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Research Article

Production Economics and Determinants for Adoption of Commercial Vegetable Production in Kathmandu Nepal

Jyoti Dhungana

Agribusiness Expert, Surbodaya Nepal, Lalitpur, Nepal

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***Corresponding author**
Jyoti Dhungana,
Agribusiness Expert, Surbodaya Nepal, Lalitpur, Nepal.
Email: jyoti.hohen@gmail.com

Abstract

The vegetable sub-sector is considered a sector having high prospects of commercialization. It supports to create the job opportunities, thereby contributes to reducing the poverty rate. However, little empirical research has been done to know the benefits of commercial production and households' behavior towards its adoption. Thus, this study seeks to assess the production economics and determinant factors of farmers for the adoption of commercial vegetable production in Kathmandu district, Nepal. In total 199 households were selected using a stratified random sampling technique. The primary data were collected from January to February 2022. The descriptive statistics, benefit-cost ratio, and binary logistic regression were applied for data analysis using SPSS. The results reveal that the gross margin and benefit-cost ratio of commercial vegetable farming were found to be NRs. 533,130/ha and 3.23 respectively, which were higher than the subsistence vegetable farming (gross margin NRs. 419, 031/ha and benefit to cost ratio 2.49). Further, the findings of binary logistic regression show that age, education of household head, experience, type of family, membership, and access to credit were significantly important determinants of commercial vegetable production. Therefore, any agricultural development programs such as financial services, business training, and encourage farmers to join into cooperatives could be instrumental for commercial vegetable farming.

Keywords: Binary logistic; factors; gross margin; variable cost

Introduction

Vegetable production is one of the promising occupations to generate cash for rural households. The area and production of vegetable in Nepal is 281,132 ha and 3,962,383 mt respectively (MoALD, 2021). It occupies 2,099 ha area and production is 57,457 mt in the Kathmandu district with the highest yield of 27.38 mt/ha than other parts of the country (MoALD, 2021). In addition, the demand for vegetable products is increasing owing to the growth of the urban population (Rai *et al.*, 2019). Consumption of vegetable is essential for good health and contains a cheap source of vitamins and minerals. The return could be gained in a short duration, even on a small piece of land. This lessens the poverty rate with higher income for farming households. It contributes to achieving the gap in food security (Thapa and Pant, 2020), and enhances the export substitution (Tiwari and Tiwari, 2018). Therefore, converting subsistence into commercial production has greatly impacted to improve the livelihoods of farmers. Moreover, the Agriculture Development Strategy (ADS) 2015-2035, of Nepal has envisioned for shifting the

traditional farming system to be more profitable, competitive and commercial; stating that more than 80% of agriculture produces needs to be marketed by 2035 (GoN, 2015). The government of Nepal have been implementing the subsidy programs for commercial vegetable farming targeted to attract the youth returnees' migrants.

Despite these initiatives, the proportion of commercial-scale farmers remains very low as few farmers participate in the marketing activities. The majority (82%) of farmers in Nepal grow vegetable for their family consumption only (Begho, 2021). Less mechanized agriculture, insufficient infrastructure, and weak value chain network are the reasons for such subsistence farming. In fact, the vegetable sub-sector is handicapped by price uncertainties and poor market management (Malla *et al.,* 2021). This is impaired by the inadequate business skills of farmers such as investment and gross margin per unit of production (Kunwar and Maharjan, 2019). It denotes that the producers have limited knowledge of the best profitable crop in their farmland. It hinders the ability of growers in production, later it ultimately inhibits the commercialization in the agriculture sector. Equally, the smallholders of Nepal are suffered from low labor efficiency (Mottaleb, 2018). The constraints notably, unorganized production and less gross margin received by farmers are ignored in policy formulation (Thapa *et al*., 2022). This leads to a slower rate of adoption to intensify the vegetable production. The rate of commercialization could not gain momentum as anticipated. One of the reasons could be the lack of motivation of producers to enter into commercial farming.

