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# PRACTICE OF PESTICIDE USE AND ITS HEALTH EFFECTS AMONG FARMERS IN BHAKTAPUR: A CROSS-SECTIONAL STUDY

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## Abstract

*The global rise in pesticide usage is a concern in the agricultural sector, with Nepal experiencing a steady annual increase in pesticide application. This study aimed to assess the pesticide use, health effects, and associated factors among farmers in Bhaktapur, District. A cross-sectional analytical study was conducted from June to December 2019, involving 320 farmers in Bhaktapur selected through a simple random sampling method. Data were collected through face-to-face interviews utilizing pre-tested semi-structured questionnaires. The statistical analysis was performed via SPSS Software version 16.0. Additionally, the Chi-Square test was applied to assess the associations between independent variables and health effects among farmers. Most of the farmers used herbicides (40%), insecticides (29.7%), and Fungicides (22%). A total of 64.2% of the respondents complained of discomfort immediately after spraying pesticides. The most common complaints reported by farmers were skin rashes and burning sensations (72.5%), headaches (27.3%), nausea (46.7%), dizziness (41.6%), and respiratory issues (8.3%). Health effects were more prevalent among farmers with over five years of pesticide use and those lacking training. Farmers' knowledge of health impacts and their use of personal protective equipment (PPE) were strongly linked to the health effects they experienced. Even though farmers are knowledgeable about pesticides, many still practice unsafe methods when using them, resulting in health problems. To address this, the government should offer regular refresher training on the safe use, handling, and disposal of pesticides, ensuring farmers can apply their knowledge safely and effectively in the field.*

**Keywords:** Farmers, Health effects, Nepal, Occupational safety, Pesticide

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## Introduction

Pesticide exposure leads to both acute and chronic health effects, with acute poisoning being the most widely recognized form of effects. (Brown et. al., 1989). Among the global consumption of pesticides, about 20% is accounted for utilization in developing countries and this percentage is on the rise. (Zyoud et. al., 2010) Every year, around 25 Million cases of mild pesticide poisoning are reported by agricultural workers in developing Asian countries (Thapa et. al., 2021).The World Health Organization (WHO) and the United Nations Environment Programme report that annually, approximately 3 million agricultural workers in developing countries suffer from severe pesticide poisoning, with around 18,000 fatalities resulting from these incidents (Zhang et. al., 2021) The Department of Agriculture (DOA) was established in 1952 AD in Nepal. More than 66% of Nepalese individuals are working in the agricultural sector (Alavanja et. al., 2004). To maximize agricultural production, most farmers use pesticides in their fields. Therefore, pesticide use has been steadily increasing annually in Nepal. Nepal, like many other countries, faces issues with the misuse, overuse, and improper application of chemical pesticides in agriculture.

Over the past five decades, pesticide use has dramatically boosted agricultural production. However, using highly toxic chemicals has increased health risks, particularly among farmers in low-income countries like Nepal (Giri, 2010). In many developing nations, including Nepal, the lack of proper training for agricultural workers in pesticide use and management has seriously affected human health and the environment(Brown et. al., 1989). Bhaktapur is one of the districts located in Bagmati Province where a significant number of people have been farming for many years to produce significant quantities of food and vegetables. Farmers are using pesticides to increase their agricultural production. Even though the application of pesticides has contributed to increasing the productivity of vegetables in Bhaktapur, the successes have unfortunately often been accompanied by the problem of mishandling pesticides (Toledo et. al., 2023) Despite being a small-scale study, this research offers valuable insights into farmers' knowledge and practices surrounding pesticide use, as well as the health issues they face. This study aimed to reveal the health effects experienced among agricultural farmers and the factors associated s with health problems.

## Methods

The researchers conducted a community-based cross-sectional study involving the farmers from Ward No. 1 of Suryabinayak Municipality in Bhaktapur District, who regularly used pesticides on their farms. The study took place between June and October 2019. A Semi-Structured questionnaire was prepared concerning various research papers and supervisors. Approval for the study was obtained from the Institutional Review Committee of Nobel College. Permission was obtained from the colleges, and informed consent was obtained from the participants before data collection. The study involved

farmers aged 20 and above who had experience handling pesticides, either on their farms or on land they worked for others. A total of 320 farmers were selected for the study, based on sample size calculations that considered the prevalence of skin problems (26.6%) among vegetable farmers in Bhaktapur. The study used a 95% confidence interval and accounted for a 6% nonresponse rate. Data were gathered through face-to-face interviews during door-to-door visits using semi-structured, pretested questionnaires. This covered demographic information, knowledge of pesticide health impacts, pesticide handling practices, and self-reported health effects. The questionnaire was pretested with 30 farmers (10% of the total sample) using a non-probability sampling method in the Kathmandu District. Data were collected, and the collected data were expressed as frequencies and percentages. Sociodemographic characteristics were assessed. Knowledge and experience were assessed. Data entry and analysis were performed using SPSS version 16. The Chi-square test was used to assess associations, with a significance level set at p-value $< 0.05$.

