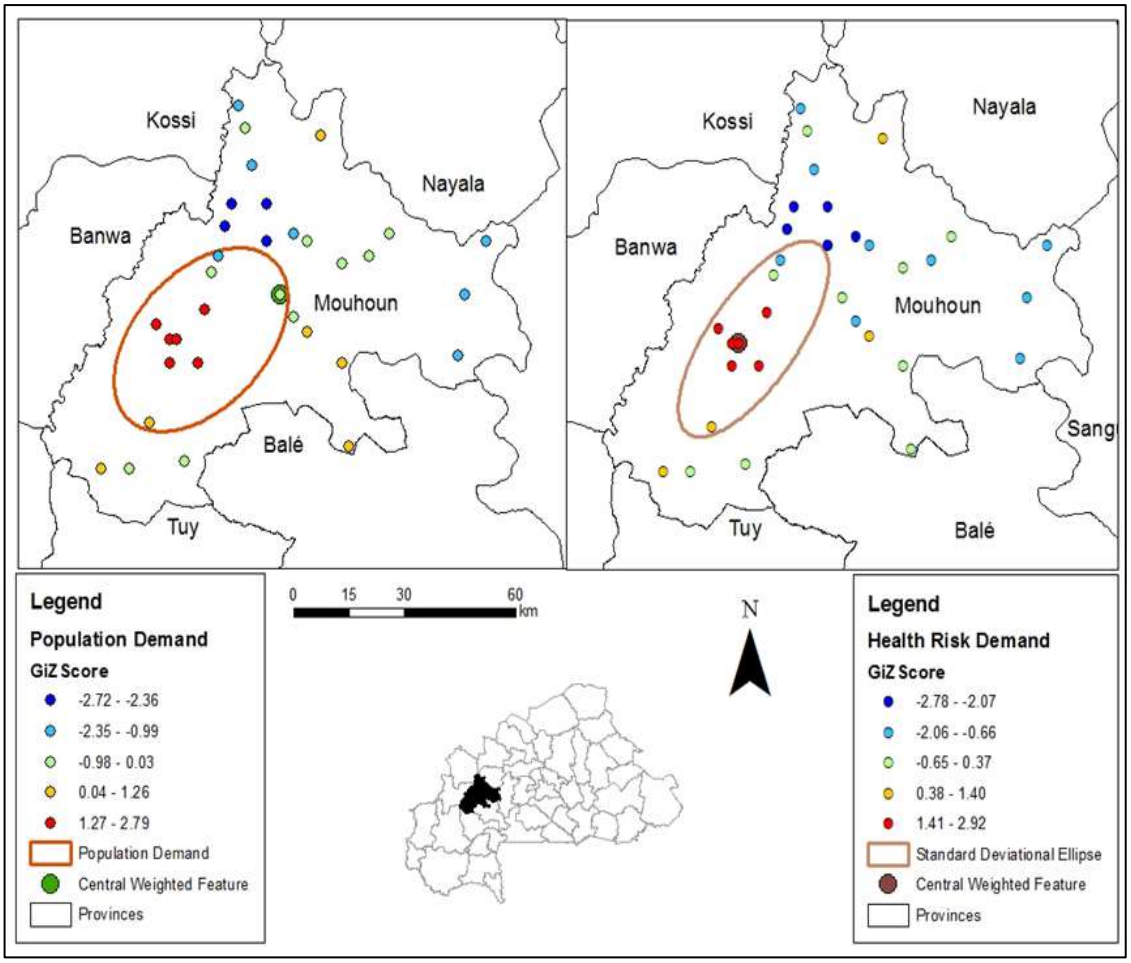

Figure 4. Comparison of population demand distribution areas (left) and areas that include wealth and health risk factors (right) in Mouhoun Province.

