

Article

Vegetable Farming and Farmers' Livelihood: Insights from Kathmandu Valley, Nepal

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Abstract: Agriculture is the main economic activity in Nepal, and vegetable farming is one of the major agricultural practices of peri-urban farmers in Kathmandu Valley (KV). In this study, it was hypothesized that vegetable farming contributes significantly to the livelihood of farmers by generating cash and providing employment opportunities. The relationship between livelihood and vegetable farming based on the practices, views, and perceptions of vegetable farmers at four different sites in the outskirts of KV was studied. A purposive sample of 140 farm households was surveyed, and key informant interviews were conducted to collect comprehensive data. Binary logistic regression was used to identify the relationships between farmer livelihood and numerous variables related to vegetable farming. It was found that the most of the surveyed farmers are migrants who have spread to different corners of KV at different times. The surveyed farmers cultivate an average area of 2551.5 m² for vegetable farming. The major vegetable products in the study area are tomato (*Solanum lycopersicum*), carrot (*Daucus carota*), and green leafy vegetables. The model results indicate a significant positive relationship between vegetable farming and livelihood. The survey results also reveal many constraints (e.g., poor market management and lack of irrigation facilities) and challenges (e.g., haphazard urban growth, price fluctuation, and vegetable diseases). Since vegetable farming has become a major source of livelihood for farmers in the peripheral areas of KV, further interventions should be implemented to strengthen the vegetable sector and sustain this source of livelihood for peri-urban farmers.

Keywords: peri-urban farming; vegetable marketing; farmers' perception; binary logistic regression; Kathmandu valley

1. Introduction

Vegetable farming within cities or on the fringes of cities is a part of urban agriculture [1]. Urban agriculture ranging from household subsistence farming to commercial-level farming plays a crucial role in improving the livelihood of people [2]. In developing countries, urban agriculture is an important contributor to the livelihood strategies of urban households [3]. According to the 2016 statistics of the Food and Agriculture Organization of the United Nations, tomato (*Solanum lycopersicum*)

is the main vegetable produced worldwide, and Asia is the leading producer of fresh vegetables, with a production of 251 million metric tons [4]. Likewise, China is the major producer of fresh vegetable, sharing more than 50% of total production [4]. Worldwide, the majority of vegetable production takes place in Asian countries, with Nepal being the sixth leading producer of fresh vegetables following China, India, Vietnam, Philippines, and Myanmar in 2016 [4]. The vegetable farming increasingly gaining its importance in Nepal [5].

Nepal is a developing country with an agricultural economy [6,7]. Farming is the main economic activity, where two third of the total population are engaged in agriculture [6,8]. Agriculture sector accounts 31% of gross domestic product (GDP) in Nepal [9]. A high proportion of households in Nepal depend on agriculture for the generation of livelihood [10]. As an important sector of the economy, vegetable production plays a significant role in determining the economic conditions for farmers [5]. Vegetable crops are efficient to generate cash even from a small plot of land in a short period of time and helps farmers to improve their livelihood [11,12]. The value of vegetable production equals or even surpasses the value of cereal production [11,13]. Vegetables have higher commercialization rates and high cost-benefit ratio compared with cereal crops [14]. Vegetable cultivation presumably supports livelihood primarily through food provision, income generation, and employment because vegetables are preferred cash crops [15,16].

Even in the highly urbanized Kathmandu Valley (KV), large tracts of land outside the central city areas are devoted to farming. The number of vegetable farmers is increasing day by day as a result of the high demand for vegetables in urban areas like KV [17]. Because of the great demand for perishable commodities such as vegetables, most farmers around urban and peri-urban areas are moving towards the commercial production of vegetables [16]. In the urban fringes, vegetable farming has emerged as a productive enterprise for cash generation and self-employment [18,19]. The vegetables produced by farmers in urban and peri-urban areas also include organic vegetables, which are consumed in Kathmandu. The vegetable products from peri-urban areas has supplemented to fulfill the growing demand of urban population in KV [20]. On the other hand, peri-urban agriculture in KV is facing a crucial challenge as a result of rapid and haphazard urbanization. Cultivated land is the land use type that is most affected by the dramatic growth of urban areas [21]. However, there is a need to improve farming practices through the development of agricultural infrastructure in peri-urban areas [20]. Research related to vegetable farming and its relationship to farmer livelihood remains limited in KV and its peri-urban areas. Therefore, this study aims to examine the relationship between vegetable farming and the livelihood of farmers engaged in vegetable farming and production in the peripheral areas of KV.

2. Materials and Methods

2.1. Study Area

Kathmandu is the capital of Nepal and is located in the central part of the country [22]. KV is of strategic importance as it is centrally located between China and India, and its urban settlements of Kathmandu, Lalitpur, and Bhaktapur became early trade centers [23]. These settlements continued as economically and politically important towns for hundreds of years [24]. Because of its livelihood options, KV is one of the most popular destinations for migrants from different parts of Nepal [25]. KV covers an area of 569.80 km² and includes three districts: Kathmandu, Bhaktapur, and Lalitpur [26]. Bagmati is the major river flowing through KV [27]. Kalimati Fruits and Vegetables Market was the first organized wholesale market in Nepal; retailers, institutional consumers, and other bulk consumers procure their supplies at this market [28]. In recent years, Balkhu vegetable market has become another asset for vegetable farmers for marketing. Vegetable production is an age-old traditional farming practice near the water resources in KV, and KV has the highest vegetable productivity per unit area in Nepal [10]. The study focuses on four different municipalities in KV, Kirtipur (western side),

Tarkeshwor (northern side), Madhyapur Thimi (eastern side), and Harisiddhi (southern side) in the valley where vegetable farming is practiced for commercial purpose (Figure 1).

