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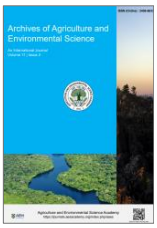

Original Research Article

Assessment of farmers' knowledge, attitude, and practices towards pesticide use in Gauradaha Municipality, Jhapa, Nepal

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ABSTRACT

Pesticides play an important role in Nepalese agricultural production by influencing both the quality and quantity of output. However, inappropriate and excessive use can pose serious environmental and human health risks. In Nepal, farmers are exposed to these chemicals directly or indirectly, often unaware of the associated environmental and health concerns. The study aimed to assess knowledge, attitudes, and practices regarding pesticide use among farmers. A descriptive cross-sectional study was conducted among 180 farmers in the Gauradaha municipality of Jhapa district, Nepal. Self-constructed, mixed-structured questionnaires and in-person interviews were used to collect data, which were then analyzed using SPSS. The majority of respondents (86.1%) learned about pesticides from Agrovet, and 75.6% viewed pesticides as poison. Understanding of pesticide labels and toxicity concepts was limited, with 68.3% never reading the instructions before applying. 58.9% had inadequate knowledge of pesticides, yet 51.7% maintained a favorable attitude toward their use. 56.1% used unsafe pesticide-handling practices. The variation in knowledge by practice was statistically significant (p-value = 0.001, which is < 0.05). Hence, we found significant gaps in knowledge regarding pesticide use. Lack of awareness led to poor pesticide practices, and respondents with better knowledge tended to have more favorable attitudes toward safe pesticide use. Level of education plays an important role in improving knowledge, favorable attitudes, and promoting safe practices of pesticide use among farmers. These findings emphasize the need to provide education and training to farmers for the safety of both farmers and the environment.

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INTRODUCTION

Pesticides are chemicals that are used to suppress several kinds of pests. Even though pesticides increase productivity in both quantity and quality, they have also threatened ecosystems and had detrimental effects on human health worldwide. The use of pesticides has surged in developing nations over the past few years, and these nations currently bear the bulk share of the global pesticide spending, at 20% (Oesterlund *et al*., 2014). They are broadly used in progressing countries, and because the recent crop production system places a premium on high agricultural yields, there is a growing need for them (Abaineh *et al*., 2023). Every year, more than 4 million tons of pesticides are used globally. Unfortunately, this figure is only anticipated to rise because of the growing global population's need for more food from shrinking agricultural areas with declining soil health (Bhandari *et al*., 2021). According to a survey in Nepal, it applies 0.396 kg of pesticides a.i./ha on average (Atreya *et al*., 2022). Studies show that the cultivation of vegetables accounts for more than 90% of all pesticide usage in Nepal (Ranabhat

et al., 2021). All elements of the ecosystem, including people, animals, and insects, are at risk from pesticides. Pesticide exposure among farmers is substantial, especially in rural areas. Incorrect perceptions and a lack of knowledge and education among farmers have been identified as some of the key causes of pesticide application safety precautions not being implemented (Zineb *et al*., 2021). Farmers frequently lack precise knowledge about how to use pesticides safely; as a result, unsafe practices like under dosing and frequent applications, unsafe handling techniques, ineffective sprayer maintenance, and the use of contaminated equipment are typically observed, especially among farmers in developing nations (Sharifzadeh & Abdollahzadeh, 2021) . Pesticide-related risks could be made worse by a lack of knowledge about pesticide hazards, farmers' attitudes and perceptions of the risk of pesticide exposure, a lack of education, and a lack of awareness of safe pesticide use procedures, such as handling, storage, and disposal (Adesuyi *et al*., 2023). Several researchers found a strong correlation between farmers' attitudes, knowledge, and perceptions regarding the use and application of pesticides (Ganaie *et al*., 2022). In numerous nations, educational initiatives have demonstrated efficacy in advancing farmers' awareness of and adherence to safe pesticide practices (Maddah *et al*., 2020). Therefore, understanding the farmers' knowledge, attitudes, and practices of pesticide safety is critical. This supports the development of efficient educational and policy initiatives to reduce the dangers associated with pesticide use and the possibility of pollution in agricultural settings (Avelia Sandy *et al*., 2024).

MATERIALS AND METHODS

Description of study area

This study was conducted in Jhapa has 8 municipalities and 7 rural municipalities with a total area of 1,606 km. The headquarters of Jhapa is at Bhadrapur. The annual rainfall is about 2,000 mm, and the maximum temperature is recorded at 42°C in summer and 10°C in winter. Gauradaha Municipality of Jhapa was selected. The area selected was feasible for conducting the study.