Demand based on population and health risk factors varied throughout Burkina Faso in each province. The three health risk factors and wealth index used for this analysis proved to be influential in locating areas of demand for healthcare facilities. The highest rates of demand based only on health risk factors were found in three main clusters located in the northern central provinces, southeast provinces and in the southwest provinces. Overall, low economic wealth and health values were found on the edges of the country while higher economic wealth and health risk values were prevalent around Ouagadougou, the capital city of Burkina Faso located in the center of the country.

Using multiple factors besides population that were included in this analysis drastically changed the demand area in a geographical region. Health factors had a greater influence in locating demand in areas of homogenous population. Including wealth and health risk factors in the methodology provided a more serviceable way to allow the disadvantaged population to access to healthcare facilities.

4. Discussion

This study considered multiple factors including population density, wealth, and health indicators to identify areas of high demand for healthcare facilities in rural Burkina Faso. The data utilized in this study can be obtained and applied, using the same methodologies outlined here, for many developing countries. A challenge for researchers and healthcare workers attempting to locate healthcare facilities in developing countries is accessing spatial data related to health and development for decision support. Few data are available on locations of current healthcare facilities in Burkina Faso. Including locations of current healthcare facilities would likely improve estimation of unmet demand in our analysis.

One concern for locating areas of demand is how to aggregate geographic data which will change where demand locations should be located. In this study, there were different types of administrative boundaries that could have been used to find the best representative location for

healthcare facilities. Provinces were selected as they represent generally similar lifestyles, agricultural use, and ethnicity. The methods used in this study can easily be related to any administrative boundary as well as siting multiple healthcare facilities needed within a certain area.

Using the weights based on the percentage of those who were at risk and the probability of someone with a health risk using a healthcare facility in this paper was believed to be an effective way of balancing the demand of population with wealth and health factors. In the example of Mouhoun province, the wealth and health factors for 95% of the cities (2 standard deviations) caused approximately a percent change of 50.5% change in scale value from the average mean when added with the population scale values. The inclusion of weighted economic wealth and health factors caused the area of demand to shift from its original location in the first analysis only using population. The results indicate that even small changes when factoring spatial weights when locating a healthcare facility can cause a spatial displacement in population area demand.

The methodology used in this paper for this study area provided a greater in-depth understanding pertaining to how weighted factors can influence a health demand area. The spatial weights provided a displacement of area demand based solely on population throughout Burkina Faso, but more particularly in the outskirt provinces of the country. Areas of high stunting in the eastern provinces and in pockets throughout the country were prevalent in causing a change in demand area. The spatial pattern of malaria based on DHS survey data in 2010 was severe in the southern areas of the country where precipitation is more abundant and also around bodies of water where there is a greater chance to be bitten by malaria-infected anopheles mosquitos (Karthe et al., 2012).

Different factors may be used based on the specific needs of a country or administrative boundary, and the severity of different health issues will likely differ by region. Education levels have shown to be an important socioeconomic factor in relation to overall health and use healthcare facilities (Fotso, 2007; Heck & Parker, 2002), however in this rural study area, there is little formal education. Similar methods can be used to understand the spatial accessibility of urban areas for both developed and undeveloped countries. Census tracts with health data available on the population in developed countries or urban areas can assist health planners in understanding the distribution of health risks and can be used to locate facilities to assist disadvantaged populations. A growing factor in this region is caring for the aging population and fulfilling specialized medical services and long-term care for the elderly but was beyond the scope of this paper.

5. Conclusion

Geographic analysis is a widespread tool used for many decision support scenarios. Methods outlined in this report demonstrate a technique to determine health-related demand locations with limited information. The inclusion of economic wealth and health factors with the population density impacted the resulting demand site selection for many of the provinces in Burkina Faso. Demand for healthcare facilities was altered from the first analysis to the second analysis for each province in this chapter where the population of villages were homogenous and could be influenced based on weighted economic wealth and health factors. Understanding the spatial accessibility is an important facet to consider when locating and allocating healthcare facilities. The information used in this analysis is publicly available data from open-source GIS data outlets. The ability for healthcare planners to weigh factors that were once thought to be nonspatial with the use of GIScience can be supportive in assisting the disadvantaged population receive healthcare needs to live healthier lives.