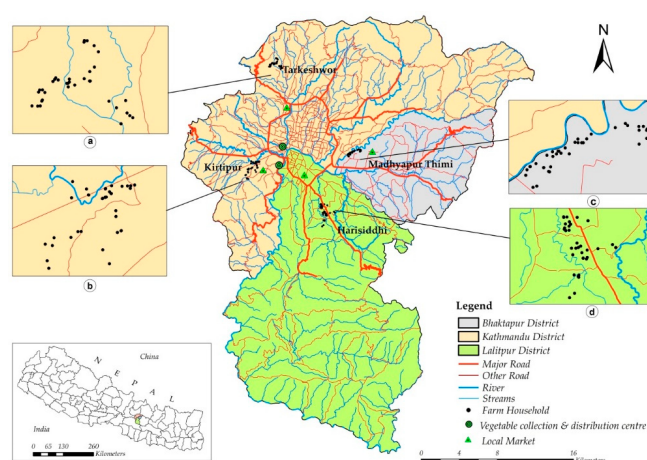


Figure 1. Study location: (a) Tarkeshwor, (b) Kirtipur, (c) Madhyapur Thimi, (d) Harisiddhi.

2.2. Questionnaire Design and Sample Size

Semi-structured questionnaires were administered to collect the socio-economic characteristics of farmers in the four different study locations in KV. The questionnaire was pretested at one selected site with a few vegetable farmers and amended before administering the final survey. Each package of questionnaires consisted of 35 questions grouped into the following five sections: section one collected information on the farmer's family composition and migration situation; section two captured information on the farmland and its ownership and accessibility along with the major vegetables cultivated; section three focused on vegetable productivity, proportion sold, and earnings from vegetable farming in a year; section four focused on the major inputs of vegetable farming and their sources along with the major expenditures and saving behaviors of the farmer; section five collected the views and suggestions of the farmers regarding vegetable farming. In total, 140 (35 from each site) farmers were selected for surveys.

2.3. Sampling Procedure and Household Surveys

An inventory of the study area was initially used to identify the vegetable farming areas in KV. As study sites, we selected vegetable farming areas in four municipalities located in different parts of KV: Tarkeshwor, Madhyapur Thimi, Harisiddhi and Kirtipur. Farm households within these sites were then selected via purposive sampling [29]. The researcher interviewed with head of the farm households. Most of the respondents were met on their farm as it was the peak time for vegetable production particularly for tomato farming. Besides the sampled household survey, five highly experienced farmers from each site were selected for key informant interviews (KIIs) to obtain empirical evidence as a compliment to the rest of the study. The empirical evidence was complimentary to this research and worthwhile. Personal interviews were conducted to ensure that the respondents answered all questions. The farmland household surveys were conducted from 7 July to 8 August 2018.

2.4. Selection of Potential Factors Related to the Livelihood of Vegetable Farmers

Altogether, 22 variables were selected to evaluate their relationships with the livelihood of vegetable farmers in KV. Each variable was selected with respect to the socio-demographic and economic conditions of farmers to understand the knowledge, attitude, and practices of commercial vegetable farmers. Each variable was selected based on assumptions developed from a pretest of the questionnaire with a few farmers at one of the selected sites. All data were collected through farm household surveys and KIIs. A description of each selected variable can be found below in Table 1.

Table 1. Variables selected for analysis using the binary logistic regression model and their descriptions.

Variables	Description
Gender	Labor potential and the farming knowledge & networking advantage on male
Age	Proxy for experience in farming
Education	Literate farmers have a better understanding of production and marketing
Family size	Smaller family size indicates lower expenditures and more savings potential; greater family size represents a greater labor pool to work in the farm
Training related to vegetable farming	Trained farmers have advantages in vegetable farming
Irrigation	Irrigation is an asset for vegetable cultivation
Local market	Access to local markets increases the probability of selling vegetable products
Type of farmland	Irrigated flatlands are more productive than sloped lands
Ownership	The amount paid by leaseholders for land increases by 10% each year
Farmland size/area	Greater farmland size can lead to greater production and income
Written agreement	Written agreements provide provisions for subsidies and loans
Year that the farmer began vegetable farming	Earlier starting dates indicate more experience and more effective production
Annual income	More earnings correspond to more savings
Loans and subsidies	Loans and subsidies lessen the financial burdens of farmers
Use of manure	Organic vegetables have more value, and manure replaces chemical fertilizers
Use of chemical fertilizer	Use of chemical fertilizers increases production
Use of pesticides	Pesticides protect vegetable from damages by different pest/insects and diseases
Savings	More savings correspond to better financial conditions
Affiliated with a vegetable production group	Networking/sharing related to farming skills, marketing, and savings practices
Farming trend	An increasing number of farmers corresponds to more market competition
Production trend	Increasing production generates more income
Livestock	Raising livestock provides additional income and a source of manure

2.5. Explanation of Selected Variables

The dependent variable in this study was whether or not vegetable farming supports the farmer's livelihood (this variable takes a value of 1 if vegetable farming improves the farmer's livelihood and 0 if it does not (see Table 2). The descriptions of the independent variables used in this study and their relationships with the dependent variable are also provided in Table 2. Except for four variables, the independent variables evaluated in this study were treated as categorical variables. Gender was measured as a categorical variable coded as 1 for male and 0 for female as Nepal has a male-dominated agricultural system [30,31]. The assumption is a positive relation with the dependent variable as men have advantage on labor potentiality and decision making [19]. The independent variable of age and year of starting vegetable farming were measured as continuous variables and can be used as proxy for vegetable farming experience, and both were expected to positively influence the livelihood of farmers [32]. Education was measured as a categorical variable with the assumption that literate farmers have advantages across the whole farming process over illiterate farmers [32]. Family size and livestock numbers were also measured as continuous variables. Independent variables such as irrigation system and local market were measured as categorical data coded with 1 if yes and 0 if no. The study postulated that access to irrigation enhances production and access to local markets reduces transportation costs [33]. Physical factors such as type and size/area of farmland were expected to have a positive relationship with the dependent variable. All other socio-economic information was collected from a farm household survey; ownership of land [34], written agreement, annual earnings, loans, use of manure, fertilizer and pesticides, saving habits, and affiliation with vegetable production groups were measured as categorical variables assuming that all variables had a positive relationship with the improvement of the farmers' livelihoods.

