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Assessment of Adoption of Sweet Orange (*Citrus sinensis* L. Osbeck) Orchard Management Practices in Ramechhap District, Nepal

Dikshya Poudel[1*], Soniya Bashyal[1] and Arvind Srivastava[2]
[1]*Faculty of Agriculture, Agriculture and Forestry University*
[2]*Department of Horticulture, Agriculture and Forestry University*
*Corresponding author's email: dikshyapoudel82@gmail.com,
*ORCID iD: 0000-0002-5068-3044

Abstract

Ramechhap district is well known for the production of sweet oranges. Farmers are often reluctant to invest in orchard management which also accounts for low sweet orange production in the district. A survey study was conducted to assess the adoption of improved orchard management practices of sweet orange in Ramechhap district. The pre-tested semi-structured questionnaire was administered among randomly selected 100 Sweet orange growers of 6,7 and 8 wards of Ramechhap Municipality to obtain the primary source data and descriptive statistics was computed using Ms-Excel and SPSS. Based on total number of sweet orange trees, farmers were grouped as small and large holder farmers. Practices like pruning, Farm Yard Manure application, mulching and intercropping were highly adopted whereas chemical fertilizer application, micronutrient application, Bordeaux paste application and irrigation were least adopted by growers. Only large growers made application of micronutrients and chemical fertilizers. Average productivity was found to be 11.74 mt/ha for large farmers while it was 8.92 mt/ha for small growers. The adoption index was found to be higher for large farmers compared to small and the index was positively correlated with the productivity. Lack of technical knowhow about orchard management practices and high cost of input materials limited the adoption of management practices while high disease and pest infestation and lack of irrigation facilities were the major constraints of production among small and large growers. This research opens up the importance of timely adoption of orchard management practices for enhancing the production of sweet orange in the study area.

Keywords: Adoption, growers, management, orchard, productivity

Introduction

Background Information

Sweet orange (*Citrus sinensis* L. Ocbeck) scientifically belongs to the family Rutaceae and sub-family Aurantioideaeandis and is considered one of the most economically important horticultural crops (Musasa, 2017). Locally termed as *Junar*, it is one of the highly demanded fruit crops in Nepal (D. Adhikari & Rayamajhi, 2012) accounting for 15% of the total cultivated area and occupying the third position in terms of production after mandarin and lime (Acharya et al., 2019). It is successfully cultivated in 47 districts out of 77 in the country (Ghimire, et al., 2006). Ramechhap is one of the leading districts in sweet orange in the country which occupies a total productive area of 880ha with a production of 11, 493 mt and a productivity of 13.4 mt/ha (MOALD, 2020).

Improved orchard management practices are needed for optimum sweet orange production from the orchards. Orchard management practices include all those practices performed from the beginning i.e from land preparation to the harvest of the product thereby enhancing the productivity of the orchard (Snyder & Mancino, 2015). Good field preparation, proper planting materials and planting sites, proper soil management, rejuvenating the orchard through disease pest management, regular training/pruning, good orchard floor cover with cover crops and irrigation according to the crop stage are some of the orchard management practices described by Lewis & Wicks (1907).

The majority of farmers in Nepal were not adopting recommended practices in agricultural production (S. Adhikari et al., 2019) and such faulty agricultural practices have resulted in various problems in the export of our agricultural produce (Pesticide-Monitoring plan, 2007). Poor orchard management has mainly accounted for the lack of availability of technical assistance and guidance which has caused a decrease in production over the years (Prasad & Dhakal, 2019). Farmers are often reluctant to invest in the management of orchards i.e, wide use and distribution of unhealthy citrus saplings along with increasing drought/dryness, lack of use of balanced plant nutrition and application of updated technology (FAO, 2011). Thus, these constraints have led to the citrus decline problem in Nepal. The same is the case with sweet oranges in Ramechap and Sindhuli districts.

