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Research Article

Farmers' perception about major insect pests of cucurbits and their management in Arghakhanchi, Nepal

Nikita Parajuli[1*], Kapil Khanal[1], Anish Nepal[1] and Bipin Bastakoti[2]

[1]Agriculture and Forestry University, Rampur, Chitwan, Nepal
[2]Mississippi State University, Mississippi, USA

*Correspondence: parajuli.nikita1999@gmail.com
*ORCID: https://orcid.org/0009-0003-4620-421X

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ABSTRACT

Cucurbits are important vegetable crops widely cultivated in subtropical and tropical regions, including Arghakhanchi, Nepal. To understand farmers' perceptions on major insect pests of cucurbits and their management in this region, a survey was conducted from February 2023 to May 2023 in Sandhikharka municipality and Chhatradev rural municipality, involving 110 selected respondents applying a stratified random sample method. Data were gathered through focus group discussions (FGD), key informant interviews (KII), and preliminary field visits. Secondary data were collected and analyzed. The results revealed that farmers ranked insect pests and diseases as their most severe problem, with an index value of 0.892, while climate change was the least severe, with an index value of 0.337. Red pumpkin beetle was identified as the most severe insect pest at the seedling (69.1%) and vegetative stages (50.9%), while fruit flies were most severe at the fruiting stage (79.1%). The 67.3% of the respondents reported a moderately increased occurrence of insect pests compared to past years. Most farmers (90%) relied on chemical pesticides, followed by mechanical, cultural, botanical, and physical methods for pest control. However, only 23.6% of farmers knew about Integrated Pest Management (IPM), with a low level of IPM adoption at 40.9%. The study highlights the potential for enhanced cucurbit production if farmers are provided with IPM knowledge, technical support, and improved irrigation facilities.

Keywords: Cucurbits, Insects, Management, IPM, Adoption

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INTRODUCTION

Nepal is a predominately agricultural country. The agriculture sector has always been a key component in the Nepalese economy contributing 24.9% to the national Gross domestic product (GDP) (MoALD, 2022). Cucurbits that belong to the family Cucurbitaceae are sown, grown, and harvested over spring, summer, and autumn. Cucurbits include bottle gourd, ash

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gourd, cucumber, sponge gourd, snake gourd, pumpkin, bitter gourd, ridge gourd, and summer squash. Among these, Cucumber is Asia's fourth most significant vegetable crop after tomato, cabbage, and onion, and Western Europe's second most important crop after tomato.

Out of 19,898 Mt of vegetables produced in the Arghakhanchi district, Cucurbits contribute to 3.65% (727Mt) (MoALD, 2022). Due to severe infestation of insect pests, Cucurbits production has become risky and caused heavy economic losses to farmers through a reduction in yield (Srivastava & Joshih, 2021) increased cost of production (Karki *et al.*, 2023), and lowered quality of produce. They cause leaf defoliation, flower abortion, and fruit damage. Apart from causing direct damage many insect pests also act as vectors for several viral diseases (Bastakoti, 2024). The major cucurbits found in the survey sites were cucumber, bottle gourd, bitter gourd, sponge gourd, and pumpkin, while red pumpkin beetle, whitefly, and, fruit fly were the major insect pests of cucurbits. A pest is any organism whose population often increases above a certain level of economic injury and its existence conflicts with man's welfare, convenience, and profits.

According to (Smith, 1966) "Integrated pest management is a pest population management system that utilizes all suitable techniques in a compatible manner to reduce pest populations and maintain them at levels below those causing economic injury."

Agriculture is undoubtedly a highly profitable sector but simultaneously loaded with diverse risks and problems (Giri *et al.*, 2022). Overviewing the scenario of Arghakhanchi district and the whole nation, the per capita domestic supply of fresh cucurbits production is declining in ratio. In Arghakhanchi district, cucurbit production is below potential while having enormous prospects. This decline has been driven mainly due to a high prevalence of insect pests in cucurbits. To protect their crops, farmers in the region have developed various local management strategies, including the use of traps, botanicals, and cultural practices. However, there is limited information on the effectiveness and sustainability of these strategies, as well as their potential impact on human health and the environment.