Table 2. Variables and their hypothesized relationship.

Variable	Variable Description	Variable Type	Relationship (+/−)
Dependent Improved farmers livelihood by vegetable farming	Value is 1 if vegetable farming improved the farmer's livelihood, otherwise the value is 0	Categorical	
Independent			
Gender	Gender of farmer (1 = male, 0 = female)	Categorical	±
Age	Age of farmer in years	Continuous	±
Education	Whether the farmer had a formal education (1 = literate, 0 = illiterate)	Categorical	+
Family size	Number of household members	Continuous	±
Training related to vegetable farming	Whether the farmer received basic training (1 = received training, 0 = did not receive training)	Categorical	+
Irrigation	Whether the farmland is irrigated (1 = irrigated, 0 = not irrigated)	Categorical	+
Local market	Whether the farmer has access to local markets (1 = yes, 0 = no)	Categorical	+
Type of farmland	Structure of farmland (1 = flatland, 0 = sloped land)	Categorical	+
Ownership	Land tenure (1 = own land, 0 = lease land)	Categorical	+
Farmland size/area	Landholding size (1 = > 2 ropani, 0 = ≤ 2 ropani) *	Categorical	+
Written agreement	Whether the farmer has an agreement with the landowner (1 = yes, 0 = no)	Categorical	+
Year that the farmer began vegetable farming	Indicates farmer experience in vegetable farming	Continuous	+
Annual income	Farmer earnings in NPR (1 = > 200,000 NPR, 0 = < 200,000 NPR)	Categorical	+
Loans and subsidies	Whether the farmer has received loans or subsidies (1 = yes, 0 = no); indicates support for vegetable farming	Categorical	+
Use of manure	Whether the farmer used livestock manure (1 = yes, 0 = no)	Categorical	+
Use of chemical fertilizer	Whether the farmer used urea, diammonium phosphate, and potash to increase production (1 = yes, 0 = no)	Categorical	+
Use of pesticides	Whether the farmer used pesticides to prevent damage to vegetables (1 = yes, 0 = no)	Categorical	±
Savings	Whether the farmer saves money (1 = yes, 0 = no)	Categorical	+
Affiliated with a vegetable production group	Whether the farmer is affiliated with a local vegetable group (1 = yes, 0 = no)	Categorical	+
Farming trend	Change in the number of farmers (1 = increased, 0 = decreased)	Categorical	−
Production trend	Change in vegetable production (1 = increased, 0 = decreased)	Categorical	+
Livestock	Number of livestock	Continuous	+

Notes: ± indicates a positive and negative relationship with the independent variable; NPR = Nepalese rupee (1 USD = 110.50 NPR); * 1 ropani = 508.84 m².

2.6. Data Analysis

The data from the completed questionnaires were entered and coded in Microsoft Excel and then exported to SPSS statistics 20 for further analysis (IBM, Armonk, NY, USA). Descriptive statistics with number and percentage were used to summarize the quantitative data. A binary logistic regression model was applied to analyze the relationships between the dependent variable and the independent variables listed in Table 2. When the outcome variable is dichotomous, the logistic regression can be an influential analytical technique for use [35]. Binary logistic regression is a type of predictive analysis [36] that is widely used to study farmer livelihood and food security [37,38]. Hence, binary logistic regression is used herein to describe the data and explain the relationships between the one dependent binary variable and the different independent variables [39]. All the selected independent variables were standardized according to Menard [36] and tested for multicollinearity [40]. The relationship between dependent and independent variables based on logistic regression was described as follows:

$$Y = \log\left(\frac{P}{P-1}\right) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \dots + b_nX_n$$

where p is the dependent variable which is probable support in the livelihood of vegetable farmers and $x_1, x_2, x_3, x_4, x_5, \dots, x_n$ are the independent variables (see Section 2.5) and $b_1, b_2, b_3, b_4, b_5, \dots, b_n$ are regression coefficients. The use of a binary model was motivated by the dichotomous fact that vegetable farming either does or does not support the farmer's livelihood [41]. Percentage correctly predicted (PCP) was adopted to determine the accuracy of the model [42]. Detailed descriptions of the dependent and independent variables are provided in Section 2.5.

3. Results

3.1. Farmers' Household Characteristics

The detailed socio-demographic characteristics of the farm households surveyed in the four study sites are shown in Table 3. Most households were located near farmlands, with the exception of households in the eastern site, which were located at a distance of approximately 1 km from the farmland. Among all respondents (140), two-thirds (96) were male, while nearly one-third (44) was female. The educational level of farmers is known to affect their farming activities. The result shows that most of the respondent farmers (81%) are literate and rest of them are illiterate. Among the literate respondents, 50% have acquired secondary and above secondary education, 19% have primary education, whereas 12% have basic knowledge of reading and writing. Approximately one-third of respondents (31%) have received basic training related to vegetable farming. More surveyed households consisted of 1–5 household members (57%) than 6–10 members (43%). Vegetable farming is a good source of income for the surveyed farmers, with the majority of farmers earning over 100,000 NPR in a year. The minimum earning of a vegetable farmer per year is 50,000 NPR, while the highest earning is over 500,000 NPR. Over 50% of the surveyed farmers earn more than 200,000 NPR yearly through vegetable farming.