## Results

*Socio-Demographic Characteristics of Farmers*

Table 1 depicts the socio-demographic characteristics of the farmers. The majority of farmers 73.1% were between 30-59 years followed by those older than 60 years 18.6%. Similarly, 59.7% of farmers were male, whereas 40.3% were female. The majority 80.9% of the farmers 51.3% were literate. The majority 67% of the farmers had been using pesticides for more than 5 years.

*Table 1*
*Sociodemographic characteristics of farmers*

| Characteristics | Number (n=320) | Percent (%) |
|---|---|---|
| **Age** | | |
| 20-29 years | 42 | 13.1 |
| 30-59 years | 234 | 73.1 |
| ≥ 60 years | 44 | 13.8 |
| **Sex** | | |
| Male | 191 | 59.7 |
| Female | 129 | 40.3 |
| **Educational Status** | | |
| Illiterate | 61 | 19.1 |
| Literate | 259 | 80.9 |

*Farmer's Profile*

Table 2 depicts the profile of the farmers involved in the study. More than three-fourths of farmers 77% use pesticides. Approximately 34.6% of the farmers had received formal training on how to handle pesticides. The majority 67% of the farmers had been using pesticides for more than five years.

*Table 2*
*Farmer's profile*

| Profile of Farmers | Number (n=320) | Percent (%) |
|---|---|---|
| **Years in Farming** | | |
| <5 years | 58 | 18.2 |
| 5-10 years | 219 | 68.4 |
| >10 years | 43 | 13.4 |
| **Use of Pesticide for Farming** | | |
| Yes | 246 | 76.9 |
| No | 74 | 23.1 |
| **Years of Pesticide Use(n=246)** | | |
| <5 years | 79 | 32.1 |
| 5-10 years | 95 | 38.6 |
| >10 years | 72 | 29.3 |
| **Trainings on handling pesticide(n=246)** | | |
| Yes | 85 | 34.6 |
| No | 161 | 65.4 |

*Farmers' knowledge and understanding of pesticide*

Table 3 illustrates the farmer's knowledge and understanding of pesticides. The majority of farmers 61% believe that pesticides are used to kill pests. This study shows that 58.9% of the farmers know the pesticide names they are using, and most of them primarily rely on herbicides which is 40% followed by insecticides, fungicides rodenticides bactericides, etc. The workers frequently associated the toxicity of pesticides with the chemical odour of the substances, believing that stronger, more intense smells indicated higher toxicity. Most people have little understanding of the scientific colour code system. Approximately 59.7% of the farmers were aware of different colors (blue, red, green, and yellow) in the pesticide container. More than half of the farmers 62.2% knew that pesticides affect human health.

*Table 3*
*Farmer's knowledge and understanding of pesticides*

| Perceived Knowledge | Number (n=246) | Percent (%) |
|---|---|---|
| **Reason for using pesticides** | | |
| Destroying pests | 150 | 61.0 |
| Increase agricultural quality production | 74 | 30.1 |
| Others | 22 | 8.9 |
| **Know the names of pesticides used for crops.** | | |
| Yes | 145 | 58.9 |
| No | 101 | 41.1 |
| **If yes (n=145)** | | |
| Insecticide | 43 | 29.7 |
| Fungicide | 32 | 22.0 |

| Perceived Knowledge | Number (n=246) | Percent (%) |
|---|---|---|
| Herbicide | 58 | 40.0 |
| Others | 12 | 8.3 |
| **Meaning of the color of the pesticide container** | | |
| Yes | 146 | 59.5 |
| No | 100 | 40.7 |
| **Knowledge of the health impact of pesticides** | | |
| Yes | 155 | 62.2 |
| No | 91 | 37.8 |

*Practice Regarding Pesticide Use*

Table 4 illustrates that 65.9% of the farmers used to read the label on the pesticide container. Almost half of the farmers had 49.2% sprayed pesticides. Five to ten times in the previous six months. The majority of the farmers 75.2% used to determine the wind direction first and spray the pesticide. The majority of the farmers 69.9% used protective measures, whereas 62.8% of the farmers covered their noses, either by wearing a mask or tying a piece of cloth around it,59.3% wore long sleeve shirts, 58.8% wore long pants, 43.6% wore long boots, 38.4% wore gloves, 21.5% wore gaggles, 25.6% wore hats, and 30.2% wore all of the above protective measures This study revealed that the majority of farmers 67.5% used bare hands while mixing pesticides. The majority of the farmers 63.8% used to wash their hands immediately after spraying and 62.2% of the farmers used to mix the pesticide outside their houses.

