

**Landholding, Cropping Intensity, and Household Food Security
in the Middle Hills of Nepal: A Case Study of Mandandeupur
Municipality, Kavrepalanchok**

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Abstract

Background: Agriculture remains the primary livelihood source in Nepal, particularly in the middle hill region where household food security is closely linked to landholding characteristics and agricultural productivity. Understanding the factors influencing food sufficiency is essential for designing effective food security interventions.

Methods: This study examined the relationship between household food sufficiency and landholding size, land fragmentation, family size, farming intensity, and agricultural productivity in Mandandeupur Municipality, Kavrepalanchok District, Nepal. Primary data were collected from 391 households through a structured questionnaire survey, complemented by focus group discussions and key informant interviews. Secondary data were used for validation and contextual analysis.

Results: The findings revealed that small and fragmented landholdings significantly contribute to lower agricultural productivity and household food deficits. The average household food sufficiency in the municipality was 9.69 months per year, indicating a moderately food-secure condition. Household food sufficiency was positively associated with landholding size, farming intensity, and agricultural productivity, whereas larger family size and land fragmentation negatively affected food availability.

Conclusion: Improving household food security in Nepal's middle hills requires agricultural modernization, irrigation expansion, access to improved seeds, and land consolidation measures that enhance farm productivity and operational efficiency.

Novelty: This study provides empirical evidence on the combined influence of landholding size, land fragmentation, family size, farming intensity, and agricultural productivity on household food sufficiency in Nepal's middle hill farming system using household-level primary data.

Keywords: Household food sufficiency, land fragmentation, agricultural productivity, land consolidation, smallholder farming

1. Introduction

1.1 Background

Food insecurity remains a major global challenge, particularly in developing countries where agriculture serves as the primary source of livelihood and food production. Despite significant advances in agricultural technology and production systems, a substantial proportion of the global population continues to experience moderate to severe food insecurity ([Özçatalbaş et al., 2020](#)). The growing global population is expected to substantially increase food demand, requiring agricultural production to nearly double by 2050 to ensure adequate food availability ([Ray et al., 2013](#)). Achieving this goal is becoming increasingly challenging due to limited agricultural land resources, environmental degradation, climate change, and rapid urbanization ([Hobbs, 2007](#)).

Sustainable agricultural land management has become a critical component of global food security strategies. Among the major issues affecting agricultural productivity are land fragmentation and the declining size of agricultural holdings. Land fragmentation often results in small and spatially dispersed parcels, reducing operational efficiency, increasing production costs, limiting mechanization, and constraining agricultural investment ([Ntihinyurwa et al., 2021](#)). Furthermore, there is growing interest among farmers in obtaining government support for semi-commercial agriculture with improved access to land and productive resources ([Khatri](#)

[et al., 2023](#)). In contrast, land consolidation is widely recognized as an important land management approach that can improve farm efficiency, increase agricultural productivity, and support sustainable agricultural development. Consequently, policymakers worldwide continue to debate the relative merits of land consolidation and land fragmentation management strategies in addressing food security challenges.

Globally, smallholder and family farmers contribute significantly to food production. According to the Food and Agriculture Organization ([FAO, 2017](#)), small-scale farmers produce a substantial share of the food consumed in Asia and Sub-Saharan Africa. However, increasing pressure on agricultural land resulting from population growth, urban expansion, and competing land uses has intensified concerns regarding agricultural productivity and food security ([FAO, 2019](#)). In many developing countries, agricultural land is increasingly being converted to other land-use categories, while farmland abandonment is becoming more common. In Nepal, national land-cover assessments indicate that forest cover has expanded, whereas agricultural land has declined, partly due to farmland abandonment and land-use change, thereby affecting agricultural production and food availability ([Rai et al., 2023](#)). Sustainable land management practices, including improved land-use planning, efficient resource utilization, and enhanced agricultural productivity, are therefore essential for ensuring future food security without compromising environmental sustainability ([Branca et al., 2013](#)). In Nepal, agriculture remains the backbone of the rural economy and continues to support the livelihoods of a large proportion of the population. However, food insecurity remains a persistent challenge, particularly in the middle-mountain region, where agricultural production is constrained by fragmented landholdings, limited irrigation facilities, low levels of mechanization, and difficult topographic conditions. Recent studies indicate that approximately half of Nepalese households experience some degree of food insecurity ([Bhandari, 2022](#)). Agricultural land fragmentation has increased over time due to inheritance practices, population pressure, and the continued subdivision of land parcels, reducing farm productivity and limiting opportunities for agricultural modernization ([Paudel et al., 2013](#)). Similarly, a study examining land use and land cover change in the Bagmati River Basin between 1998 and 2018 reported a 247.5% increase in urban areas and a 109.5% increase in barren land, accompanied by a decline in agricultural land. These changes pose significant challenges to agricultural production and highlight the need for effective conservation and management of agricultural land resources to support food production ([Rijal et al., 2021](#)).