Hence, intensive production of vegetable has been initiating among the farmers of Nepal (CASA, 2020) because of its comparative advantage gained from the agro-ecological diversity (Piya and Joshi, 2021). The marketable vegetable products have risen in recent years, consequently, supporting to increase in rural earnings (Mariyono, 2017). The heavy import of other goods have to be replaced by profitable produces like vegetable to promote trade in other countries (Thapa and Dhimal, 2017). So, specialization in agriculture, development of markets, and trade stimulate the economic growth of the country. Inspiring vegetable growers for commercial-scale of production could be a reliable source of income for farmers (Dahal and Manandhar, 2021). Such transformation also contributes to narrowing the yield gap.

Furthermore, there is limited know-how on why the majority of farmers have lesser participation in commercial agriculture. To address this gap, it is key to understand the investment and its return from vegetable, and the adoption behavior of vegetable growers. Also, no study to date has been noted about the farm economics and their households' behavior on vegetable farming in the study area. Thus, the overall objective of this study was to assess the production economics and determinant factors of farmers for the adoption of commercial vegetable production in Chandragiri Kathmandu Nepal. The specific objectives were i) to describe the socio-economic characteristics of the vegetable producers ii) to examine the production economics such as gross margin and Benefit-Cost Ratio (BCR) from vegetable, and iii) to identify the determinant factors for the adoption of commercial vegetable production.

Conceptual Framework

The BCR measures the benefit to cost ratio in per unit of investment. It helps to determine the profit gain and is used as a decision-making tool for the acceptance or rejection of any project (Rathod and Gavali, 2021). The farm is in profit if the ratio value is positive. In this study, BCR was computed by gross return divided by total variable cost, which was used to compare the profit level of commercial and subsistence vegetable farming. Gross margin can be computed from the difference between gross return and the total variable cost incurred in the production process (Pandey *et al.,* 2020).

Similar way, it is important to identify the factors of engagement of vegetable farmers in commercial scale. Farmers who produce vegetable for marketable sales are referred to as commercial farmers (Joshi, 2018; GC and Hall, 2020). Apart from this, subsistence farming is defined as growing vegetables just for own consumption (Mariyono, 2019), while commercial farming is intended to get income for their livelihoods (Piya and Joshi, 2021). In other words, the products need to be sold out in surplus quantity in the market. It is beyond that level, the tendency towards commercial farming also takes into account the decision-making behavior of growers (von Braun *et al.,* 1994). Though, farmers' motivation plays a significant role in the commercial-scale of production.

In the course of recognizing the determinant factors, potential variables were assumed as independent variables in the study. The literature concludes the variables such as education, household size, age (Megerssa *et al.,* 2020); type of family (Kattel and Acharya, 2016), and access to credit (Ghimire *et al.,* 2018) had positively associated with the adoption behavior. The results showed that, among the institutional variables, membership in the farmer's group, credit availability, participation in training (Hoang, 2021); gender, farming experience (Amao and Egbetokun, 2018) and gender of household head, access to extension, access to finance (Rubhara and Mudhara, 2019) were the significant factors for commercialization in agriculture. Therefore, this study hypothesized that the relationship exists between the dependent variable (if adopt the commercial or not) and the independent variables such as age, gender of Household Head (HH), education of HH,

household size, experiences, type of family, membership, extension contact, training, and access to credit.

Materials and Methods

Selection of the Study Area

Chandragiri of Kathmandu district of Nepal was chosen for the study due to a large number of farmers' concentrating on vegetable production. The area has plenty of opportunities for vegetable production because of its fertile land. Also, the demand of growing urban population of Kathmandu valley would have the potential to produce more vegetable. In terms of productivity, Bagmati province ranks in the first position and highest number of consumers (CASA, 2020). The pocket vegetable production program is taking place in Dahachowk, Thankot, Matatirtha, and Satungal of Chandragiri municipality, where 21.6% of the land is utilized in agriculture activities (GoN, 2019). Equally, the biggest vegetable market hubs are located in the Kathmandu district namely Kalimati, and Balkhu with retailers, wholesalers, and traders (Bhattarai *et al.*, 2017).

Sampling Frame and Sample Size

A total of 408 vegetable growers were identified as the sampling frame (GoN, 2019). Four locations namely Dahachowk, Thankot, Matatirtha, and Satungal of Chandragiri Municipality of Kathmandu district were taken as four strata. A stratified random sampling method was applied and selected 199 sampling households based on their proportional size. The random sampling method is the best method to avoid sampling bias (Baker *et al.*, 2013). The Rao software was used to calculate the sample size, where 95% confidence interval and 5% margin error were fixed. The primary data were collected through a household survey from January to February 2022. Pretest surveys were conducted and some variables were adapted to get the necessary information from the field. Two Focus Group Discussions and five key informant interviews were taken to further validation of the survey data.