*Table 4*
*Practice regarding pesticide use*

| Practice regarding pesticide use | Number (n=246) | Percent (%) |
|---|---|---|
| **Read the label** | | |
| Yes | 162 | 65.9 |
| No | 84 | 34.1 |
| **No. of spraying time in the last 6 months** | | |
| <5 times | 59 | 24.0 |
| 5-10 times | 121 | 49.2 |
| >10 times | 66 | 26.8 |
| **Determine wind direction first and spray** | | |
| Yes | 185 | 75.2 |
| No | 61 | 24.8 |
| **Use of Personal Protective Equipment While Spraying Pesticide** | | |
| Yes | 172 | 69.9 |
| No | 74 | 30.1 |
| **If Yes (n=172) *** | | |
| Mask | 108 | 62.8 |
| Boot | 75 | 43.6 |
| Long sleeve shirt | 102 | 59.3 |
| Long pant | 96 | 58.8 |
| Gaggles | 37 | 21.5 |

| Practice regarding pesticide use | Number (n=246) | Percent (%) |
|---|---|---|
| Gloves | 66 | 38.4 |
| Hat | 44 | 25.6 |
| All of the above | 52 | 30.2 |
| **Mix Pesticide Solution** | | |
| By bare hand | 166 | 67.5 |
| By wearing gloves | 80 | 32.5 |
| **Personal hygiene measures after Spraying** | | |
| Wash hands immediately after spraying | 157 | 63.8 |
| Take a bath after spraying | 89 | 36.2 |
| **Mixing place** | | |
| In the living house | 7 | 2.8 |
| Outside the house | 153 | 62.2 |
| In the field | 41 | 16.7 |
| Beside a water source | 19 | 7.7 |
| Distance from well or open water | 26 | 10.6 |

* Multiple response

*Self -reported Health Problems of the farmers*

Table 5 depicts the self-reported health problems of the farmers. Among the 246 farmers, 48.8% experienced health problems due to pesticides. Approximately 72.5% of the farmers complained of skin rashes and burning sensations, followed by 70% with headache, 46.7% with nausea, 41.6% with dizziness, 8.3% with respiratory problems, and 8.3% with other symptoms (weakness, abdominal pain)

*Table 5*
*Self-reported health problem related to felt problems and symptoms of that health problem due to pesticide*

| Self-reported health problem | Number (n=246) | Percent (%) |
|---|---|---|
| **Felt any health problems due to pesticides in the past** | | |
| Yes | 120 | 48.8 |
| No | 126 | 51.2 |
| **If Yes (n=120) *** | | |
| Skin rashes/ burning sensation | 87 | 72.5 |
| Headache | 84 | 70 |
| Nausea | 56 | 46.7 |
| Dizziness | 50 | 41.6 |
| Respiratory problem | 45 | 37.5 |
| Other | 9 | 8.3 |

* Multiple response

*Associations between Independent variables and health effects among farmers*

Table 6 shows the association between training on pesticides and years of pesticide use and health effects on farmers. Farmers who had no training in pesticides and more

than 5 years of pesticide use had a high proportion of health effects. There was a significant association between the mixing of pesticides and health effects. Compared with farmers who used gloves, those who used bare hands had a higher proportion of health effects Similarly, the use of PPE was associated with health effects. There was a high proportion of health effects among farmers who did not use PPE.

*Table 6*
*Associations between Independent Variables and Health Effects among Farmers*

| Independent Variables (Characteristics) | Health Effects | | | p-value |
|---|---|---|---|---|
| | Yes Number (%) | No Number (%) | Total Number (%) | |
| **Training on pesticide handling** | | | | |
| Yes | 26(30.6%) | 59(69.4%) | 85(34.6%) | <0.002 |
| No | 94(58.4%) | 67(41.6%) | 161(65.4%) | |
| **Years of pesticide use** | | | | |
| Less than five years | 27(34.2%) | 52(65.8%) | 79(32.1%) | |
| Five to ten years | 45(47.4%) | 50(52.6%) | 95(38.6%) | <0.001 |
| More than ten years | 48(66.7%) | 24(19%) | 72(29.3%) | |
| **Knowledge of health impact** | | | | |
| Yes | 44(28.4%) | 111(71.6%) | 155(63%) | <0.001 |
| No | 76(83.5%) | 15(16.5%) | 91(37%) | |
| **Mixing the pesticides** | | | | |
| By wearing gloves | 17(21.2%) | 63(78.8%) | 80(32.5%) | <0.002 |
| By bare hands | 103(62%) | 63(30%) | 166(67.5%) | |
| **Use of PPE** | | | | |
| Yes | 75(43.6%) | 97(56.4%) | 172(69.9%) | <0.013 |
| No | 45(60.8%) | 29(39.2%) | 74(30.1%) | |

## Discussion

The results of the study show that the majority of the farmers 73.1% were in the 30-59 years age group, followed by those older than 60 years 13.8% which is somewhat similar to the findings of previous studies 59.7% males and 40.3% females. (Oesterlund et. al., 2014).