Various research had been conducted in the Arghakhanchi district regarding the value chain analysis of cucumber which concluded that the benefit-cost ratio was higher in the case of Bhaktapur Local (3.18) followed by hybrids (2.44) (Khanal & Dhakal, 2020) and efficacy of growth regulators in cucurbits but these research didn't assess the information regarding farmers' perceptions about insect pests of cucurbits and their management in Arghakhanchi. Studies on management methods followed by farmers are still lacking (Ghimire *et al.*, 2022). Several types of research have been carried out in respect of either chemical or botanical pesticides in the crop (Ali *et al.*, 2011) however research on effective management strategies of insect pests of cucurbits has been limited. Farmers have less knowledge of pests, their modes of damage, and effective management techniques, which have an impact on productivity (Bastakoti *et al.*, 2024). Use of impure seed of the same susceptible variety, higher crop density, use of fertilizer without considering the recommended rate, and other traditional cultural practices cause the growth and development of insect pests and extensive use of chemical pesticides instead of bio-pesticide, selection of inappropriate pesticides, incorrect timing of application, and improper doses causes a financial burden on farmers as well as the nation as a whole (Tripathi *et al.*, 2020) and exacerbates the issues of pesticide resistance, loss of natural enemies, the resurgence of the resistant pest population, imbalanced ecosystems, and reduction in crop yield and lower the net profit in the long run.

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Several approaches to managing insects have been used in Nepal. Nevertheless, farmers are either unaware of or unable to obtain other methods on their own that are affordable and carry lower risks to people and the environment.

This study will be helpful to know the perception of farmers about major insect pests of cucurbits, and various management practices used by them which will help the farmers to adopt sound management practices and discard the wrong traditional practices. This will also help the farmers to know about the insect-growing climate and causes of insect pest infestation, their damage extent, and symptoms so that they can apply suitable management tactics to reduce the losses. Furthermore, the assessment of insect pest management practices will serve to distinguish between management practices followed and ideal practices to be followed. As a result, it will serve to suggest improvement in existing management practices. Finding out the chemical use rate will be helpful for the governmental organization to implement different programs like IPM training, safety training during pesticide application, and technical information about pests and their management according to their knowledge level. This will ultimately benefit the farmers by reducing the loss by insects using a suitable IPM approach according to the situation and help to increase the yield and thereby livelihood of the rural farmers. The findings will be beneficial during the formulation of policies by the Prime Minister Agriculture Modernization Project (PMAMP), Agriculture Knowledge Center (AKC), Ministry of Agriculture and Livestock Department (MOALD), and Plant Protection Department (PPD) to adopt ecological, environmental, and economically sound crop production practices.

MATERIALS AND METHODS

Study site

The study was conducted in Arghakhanchi, a typical mid-hill district of Lumbini province, Nepal, which exhibits immense climatic potential to produce different types of crops. The district has a total area of 1,193 km^2, with latitudes of 27’45” N-28’6” N and longitudes of 80’45” E-83’23” E, and altitudes vary from 305 to 2,515 masl. The average annual rainfall is approximately 1600mm.

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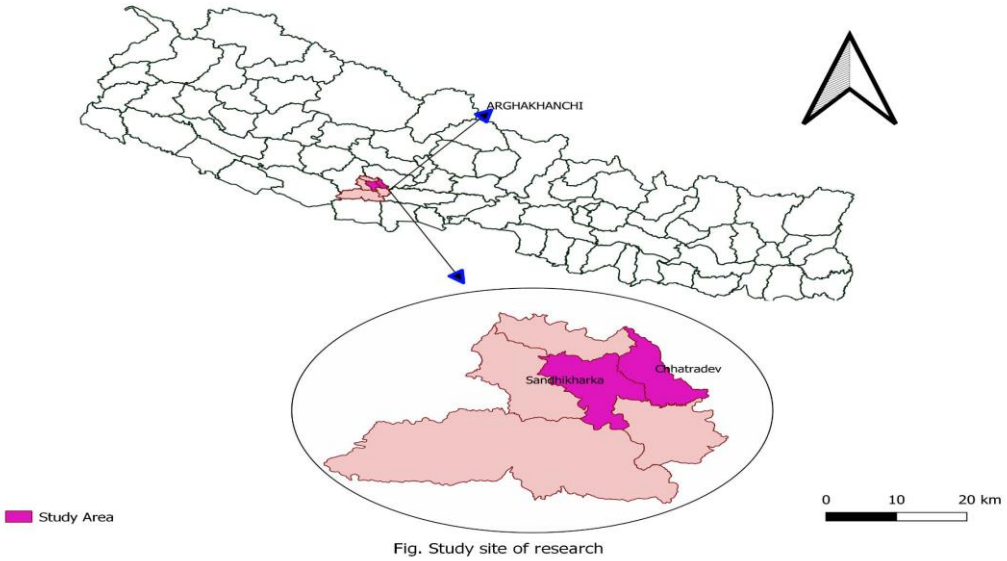