The middle-hill farming system of Nepal is characterized by small and fragmented landholdings, diverse cropping patterns, and a strong dependence on subsistence agriculture. Household food sufficiency in these areas is influenced by several interconnected factors, including landholding size, land fragmentation, cropping intensity, agricultural productivity, and family size. Larger landholdings generally provide greater opportunities for agricultural production, whereas fragmented holdings may reduce production efficiency and increase cultivation costs. Similarly, higher cropping intensity and agricultural productivity can improve food availability, while larger household sizes may increase food demand and place additional pressure on available resources. Understanding the relationships among these factors is

essential for designing effective policies aimed at improving household food security and promoting sustainable agricultural development in Nepal's middle-hill region.

1.2 Research Gap and Rationale

Although numerous studies have examined food security, agricultural productivity, and land fragmentation in Nepal, limited empirical research has investigated the combined influence of landholding size, land fragmentation, cropping intensity, family size, and agricultural productivity on household food sufficiency at the local level. Most existing studies focus either on national-level trends or on individual determinants of food security, providing limited insight into how these factors interact within middle mountain farming systems.

Furthermore, recent changes in agricultural landholding patterns, demographic characteristics, and farming practices highlight the need for updated evidence to support policy formulation and land management interventions. Mandandepur Municipality represents a typical middle hill agricultural landscape characterized by fragmented landholdings and subsistence-oriented farming systems. Therefore, examining the determinants of household food sufficiency in this area can provide valuable insights for improving food security and agricultural sustainability in Nepal's middle mountain region.

1.3 Research Objectives

The main objective of this study is to examine the relationship between landholding characteristics and household food sufficiency in Mandandepur Municipality of Kavrepalanchok District, Nepal. The specific objectives are:

- To analyze the relationship between landholding characteristics and household food sufficiency in Mandandepur Municipality.
- To examine the effects of cropping intensity, land productivity, family size, and land fragmentation on household food sufficiency.
- To assess the potential role of land consolidation and agricultural modernization in improving food security in the middle mountain region of Nepal.

2. Literature review

2.1 Landholding Pattern and Land Fragmentation

Landholding size and land fragmentation are important determinants of agricultural productivity and household food security in developing countries. Land fragmentation refers to the division of agricultural land into multiple small and spatially dispersed parcels, often resulting from inheritance practices, population growth, and socio-economic factors. Fragmented landholdings increase production costs, reduce operational efficiency, limit mechanization, and constrain agricultural investment, ultimately affecting farm productivity and household welfare ([Ntihinyurwa et al., 2021](#)).

In Nepal, land fragmentation has increased considerably over the past decade. According to the Agricultural Census 2021/22, the total number of agricultural parcels increased from 9.52 million in 2011/12 to 12.10 million in 2021/22, while the average parcel size decreased from 0.21 ha to 0.19 ha (National Statistics Office [NSO], 2023). The predominance of small and

fragmented landholdings has become a major challenge to agricultural modernization and efficient land management. Previous studies have reported that fragmented landholdings negatively affect crop productivity, increase labor requirements, and reduce farm profitability, thereby contributing to household food insecurity ([Ntihinurwa et al., 2021](#); [Paudel et al., 2013](#)).

Farmland abandonment has emerged as a significant characteristic of Nepalese agriculture, particularly in the hilly and mountainous regions. This phenomenon affects local communities and society as a whole through reduced production of agricultural goods such as food, feed, and fiber ([Chaudhary et al., 2020](#)).

A study on land use/land cover change and land fragmentation in Nepal found that substantial land-use transitions occurred between 2001 and 2020, particularly involving conversions between forestland and cropland. The study further highlighted that land fragmentation remains a serious issue and emphasized the need for sustainable land management practices to meet the growing demand for food. The authors recommended the implementation of appropriate land-use policies, community forest management programs, agricultural land consolidation, and measures to reduce parcel fragmentation, especially in urban and peri-urban areas ([Ning et al., 2023](#)).

Land consolidation has been widely promoted as a strategy to improve agricultural efficiency and enhance food production. By reducing parcel fragmentation and increasing operational farm size, land consolidation can facilitate mechanization, improve irrigation management, and support the adoption of modern agricultural technologies. Consequently, understanding the relationship between landholding structure and food sufficiency remains an important area of research in Nepal's middle-hill farming systems.

2.2 Cropping Intensity and Agricultural Productivity

Cropping intensity refers to the ratio of total cropped area to net cultivated area during a given period and is commonly used as an indicator of agricultural land-use efficiency. In countries with limited arable land resources, increasing cropping intensity is often regarded as an effective strategy for enhancing agricultural production and improving food security ([Paudel et al., 2017](#)).

Crop intensification is considered one of the most effective approaches for increasing agricultural production and strengthening food security. A study conducted in Nawalparasi District found that farmers practice multiple cropping systems on the same plot and adopt improved crop varieties to increase agricultural output ([Dhakal, 2022](#)).