Research design and sampling technique

A descriptive cross-sectional study was conducted in Gauradaha Municipality, Jhapa District, Nepal. The study was conducted between April and May 2024.

$$Sample\ size\ formula: n = \frac{Z^2 pq}{e^2} \quad (1)$$

Prevalence (p) = 0.78. The estimated prevalence (p) was set based on the findings that 78% have not received training related to pesticides (Jyoti *et al*., 2023; Kafle *et al*., 2021).

$$q = 1 - p = 0.22 \quad (2)$$

e = Allowable error (i.e., 6%); So, the total sample size (n) = 180

Purposive sampling was used to select a sample from 5 wards. As a result, 180 representative farmers were selected through purposive sampling for the research population. Data were collected primarily through interviews and self-constructed mixed-structured questionnaires. Qualitative and quantitative data on respondents' knowledge, attitudes, and practices were collected. A pilot test was conducted using random sampling techniques to survey 20 farmers from Kamal Municipality and to assess the understandability, phrasing, and clarity of the questions. The mobile application m-Water Surveyor version 74.0 was used to collect data from respondents.

Data analysis

The Statistical Package for Social Sciences (SPSS) version 29 was employed to enter the acquired data and carry out the statistical analysis. Descriptive statistics were used for data analysis, and the frequency table, mean, median, and percentages were computed to assess the level of practice and degree of knowledge of the two respondent groups. Pearson chi-square test was used for bivariate analysis to determine the presence of an association between the dependent and independent variables. All tests were done with a significance level of 5% (i.e., p-value < 0.05).

Ethical clearance

Ethical approval was obtained from the advisor and assistant professor of Gauradaha Agriculture Campus, Ram Krishna Tamang. A formal consent form was obtained, and all participants were given comprehensive information about the research. Individuals who had worked as farmers and were directly exposed to pesticides, regardless of gender, met the inclusion criteria, but those in other professions were excluded.

RESULTS AND DISCUSSION

Knowledge of respondents

The data present in Table 1 shows the knowledge of pesticides among the farmers under study. The majority of the farmers (86.1%) got this information from an agro-vet. It was also found that 75.6% viewed pesticides as poison. 11.7% of the farmers had received training related to pesticides. When asked about personal protective equipment, 20.6% were aware of it. 59.4% sprayed the pesticide in the direction they felt comfortable with, and 82.8% during the afternoon. When asked about the use of pesticide cocktails, 58.9% responded positively. 51.7% knew about pesticide labels, but only 23.9% knew about the toxicity level. 84.4% knew about the waiting period after the application of pesticides. When asked about their habits after pesticide application, 94.4% washed hands with soap, 70.6% took a bath, 66.7% changed their clothes, 26.7% washed hands with plain water, and 0.6% did nothing. Furthermore, 66.7% of the farmers stored the pesticides outside the house. When questioned about their storage practices, it was found that the majority of them burned the pesticide containers. 78.3% cleaned their equipment after application, with 90.6% cleaning it outside the house. It was also found that 88.9% of the farmers were aware of the impacts of pesticides on human health, the environment, and soil. 80.6% knew about the different entry ways of pesticides into the body. However, 74.4% ignored the effects of pesticides seen on their body.

Association of level of knowledge and demography

The difference in the level of knowledge due to the education level of the respondent was significant (i.e., p-value = 0.001<0.05). 60.1% of respondents were illiterate, 75% of them could read and write, and 77.5% had completed their primary level of education, which fell under an inadequate knowledge level, whereas 52.9%, 66.7%, and 60% of respondents with secondary, higher secondary, and graduate levels of education fell under an adequate knowledge level (Figure 1). The difference in the level of knowledge due to the yearly income of the household was also significant (i.e., p-value = 0.002<0.05). Households with yearly income > 400000 fell under an inadequate knowledge level, and those equal to or above it fell under an adequate knowledge level (Supplementary Table 1).

Table 1. Knowledge of respondents (N= 180).