Figure 1: Map of Nepal showing study site
Source: (National Geoportal, Nepal. Edited on QGis version 3.16)

The study was conducted at the local levels mainly in Sandhikharka Municipality and Chhatradev Rural Municipality. These sites were purposively selected as they were the principle vegetable-producing regions of Arghakhanchi districts and were also under the working area of PMAMP, PIU, and vegetable zone, Arghakhanchi.

Sample size and sampling technique:
The research was carried out from February 2023 to May 2023 at Arghakhanchi district. Cucurbit growers of the study site were the target population for the study. A list of all the registered number of vegetable growers was obtained by AKC and PMAMP zone of Arghakhanchi district. It was used as a sampling frame to select respondent farmers. Under the criteria of year-round cucurbit production and cultivation done at least 1.5 ropanies of land, farmers were selected.

The registered number of vegetable growers in the study area was 536 according to the database of AKC & PMAMP, containing both large-scale farmers and small-scale farmers. The sample size of 206 matched the criteria. By using the sample size formula from Roasoft at a 6% margin of error and 95% level of confidence, 110 was obtained as sampling number for survey. The samples were drawn by the stratified random sample technique method. This sample size was distributed to the Chhatradev Rural municipality and Sandhikharka municipality.

Data collection
A preliminary study was carried out before the main survey to collect various socio-economic, demographic, and geophysical conditions of the study sites. The household survey was conducted by a face-to-face technique using a semi-structured pre-tested interview schedule. Key Informant Interview (KII) was conducted with progressive farmers, farmer leaders, managers of private farms, and local extension workers to seek some key information

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about the overall trend of insect pest severity, and IPM strategies adopted by farmers for controlling insect pests of cucurbits in the study area. Focus Group Discussion (FGD) was conducted at the research site with the help of a checklist to verify the results obtained from the field survey. Field observation was done at different times on the site to witness the situation which was useful in verifying the information from the household survey.

Data Analysis:

The collected data was coded, entered, and analyzed by using SPSS version 25 (Statistical Package for Social Science) and MS Excel software 15. Data was analyzed by using statistical tools like descriptive statistics, frequency distribution, trend analysis, mean comparison, etc.

To study whether the two variables were independent or associated with each other; chi-square will be applied. This test was used to determine farmers' perceptions of severity of insect pests and, effectiveness of insect pest management practices, and methods of insect pest management.

$$X^2 = \sum \frac{(oij - eij)2}{eij} \quad \text{.....(1)}$$

Where, χ^2 = Chi-square

o_{ij}= observed frequency of each ij^{th} term
e_{ij} = indicates expected frequency of ij^{th} term
i= 1, 2, 3..... r
j= 1, 2, 3.....k

The problems related to the production of cucurbits in Arghakhanchi were identified by household surveys. Five-point scaling technique was used to measure the relative severity of production problems. Farmers' perceptions on the importance given to the different production constraints were analyzed by using 5-point scale of constraint indicating major factor or problem (1) to minor factor or problem (0.2). Indexing was also used in the ranking of major insect pests, and their infestation on cucurbits.