Methods of Data Analysis and Empirical Model

Statistical Packages of Social Sciences (SPSS) software was applied to analyze the data. The descriptive statistics, mean comparison using t-test and chi-square test, BCR, and a binary logistic model were used to get the result. The study considered the major four vegetables namely cauliflower, tomato, potato, and carrot, that were produced intensively in the study area. The average value of four vegetables mentioned above was taken into account to calculate the cost of inputs and gross return.

Cost of Production

The variable cost included in vegetable production were different six cost headings.

Total variable cost = $C_{Labor}+C_{Seed}+C_{Fertilizer}+C_{Tillage\ operation}+C_{Agrochemical}+C_{Management}$

Where,

C_{Labor} = Total labor cost (for land preparation, weeding, applying manure and pesticides, harvesting) in NRs/ha

C_{Seed} = Total cost of seed in NRs/ha

$C_{Fertilizer}$ = Total cost of farm yard manure and chemical fertilizer in NRs/ha

$C_{Tillage\ operation}$ = Total cost of machinery used in tillage operations in NRs/ha

$C_{Agrochemical}$ = Total cost of micro nutrient and pesticide in NRs/ha

$C_{Management}$ = Total management cost such as communication, transportation in NRs/ha

Benefit Cost Analysis

BCR is the easiest and quick method to know the farm income (Pandey *et al.*, 2020). The ratio computes the gross profit value per unit of input use. It was calculated by using the following formula:

$$\text{B: C ratio} = \frac{\text{Gross Revenue (NRs)}}{\text{Total Variable Cost (NRs)}}$$

Where, gross revenue is the volume of production (Kg.) × average farm gate price (NRs). Total cost of production is the summation of the cost incurred in the variable inputs.

Decision rule: B: C ratio =1, >1 or <1, farm is indifferent, profitable and loss respectively

Gross Margin

Gross margin is the difference of gross revenue received after sales minus the cost of goods sold (variable costs). It was used in the study of vegetable, by Pandey and Gautam (2021). The vegetable production requires only the variable inputs except the land rent, which is taken as fixed cost. In this study, to calculate the gross margin, following formula was used:

Gross margin (NRs) = Gross return (NRs)–Total variable cost (NRs)

Where, Gross return = Price of vegetable (NRs/unit) × Total quantity sold (Kg)

Total Variable cost= Summation of all the variable costs

Econometric Models

Binary Logistic Regression Model:

A binary logistic regression model was applied to regress the dependent variable and independent variables as shown in **Table 1**. For categorizing the farm, the average size of the vegetable farm (0.12 ha) of all vegetable growers was taken as a reference. Farmers with less than the average (<0.12 ha) were considered as subsistence vegetable producers and equal to or more than the average (≥0.12 ha) were taken as commercial vegetable producers. This method was also used by Dahal and Rijal (2019). The binary

logistic regression model predicts the outcome of the dependent variable as dichotomous of 0 or 1, which was applied to know the relationship with independent variables (Bui and Nguyen, 2021). This model was used to predict the probability of adoption by using the value of the odds ratio. It estimates for the changes in the probability of happening certain events on the outcome (dependent variable) due to changes in the explanatory variables. Begho (2021) identified the major factors influencing the adoption of commercial vegetable production using a binary logistic model. In this study, it was assumed that the dependent variable takes a binary choice between 1 for adopting commercial vegetable production and 0 for otherwise (subsistence vegetable production), from selected samples.

The probability is given by,

pi =1/ $(1+e^{-zi})$, where, pi = probability of adoption of commercial vegetable production

$zi = \tilde{Y} = \log(odds) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots + \beta_n X_n$

Where, β_0 is the constant term, β_1, β_2,……., β_n are the coefficients and X_1, X_2,…., X_n are explanatory variables.

***Odds*:** Odds is the ratio of the probability of adopting commercial vegetable production (pi) to the probability of not adopting commercial vegetable production (1- pi). Odds = $\frac{pi}{1-pi}$

Wald test: Wald test measures the significance of given coefficients of the explanatory variables

= $(B/ S.E.)^2$

Where, B= coefficient of explanatory variables, S.E. = estimate of the standard error of the coefficient.