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Data Availability Statement: Publicly available datasets were analyzed in this study. This data can be found here: http://dhsprogram.com/What-We-Do/Survey-Types/DHS-Methodology.cfm and https://www.worldpop.org.uk.

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(3) Smart agriculture, rural e-commerce and digital governance.

(4) Understanding and analysis of contemporary agricultural, rural and farmers' issues and policies (Chinese/domestic and global), as broadly defined by the disciplines of economics, sociology, human geography and cognate subjects.

(5) Other related novel sciences and technologies with agricultural and rural perspectives.

3. Article Types

A&R seeks to publish perspective, review, original research and commentary articles.

3.1 **Perspective** Article

Perspective articles provide a forum for authors to discuss models and ideas from a personal viewpoint. Perspectives typically range from 2,000 to 4,000 words (including the abstract, references, and figures). They should consist of (1) a short, pithy title; (2) an abstract (max. 250 words); (3) references (max. 35 items); and (4) up to two figures or tables.

3.2 **Review** Article

Review Articles are overviews of a specific field of scientific literature. They aim to synthesise and evaluate recent primary literature on a topic, address controversies or provide a comprehensive list of references. Review Articles should not exceed 10,000 words (excluding references) with up to 100 references.

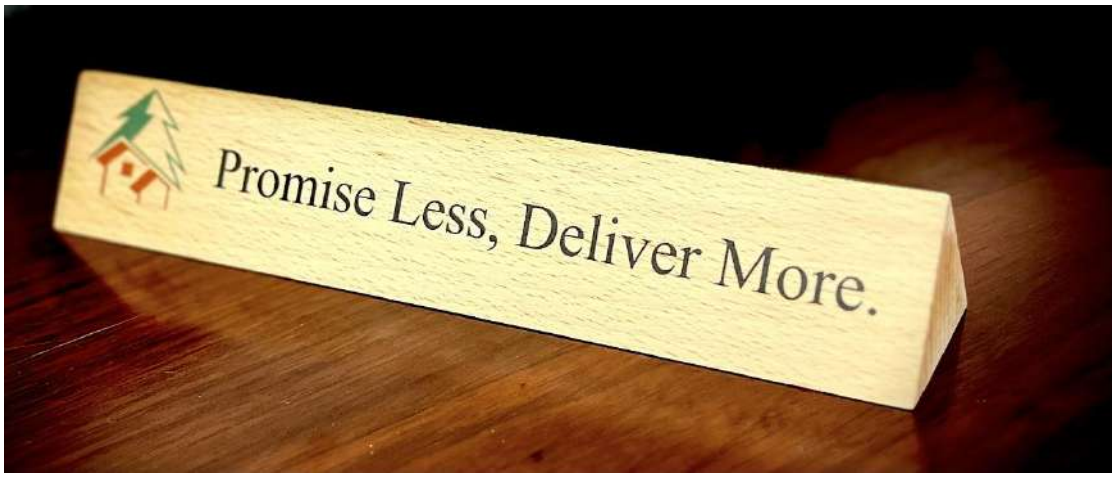
3.3 **Original Research** Article

Original/Research Articles are full-length scientific publications of original (i.e., unpublished) research. They should not exceed 8,000 words (excluding references) and a maximum of 12 images. Research articles over 8,000 words will only be accepted subject to Editorial decisions on needing a lengthier publication.

3.4 **Commentary** Article

Commentaries are short, narrowly focused articles of contemporary interest, usually commissioned by journal editors, serving as science critiques. They can discuss a variety of topics: (1) previous research published in scientific journals and/or scholarly books; (2) current research trends; (3) emerging empirical phenomena and issues; and (4) policies on relevant agriculture, rural areas and farming/farmers-related topics. They should not exceed 1,000 words, with a maximum of 10 references (no figures or tables).

If you have unpublished papers in hand, please feel free to submit your manuscripts on-line: www.sccpress.com



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