The index of importance was computed by using the formula (Miah, 1993):

$$I_{imp} = \sum \frac{Sifi}{N} \quad \text{.....(2)}$$

Where,
I_{imp} (index of importance) = 0<I<1
$\sum$ = summation
S_i= i^{th} scale value
F_i= frequency of i^{th} importance given by the respondents
N = total number of respondents

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Figure 2: Scale of Rating

A scaling technique was applied to identify the major insect pests in maize in the Sindhupalchok district of Nepal. The adopters of the IPM technology were classified under three categories as either low, medium adopter, or high adopter by using the Adoption Index (AI). The adoption index was calculated from the adoption scores. Based on the AI, the respondents were grouped into three categories i.e., low (less than mean minus SD), medium adopters (mean minus SD to mean plus SD), and high adopters (mean plus SD). The degree to which an innovation is adopted by the farmer is the adoption index.
Adoption Index will be calculated as (Dongol, 1979) :

$$\text{Adoption Index (AI)} = \frac{\text{TAS}}{\text{MSO}} \text{X } 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where.
AI: Adoption Index
TAS: Total adoption score obtained by an individual farmer.
MSO: Maximum score one can obtain

Adoption index was applied by (Dhital & Joshi, 2016) to determine the factors affecting adoption of recommended cauliflower production technology in Nepal.

RESULTS AND DISCUSSION

Socio-economic profile of respondents

Out of 110 respondents, a significant majority, constituting 82.7% were men while about 17.3% were female (Table 1). It revealed that cucurbit farming and decision-making were primarily dominated by men, while women were mainly engaged in household activities.

Agriculture was found to be the major occupation of the sampled household i.e. 91.8% followed by Business at 3.6% and Government service and non-government service, each of which contributed to 1.8% and others at 0.9%. It was found that there were no significant differences in gender composition and occupation status between Sandhikharka and Chhatradev. This shows the adoption of agriculture as their main occupation in Arghakhanchi, which is significantly higher than the national number of 70.4 % (CBS, 2021). 52.7 % of the farmers had no alternate source of occupation (Table 1).

The education level of the farmers affects the way of vegetable farming and practice of pesticide use along with alternative methods of pest management The educational status of

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the respondents revealed that about 36.4% of the respondents had school-level certificates followed by Lower secondary level (14.5%), +2 (13.6%), Literate 13.6%), Primary class (10%), Bachelor (10%), and Illiterate (1.8%) and Sandhikharka and Chhatradev were found to be significantly different at 1% level of significance. It portrayed that the majority of the cucurbits growing farmers in the study area were educated with a considerable proportion of the illiterate population. A study found that farmers with higher levels of education contribute to increased crop production and a reduction in land fragmentation, to some degree (Guo *et al.*, 2015)

Majority of the households belonged to Brahmin/Chhetri (77.3%) which is higher than the national data of 27.74% (CBS, 2021) followed by Janajati/Adhibasi (11.8%), Dalit (9.1%), and others (1.8%).

Table 1: Socio-economic profile of respondents

Variable	Sandhikharka	Chhatradev	Overall Response Frequency (%) (n=110)	Chi-square (χ^2)	P-value
	Response Frequency (%) (n=80)	Response Frequency (%) (n=30)			
Gender					
Male	67(83.8)	24(80)	91(82.7)	0.215	0.643
Female	13(16.3)	6(20)	19(17.3)		
Major Occupation					
Agriculture	72(90)	29(96.7)	101(91.8)	5.772	0.217
Government service	2(2.5)	0	2(1.8)		
Non-Government service	2(2.5)	0	2(1.8)		
Business	4(5)	0	4(3.6)		
	0	1(3.3)	1(0.9)		
Level of education					
Illiterate	2(2.5)	0	2(1.8)	18.973***	0.004
Primary class	5(6.3)	6(20)	11(10)		
Lower Secondary	11(13.8)	5(16.7)	16(14.5)		
SLC	35(43.8)	5(16.7)	40(36.4)		
+2	13(16.3)	2(6.7)	15(13.6)		
Bachelor	8(10)	3(10)	11(10)		
Literate	6(7.5)	9(30)	15(13.6)		
Ethnicity					
Brahmin/Chhetri	55(68.8)	30(100)	85(77.3)	12.132***	0.007
Janajati/Adhibasi	13(16.3)	0	13(11.8)		
Dalit	10(12.5)	0	10(9.1)		
Other	2(2.5)	0	2(1.8)		

Note: Figures in the parentheses indicate percentage (%). *** indicates significance at 1% level.
(Source: Field survey, 2023)

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Chemical methods to control cucurbits insect pests