Table 3. Socio-demographic characteristics of farmer households.

Variables	Tarkeshwor	Madhyapur Thimi	Harisiddhi	Kirtipur	Total
Gender (%)					
Male	68.57	65.71	65.71	74.29	68.57
Female	31.43	34.29	34.29	25.71	31.43
Education (%) *					
Illiterate	20.00	34.29	2.86	17.14	18.57
Literate	5.71	5.71	17.14	20.00	12.14
Primary	14.29	22.86	22.86	17.14	19.29
Secondary	54.29	34.28	57.14	40.00	46.43
Above secondary	5.71	2.86	0.00	5.72	3.57
Training in vegetable farming (%) **					
Yes	37.14	14.29	48.57	25.71	31.43
Family size (%)					
1–5 members	65.71	77.14	65.71	20.00	57.14
6–10 members	34.29	22.86	34.29	80.00	42.86
Annual income (%) (NPR) ***					
50,000–100,000	22.86	14.29	14.29	20.00	17.86
100,000–200,000	20.00	45.71	34.29	25.71	31.43
200,000–500,000	28.57	37.14	25.71	14.29	26.43
More than 500,000	28.57	2.86	25.71	40.00	24.28

Notes: * Literate = basic reading and writing, primary = up to grade 5, secondary = up to grade 10; ** Basic training conducted by a government agency, nongovernmental organization, or a local farmer's group; *** NPR = Nepalese rupee (1 USD = 110.50 NPR) Source: Field Survey, 2018.

3.2. Migration Status

The migration statuses of the surveyed farmers are shown in Table 4. Most of the vegetable farmers migrated from different parts of the country. The number of migrated vegetable farmers is

nearly double the number of local vegetable farmers. Migrant farmers outnumber local farmers at all sites except the eastern site, which has more local farmers than migrant farmers. The farmers migrated to the outskirts of KV during different time periods in search of better livelihoods. The percentages of farmers who migrated to KV 6–10 years ago and 11–20 years ago are nearly the same, while fewer farmers migrated between 21 and 30 years ago (Table 4). The massive earthquake in 2015 seems to be a major factor in recent migration from earthquake-affected districts such as Rasuwa, Gorkha, Ramechhap, Dhading, Sidhupalchok, and Dolakha.

Table 4. Migration trend of vegetable farmers.

Variables	Tarkeshwor	Madhyapur Thimi	Harisiddhi	Kirtipur	Total
Local households *	7	31	8	2	48
Percentage	20.00	88.57	22.86	5.71	34.29
Migrated households	28	4	27	33	92
Percentage	80.00	11.43	77.14	94.29	65.71
Migration period (%)					
<5 years	25.71	0.00	17.14	22.86	16.43
6–10 years	28.57	0.00	28.57	31.43	22.86
11–20 years	17.14	2.86	28.57	34.29	20.71
21–30 years	8.58	5.71	2.86	5.71	5.00
30–40 years	0.00	2.86	0.00	0.00	0.71

Note: * Local households indicate farming households that been living in the same place for generations. Source: Field Survey, 2018.

3.3. Accessibility and Affiliations

Road networks have played a significant role in accelerating agricultural production in the study area. As shown in Table 5, almost all farmlands can be accessed by road. Most farmlands are connected to gravel roads, with fewer connected to blacktop and earthen roads. Electricity and drinking water are largely available to vegetable farmers, except those in the western site, where only 60% have access to drinking water (Table 5).

Table 5. Accessibility and affiliations among farmers group in Kathmandu Valley.

Variables	Tarkeshwor	Madhyapur Thimi	Harisiddhi	Kirtipur	Total
Accessibility (%)					
Black top road	71.43	22.86	11.43	25.71	32.86
Graveled road	28.57	77.14	57.14	62.86	56.43
Earthen road	0.00	0.00	31.43	11.43	10.71
Electricity	100	100	100	100	100
Drinking water	100	100	100	60	90
Local market	100	100	100	100	100
Source of irrigation (%)					
Pumped water	45.71	100.00	20.00	42.86	54.28
Streams	54.29	0.00	28.57	40.00	28.57
Canal	0.00	0.00	51.43	5.71	14.29
Others	0.00	0.00	0.00	11.43	2.86
Affiliations *	2	6	2	8	18
Percentage	5.71	17.14	5.71	22.86	12.86

Note: * Indicates affiliation with a local farmers group (either registered or non-registered) where the farmer has savings (200–500 NPR per month) in their locality. Source: Field Survey, 2018.

The farmland irrigation sources differ among farmers (Table 5). The most common irrigation source is pumped groundwater followed by streams. A small number of farmers use local reservoirs for irrigation purposes. In the eastern site, all surveyed farmers depend on underground pumped water for irrigation due to the dredging of the Manohara River, which was the only source for irrigation

water. In contrast, in the southern site, most farmers use a canal to supply water to their farmlands. A nominal percentage of farmers have developed other irrigation techniques, which are included in the “other” category in Table 5. The survey results also indicate that few farmers are affiliated with a vegetable production group (either registered or non-registered) in their locality. In such groups, farmers used to collect some money for saving purpose and conduct meeting on a monthly basis.