Agricultural productivity and cropping intensity are influenced by several factors, including irrigation availability, soil fertility, climatic conditions, market access, labor availability, and technological inputs. Recent studies have highlighted that climate variability and environmental degradation adversely affect agricultural productivity, particularly in developing countries where farming systems are highly dependent on natural resources ([Andrianarimanana et al., 2023](#)). Climate change has emerged as a significant challenge to food production systems by altering rainfall patterns, increasing the frequency of extreme weather events, and reducing crop yields ([Bhattarai et al., 2025](#)).

Similarly, a study conducted in Kaski District, Nepal, found that a significant proportion of agricultural land is cultivated only once per year and remains fallow during another cropping season. The study emphasized that increasing cropping intensity can play a vital role in enhancing agricultural production and reducing the risk of future food insecurity ([Mishra et al., 2023](#)).

In Nepal, higher cropping intensity has been associated with improved household food availability and increased agricultural income. However, achieving higher cropping intensity remains challenging in many middle-hill areas due to limited irrigation infrastructure, fragmented landholdings, labor shortages, and poor market accessibility. Therefore, enhancing cropping intensity through improved agricultural practices and infrastructure development is considered an important pathway for improving household food sufficiency.

2.3 Food Security and Household Food Sufficiency

Food security is a multidimensional concept that extends beyond food production alone. According to widely accepted definitions, food security exists when all people have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Consequently, food security encompasses not only food availability but also food access, utilization, and stability ([Fischer et al., 2014](#)).

The continuous growth of the global population and changing consumption patterns are expected to substantially increase food demand in the coming decades ([Godfray et al., 2010](#)). As a result, food security has become a critical development issue requiring integrated approaches that address agricultural, economic, environmental, and social dimensions ([Karunasagar et al., 2016](#)).

Food security conditions vary considerably across households in Nepal. Research conducted in the Kaligandaki Basin revealed that small-scale food-producing households often cannot meet their food requirements through their own production and therefore depend on markets to supplement their food needs ([Pandey & Bardsley, 2019](#)).

Food insecurity remains a major challenge in Nepal despite agriculture being the primary source of livelihood for a large proportion of the population. The Constitution of Nepal recognizes food sovereignty as a fundamental right ([Nepal Law Commission \[NLC\], 2015](#)). However, food security continues to be affected by low agricultural productivity, climate change, land fragmentation, population pressure, and socio-economic inequalities ([Koirala et al., 2024](#)). Nepalese agriculture is largely characterized by smallholder and subsistence-oriented farming systems, making rural households particularly vulnerable to food shortages and production shocks ([Bista et al., 2013](#)).

Household food sufficiency is widely used as an indicator of rural food security in Nepal because it reflects the ability of households to meet their annual food requirements from their own agricultural production and available resources ([Dahal et al., 2009](#)). Previous studies have shown that household food sufficiency is strongly associated with landholding size, agricultural productivity, family size, access to irrigation, and farm management practices. Therefore, examining these relationships is essential for understanding the determinants of food security in Nepal's middle-mountain farming systems.

2.4 Conceptual Relationship Between Landholding Characteristics and Household Food Sufficiency

The existing literature suggests that household food sufficiency is influenced by multiple interconnected factors. Larger landholdings generally provide greater opportunities for agricultural production, whereas land fragmentation can reduce operational efficiency and increase production costs. Similarly, higher cropping intensity and agricultural productivity contribute positively to food availability, while larger household sizes increase food demand and may reduce food sufficiency if agricultural output does not increase proportionately.

Based on these relationships, this study conceptualizes household food sufficiency as a function of landholding size, land fragmentation, cropping intensity, agricultural productivity, and family size. Understanding the interactions among these factors provides an important basis for developing policies aimed at improving food security and promoting sustainable agricultural development in Nepal's middle-mountain region.

3. Methodology

3.1 Study area:

The study area, as shown in Figure 1, is Mandandeupur Municipality in Kavrepalanchok District, Nepal. The municipality is located at a moderate distance from the district headquarters but remains economically active, primarily through agriculture and local market-based livelihoods. It covers an area of 89 km² and has a total population of 30,381 distributed across 7,924 households (NSO, 2023a).