Variables	Frequency	Percentage
How do you know about pesticides?		
Agro vet	155	86.1
Family	19	10.6
Friends/relatives	3	1.7
Neighbors	3	1.7
Cooperatives	27	15
Media /social media	2	1.1
AKC	12	6.7
Book	1	0.6
How do you view pesticides?		
Poison	136	75.6
Medicine	64	35.6
Have you received any training related to pesticides?	21	11.7
Do you use personal protective equipment?	37	20.6
In which direction do you spray pesticides?		
As comfortable	64	35.6
Backward	9	5
Forward	107	59.4
Do you use pesticide cocktails?	106	58.9
At what time do you spray pesticides?		
Morning	27	15
Afternoon	149	82.8
Evening	49	27.2
Do you know about the toxicity label of pesticides?	43	23.9
Do you know about the waiting period for pesticides?	152	84.4
What do you do after using pesticides?		
Wash hands with plain water	48	26.7
Wash hands with soap	170	94.4
Change clothes	120	66.7
Take a bath	127	70.6
Do nothing	1	0.6
Where do you store the pesticide?		
Room within the house	52	28.9
Outside the house	120	66.7
On roof	6	3.3
Doesn't store	2	1.1
What do you do with the empty pesticide container?		
Throw outside	77	42.8
Bury	51	28.3
Burn	92	51.1
Reuse	2	1.1
Don't know	3	1.7
Municipality Van	8	4.4
Where do you wash the equipment after use?		
Inside the house	1	0.6
Outside the house	163	90.6
Near water sources	1	0.6
Don't wash	15	8.3
Do you think pesticides are harmful to the environment, human health, and soil?	160	88.9
How do you deal with the effects of pesticides?		
Consultation with health professionals	40	22.2
Home remedies	6	3.3
Ignore	134	74.4
Do you know about Insect management techniques?	114	63.3
Have you heard about pesticide drift?	105	58.3
Do you know about pesticides being banned in Nepal?	51	28.3
Do you know about pesticide residue?	104	57.8

Attitude of respondents

From the given table, we found that 31.1% of farmers strongly say that PPE is not required when pesticides are used in small amounts. 43.3% of farmers strongly disagree that pesticides are essential for good production (Table 2). Similarly, 56.7% of them disagree that doing nothing is enough after pesticide application. 56.1% of them agree that PPE is important to prevent the body from pesticide poisoning (Figure 1). 50.6% of farmers claim that bathing immediately after pesticide application reduces poisoning. 46.7% of farmers agree that smoking during application increases pesticide inhalation. 41.1% disagree that eating and drinking during pesticide application is no problem. Additionally, 60.6% agree that pesticides don't affect the soil and environment, and 59.4% agree that there is no such thing as pesticide poisoning. 57.8% of them say that pesticides are non-toxic.

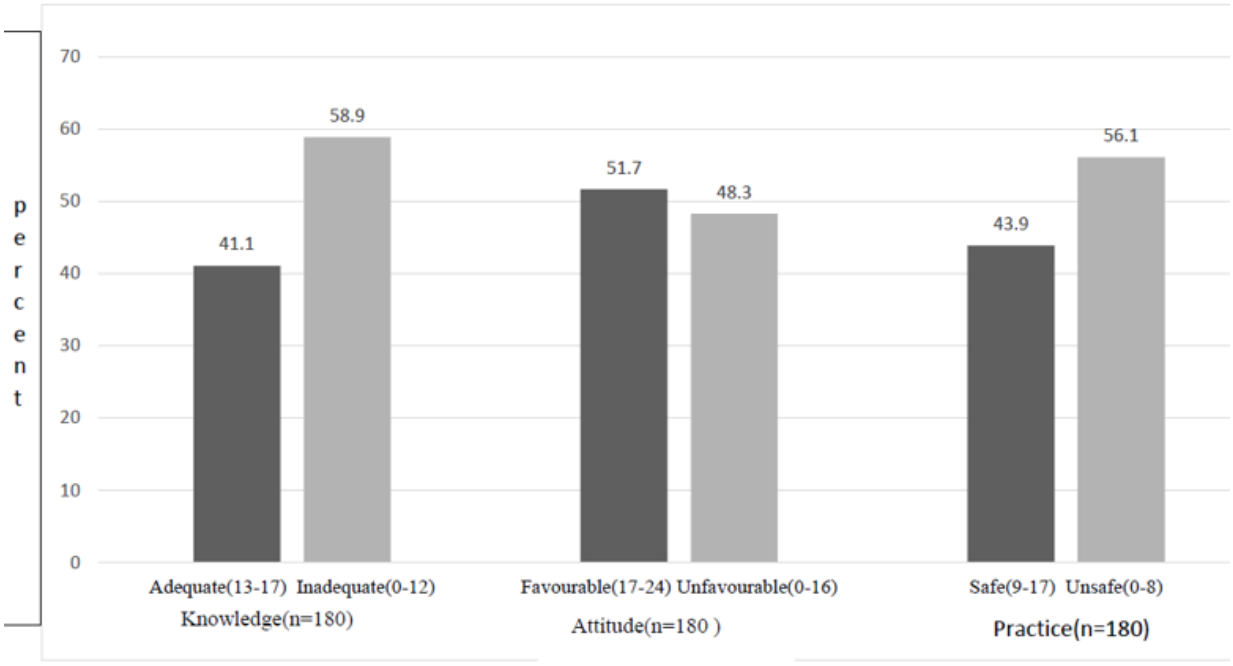

Figure 1. *Level of knowledge, attitude, and practice.*

Table 2. Attitude of respondents (N=180).

Questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
PPE is not required when pesticides are used in small amounts.	29 (16.1%)	36 (20%)	18 (10%)	41 (22.8%)	56 (31.1%)
Any kind of pesticide can be used	30 (16.7%)	69 (38.3%)	14 (7.8%)	54 (30%)	13 (7.2%)
Good-quality pesticides are not dangerous.	30 (16.7%)	39 (21.7%)	30 (16.7%)	57 (31.7%)	24 (13.3%)
Using pesticides is essential for more production	4 (2.2%)	21 (11.7%)	9 (5%)	68 (37.8%)	78 (43.3%)
After pesticide exposure, is doing nothing enough?	57 (31.7%)	102 (56.7%)	13 (7.2%)	5 (2.8%)	3 (1.7%)
PPE is important to prevent the body from pesticide poisoning	1 (0.6%)	2 (1.1%)	10 (5.6%)	101 (56.1%)	66 (36.7%)
Bathing immediately after pesticide application reduces pesticide poisoning	4 (2.2%)	13 (7.2%)	8 (4.4%)	91 (50.6%)	64 (35.6%)
Smoking while using pesticides increases the inhalation of pesticides	2 (1.1%)	8 (4.4%)	12 (6.7%)	84 (46.7%)	74 (41.1%)
During the use of pesticides, drinking and eating are not a problem	24 (13.3%)	74 (41.1%)	6 (3.3%)	43 (23.9%)	33 (18.3%)
Pesticides do not affect the soil and the environment	0	3 (1.7%)	13 (7.2%)	109 (60.6%)	55 (30.6%)
There is no such thing as pesticide poisoning	1 (0.6%)	14 (7.8%)	8 (4.4%)	107 (59.4%)	50 (27.8%)
Pesticides are non-toxic	0	3 (1.7%)	5 (2.8%)	104 (57.8%)	68 (37.8%)

Association between demography and attitude

The difference in the level of attitude due to sociodemographic factors like age, gender, ethnicity, Religion, Education of the respondent, Occupation, Marital Status, Family size, Members involved in agriculture, and years of experience in agriculture was not significant (i.e., p-value >0.005); however, it was significant with the expected yearly income (i.e., p-value=0.033 < 0.005) (Supplementary Table 2).

Practice of respondents

Among the respondents, the majority never read the instructions given on the container; a similar proportion of farmers never used gloves while mixing the pesticide, and 80% used a sprayer to apply pesticide (Table 3). Personal protective equipment was always used by 7.2% of the respondents, whereas a long-sleeved shirt was always worn by 72.2% of the respondents. We also found that most respondents washed their hands immediately after the application; however, only 63.3% always took a bath afterwards. Moreover, 56.1% of respondents are always willing to pay as much as required to control the pest, whereas only 7.8% are never willing to pay as much (Figure 1).

Table 3. Practice of respondents (N=80).

Questions	Always	Sometimes	Never
I read the instructions on the container before applying pesticide	24 (13.3%)	33 (18.3%)	123 (68.3%)
I use gloves to mix pesticide.	29 (16.1%)	27 (15%)	124 (68.9%)
I use a sprayer while applying a pesticide	144 (80%)	21 (11.7%)	15 (8.3%)
I wear long sleeve shirt while applying pesticides	130 (72.2%)	32 (17.8%)	18 (10%)
I use PPE (Protective suit) while applying pesticides	13 (7.2%)	10 (5.6%)	157 (87.2%)
I'm willing to pay as much as required to control the pest.	101 (56.1%)	65 (36.1%)	14 (7.8%)

Association between practice and demography

The final knowledge score was calculated based on the scores obtained in 14 different aspects of pesticides. The respondents' knowledge was classified into either adequate (above the median) or inadequate (below or equal to the median) based on the median score. Among the respondents, 58.9% had an inadequate knowledge level regarding pesticides, and only 41.1% had an adequate knowledge level. In terms of attitude, 51.7% of the respondents under study had a favorable attitude regarding pesticides, whereas 48.3% of the remaining farmers had an unfavorable attitude. In terms of practice level, 101(56.1%) practiced an unsafe level of pesticide handling, while the remaining practiced safe handling procedures (Supplementary Table 3).