Based on the regressand and the regressors, the binary logistic analysis was specified by using the following equation:

$\tilde{Y}=\log(odds)=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}$

$\tilde{Y}$ = Estimator of adoption of commercial vegetable production

β_0 is a constant term and $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$ are coefficient of explanatory variables. The description of explanatory variables used in the model are illustrated in Table 1. The average Variance Inflation Factor (VIF) from 1.30 to 1.99 was found at the acceptance level.

Results and Discussion

Status of Vegetable Growers

Table 2 presents the differences in various socio-economic variables of commercial and subsistence vegetable growers in the study area. Only 42.7% of vegetable growers were engaged in commercial farming and hold equal to or more than the average size of the vegetable farm (≥0.12 ha). The findings of this study present the majority of household heads were male, 61.6% in commercial and 62.8% in subsistence farming. Similarly, the average age of respondents was 39; which implies the younger farmers were involved in vegetable production. In addition, average years of experience in vegetable production on a commercial scale was found to be higher (5.8) than the subsistence growers (2.71). In this line, Issaka *et al.* (2021) stated the experience had a significant impact on yield. The expertise in production acquired from experiences would be supportive to scale up the production. The average age and years of experience have statistically different between the two groups at 5% level of significance. The literacy rate of household heads was found to be higher (82.6%) for commercial vegetable growers than for subsistence vegetable growers (28.3%). This is supported by findings in Nepal, who reported 78% literacy rate of commercial vegetable farmers (Bhandari and Poudel, 2021). Thusly, education always contributes to farm upgrading. Literate farmers are able to calculate the farm cost and would be easier to sell the products in the market. Further, the chi-square test value showed the type of family, membership, extension contact, training, and access to credit are statistically different between the two categories at 5% level of significance.

Table 1: Variables used in the binary logistic regression model

Notation	Variables	Description	Variable type
Y	Adoption (Dependent)	Adoption of commercial vegetable production	Dummy: 1 if adopted, 0 otherwise
X1	Age	Age of farm holders (years)	Continuous
X2	Gender of HH	Gender of household head	Dummy:1 if male, 0 otherwise
X3	Education of HH	Education of household head	Dummy:1 if literate, 0 otherwise
X4	Household size	Number of family members (no.)	Continuous
X5	Experience	Vegetable production (years)	Continuous
X6	Type of family	Type of family	Dummy:1 if nuclear 0 otherwise
X7	Membership	Membership in group or cooperative	Dummy: 1 if yes, 0 otherwise
X8	Extension contact	Visit with extension services	Dummy: 1 if yes, 0 otherwise
X9	Training	Participation in training	Dummy: 1 if yes, 0 otherwise
X10	Access to credit	Access to credit facilities	Dummy: 1 if yes, 0 otherwise

Table 2: Comparison of socio-economic variables between two categories

Variables (Categorical)		Commercial	Subsistence	Total	χ2-value	p-value
Gender of HH	-Male	53(61.6)	71(62.8)	124(62.3)	0.030	0.862
	-Female	33(38.4)	42(37.2)	75(37.7)		
Education of HH-	Literate	71(82.6)	32(28.3)	103(51.8)	57.538	0.000**
	-Illiterate	15(17.4)	81(71.7)	96(48.2)		
Type of family	-Nuclear	46(53.5)	97(85.8)	143(71.9)	25.277	0.000**
	-Joint	40(46.5)	16(14.2)	56(28.1)		
Membership	-Yes	74(86)	55(48.7)	129(64.8)	29..914	0.000**
	-No	12(14)	58(51.3)	70(35.2)		
Extension contact	-Yes	62(72.1)	46(40.7)	108(54.3)	19.383	0.000**
	-No	24(27.9)	67(59.3)	91(45.7)		
Training	-Yes	64(74.4)	39(34.5)	103(51.8)	31.145	0.000**
	-No	22(25.6)	74(65.5)	96(48.2)		
Access to credit	-Yes	54(62.8)	30(26.5)	84(42.2)	26.295	0.000**
	-No	32(37.2)	83(73.5)	115(57.8)		
Variables (Continuous		**Commercial**	**Subsistence**	**Total**	**t-value**	**p-value**
Age (years)		37.2±4.35	40.4±5.48	39±5.3	4.487	0.000**
household size (no.)		5.26±1.33	5.21±1.72	5.23±1.6	0.194	0.847
Experiences (years)		5.8±1.80	2.71±2.18	4±2.5	10.561	0.000**
Average farm size (ha)		0.17±0.04	0.08±0.03	0.12±0.05	-20.009	0.000**

(Source: field survey 2022), Note: value after "±" indicate standard deviation and figures in parentheses indicate percentage
Note: ***, **, * indicate significant at 1%, 5%, 10% level of significance, respectively.