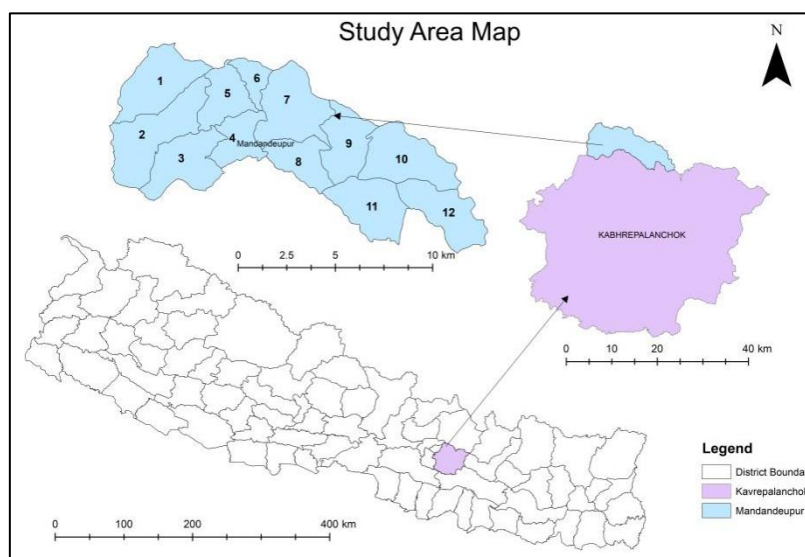


Figure 1: Study Area Map of Mandandeupur

3.2 Data Sources

The study is based on both primary and secondary data sources. Primary quantitative data were collected through a structured household questionnaire survey administered to 391 households selected using a stratified random sampling technique. Stratification was carried out based on

covering majority of wards to ensure spatial and socio-economic representation across the municipality. The spatial distribution of sampled households is presented in Figure 2.

Qualitative data were collected to complement and validate the quantitative findings. A total of four Focus Group Discussions (FGDs) were conducted with community members representing smallholder farmers, marginal landholders, and mixed farming households. Each FGD included 6–8 participants, ensuring diversity in age, gender, and landholding size. In addition, six Key Informant Interviews (KIIs) were conducted with local stakeholders, including agricultural extension officers, elected local representatives, and community leaders. Each interview lasted approximately 45–60 minutes.

The qualitative data were analyzed using thematic analysis, focusing on recurring themes such as land fragmentation, agricultural productivity constraints, and household food security dynamics.

Secondary data were obtained from official publications, including policy documents and statistical reports of the Government of Nepal. Peer-reviewed journal articles accessed through academic databases were used to develop the theoretical and analytical framework of the study. The key variables used in the study include family size (number of household members), number of land parcels per holding, total landholding area (hectares), cropping intensity (number of major crops per year), and land productivity (categorical scale from “not good” to “very good”) as independent variables. Household food sufficiency (measured in months) is used as the dependent variable.

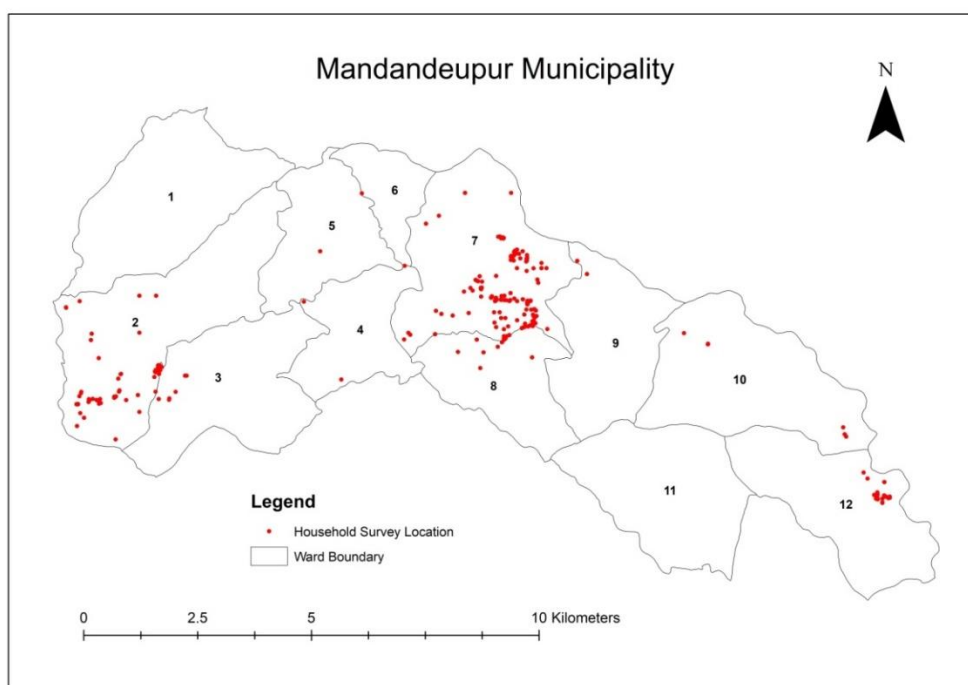


Figure 2 : Map of Household Survey Location

3.3 Analytical approach

The study employed descriptive statistical analysis along with correlation and multiple regression techniques to examine the relationship between household food sufficiency and selected explanatory variables, including land productivity, landholding area, number of land parcels, and family size. The Gini coefficient is calculated for analysis of inequality in land holding pattern of the study area. Prior to analysis, categorical variables were converted into ordinal numerical scales to enable statistical modeling. This approach follows standard practice in socio-economic and land management studies, where ordinal coding is used to quantify ranked qualitative responses for regression analysis.