Majority of the respondents adopted chemical methods by applying different chemicals such as Dimethoate, Cypermethrin, Imidacloprid, Malathion, and Chlorpyriphos+Cypermethrin, which were the major pesticides applied by the farmer to control insect pests of cucurbits, were obtained through field survey. 86.9% of the respondents used chlorpyriphos+cypermethrin to control insect pests which was higher in Sandhikharka (91.4%) as compared to Chhatradev (75.9%). The other commonly used chemicals are Imidacloprid (75.8%), followed by Dimethoate (37.9%), which was found to be higher in Chhatradev than in Sandhikharka. Few of the respondents (22.2%) used dimethoate for insect pest control. It was determined that Sandhikharka and Chhatradev were found to be statistically significant for chemical management practices at 1% level of significance. This result is in line with the findings of (Ghimire *et al*., 2022).

Most farmers were inclined toward commercial production and, to boost productivity, they quickly embraced chemical methods over other alternatives. They trusted chemical pesticides to control pests faster than biological methods, and the easy availability of these chemicals in the market further steered them toward their use. Considering the time of pesticide application, out of 99 farmers who adopted chemical method, majority of (63.6%) farmers sprayed pesticide just after the insect attack and 36.4% sprayed only at the insect severity time. (Ghimire *et al.,* 2022) reported that only 34 % of farmers apply pesticides at the severity stage which is in line with this finding. With regards to the estimation of dose of pesticide, most of the farmers (78.8%) followed the recommendation of Agro-vets, and 21.2% estimated themselves based on the experience and label indicated on the bottle. This study shows that Agro-vet has high influence on farmers regarding the estimation of dose of pesticide. A similar result was found in a research conducted in 2018 within the Chitwan district, it was observed that farmers exhibited a preference for relying on agricultural veterinarians for information (Rijal *et al.,* 2018).

Table 4: Adoption status of chemical method for insect pest control

Variable	Sandhikharka	Chhatradev	Overall Response frequency (%) (n=110)	Chi-square (χ^2)	P-value
	Response frequency (%) (n=80)	Response frequency (%) (n=30)			
Chemical method					
No	10(12.5)	1(3.3)	11(10)	2.037	0.154
Yes	70(87.5)	29(96.7)	99(90)		
Commonly used chemicals					
Dimethoate	11(15.7)	11(37.9)	22(22.2)		0.021
Chlorpyriphos+ cypermethrin	64(91.4)	22(75.9)	86(86.9)	13.227**	
Cypermethrin	23(32.9)	12(41.4)	35(35.4)		
Imidacloprid	51(72.9)	24(82.8)	75(75.8)		
Malathion	47(67.1)	16(55.2)	63(63.6)		
Pesticide application time					
Just after the insect attack	45(64.3)	18(62.1)	63(63.6)	0.044	0.835
Only at the insect severity time	25(35.7)	11(37.9)	36(36.4)		

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Variable	Sandhikharka	Chhatradev	Overall Response frequency (%) (n=110)	Chi-square (χ^2)	P-value
	Response frequency (%) (n=80)	Response frequency (%) (n=30)			
Dose of pesticide					
From Agro-vets	57(81.4)	21(72.4)	78(78.8)	0.997	0.318
Estimate Myself	13(18.6)	8(27.6)	21(21.2)		

Notes: Figures in parentheses indicate percentage (%). ** indicates significance at 5% level.
(Source: Field survey, 2023)

IPM practice in management of cucurbits insect pests

The study showed that, 23.6% of farmers had knowledge of IPM and adopted it, whereas 76.4% of the respondents neither had knowledge nor adopted it, reflecting a lack of training on IPM among vegetable growers. The extent or rate of adoption of IPM is presented in Table 5. The detailed adoption level of selected method is depicted in table 5. The rate of adoption was classified into three levels namely low, medium, and high levels based on the average adoption index. The average adoption index was 56%. A low level of adoption was indicated by respondents; average adoption index below 56%, medium level of index was found between 56% to 74% and high level of adoption index was more than 74%. Low level of adoption was found higher (40.9%) followed by medium level (39.1%) and high level (20%) of adoption of IPM. So the study revealed that majority of the respondents were found to be low to medium level (80%) of adoption of IPM. Despite the implementation of national IPM Training Program (Farmers Field School) since the mid-1990s in Nepal, low adoption of IPM practices suggests a communication gap among government extension organizations, related agencies, and farmers. This scenario clearly showed a need for education and training programs for farmers and government employees through community or other forms of IPM programs.