Cost of Inputs Used in Vegetable Production

The major cost headings were labor, seed, fertilizer, tillage operations, agrochemical, and management (Table 3). The total variable cost for vegetable production in the study area was found to be NRs. 266,975/ha, which was significantly lower in commercial (NRs. 242,886/ha) than in subsistence cultivation (NRs. 285,308/ha). The t-statistics showed that the average cost of other inputs except for fertilizer was found to be lower in the case of commercial farming than in the subsistence production system, but the differences between the two categories were found statistically significant only in three major inputs of labor, seed, and fertilizer.

The survey result affirmed that the largest share of cost 37.6% used for labor, followed by fertilizer and seed constitute 17.7 % and seed occupied 18%, whereas, agrochemical and management costs occupied 13.5% and 12% respectively. The cost for tillage operation was found to be the lowest (1%). In the same manner, a study of vegetable in the Parsa district of Nepal by Paudel *et al.* (2021) found the highest share of the cost for labor (48.26%), afterward, followed by fertilizer cost (13.89%) and agrochemicals cost (12.54%). However, the contradictory to the outcome presented by Bolakhe *et al.* (2022), who pointed out the cost of seed occupied (43.76%) and labor cost found to be (12.31%) for vegetable production.

From these results, it can be concluded that labor, seed, and fertilizer were the key inputs used in vegetable production. Intensive care needs to be performed manually, so, a higher portion of the money was invested in labor. The use of equipment and machinery was very low due to the small parcel of land size in the study area. Field tasks from planting to harvesting, except machinery used in tillage, should be executed by human labor. Also, organic manure is expensive because of the urban area, as they do not rear the livestock animals. Nevertheless, the finding of this survey shows the total cost of production was lower in commercial vegetable production than in subsistence production. So, more use of machinery in field operations might have helped to further lower the production costs.

Table 3: Cost of inputs used for vegetable production (hectare basis)

Variables	Overall	Vegetable growers		Mean differences	p-value
		Commercial	Subsistence		
Labor	100401±25850	79224±17537	116518±18479	37294	0.000**
Seed	47150±8735	41320±8454	51588+5889	10268	0.000**
Fertilizer	48637±8239	53374±3146	45032±5063	8342	0.000**
Tillage operation	2623±99	2622±93	2623±103	22	0.913
Agro chemical	35972±13953	35039±1516	36682±1297	1592	0.412
Management	32192±1025	31307±1061	32866±996	1559	0.290

(Source: field survey, 2022), Note: value after "±" indicate standard deviation
Note: ***, **, * indicate significant at 1%, 5%, 10% level of significance, respectively.

Economic Analysis of Vegetable Production

As depicted in Table 4, the average gross margin from vegetable production was NRs. 468,340/ha, which was found to be higher (NRs. 533,130/ha) for commercial vegetable farming than subsistence (NRs. 419,031/ha). Again, the average BCR ratio of vegetable was found to be higher (3.23) for commercial farming than for subsistence (2.49). The mean of both variables was statistically different at 5% level of significance. Nearly the same result noted in the study of vegetable in Syangja Nepal, by Pandey and Gautam (2021), found that the gross margin of NRs. 537, 325/ha with BCR of vegetables ranges from 1.47 to 2.69. In contrast, the lower gross margin of NRs. 190,702/ha was found in the study in Chitwan (Pandey *et al.*, 2020). BCR of vegetables was found from 4.16 to 5.0 in Parsa Nepal (Paudel *et al.*, 2021), which was more than this survey findings. It denotes that vegetable production is the most lucrative crop in Kathmandu valley with the highest yield of 22.56 mt/ha. It is higher than the national average of 14.09 mt/ha but lower than the average productivity of Kathmandu of 27.38 mt/ha of vegetable (MoALD, 2021). Hence, the commercial production of vegetable seems to be more profitable than subsistence production; it has ample opportunities to increase the income of households.