Several studies have been conducted to evaluate the state of orchard management practices, revealing various socio-economic, institutional and technological factors that are linked to adoption. There have been scant studies on the subject of citrus orchard management practices and those that do exist are predominantly confined to Mandarin orchards (A. Adhikari et al., 2021; Poudel et al., 2021; Belbase et al., 2020a). Thus, conducting a study to evaluate orchard management practices for sweet orange is equally crucial to derive the benefits of its cultivation.

It is deemed important to encourage the adoption of essential orchard management practices to boost the productivity of sweet orange and sustain its cultivation in the long term. Accordingly, a study was undertaken in the Ramcehhap district of Nepal to figure out the extent of adoption of improved orchard management practices, the reasons for the lack of adoption of these practices, socio-economic factors affecting the adoption of these practices and the major production constraints for sweet orange production.

Methodology

Data Collection

The study was conducted in Ramechhap district of Nepal. The district lies within coordinates of 27.3554^0N latitude and 86.1345^0E longitude, at an altitude of 300 to 5000 masl and covers an area of 1,546 km^2. Three wards 6,7 and 8 of Ramechhap municipality were purposively selected for the study because the majority of the sweet orange growers were from these locations. The preliminary field visit was conducted to gather information regarding the demographic, socio-cultural, topographical setting and farming status of the site, which was helpful in preparing a schedule and designing a sampling framework. A simple random sampling technique without replacement was then used for the selection of the 100 Sweet Orange growers of the zone from the selected location.

Primary data was obtained through Household survey survey using pre-tested questionnaire. The collected data was analyzed to draw meaningful inferences about adoption of improved orchard management practices among farmers of Ramechaap district by using SPSS and MS Excel software.

Farmer's categorization

Farmers were categorized as small and large holder farmers based on the number of sweet orange trees on their farms. First, the mean of the sweet orange trees was calculated from the obtained data. Then the farmers having tree numbers greater than the mean were categorized as large farmers and less than the mean as small farmers. This concept of categorization was taken from the guidelines given by (FAO, 2017). Among the sampled farmers, 69% of them were categorized as small farmers and the rest 31% were large farmers (Table 1).

Table 1. Farmer's category based on the number of sweet orange trees in Ramechaap district, Nepal, 2021

Farmers type	Frequency
Small farmers	69 (69)
Large farmers	31 (31)
Total	100 (100)

Note: figures in parentheses resemble percentage
Source: Field Survey, 2021

Similarly, descriptive statistics such as frequency, percentage, were performed to establish the distribution of the variables. Independent t-test and chi-square test were conducted to test the significance differences in variables among small and large holders.

Characterization of adopter and calculation of adoption index

A total of nine orchard management practices were taken into the study viz FYM application, chemical fertilizer application, pruning, Bordeaux paste application, micronutrients application, irrigation, use of disease/pest control method, intercropping and mulching in the orchard. Arbitrary values 1 and 0 were assigned for the adoption and non-adoption of the practices. Then adoption score was calculated for each farmer to compute the adoption index. Adoption index is computed as;

$$\text{Adoption Index (AI)} = \frac{\text{Obtained Adoption score}}{\text{Maximum obtainable score}} * 100$$

Model Description

Multivariate linear regression analysis was done to assess the factors affecting adoption index,. The dependent variable, adoption index, was hypothesized as being influenced by a set of independent variables i.e. age (in years), gender (1= male, 0=otherwise), economically active family members, education (in years), institutional involvement (1= yes, 0=otherwise), training and extension services received (1= yes, 0=otherwise), access to input and services (1= yes, 0=otherwise) and total trees in the orchard. A multi-collinearity test was performed to assess the correlation between selected independent variables with one-another before regression analysis.