Land productivity was coded as: Not Good = 1, Ok = 2, Good = 3, and Very Good = 4, representing increasing levels of agricultural output potential and land quality. Household food sufficiency was measured in months; however, values exceeding 12 months were capped at 15 to reduce the influence of extreme outliers based on the sufficiency measure is at 3 months interval and improve model stability.

The number of land parcels was coded in reverse order to represent the degree of land fragmentation, as greater fragmentation is generally associated with lower agricultural efficiency. Accordingly, households with 12 parcels were assigned a value of 1, 11 parcels a value of 2, 10 parcels a value of 3, and so on, with a single parcel assigned a value of 12. This reverse coding allows higher values to represent less fragmented landholdings, which are expected to be associated with greater farming efficiency and higher agricultural production.

Similarly, family size was included as an indicator of household population. Larger households are generally associated with higher consumption requirements, which may reduce per capita food availability. However, they may also provide a larger family labor force, thereby reducing the need for hired labor and lowering labour costs.

These transformations were applied to ensure comparability across variables and to align with established approaches in rural livelihood and food security research. The regression results were interpreted with consideration of these ordinal transformations and their theoretical implications.

4. Results

The household data analysis is presented under thematic sections covering demographic characteristics, landholding patterns, agricultural productivity, cropping intensity, food sufficiency, and statistical relationships between variables.

4.1 Demographic and Landholding Characteristics

The landholding pattern of the study area indicates that agriculture is predominantly characterized by small and fragmented farms. A majority of households (65.22%) own less than 0.5 ha of agricultural land. Among them, 35.81% possess between 0.25 and 0.5 ha, while 29.41% own less than 0.25 ha. This distribution reflects the dominance of subsistence-oriented farming systems and limited opportunities for commercial agricultural production.

Furthermore, 26.60% of households own between 0.5 and 1.0 ha of land, whereas only 8.18% possess more than 1 ha. The findings highlight the prevalence of small and fragmented landholdings, which may constrain agricultural productivity and household food sufficiency. The distribution of landholding size is presented in Table 1.

Table 1: Land holding pattern of study area

Area	No of household	Household %
<0.25 ha	115	29.41
0.25 to <0.5 ha	140	35.81
0.5 to <1 ha	104	26.60
>1 ha	32	8.18

The average landholding size was 0.451 ha with a standard deviation of 0.329 ha, indicating moderate variation among households. Landholding sizes ranged from 0.019 ha to 1.841 ha. The mean household size was six members, varying from one to twenty-four members. Similarly, the average number of land parcels per household was 3.4, indicating considerable land fragmentation within the municipality. Descriptive statistics of household characteristics are presented in Table 2.

Table 2: Descriptive Statistics of Household Characteristics

Statistics	Area (ha)	Family member	No of parcels
Mean	0.4511	6.0	3.4
SD	0.3294	3.2	1.9
Minimum	0.0191	1	1
Maximum	1.8410	24	12
Mode	0.3561	4	2

The land holding inequality in the study area is plotted in Figure 3 and calculated as below;

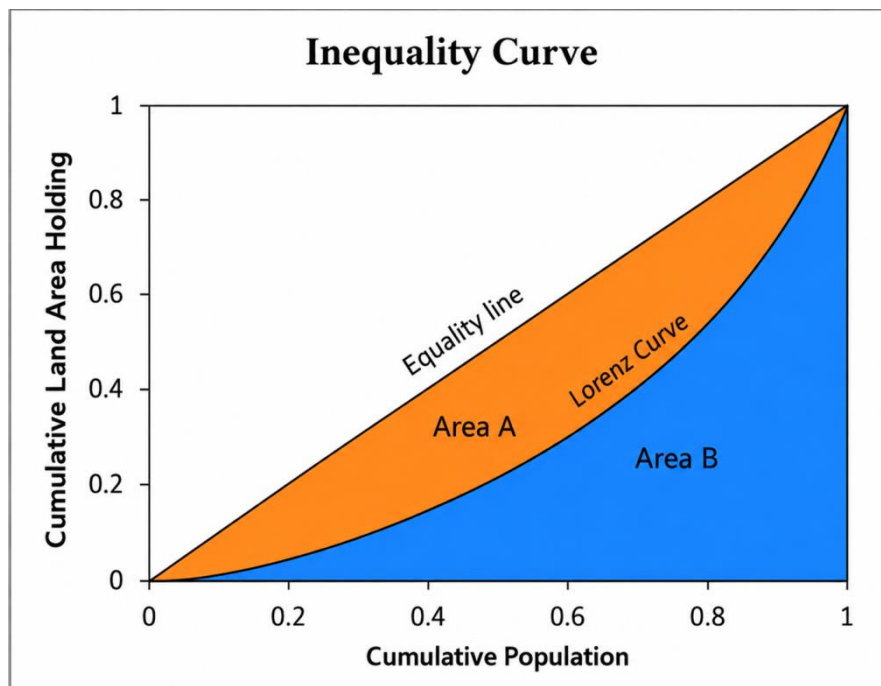


Figure 3: Inequality Curve of Land Holding

The area between line of Equality and Lorenz Curve (Area A) = 0.19179

The area below the Lorenz Curve (Area B) = 0.5- Area A

This means,

Area A+ Area B= 0.5

The inequality formula for Gini coefficient is;