Table 5: Level of adoption and adopters category

Variables	Frequency	Percentage (%)
Knowledge about IPM		
No	84	76.4
Yes	26	23.6
Extent of adoption of the respondents		
Low level (less than 56%)	45	0.9
Medium level (56% to 74%)	43	39.1
High level (more than 74%)	22	20

(Source: Field survey, 2023)

Problems ranking of farmers major constraints to cucurbits farming

Five major problems were identified from key informant interviews and farmers were asked to rank them on the basis of severity from the most severe problem to the least one. Farmers ranked insect pests and disease as most severe problem with index value (0.892),Technical know-how as highly severe, lack of irrigation facilities as moderately severe, Labor unavailability as less severe and Climate change as least severe problem with index value(0.337) in rank I, II,III,IV and V respectively, are presented in the table 6. (Tripathi *et*

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al., 2020) reported a similar field observation, which concluded that 73% of respondents considered insect pests and disease as major constraints to cucurbits farming which aligns with the findings of the current study. Each year, these diseases and insects result in approximately a 50% economic loss in fresh vegetable production, and in certain regions, this loss can escalate to as much as 90%.

Table 6: Problems ranking of farmers major constraints to cucurbits farming

Problems	Most Severe	Highly severe	Moderately severe	Less severe	Least severe	Weight	Index	Rank
	1	0.8	0.6	0.4	0.2			
Insect pest and disease	64	35	10	0	1	98.2	0.892	I
Technical know-how	16	27	52	12	3	74.2	0.674	II
Lack of Irrigation facilities	24	29	24	21	12	72.4	0.658	III
Labor	5	14	15	45	31	49.4	0.449	IV
Climate Change	2	5	9	32	62	36.6	0.337	V

(Source: Field survey, 2023)

CONCLUSION

Red Pumpkin beetle was considered as most severe insect pest at seedling and vegetative stage whereas Fruit fly was perceived as most severe insect at fruiting stage. Majority of the respondents adopted chemical method. This study showed the current status of cucurbits and their insect pest management in Argakhanchi district of Nepal. This study showed that the most of the farmers have adopted chemical methods. The reason behind this was due to quicker control of insect pests than biological methods, and the easy availability of chemicals in the market. Chlorpyriphos + cypermethrin, Imidacloprid, Malathion, Cypermethrin, and Dimethoate were some of the major pesticides used in the study area. Few respondents were found to be using alternative management methods besides insecticides such as use of traps, lures, mulching, crop rotation biological pest management, and IPM. It was noted that only few respondents were aware of IPM which was mainly through training. This indicates that few farmers attended the training related to IPM and reflect the need of training in the study related to IPM. Low level of IPM adopters were more followed by medium and high-level of adopters. Higher percentage of low level of adopters of IPM revealed there is need of training regarding the IPM.

Majority of respondents followed the recommendation from Agro-vets while chemical pesticides application whereas only few respondents estimated the dose themselves. This revealed that more farmers relied on Agro-vets for technical information in line with those estimate themselves based on the experience and the label indicated on the bottle. This study concludes that insect pests and disease severity were one of the prominent constraints to cucurbit farming whereas fruit flies were more prominent in terms of severity. Most of the farmers used at least one protective measure i.e. Mask. Gloves and long pants as they were

more aware of harmful effects of pesticides.

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Authors' Contributions

Conceptualization and methodology: Nikita Parajuli and Kapil Khanal
Software and validation: Nikita Parajuli and Kapil Khanal
Formal analysis and investigation: Nikita Parajuli, Anish Nepal, Bipin Bastakoti,
Resources: Nikita Parajuli
Data curation: Nikita Parajuli,
Writing-original draft preparation: Nikita Parajuli,
Writing revised draft and editing: Nikita Parajuli, Kapil Khanal, Anish Nepal, Bipin Bastakoti
Supervision: Nikita Parajuli and Kapil Khanal.

All authors have read and agreed to the publication version of the manuscript.

Conflicts of interest

The authors declare no conflict of interest.

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