The model was developed in the form of:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

where Y denotes the dependent variable (adoption index), β_0 is the intercept, β_i is the regression coefficient of explanatory variables X_i and i = 1,2,3,….9

Problem ranking

A five-point scaling technique was used to measure the relative severity of production and hindrance to orchard management practices. The index was calculated using the following formula,

$$\mathbf{I} = \sum \frac{S_i * f_i}{n}$$

Where,

I= Index of Importance

Σ= summation

Si=Scale value at i^{th}severity/reason

f_i = frequency of the i^{th} severity given by sweet orange growers

n= total number of sweet orange growers

i = 1, 2, 3, 4, 5

Results

Socio and demographic characteristics of the respondent (continuous variable)

The socio-demographic characteristics (continuous variable) of the respondents are presented in Table 2. From the study, it was found the overall mean age was 49.09 years; it was 48.87 years and 49.58 years for small and large holders respectively. The overall mean number of family members was 6.62 and that in small and large holder farmers were 6.51 and 6.87 respectively. Similarly, the overall mean number of economically active family members was 3.91 and that in small and large holder farmers were 3.86 and 4.03 respectively. The farmer's category had significant association with education at a 5% level.

Table 2. Demographic characteristics of the respondents in Ramechaap district, Nepal, 2021

Variables	Overall mean (N=100)	Small Holder Farmers (n=69)	Large Holder Farmers (n=31)	Mean difference	t-value	p-value
Age of respondent (years)	49.09 (10.90)	48.87 (11.728)	49.58 (8.977)	-.711	.300	.741
Family size	6.62 (2.155)	6.51(2.234)	6.87 (1.979)	-.364	-.816	.417
Economically active members	3.91 (1.408)	3.86 (1.527)	4.03 (1.110)	-.177	-.653	.515
Education years	4.39 (4.280)	3.59 (3.821)	6.15 (4.767)	-2.551	-2.625	.012**

*Note: Figures in parentheses resemble standard deviation, ** indicates significance at 5% level*

Source: Field Survey, 2021

Likewise, Table 3 shows the details of categorical variables among large and small respondents. For both farmer categories, the majority of the respondents were male and there was significant association of gender with farmer's category. The percentage of respondents following Hinduism was greater for both categories (78.3% Small and 64.5% Large). However, in the case of ethnicity, the majority of the respondents were Chhetri (44.9%) followed by Janajati (34.8%) and Brahmin (20.3%) for the smallholder and for large holders, majority belonged to Janajati (48.8%) followed by Chhetri (38.7%) and Brahmin (12.9%).

Table 3. Socio-demographic characteristics of the respondent in Ramechaap district, Nepal, 2021

Variables	Overall mean (N=100)	Small Holder Farmers (n=69)	Large Holder Farmers (n=31)	Chi-square value	p- value
Gender of Respondent				5.131**	0.023
Male	81 (81)	60 (87)	21 (67.7)		
Female	19 (19)	9 (13)	10 (32.3)		
Religion of Respondent				2.100	.147
Hindu	74 (74)	54 (78.3)	20 (64.5)		
Buddhist	26 (26)	15 (21.7)	11 (35.3)		
Ethnicity of Respondent				1.856	0.395
Brahmin	18 (18)	14 (20.3)	4 (12.9)		
Chhetri	43 (43)	31 (44.9)	12 (38.7)		
Janajati	39 (39)	24 (34.8)	15 (48.8)		

*Note: figures in parentheses resemble percentages, ** indicates significance at 5% level*
Source: Field Survey, 2021

Landholding, trees in the orchard and productivity of the orchard

Regarding the land holding of the respondents, the overall mean of total land holding was found to be 0.850 ha while it was 0.722 ha for smallholders and 0.99 ha for large holders. Similarly, the mean land under sweet orange cultivation was found higher in the case of large farmers (0.394 ha) than small farmers (0.107 ha). Similar was the case for the total number of trees and productive sweet orange tree in the orchard. The average total number of sweet orange trees and productive trees in the orchard for large holders was found to be 149.35 and 113.13 for large farmers while it was 33.07 and 24.45 for smallholders. The average productivity differed by 2.848 mt/ha among large and small growers. Except productivity which is significantly associated at 5% level of significance with the farmer's category, other variables i.e total landholding, total land under sweet orange cultivation, total trees and productive trees had significant association with the farmer's category at a 1% level of significance (Table 4).