3.4. Farmland Occupancy and Ownership and Major Vegetables Cultivated

The average farmland area of the surveyed farmers is 2551.50 m² (Table 6). The farmlands are largest in the western site followed by the southern and northern sites. The eastern site has the lowest average cultivated area. Over three-fourths of the farmers lease their farmland (Table 6). Given the lack of agricultural labor in the study area, especially for paddy cultivation, the local people began to lease their land for vegetable farming. On average, leasehold farmers pay 15,000 NPR per ropani (508.84 m²) of farmland to the landowner on a yearly basis. In addition, the rent increases by 10% every year. Written agreements between landowners and leaseholders are in place in 46% of cases. At three out of the four sites, tomato (*Solanum lycopersicum*) is the primary cultivated vegetable, whereas the main crops in the eastern site (Madhyapur Thimi) are carrot (*Daucus carota*) and green leafy vegetables. The study area has a long history (over four decades) of commercial vegetable farming, and farming remains the main occupation of residents. Furthermore, almost all surveyed farmers sell more than 80% of their vegetable products.

Table 6. Farmland occupancy and ownership and major cultivated vegetables.

Variable	Tarkeshwor	Madhyapur Thimi	Harisiddhi	Kirtipur	Total
Average farmland (m ²)	2784.82	1068.56	2929.46	3423.76	2551.50
Ownership (%)					
Own farmland	17.14	74.29	8.57	0.00	25.00
Leasehold farmland	82.86	25.71	91.43	100.00	75.00
Agreement (%)	60.00	6.00	40.00	77.00	46.00
Major vegetables (%)					
Tomato (<i>Solanum lycopersicum</i>)	100.00	2.86	100.00	82.86	71.43
Carrot (<i>Daucus carota</i>)	0.00	57.14	0.00	0.00	14.29
Green leafy vegetables	0.00	40.00	0.00	2.85	10.71
Mushrooms	0.00	0.00	0.00	14.29	3.57
Vegetable products sold (%)					
>60% sold	0.00	0.00	0.00	8.57	2.14
>80% sold	100.00	100.00	100.00	91.43	97.86

Source: Field Survey, 2018.

3.5. Loans, Expenditures, and Saving Behaviors

Among all respondents, 25% have obtained loans for farming activities (Table 7). Most farmers borrowed money from an individual rather than from a cooperative or bank. The low rate of loans and subsidies is attributed to the lack of written agreements between farmers and landowners. More than half of the surveyed farmers incur expenses for agricultural inputs and these exceeds those expenses for consumables and other sector as a whole. The investment on children’s education is the second most common expense, followed by consumables (20%). The vegetable farmers of all three sites have maximum expenses on agricultural inputs except in the Kirtipur area, where farmers invest more for children’s education. More than half of the farmers have savings out of vegetable farming, and Tarkeshwor’s farmers have the highest average annual savings while Harididdhi’s farmers have the lowest average annual savings.

In the Harisiddhi area, vegetable farmers invest twice in consumables than children’s education, whereas in the Kirtipur area the farmers have maximum expenses for children’s education rather than other sectors. Around half of the farmers have the habit of cash saving either in a group (agricultural, women) and local saving cooperatives or in a bank. The highest rates of savings are observed in the

eastern and western sites. The average saving is more than 100,000 per year, and the Tarkeshwor area has the highest and the Harisiddhi area has the lowest average saving ratio of farmers among the four sites (Table 7).

Table 7. Loans, expenditures, and saving behaviors of vegetable farmers.

Variables	Tarkeshwor	Madhyapur Thimi	Harisiddhi	Kirtipur	Total
Loans (%) *	22.86	14.29	37.14	25.71	25.00
Major expenditure (%)					
Agricultural inputs	54.29	60.00	57.14	34.29	51.43
Consumables	20.00	11.43	28.57	20.00	20.00
Children education	25.71	25.71	14.29	45.71	27.86
Health cure	0.00	2.86	0.00	0.00	0.71
Savings practice (%) **	31.43	71.43	40.00	62.86	51.43
Average saving (NPR) ***	189,090.91	67,008.00	66,171.43	186,681.82	122,063.89

Notes: * Indicates the borrowing of money for all farming activities, including infrastructure, labor, seed supply, transportation, fertilizers and pesticides; ** indicates savings in the form of cash through a group, local savings cooperative or bank. *** NPR = Nepalese rupee (1 USD = 110.50 NPR) Source: Field Survey, 2018.

3.6. Marketing of Vegetable Products

According to the field survey, two-thirds of the vegetable farmers sell their product directly to a Collection and Distribution center, while more than one-fourth sell to a local market, and the remaining farmers sell their products within their locality (Figure 2). The farmers in all four surveyed sites have access to local markets within an average distance of 3 km, although it is not feasible for all farmers to travel to local markets (Figure 2). Most of the farmers (66%) sell their products to suppliers that are directly connected to the collection center at the Kalimati and Balkhu Fruit and Vegetable Wholesale Market. Approximately one-third of the farmers sell their products by themselves, either within their locality or at a nearby market. The farmers rarely sell their products through local vendors.

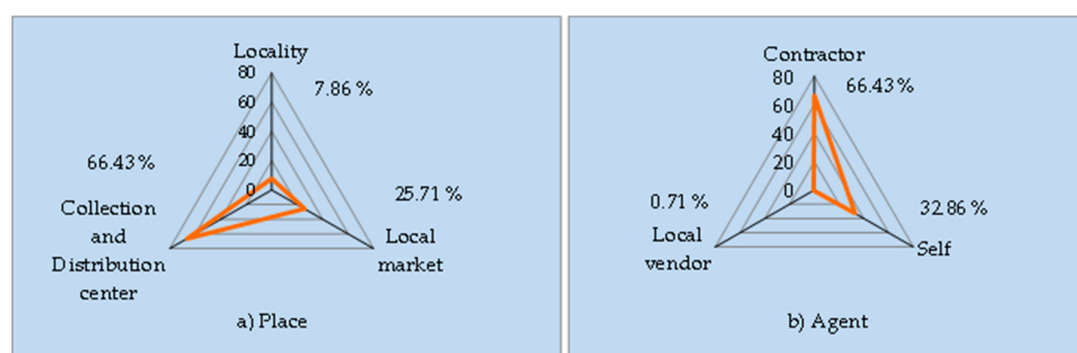


Figure 2. Vegetable marketing channels in Kathmandu Valley.