$$\text{Gini Coefficient (G)} = \frac{\text{Area A}}{\text{Area A} + \text{Area B}} = \frac{0.19179}{0.5} = 0.38359$$

The calculated Gini coefficient of 0.384 indicates a moderate degree of inequality in landholding distribution among households in the study area, reflecting considerable variation in land ownership size.

4.2 Land productivity and cropping Intensity

Agricultural land productivity varied among households. Nearly half of the households (46.55%) classified their agricultural land as having moderate productivity (“Ok”), while 39.39% reported good productivity. Only 8.44% reported very good productivity, whereas 5.63% considered their land to have poor productivity. These findings suggest that although most households possess moderately productive land, only a limited proportion benefit from highly productive agricultural resources (Table 3).

Table 3: Land Productivity Category

Category	No of household	Percentage
Not Good	22	5.63
ok	182	46.55
Good	154	39.39
Very Good	33	8.44

Cropping intensity analysis revealed that agricultural land is utilized relatively intensively in the study area. More than half of the households (53.71%) practiced cropping intensity level 3, indicating cultivation of three major crops per year. Similarly, 32.74% of households reported cropping intensity level 2, whereas only 13.55% practiced cropping intensity level 1. The results indicate that farmers are attempting to maximize production from limited land resources through multiple cropping practices (Table 4)

Table 4: Crop Intensity data

Intensity	No of household	Percentage
1	53	13.55
2	128	32.74
3	210	53.71

4.3 Household Food Sufficiency

Household food sufficiency varied considerably across the study area. Only 12.02% of households reported food sufficiency exceeding twelve months, indicating surplus production beyond annual household requirements. Similarly, 36.57% of households achieved food sufficiency for twelve months, suggesting year-round food availability from their own agricultural production.

However, a substantial proportion of households experienced varying degrees of food insecurity. About 22.51% of households reported food sufficiency for only six months, while 9.97% remained food sufficient for merely three months. Overall, more than half of the surveyed households failed to achieve food sufficiency beyond one year, indicating the persistence of seasonal and chronic food insecurity within the municipality (Table 5).

Table 5: Household Food Sufficiency

Months	Number of Household	Percentage
3	39	9.97
6	88	22.51
9	74	18.93
12	143	36.57
>12	47	12.02
Total	391	100

A clear positive relationship was observed between landholding size and food sufficiency. Households with an average landholding size of 0.28 ha reported food sufficiency for approximately three months, whereas households possessing an average landholding size of 0.73 ha achieved food sufficiency beyond twelve months. This trend suggests that larger agricultural holdings contribute positively to household food availability (Table 6 and Figure 4).

Table 6: Average land holding and Food sufficiency

Average land holding area (in ha)	Food Sufficiency Months
0.28	3
0.31	6
0.42	9
0.51	12
0.73	>12

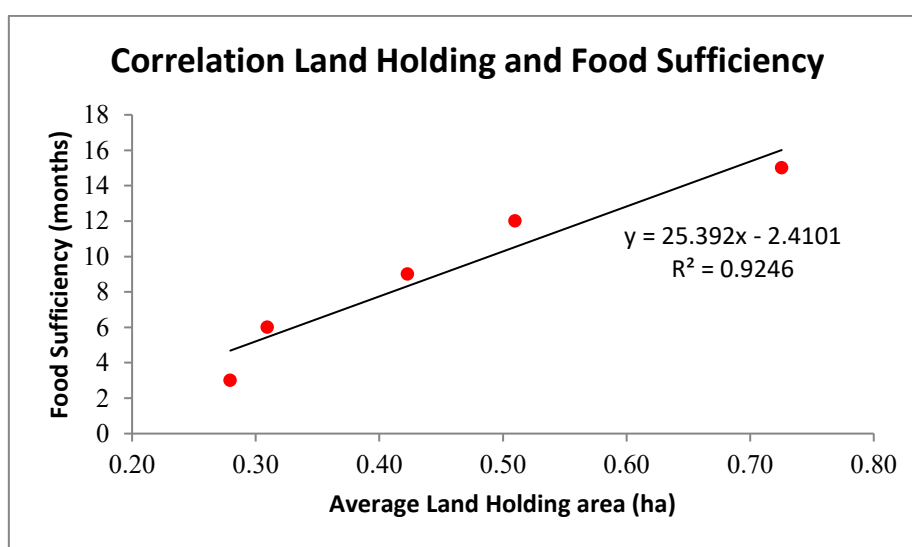


Figure 4: Average Land Holding and Food Sufficiency

The food sufficiency month's descriptive statistics shows that the average household can sustain food availability for around 9.69 months per year, means overall partial food insecurity in the study area. 3.52 months standard deviation indicates moderate variation among household, reflects the unequal access to food resources. It also shows that the mode value 12 means majority of the population is food secured for whole year. The data is shown in Table 7.