Table 4. Landholding, trees and productivity of sweet orange farmers in Ramechaap district, Nepal, 2021

Variables	Overall mean (N=100)	Small Holder Farmers (n=69)	Large Holder Farmers (n=31)	Mean difference	t-value	p-value
Total land holdings (ropani)	0.805 (0.3812)	0.722 (0.3525)	0.990 (0.3826)	-.2686	-3.325	.002***
The total land under sweet orange cultivation	0.195(0.1850)	0.107(.0533)	0.394 (.2186)	-.2870	-7.214	.000***
Total number of sweet orange trees	69.12 (78.46)	33.07 (18.455)	149.35 (99.5)	-116.282	-9.406	.000***
Total number of productive trees	51.94 (71.78)	24.45 (15.003)	113.13 (104.33)	-88.68	-4.71	.000***
Total sweet orange productivity (mt/ha)	9.783 (6.67)	8.90 (4.64)	11.75 (9.60)	-2.848	-1.570	.048**

Note: Figures in parentheses resemble standard deviation,
**** indicates significance at 1% level, ** indicates significance at 5% level*
Source: Field Survey, 2021

Institutional involvement and extension services received

Majority of respondents in both farmer's categories (small and large) were the members of farmer's group, cooperatives or any other agriculture based institutions. From Table 5, it can be generalized that large holder farmers have greater access to institutions, input services and trainings related to sweet orange farming.

Table 5. Institutional involvement and extension services received by respondents in Ramechaap district, Nepal, 2021

Variables	Overall mean (N=100)	Small Holder Farmers (n=69)	Large Holder Farmers (n=31)	Chi-square value	p-value
Involvement in Institution				6.644**	0.01
Yes	82 (82)	52 (75.4)	30 (96.7)		
No	12 (12)	17 (24.6)	1 (3.3)		
Input services received				15.194 ***	0.000
Yes	66 (66)	37 (53.6)	29 (93.5)		
No	34 (34)	32 (46.4)	2 (6.5)		
Training received					
Yes	33 (33)	16 (23.2)	17 (54.8)	9.691***	0.002
No	67 (67)	53 (76.8)	14(45.2)		

Note: Figures in parentheses resemble percentage,
**** indicates significance at 1% level, ** indicates significance at 5% level*
Source: Field Survey, 2021

Adoption Index

A total of 9 orchard management practices were taken for determining the adoption of orchard management practices among large and smallholder farmers. Based on practices adopted, the adoption index was calculated separately for the farmer category. And the study revealed that large farmers had higher adoption index (72.19) compared to small farmers (48.62). The result is presented in Table 6.

Table 6. Adoption index by farmer's category in Ramechaap district, Nepal, 2021

Farmer's Category	Adoption Index (Average)
Large Farmer	72.19
Small Farmer	48.62

Source: Field Survey, 2021

Adoption Index and Productivity

From Table 7, it was found that the productivity and adoption index were significantly correlated at 1% level of significance which indicates the likelihood of an increase in productivity with an increase in the adoption of orchard management practices.

Table 7. Correlation between adoption index and productivity of sweet orange in Ramechaap district, Nepal, 2021

		adoption index	productivity
Adoption index	Pearson Correlation	1	.338***
	Sig. (2-tailed)		.001
Productivity	Pearson Correlation	.338***	1
	Sig. (2-tailed)	.001	

**** indicates significance at 1% level*
Source: Field Survey, 2021

Orchard Management Practices

The study revealed that 100% of the respondents applied Farm Yard Manure (FYM) in their orchard. However, only 54.8% of large farmers and 31.9 % of small farmers knew the method and time of FYM application. Interestingly, chemical fertilizer and micronutrient application were only done by the large farmers. The percentage recorded for the practices mentioned were 22.6% and 48.4% respectively. In the case of irrigation, only 54.8% of

large and 13% of small farmers applied irrigation in their orchards. Farmers revealed the problem of water shortage and majority of them were dependent upon rain for irrigating their orchards. 90.3% of large farmers and 79.7% of small farmers practiced pruning in their orchards. According to them, the pruning practice is carried out during Jan/Feb month of the year. Likewise, 96.8% of large and 92.8% of small farmers practiced intercropping in their orchards. Vegetables, spices, cereals and legumes were the major intercrops practiced for intercropping by the farmers in the study area. Regarding disease/pest control, 87.1% of the large and 63.8% of the small farmers adopted pest control measures in their orchards. Similarly, Bordeaux paste application is mostly carried out by the farmers of the study area after pruning during Feb/ March month. It was found that 96.8 % of large and 73.9% of small farmers adopted the practice in their orchards (Table 8).