3.7. Farmer Experience and Perceptions Related to Vegetable Farming

The farming techniques adopted by farmers depend on the experience of the farmers. Among the surveyed farmers, 42% have 6–10 years of farming experience, 31% have less than five years of experience, 16% have 11–20 years of experience, and the remaining 10% have over 20 years of vegetable farming experience (Table 8). Among the survey sites, the eastern site has the largest percentage of farmers who have been involved in vegetable farming for more than two decades, while the other three sites have higher percentages of farmers with less than 10 years of experience. In recent years, the number of farmers has increased due to migration from different parts of the country. Among the respondents, over three-fourths reported an increase in the number of farmers in recent years. Growth in the number of farmers indicates a growth in the amount of farmland. However, most farmers (64%) reported that production is decreasing (Table 8).

Table 8. Farmers' experience and perception on vegetable farming.

Variables	Tarkeshwor	Madhyapur Thimi	Harisiddhi	Kirtipur	Total
Farming experience (%)					
Up to 5 years	42.86	0.00	48.57	34.29	31.43
6–10 years	54.29	14.29	42.86	57.14	42.14
11–20 years	2.85	45.71	5.71	8.57	15.71
More than 20 years	0.00	40.00	2.86	0.00	10.72
Farming trend (%)		C			
Increasing	100.00	14.29	97.14	100.00	77.86
Production trend (%)					
Decreasing	80.00	85.71	40.00	48.57	63.57
Factors hindering production (%) *					
Diseases	91.43	68.57	85.71	100.00	86.43
Soil fertility	45.71	22.86	42.86	40.00	37.86
Lack of irrigation	51.43	48.57	97.14	114.29	77.86
Land holdings	22.86	54.29	28.57	17.14	30.71
Climate	20.00	11.43	22.86	31.43	21.43
Seeds quality	17.14	11.43	31.43	11.43	17.86
Factors affecting marketing (%) *					
Pricing	100.00	100.00	97.14	97.14	98.57
Market management	22.86	11.43	28.57	71.43	33.57
Others	65.71	0.00	28.57	14.29	27.14
Transportation	2.86	2.86	5.71	5.71	4.29

Note: * Indicates that individual farmers chose multiple answers from the given options. Source: Field Survey, 2018.

The farmers' survey responses indicate that various factors are affecting vegetable production in the study area. The emergence of new diseases is a key factor in decreased vegetable production in general and particularly tomato production in KV. Likewise, the lack of proper irrigation systems is another vital factor affecting vegetable production. The loss of soil fertility due to the extensive use of chemical fertilizers and shrinking land holdings due to urbanization (e.g., plotting and infrastructural development) were also reported as factors affecting production. Climatic variation and shortages of quality seeds also have negative effects on vegetable production in the study area (Table 8).

According to the surveyed farmers in KV, numerous factors are affecting vegetable marketing. Almost all surveyed farmers think that recurrent price fluctuations are the main factor affecting vegetable marketing. One-third of farmers reported that the lack of proper management (e.g., the establishment of more collection centers and cool storage) by the government/public sector is a problem in vegetable marketing. Similarly, over one-fourth of respondents indicated that imports of similar vegetables, particularly tomatoes, from neighboring states at harvest time hinders marketing channels, and some farmers expressed the need for farmer-based organizations. Transportation was not seen as a major factor affecting marketing in the study area (Table 8).

3.8. Livestock Farming

Humans rely on livestock for food and other products that affect socio-economic factors. In addition to cultivating vegetables, farmers rear and keep livestock in three sites except Madhyapur Thimi, where none of the surveyed farm household has livestock (Table 9). This area has the lowest average farmland (Table 6) compared to the other three sites and mostly produces carrots and green leafy vegetables (Table 6), relying on manure from poultry farms and chemical fertilizers. Overall, the northern site of the study area seems to have a higher percentage of livestock followed by the eastern and southern sites, respectively (Table 9).

Table 9. Status of livestock ownership by vegetables farmers.

Livestock	Tarkeshwor		Harisiddhi		Madhyapur Thimi		Kirtipur		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Cattle	16	4.57	12	38.71	n/a	n/a	43	25.29	71	13.12
Buffalo	16	4.57	2	6.45	n/a	n/a	1	0.59	19	3.51
Goat	18	5.14	0	0	n/a	n/a	18	10.59	36	6.65
Pig	0	0.00	5	16.13	n/a	n/a	71	41.76	76	14.05
Chicken	300	85.71	12	38.71	n/a	n/a	37	21.76	349	64.51
Total	350	100.	31	100	n/a	n/a	170	100.	541	100

Note: n/a indicates that the livestock is not domesticated by the farmers of the survey site.

3.9. Relationship between Vegetable Farming and Farmer Livelihood

There were five major types of livestock domesticated by the farmers (Table 9). The farmers rear livestock for supplementary income and for a source of manure for vegetable farming. Among the major types of livestock, chicken makes up the largest proportion, followed by pigs and cattle. Farmers in the study area have low numbers of goats and buffalo. Furthermore, the highest quantities of chickens are found in Tarkeshwor and cattle in Kirtipur. The percentage of cattle and chicken are equal in Harisiddhi, whereas the percentage of cattle and buffalo are similar in Tarkeshwor (Table 9).