Factors Motivating Farmers to Adopt the Commercial Vegetable Production

A binary logistic regression model was applied to determine the factors that impact the farmers to cultivate vegetable production on a commercial scale in Chandragiri, Kathmandu district. The results of the binary logistic regression and the value of the odds ratio are reported in Table 5. Out of ten, six variables namely age, education of household head, experience, membership, access to credit, and type of family were found to be statistically significant at 1% level of significance. These variables were the determinant factors for farmers' decision to adopt or not to adopt the commercial vegetable production. Gender of household head, household size, extension contact, and training were found to be insignificant and were not determining the adoption behavior of farmers. Further, the log-likelihood ratio of 128.069, indicated the chi-square goodness of fit value was 144.129. The R2 value of the logistic regression analysis showed that 69.1% of the dependent variable was predicted by the explanatory variables in the model.

The estimated results of the model (Table 5) showed the age of respondents had a negative and significant effect on the adoption of commercial vegetable farming. This result indicates that an increase in the age of the farmer by 1 year, would tend to decrease the likelihood of adoption of commercial vegetable production by 0.880 times. In the same line, the result of a previous study described that adoption had an inverse relationship with age (Panta, 2019). It signifies the chances of adoption of commercial production decrease with older age. However, the opposite result was found in the study by Donkoh (2020), who reported that older aged farmers were more willing to adopt agriculture commercialization. The result of this survey reveals that younger farmers are more ready to take the risk. It could be linked to the returnees' migrants from abroad doing vegetable farming in Kathmandu; as they have viewed it as a prospect of youth employment.

The findings of this survey showed a positive and significant association between the education of household heads and the adoption of commercial vegetable production (Table 5). If the education level of farmers changes from illiterate to literate the probability of adoption increases by 5.912 times. These findings are consistent with the study by GC and Hall (2020), who concluded that the household head with literacy had likely to influence market participation. Education has a multiplier effect on households and farmers could take advantage of it to increase the production level (Adeoye, 2020). It can be explained by the fact that relatively literate farmers had engaged in commercial vegetable production. On the contrary, Melese *et al.* (2018) reported the likelihood to participate in market activities decreases if the household is literate. Therefore, this research confirms that, for commercial production, growers need to be literate to know the technical know-how. It helps to link the farmers with output markets, and access to input suppliers and other service holders.

Table 4: Economic analysis of vegetable production (hectare basis)

Variables	Overall	Vegetable growers		Mean differences	p-value
		Commercial	Subsistence		
Productivity (mt/ha)	22.56±1.96	22.29±1.19	22.76±1.38	0.47	0.097
Total cost (NRs.)	266975±34848	242885±29472	285308±26513	42423	0.000**
Gross return (NRs.)	735315±78967	776015±38288	704339±57586	71676	0.000**
Gross margin (NRs)	468340±93716	533130±44818	419031±31245	114099	0.000**
B:C ratio	2.82±0.53	3.23±0.38	2.49±0.39	0.74	0.000**

(Source: field survey, 2022), Note: Value after "±" indicate standard deviation.
Note: ***, **, * indicate significant at 1%, 5%, 10% level of significance, respectively.

Table 5: The maximum likelihood estimation of the binary logistic model

Notation	Variables	B value	SE	Wald	Sig.	Odds ratio
X1	Age	-0.128	0.053	5.841	0.016***	0.880
X2	Gender of HH	0.402	0.487	0.681	0.409	1.495
X3	Education of HH	1.777	0.494	12.959	0.000***	5.912
X4	Household size	0.260	0.187	1.933	0.164	1.296
X5	Experience	0.348	0.103	11.354	0.001***	1.416
X6	Type of family	-1.756	0.657	7.139	0.008***	0.173
X7	Membership	2.135	0.688	9.629	0.002***	8.459
X8	Extension contact	-0.191	0.560	0.116	0.733	0.826
X9	Training	0.644	0.605	1.134	0.287	1.904
X10	Access to credit	1.389	0.485	8.216	0.004***	4.010
	Constant	-1.036	2.665	0.151	0.697	0.355
	No. of observations	199				
	-2 Log likelihood	128.069				
	R^2	69.1 %				
	chi-square value	144.129				

(Source: field survey, 2022), Note: ***, **, * indicate significant at 1%, 5%, 10% level of significance, respectively.