Table 8. Orchard Management Practices adopted by farmers in Ramechaap district, Nepal, 2021

Orchard Management Practices	Small Holder Farmers (n=69)		Large Holder Farmers (n=31)	
	Yes	No	Yes	No
FYM	69 (100)	0 (0)	31 (100)	0 (0)
Chemical fertilizer	0 (0)	69 (100)	7 (22.6)	24 (77.4)
Micronutrient	0 (0)	69 (100)	16 (48.4)	15 (51.6)
Irrigation application	9 (13)	60 (87)	14 (45.2)	17 (54.8)
Pruning	55 (79.7)	14(20.3)	28 (90.3)	3 (9.7)
Mulching	42 (60.9)	27 (39.1)	27 (87.1)	4 (12.9)
Intercropping	64 (92.8)	5 (7.2)	30 (96.8)	1 (3.2)
Pest control	25 (36.2)	44 (63.8%)	27 (87.1)	4 (12.9)
Bordeaux paste application	51 (73.9)	18 (26.1)	30 (96.8)	1 (3.2)

Source: Field Survey, 2021

Factors affecting adoption index (Model Prediction) of orchard management practices in Ramechaap district, Nepal, 2021

The eight independent variables which showed a strong correlation with the dependent variable were entered step by step in the regression model and all the variables significantly affected the adoption index. Initially low explanatory value at model one went on increasing with the addition of each next variable (even though with low values) and the highest explanatory power was observed in model 8.

Inclusion of traning and extension service received increased the explanatory power by 23% while addition to total sweet orange trees along with other 7 variables increased the explanatory power by 44%.

Looking at the best model, total trees in the orchard affected the adoption index at 1% level of significance, training and extension services received by the respondent affected the adoption index at 5% level of significance while age and education of the respondents affected at 10% level of significance. In the other words, one unit increase in age, education years, training and extensions services received and number of sweet orange trees in orchard of respondent increased the rate of adoption by 0.226, 0.525, 7.30 and 0.124 units respectively (Table 9).

Table 9. Model Summary for factors affecting adoption index in Ramechaap district, Nepal, 2021

Model	R^2	Adjusted R^2	Std. error of estimate	F-ratio	Significance
1	0.060[a]	0.051	18.162	6.268	0.014
2	0.064 [b]	0.045	18.214	3.338	0.04
3	0.163 [c]	0.137	17.313	6.248	0.01
4	0.167 [d]	0.132	17.366	4.762	0.02
5	0.267 [e]	0.228	16.377	6.848	0.000
6	0.347 [f]	0.305	15.540	8.238	0.000
7	0.428 [g]	0.385	14.617	9.852	0.000
8	0.620 [h]	0.587	11.977	18.593	0.000

Source: Authors' illustration

[a]Predictors: (Constant), Age of respondent
[b]Predictors: (Constant), Age of respondent, Gender of respondent
[c]Predictors: (Constant), Age of respondent, Gender of respondent, Education years
[d]Predictors: (Constant), Age of respondent, Gender of respondent, Education years, economically active family members,
[e]Predictors: (Constant), Age of respondent, Gender of respondent, Education years, economically active family members, Involvement in farmer's group,
[f]Predictors: (Constant), Age of respondent, Gender of respondent, Education years, economically active family members, Involvement in farmer's group, Input support received,
[g]Predictors: (Constant), Age of respondent, Gender of respondent, Education years, economically active family members, Involvement in farmer's group, Input support received, Training and extension service received,
[h]Predictors: (Constant), Age of respondent, Gender of respondent, Education years, economically active family members, Involvement in farmer's group, Input support received, Training and extension service received, Total number of sweet orange trees in the orchard.