Table 7: Descriptive Statistics of Food Sufficiency months

Statistics	Food sufficiency months
Mean	9.69
SD	3.52
Minimum	3
Maximum	>12 (15)
Mode	12

Relationship Between Food Sufficiency and Explanatory Variables

Multiple linear regression analysis was performed to examine the influence of family size, number of land parcels, landholding area, cropping intensity, and land productivity on household food sufficiency. The survey included 391 households; however, outlier observations were identified and excluded prior to the regression analysis. Consequently, the regression model was estimated using data from 380 households.

The regression model explained 34.5% of the variation in household food sufficiency ($R^2 = 0.345$), while the adjusted R^2 value of 0.336 indicates moderate explanatory power after accounting for the number of predictor variables. The standard error of the estimate was 2.87 months, indicating a moderate level of prediction error. Although the model explains a substantial proportion of the variation in household food sufficiency, additional socio-economic and environmental variables may further improve its predictive performance (Table 8).

Table 8: Regression Statistics of Dependent and Independent variables

<i>Regression Statistics</i>	
Multiple R	0.587
R Square	0.345
Adjusted R Square	0.336
Standard Error	2.87
Observations	380

The correlation equation for food sufficiency based on statistical analysis based on Table 10 is;

$$FS = 6.075 + 3.87(LA) + 1.60(C_{Int}) + 0.79(LP) - 0.22(F_{Siz}) - 0.26(PN)$$

Where,
 FS= food sufficiency
 LA= Land holding Area
 C_{Int}= Crop intensity (number of major crops per year)
 LP= Land productivity category
 F_{Siz}= Family size (number of people)
 PN= Number of parcels

The ANOVA results indicate that the regression model is statistically significant ($F = 39.322$, $p < 0.05$), demonstrating that the selected explanatory variables collectively have a significant influence on household food sufficiency (Table 9).

Table 9: ANOVA Test Result

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	5	1617.575	323.515	39.322	1.96E-32
Residual	374	3077.014	8.227		
Total	379	4694.589			

The regression coefficients from Table 10 reveal that landholding area exerts the strongest positive influence on food sufficiency ($\beta = 3.87$, $p < 0.05$). This finding indicates that households with larger agricultural holdings are more likely to achieve higher levels of food sufficiency. Cropping intensity also shows a strong positive and statistically significant

relationship with food sufficiency ($\beta = 1.60, p < 0.05$), suggesting that intensive utilization of agricultural land contributes substantially to household food availability.

Land productivity exhibits a positive and significant effect on food sufficiency ($\beta = 0.79, p < 0.05$), implying that households possessing more productive agricultural land are likely to achieve greater food security. In contrast, the number of land parcels shows a significant negative relationship with food sufficiency ($\beta = -0.26, p < 0.05$), indicating that land fragmentation reduces agricultural efficiency and negatively affects food availability.

Family size also demonstrates a statistically significant relationship with food sufficiency ($\beta = -0.22, p < 0.05$), indicates that increase in family size needs more food consumption creates pressure on food availability. This result suggests that larger households may benefit from greater family labor availability for agricultural activities; however, the relationship should be interpreted cautiously as household size may simultaneously increase food consumption requirements.

Overall, the results demonstrate that landholding size, cropping intensity, land productivity, family size and land fragmentation are important determinants of household food sufficiency in the study area, with landholding area emerging as the most influential factor.

Table 10: Overall Statistical Result

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	6.075	1.279	4.748	2.93171E-06	3.559	8.591
Productivity	0.79	0.202	3.895	0.000116317	0.389	1.184
Crop Intensity	1.60	0.209	7.596	2.47375E-13	1.178	2.001
Area (ha)	3.87	0.532	7.277	2.02722E-12	2.826	4.919
Family size	-0.22	0.050	-4.517	8.40756E-06	-0.326	-0.128
Number of Parcels	-0.26	0.089	-2.980	0.003071132	-0.440	-0.090

5. Discussion

The findings of this study demonstrate that household food sufficiency in Mandandeupur Municipality is strongly influenced by landholding characteristics, cropping intensity, land productivity, and household demographic factors. The predominance of small and fragmented landholdings observed in the study area reflects the broader agricultural situation of Nepal's middle hill region, where subsistence farming remains the dominant production system.