Similarly, the experience had a positive, significant impact on the probability of farmers adopting commercial vegetable farming (Table 5). It describes with an increase in the years of vegetable production by 1 year, the odds ratio of the adoption of commercial vegetable production increases by 1.416 times. This result was consistent with the study in Nigeria, the rate of commercialization increased with many years of cultivation (Amao and Egbetokun, 2018). The same occupation for many years contributes to build up the farmers' confidence. In other words, experienced farmers may get access to information and develop knowledge of production and marketing as well. However, it contradicts the findings of another region, where many years of involvement in vegetable farming had negatively and significantly influenced the adoption of commercial production (Mariyono, 2017). The fact may be the less tendency for changing attitude of growers from traditional to new farming systems. The findings of this study conclude that the experience in vegetable farming tends to enhance the ability of farmers to do better.

As shown in Table 5, the type of family was found to be negatively and significantly related to the adoption decision. If a family with a nuclear type, the likelihood of adopting commercial vegetable cultivation, decreases by 0.173 times more than the farmers who lived in joint. This is agreed in the study by Dahal and Rijal (2019), who declared the type of family of farmers was negatively correlated with the adoption rate. The contradictory result observed by Kattel and Acharya (2016) found that the likelihood of adoption increased by 76% with the nuclear type family. The family living in a single-parent or with joint members is a decisive factor for the rate of adoption of commercial farming.

Further, farmers who have joined into groups or cooperatives were more likely to cultivate vegetables on large scale compared to those without membership. The likelihood of producing vegetables on a commercial scale was found to be 8.459 times higher than non-member farmers (Table 5)**.** The fact may be the community-based organizations facilitate member farmers to deliver skills. This is agreed in a previous study, which stated that member farmers were more aware of the latest technology and practices (Adeoye, 2020). Tanimonure *et al.* (2020) suggested the vegetable farmers to engage in cooperative societies or form active groups. As a result, member farmers could take advantage of production technology and market information. They can also share their ideas and farming practices among the members.

In addition, access to credit is a significant factor that inspires to invest in any new business opportunities. For the farmers who had access to credit, the likelihood of adopting commercial-scale vegetable production increases by 4.010 times higher than for those who had less access to financial services (Table 5)**.** The positive relationship between access to credit and commercial farming may simply mean that farmers could utilize the loan in vegetable production. This result is consistent with Maruf *et al.* (2021); Rubhara and Mudhara (2019) reported that easy access to loan plays a prime role in the adoption rate. Credit supports the vegetable growers to procure the necessary inputs on time. Conversely, Joshi (2018) claimed that credit did not have any effect on decision-making behavior for commercial vegetable farming. The reason was that the loan was utilized for other purposes rather than agriculture activities.

The combined result of the above indicated that membership and access to credit serve as a proxy to engage in commercial farming. If the farmers join into groups or cooperatives, loan could be taken from there. The same result was observed in the study by Ruzzante *et al.* (2021) and Hoang (2021), declaring that access to credit and membership in farmers' organizations had a positive influence on the adoption rate. From these, it is possible to say that smallholder farmers who have access to credit programs and membership have tendency towards commercialization.

Conclusion

The productivity of vegetable was found to be higher than the national average in the study area. The commercial vegetable farm seems to be more profitable due to its higher gross margin and benefit-cost ratio than subsistence vegetable production. Besides, the major determinants of farmers for the adoption of commercial vegetable production were age, experience, education of household head, type of family, membership, and access to the credit facility. Therefore, the research suggests the policy-makers to formulate policies that motivate farmers to join into farmers-based associations like farmers' interest groups or cooperatives. They should be encouraged to participate in collective marketing as well. Along with, the experiences gained in vegetable production could be utilized in farmer-to-farmer extension programs. The program to attract the young returnees' migrant and create favorable conditions for credit services could be a better option to foster the commercial vegetable production in the study area.

Author's Contribution

All works are performed by the author alone.

Conflict of Interest

The author declares that there is no conflict of interest with this publication.

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