Table 10. Coefficient of Independent variable included in model 8

Model 8		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	21.870	7.408		2.952	.004
	Age of the respondent	.226	.122	.132	1.854	.067*
	Gender of the respondent	3.541	3.223	.075	1.099	.275
	Education_years	.525	.300	.121	1.753	.083*
	Economically active family members	-.241	.885	-.018	-.273	.786
	Are you involved in any farmers group/co-operative/ organization	5.313	4.185	.110	1.270	.207
	have you recieved input and services from different organization	5.176	3.633	.132	1.425	.158
	Have you ever recieved training and extension services	7.300	2.830	.185	2.579	.012**
	Total no of trees in the orchard	.124	.018	.522	6.785	.000***
a. Dependent Variable: adoption index						

**** indicates significance at 1% level, ** indicates significance at 5% level*
Source: Authors' illustration

Reasons for lack of orchard management practices

Respondents were asked to rank the provided reasons from 1 to 5 where 1 was signified as the most important reason and 5 as the least important. The study revealed (Table 11) that the high cost of orchard management was the most important reason for large growers and lack of technical know-how was found to be the most important reason for lack of orchard management practices among small growers. Likewise, time-consuming nature of orchard management practices was the least important reason for both large and small growers.

Table 11. Reason for lack of adoption of orchard management practices among farmers in Ramechaap district, Nepal, 2021

Reasons	Small Grower		Larger Growers	
	Index	Rank	Index	Rank
Orchard management practices are time-consuming	0.3536	V	0.577806	V
Orchard management practices are costly to adopt	0.814493	II	0.805677	I
Lack of technical know-how about management practices	0.889855	I	0.705548	IV
Lack of availability of skilled labor	0.565217	III	0.735484	II
Orchards nearby don't follow any orchard management practices	0.376812	IV	0.718968	III

Source: Field Survey, 2021

Production Constraints of Sweet Orange

Production constraints were analyzed separately for large and small growers. Respondents were asked to rank the problems between 1 to 7, 1 being the most important problem and 7 as the least important problem. Analysis of the obtained data was done to find the major problem among large and small growers respectively. From Table no. 13, it was found that lack of irrigation facilities was the major problem for the large growers followed by disease pest severity. In case of small holders, the disease/ insects severity is the major problem while lacking cold storage facilities was found to be the least important problem among the small growers (Table 12).

Table 12. Sweet orange production constraints in Ramechaap district, Nepal, 2021

Reasons	Small Grower		Larger Growers	
	Index	Rank	Index	Rank
Lack of proper planting materials	0.399586	VI	0.400922	VI
Lack of Irrigation facilities	0.761905	II	0.764977	I
Heavy infestation of disease and pest	0.921325	I	0.728111	II
Attack of wild animals on the orchard	0.652174	III	0.654378	IV
Climatic Constraints	0.407867	V	0.419355	V
Lack of technical support	0.627329	IV	0.37788	VII
Lack of cold storage facilities	0.229814	VII	0.677419	III

Source: Field Survey, 2021

Discussion

Technology adoption is a process characterized by a certain level of heterogeneity as new technologies are not equally adopted by all farmers. Those farmers who become early adopters can foster a competitive advantage over those who do not adopt them or become late adopters (Foster & Roseenzweig, 2010). For enhancing the productivity of any farm, the adoption of better management practices becomes a prerequisite. The positive correlation between the adoption index and productivity obtained in our research is in accordance with Jain et al. (2009), who argues that the adoption of scientific management practices is crucial for increasing productivity in farm businesses. A similar result was obtained in a research study carried out by Tiamiyu et al., (2009) where an increase in the adoption of complementary technology increased the productivity of rice.

The adoption of technology by farmers depends upon farmers' needs and several other economic, social, political, institutional and policy factors. Also, the technology must fit the complex pattern of agricultural dynamism in which every actor for whom the technology is designed must participate (Sennuga et al., 2020). The large and small farmers differ in many such aspects. There is a difference in technology adoption by large and small farmers and our study represented the case via the adoption index. The low adoption index of small farmers compared to large farmers may be accounted for differences in education level, access to input and extension services received, farm size and other resources available to the farmers. Bargali et al., (2007) also attributed lesser land holding, limited resources and moderate literacy level to the low adoption index of small farmers. A study done by Akila & Chander, (2012) also supported the fact that better socioeconomic status of large farmer and better knowledge level of large farmers make them better at technology adoption while Hoang et al., (2022) stated that large farmers had more ideas regarding crop management practices than small farmers.