Association of knowledge and attitude

The difference in level of knowledge due to attitude is insignificant (i.e., p-value = 0.059 > 0.05). 57.5% of respondents falling under the inadequate knowledge level had unfavorable behavior, whereas 56.8% of respondents having an adequate knowledge level had a favorable attitude (Table 4). There is a significant difference in knowledge based on practices (p-value: 0.001<0.05). While 69.8% of respondents with inadequate knowledge had adhered to safe practices, 63.5% of respondents with adequate knowledge had engaged in unsafe practices (Table 5). The main objective of this study was to assess the knowledge, attitude, and practices regarding pesticide use among farmers in Gauradaha Municipality, Jhapa District, Nepal. A study in Madhyapur Thimi has reported that around 89.87% of farmers received information from their friends and family, in contrast to our finding that most of the respondents were informed through Agro Vet A survey held in Ethiopia revealed that 65.7% of workers did not follow pesticide label instructions before applying, which is a similar proportion to our results, where 68.3% do not read labels . In our study, less than one-tenth of respondents wore PPE, whereas in the study done in Bhaktapur District, the opposite was found to be true, i.e., 90% used PPE during pesticide application. Similarly, 63.3% of participants always took a bath immediately after pesticide application (Humagain et al., 2024), but 30% of participants sometimes took bath immediately after pesticide application whereas 6.7% participants never took bath immediately after the pesticide application which was similar to research done in Kavrepalanchok where 85% of farmers had a full body shower following the application of pesticides, while 15% had just cleaned their feet and not had a shower In our study, less than half of the respondents (41.1%) had adequate knowledge; similar results were found in the studies done in Lamatar Village Development Committee, Lalitpur District, and Chitwan District (Jyoti et al., 2023; Kafle et al., 2021). At the level of attitude, 48.3% of the remaining farmers had an unfavorable attitude, which is slightly less than that of a study conducted in Lalitpur District In a study done in Chitwan District, similar percentages of respondents practiced safe practices as in this study (Kafle *et al*., 2021). The association between knowledge and attitude was not statistically significant, similar to that of the research done in Kavrepalanchok . Our study illustrates a gap between knowledge and practices of pesticide use. However, adequate knowledge did not consistently translate into safe pesticide-use practices.

Table 4. Association of knowledge and attitude.

Knowledge				
Attitude	**Inadequate**	**Adequate**	**Total**	**P-value**
Unfavorable	61(57.5%)	45(42.5%)	106	0.059
Favorable	32(43.2%)	42(56.8%)	74	
Total	93(51.7%)	87(48.3%)	180	

Table 5. Association of knowledge and practice.

Knowledge				
Practice	**Inadequate**	**Adequate**	**Total**	**P-value**
Safe	74(69.8%)	32(30.2%)	106	0.001*
Unsafe	27(36.5%)	47(63.5%)	74	
Total	101(56.1%)	79(43.9%)	180	

Conclusion and recommendation

From our study, we found significant gaps in knowledge regarding the selection of appropriate pesticides, harmful effects of pesticides, the purposeful use of pesticides, the spraying of pesticides, and the drift of pesticide residues into the environment. Lack of awareness resulted in bad practices of pesticide use, and respondents with better knowledge tended to have more favorable attitudes toward safe pesticide use. Similarly, favorable attitudes are held by farmers with higher income and education status, suggesting that financial capacity and education level determine willingness to adopt safer pesticide handling practices. Overall, the level of education plays an important role in improving knowledge, favorable attitudes, and good practices of pesticide use among farmers. To reduce the detrimental effects of pesticides on people and ecosystems, it is essential to provide education and training to farmers to lower the dangers associated with pesticide use. Effective law enforcement should be combined with awareness-raising efforts. In addition, the district and sub-district levels ought to have a responsible body or organization in place to oversee the pesticide supply chain and its applications.

DECLARATIONS

Author contribution statement: Conceptualization: P.B.; Methodology: P.B., B.T., P.K.; Software and validation: P.B., B.T. and P.K.; Formal analysis and investigation: P.B., B.T., P.K.; Resources: P.B., B.T., P.K., S.P., and S.T.; Data curation: P.B., B.T., P.K.; Writing—original draft preparation: P.B.; Writing—review and editing: P.B.; Visualization: P.B. and P.K.; Supervision: P.B and B.T.; Project administration: P.B., B.T., P.K., S.P., and S.T.; Funding acquisition: P.B., B.T., P.K., S.P., and S.T. All authors have read and agreed to the published version of the manuscript.

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Ethics approval: This study was conducted in view of the institutional ethical guidelines and does not harm the human participants.

Consent for publication: All co-authors gave their consent to publish this paper in AAES.

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