The descriptive analysis revealed that more than 65% of households possess less than 0.5 ha of agricultural land, indicating severe limitations in agricultural production capacity. Fragmented landholdings reduce operational efficiency, increase production costs, and constrain the adoption of agricultural mechanization. Similar findings have been reported in previous studies, which identified land fragmentation as a major barrier to agricultural modernization and productivity improvement in Nepal and other developing countries ([Paudel et al., 2013](#); [Ntihinurwa et al., 2021](#)).

The average household food sufficiency of 9.69 months per year indicates a moderately food-secure condition. However, a considerable proportion of households remain unable to meet their annual food requirements from their own agricultural production. The persistence of seasonal food shortages suggests that food security challenges remain significant despite relatively intensive agricultural land use practices. These findings are consistent with previous studies that reported food insecurity as a persistent challenge among smallholder farming households in Nepal's middle mountain region ([Bhandari, 2022](#); [Koirala et al., 2024](#)).

The results further indicate that cropping intensity contributes positively to household food sufficiency. More than half of the surveyed households practiced cropping intensity level 3, demonstrating efforts to maximize agricultural output from limited land resources. The positive relationship between cropping intensity and food sufficiency suggests that increasing the frequency of cultivation can partially compensate for limited land availability. However, sustaining higher cropping intensity requires adequate irrigation facilities, access to improved agricultural technologies, and effective soil fertility management.

The regression analysis provides further insights into the determinants of household food sufficiency. Among all explanatory variables, landholding area emerged as the most influential factor, indicating that households with larger agricultural holdings are more likely to achieve year-round food sufficiency. This finding supports previous research that identified landholding size as a critical determinant of agricultural production and rural food security. Cropping intensity also exhibited a strong positive and statistically significant effect, highlighting the importance of efficient land utilization in enhancing food availability.

Land productivity showed a positive and significant contribution to food sufficiency, suggesting that improvements in agricultural management practices, irrigation, and input use can enhance household food security. In contrast, the number of land parcels exhibited a negative relationship with food sufficiency, confirming that land fragmentation adversely affects agricultural performance. Similarly, family size also showed a negative and statistically significant relationship with household food sufficiency. Although larger households may have greater family labor available for agricultural activities, they also have higher food consumption requirements, which may reduce overall household food sufficiency.

Overall, the findings suggest that improving household food security in Nepal's middle hill region requires integrated interventions focusing on land consolidation, irrigation development, agricultural modernization, productivity enhancement, and climate-resilient farming practices. Such interventions can contribute to sustainable agricultural development while reducing household vulnerability to food insecurity.

6. Conclusion & Recommendation

This study examined the relationship between landholding characteristics and household food sufficiency in Mandandeupur Municipality of Kavrepalanchok District, Nepal. The findings indicate that small and fragmented landholdings are dominant features of the study area and represent major constraints to agricultural productivity and household food security.

The average household food sufficiency was found to be 9.69 months per year, indicating a moderately food-secure condition. The results show that landholding area exhibited the strongest positive association with household food sufficiency, followed by cropping intensity. Land productivity also contributed positively to household food sufficiency, whereas larger family size and greater land fragmentation, measured by the number of land parcels, were associated with lower household food sufficiency. These findings highlight that both the quantity of agricultural land and its effective management play important roles in determining household food security.

The multiple regression analysis revealed that landholding area, cropping intensity, and land productivity had significant positive relationships with household food sufficiency, whereas family size and the number of land parcels had significant negative relationships ($p < 0.05$). The overall regression model was statistically significant ($F = 39.32$, $p < 0.001$) and explained approximately 34.4% of the variation in household food sufficiency, indicating that the selected variables are important determinants of household food security, although additional socio-economic and environmental factors also influence food sufficiency.

Based on these findings, the study recommends the implementation of land consolidation programs to reduce land fragmentation and improve agricultural efficiency. Strengthening irrigation infrastructure can support higher cropping intensity and enhance agricultural productivity. The promotion of improved agricultural technologies, quality seeds, crop diversification, and climate-resilient farming practices can further improve household food security. In addition, targeted agricultural support programs for highly food-insecure households and the creation of alternative livelihood opportunities can strengthen household resilience and contribute to long-term food security.

Future research should incorporate additional socio-economic, institutional, and environmental variables, such as household income, education, access to irrigation, market accessibility, and climate-related factors, to better explain variations in household food sufficiency and provide a more comprehensive understanding of food security dynamics in Nepal's middle mountain region.

7. Author Contributions

Tanka Prasad Dahal contributed to the conceptualization, methodology development, data analysis, and manuscript preparation. Reshma Shrestha contributed to supervision, technical review, and manuscript editing. Purna Bahadur Nepali contributed to statistical analysis guidance, interpretation of results, and manuscript review. Bhuwan Singh Bisht contributed to data collection, GIS analysis, map preparation, and manuscript drafting. Nabaraj Subedi contributed to data collection, field verification, data validation, literature review, and final manuscript preparation. All authors reviewed and approved the final manuscript.

8. Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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