Our findings suggest that the education of the respondent significantly influenced the adoption index. The result is consistent with Ghimire et al., (2015) as they reported that the increase in education level increases the level of awareness among the farmers; thus farmers are more likely to adopt better technology. Further, education affecting the level of adoption is supported by studies made by (A. Adhikari et al., 2021; Dhakal et al., 2015; Belbase et al., 2020).

Likewise, the number of trees in the orchard significantly affected the adoption index. This might be because farmers with larger landholding are more conscious about increasing production, taking a risk in adopting new technology and are the center of attraction of government organizations for receiving more subsidies. Wordofa et

al., (2021) state similar reasons for new technology adoption by farmers with a high number of livestock on their farms.

Age is significant because it impacts how individuals adopt new ideas and comprehend information and our study showed a positive influence of age on the adoption index. The result is in accordance with the study of Mignouna et al., (2011) in which they stated that the farming experience of farmers, better knowledge related to management practices, etc. is enhanced with their age; positively impacting technology adoption. However, an explanation by Asfaw et al. (2012) says that young farmers are more innovative and have more likelihood to take the risk, there are also cases where they are found to be more likely to adopt technologies better.

Extension and training received by farmers affect technology adoption. The positive coefficient of the extension contact variable in the study by Odoemenem & Obinne, (2010) suggests that a higher intensity of extension services offered to farmers leads to an increase in adoption levels. A consistent and frequent interaction between extension personnel and farmers can enhance farmers' knowledge and awareness of the benefits of improved agricultural innovations. A similar result was obtained in the study done by A. Adhikari et al. (2021)

Our study revealed the lack of technical knowledge and the high cost of input material being the major important reasons for the lack of practice of orchard management practices. A study carried out by Belbase, Tiwari, Baral, Banjade, & Pandey (2020) showed that many of the farmers didn't adopt the management practices and lack of irrigation, insect and disease, training, lack of labor and cost of input were encountered during the adoption of improved mandarin orchard management practices. However, a lack of technical guidance and assistance has led to poor adoption of orchard management practices in the citrus orchards of Nepal (Prasad & Dhakal, 2019). So, strengthening the literacy program, timely availability of training based on felt need and provision of subsidies to the farmers might encourage them towards cultivation as well as the adoption of improved orchard management practices (Belbase et al., 2020b).

Conclusion

We found a significant association of small and large sweet orange growers category of farmers with various socio-demographic characteristics such as gender, education level, landholding, sweet orange cultivation, orchard productivity, institutional involvement and training and extension services received. The study found that large farmers had a higher adoption rate and greater productivity in comparison to small holders and there was a positive correlation between adoption index and orchard productivity. Among 9 orchard management practices taken under study, the adoption of micronutrient and chemical fertilizers practices was primarily limited to large farmers.

The study also identified several variables, such as age, gender, education level, institutional involvement, input services received and total trees in the orchard, as crucial factors that influenced the adoption of orchard management practices. More precisely, the probability of adoption was found to be impacted by age, education level, training and extension services and total trees in the orchard. Lack of technical knowledge and the high cost of input materials were major limitations that hindered orchard management practices among small and large farmers, respectively.

The findings suggest that increased commercialization and economies of scale are important in encouraging adoption of better management practices for increasing sweet orange productivity. Furthermore, farmers should be encouraged to adopt proper orchard management practices, while stakeholders should provide adequate support to growers, regardless of their farm size, in terms of extension facilities, input services and timely assistance. The study also emphasized the need for concerted efforts from the government, technical experts and farmers to address critical issues such as the lack of irrigation facilities and high disease pest infestation, which were prioritized by farmers.

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Conflict of Interest

The authors have no conflict of interest.

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