The results of the binary logistic model are presented in Table 10. The PCP of this model was 89.17 and regression coefficient (R^2) value was 0.86. Most assigned and hypothesized variables show significant positive relationships with farmer livelihood in KV. The result shows that the variables use of manure in vegetable farming, affiliation of farmer to the vegetable production group in the locality, and the condition of farmer receiving training have significant positive relation with p values of 0.016, 0.024, and 0.130, respectively (Table 10). The model results suggest that farmers are likely to continue vegetable farming as most of the variables indicate a positive relationship between vegetable farming and farmer livelihood. Thus, the result suggested that the farmers engaged in vegetable farming in the peri-urban areas of the KV are continuously improving their livelihood. The use of manure has a major role in vegetable farming, being ranked first for farmer's livelihood improvement as the manure-treated vegetables can be counted as organic vegetables and have higher prices. Likewise, the farmer's affiliation to a vegetable production group and farmers trained on vegetable farming were ranked second and third, respectively, as both attribute for the increment in the quality production and the farmer's well-being. The ownership of farmland with p value 0.211 shows positive significance, as one advantage of owning land is lower expenditures. Owning farmland has greatly benefited the livelihood of farmers, especially with raises in yielding capacity. Simultaneously, rearing livestock appears as an inseparable part of agriculture farming, as the additional income contributes to improving the livelihood of the farmers. The annual income through vegetable farming has greatly supported in the livelihood of farmers in KV.

Table 10. Summary of results from the binary logistic regression analysis.

Variables	Sig. (<i>p</i>)
Gender	0.631
Age	0.410
Education	0.798
Family size	0.505
Training related to vegetable farming	0.130
Irrigation	0.403
Local market	0.397
Type of farmland	0.221
Ownership	0.211
Farmland size/area	0.487
Written agreement	0.370
Year that the farmer began vegetable farming	0.587
Annual income	0.366
Loans and subsidies	0.271
Use of manure	0.016
Use of chemical fertilizer	0.419
Use of pesticides	0.581
Savings	0.535
Affiliated with a vegetable production group	0.024
Farming trend	0.662
Production trend	0.659
Livestock	0.344
Constant	0.363
Number of points	140
Percentage correctly predicted (PCP)	89.17
Nagelkerke R^2	0.862

Note: Significance was tested at the 5% level.

4. Discussion

4.1. The Role of Vegetable Farming in Improving Farmer Livelihood

The cultivation of vegetables, which are preferred cash crops, presumably supports livelihood by providing food, income, and employment [43]. Increased vegetable production has the potential to generate more income and employment than other segments of the agricultural economy, making vegetables an important element of any agricultural growth strategy. During the last 10 years (2007–2017) in Nepal, the cultivated area, production, and yield of vegetables increased by 33%, 48%, and 11%, respectively [44]. Urban vegetable farming contributes substantially to the economy as well as to livelihood and food security [15]. In this study, we found that the households of most farmers earn more than 100,000 NPR annually through vegetable farming. The farmers cultivate tomato once in a year and green leafy vegetables in rotational order throughout the year (Table 6). Apart from expenditures on agriculture inputs, children's education, and consumables, most of the farmers are able to save some of their earnings either on a monthly or yearly basis (Table 7). In urban peripheral areas, vegetable farming is a productive enterprise for cash generation and self-employment [18]. The increment in the number of vegetable farmers day by day (Table 8) indicates that they have seen the opportunity to improve their livelihood through vegetable farming in KV. Tomatoes have become the preferred crop for vegetable farmers because tomatoes are more profitable than other vegetables and hence are valuable for low-income farmers [5]. Tomato production is one of the major vegetable farming practices in the study area (Table 6). In addition to vegetable farming, many farmers raise livestock to supplement their income and provide manure for vegetable farming (Table 9). The results of this study indicate that the number of vegetable farmers is increasing as vegetable farming becomes recognized as a potential source of income.

Vegetables are a rich and inexpensive source of carbohydrates, protein, vitamins, and minerals, and can complement the main cereal crops [45]. In addition to income generation, vegetable products are a part of the daily diet. To a large extent, the livelihood of vegetable farmers depends on the two-way relationship between vegetable farming and urban growth. Based on the logistic regression analysis in this study, vegetable farming in KV contributes significantly to the livelihood of farmers. Therefore, vegetable farming is expected to continue to be an important part of urban agriculture in KV.

4.2. Land and Market Management and Farmer's Expectations

KV has been experiencing rapid population growth, particularly since the 1980s. As home to 22.3% of Nepal's urban population, KV is a fast-growing urban area in South Asia [25,46]. The most aggressive period of urban growth in KV occurred between 1999 and 2009. This time period coincides with a boom in the real-estate market, which is largely fueled by the entry of migrants from the countryside displaced by political and searching for a better life [25,47]. Due to internal conflict, large numbers of people have been displaced and migrated to urban areas, including KV [47]. The critical urban growth in KV will lead unparalleled stress on land resources by the next decade [22]. The soil in KV was once considered to be the most fertile and productive in Nepal [48]. In the outskirts of KV, the agriculture is facing a crucial challenge because of the rapid and haphazard urbanization [49]. In this study, one-third of surveyed farmers migrated to KV in search of a better livelihood (Table 4). These farmers have leasehold their farmland under different circumstances [50].

The National Land Use Project of Nepal is developing an integrated land-use plan with a focus on cropland management [51]. This plan will cover zoning for agricultural, residential, forest, commercial, industrial, public, and other lands to help manage all land uses together with cropland [52]. Such initiation can prevent chaotic destruction of fertile soil to sustain imperative urban agriculture like vegetable farming in the outskirts of the valley. Moreover, farmers are expecting possible subsidies and a proper land-use policy for their well-being (Figure 3). As urban areas grow, the demand for vegetables increases, which leads to more vegetable farming and thus supports the livelihood of farmers in the urban peripheries. However, haphazard urban growth has a negative effect on vegetable farming as it sacrifices fertile agricultural land in favor of urban development. To protect the abundant land, there should be clear demarcation of vegetable pocket areas (Figure 3).

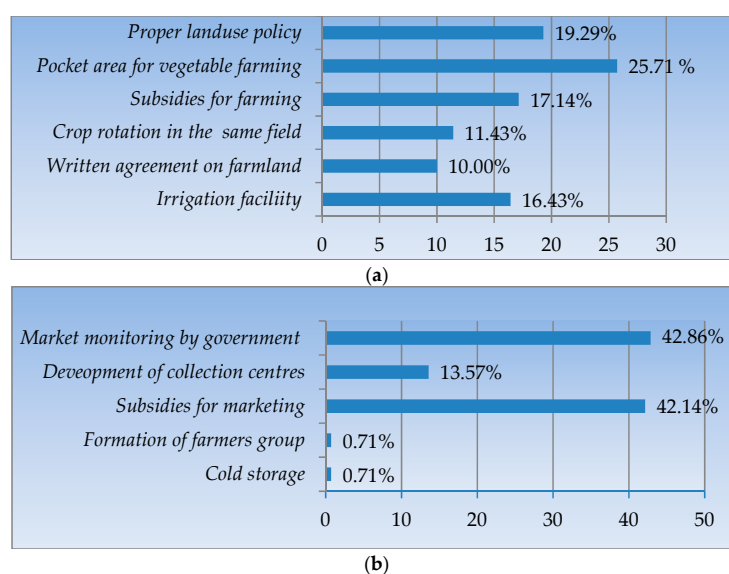


Figure 3. Farmer suggestions related to (a) land management and (b) vegetable market management in Kathmandu Valley (KV).

Marketing management systems have been a major problem for vegetable farmers [33,53]. However, the 2015 Agricultural Development Policy of the Nepalese government prioritized agriculture roads, collection centers, and market infrastructure to spur economic growth, improve livelihood, and enhance food security [33]. The government should also place more emphasis on monitoring and evaluating the vegetable market to protect farmers from prospective parasitic middlemen in the vegetable markets (Figure 3). Furthermore, government subsidies on marketing should be provided to encourage farmers to continue their agricultural practices [48]. Based on the survey responses, additional collection centers would be an asset for vegetable farmers and would help ensure a constant vegetable supply in KV (Figure 3).

4.3. Major Challenges of Vegetable Farming in Kathmandu Valley

Vegetable farming in KV has many challenges. As a result of rapid and haphazard urbanization, some available agricultural land has been converted to built-up areas. The land market has become a potential factor contributing to dynamic urban growth [25]. The conversion of available agricultural land into building plots and town planning has squeezed farmlands [49]. The loss of fertile farmland near the urban area is one of the major constraints to the vegetable farmers [41]. Although urban agriculture is important for poor urban households in developing countries like Nepal, land-use policies are not effectively enacted [22]. The enforcement of urban growth policies to alter the current growth rate would effectively improve the urban environment [22]. Land brokers and housing development companies hold large parcels of land in peri-urban areas for speculative purposes, fragmenting or permanently removing potential fertile agricultural land [54]. The lack of written agreements between lease-holding farmers and landowners has deprived farmers from receiving government subsidies in the study area. Thus, a proper monitoring system should be implemented to improve the system of land tenure [50] and ownership. Currently, most national land use policies focus on land management and increasing production rather than the control of land fragmentation [52].

Marketing is an important part of vegetable farming. Price fluctuations are a major challenge in vegetable farming [33,55,56]. There have been huge ups and downs in vegetable prices during production and for an extended period [28]. The middlemen tend to be parasites who take a large share of the benefits during vegetable marketing [57]. Vegetable production has shorter market channels [18], although a market monitoring system would help farmers avoid losing profit to middlemen [58]. Irrigation is the backbone of agriculture in general and vegetable farming in particular. Thus, the lack of irrigation systems is a major obstruction to agricultural productivity [59]. In the study area, the lack of irrigation facilities is one of the major challenges that prevent farmers from achieving the expected returns. The farmers in KV are managing water through different means (e.g., pumped water and pipelines) on their own. There is a need for local-level agricultural institutions and farmer groups [60]. The formation of farmer-based organizations would also enhance farmers' access to information, build mutual trust among farmers, and lower the cost of working together [61]. This would further improve the management of common resources to increase farmers' productivity and income [60]. The emergence of vegetable diseases at the time of production is a major factor in vegetable yield loss [62]. As a result, farmers use more pesticides to protect their products.

5. Conclusions

Overall, the results show a significant positive relationship between vegetable farming and farmer livelihood improvement in KV. The number of vegetable farmers in the study area is increasing as vegetable farming has been recognized as a valuable source of income, and as the demand for vegetables has increased with urban growth. Haphazard urban growth has a negative effect on urban farming. To help farmers overcome the challenges in vegetable farming, the government should support farmers with quality extension services aimed at increasing production and preserve urban farming. Systematic marketing management and frequent monitoring through formation of informal/formal local groups of vegetable farmers/government agencies would help protect farmers

from middlemen. The study findings revealed the advantages of vegetable farming on livelihood along with the challenges to a certain extent. For the sustainability of urban agriculture and continued contribution of vegetable farming to economic development, further research on these matters would be significant.

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