In terms of the profile of the farmers, 18.2% had less than five years of farming experience which is in line with the study conducted in Palestine.(Zyoud et. al., 2010). In this study, 65.4% of the farmers did not receive any training related to pesticide use and handling. In a similar study conducted in Dhading 93.3% did not receive any training on pesticide use. (Karunamoorthi et. al., 2011).

In this study, most farmers understood that pesticides are used to kill pests and increase agricultural production. While they were generally aware of the health risks associated with pesticide use, they often neglected safety measures, leading to greater exposure to pesticide poisoning. This finding aligns with a similar study conducted in Nepal. (Kafle et. al., 2014). It shows that only (n=146, 59.3%) of the farmers knew about

the meaning of different colors (blue, red, green, and yellow) on the pesticide container. Similarly, 48.4% of the farmers knew that pesticides affect human health. In a similar study done in Palestine 57.7% of the respondents reported that pesticides affect human health. (Zyoud et. al., 2010).

While purchasing, approximately 65.9% of the farmers carefully looked for pesticide labels on the container, showing their alertness and attentive nature toward safe handling. Many farmers do not care about the importance of safe handling of pesticides. Our study revealed that 51.9% of the farmers used their bare hands while mixing pesticides. Similarly, a study conducted in the Dhading District found that almost all farmers did not consider looking for pesticide labels The study also reported that farmers continued to use 16.7% highly hazardous and 50% moderately hazardous pesticides, with half of them using their bare hands while mixing the chemicals., this study revealed that farmers who used their bare hands were more likely to be at risk than those who wore gloves while mixing pesticides.(Shrestha et. al., 2010).

In our study, 49.2% of farmers reported spraying pesticides five to ten times in the last six months. Additionally, almost 75.2% of them applied pesticides without considering the wind direction. This oversight could increase their inhalation of pesticides and skin contact. Even those who were aware of wind direction often did not postpone spraying on windy days. A similar study conducted in Sunsari District found that 35.4% of farmers sprayed pesticides five to nine times per year. Furthermore, 71.7% of the farmers in that study checked the wind direction before applying pesticides. Studies have shown that farmers who do not consider wind direction when spraying are at a higher risk for health issues. Specifically, those who ignore wind direction are 2.25 times more likely to report health problems. These findings highlight the need for better awareness and safety practices among farmers regarding pesticide application. (Lamichhane et. al., 2019)

Our study revealed that farmers were not using adequate personal protective measures (PPE) when applying pesticides, mainly because they weren't in the habit of wearing it and found it too costly. A similar study showed that 66.6% of farmers did not use any form of PPE due to a lack of knowledge. Lack of habit of wearing such protective measures and poor affordability. (Kafle et. al., 2014). This finding is in line with our findings which showed that face masks were the most popular PPE worn by farmers 62.8%. Ironically, the purpose of using a face mask was not to prevent pesticide exposure but to eliminate bad odour. Similarly, 59.3% of the farmers reported using long-sleeved shirts, and 58.8% used long pants during spraying.

The majority followed the practice of washing hands immediately after spraying pesticides which was found to be a basic precautionary measure followed by the farmers. It showed that the study showed that most farmers followed safer practices, reducing their risk of pesticide poisoning. Similar to research conducted in Nepal, Oman, Ethiopia, and Bolivia but highly skewed from Cambodian findings which reported that 97% of farmers washed their bodies after spraying (Aryal et. al., 2016).This statement is supported by our study results.

The preferred mixing pesticide area was a place far from the living house which is the most accepted site but 7.7% of farmers mix pesticides beside a water source, which is not a good sign. Pesticide use brings about various environmental issues since they are a major leading cause of water pollution. Some pesticides are considered persistent organic pollutants, contributing significantly to environmental contamination (EPA, Safe & Effective Handling of Pesticides). With high environmental contamination. This kind of behavior may lead to accidental poisoning of domestic animals and humans. Very few had chosen the living room as a place for mixing pesticides. Only those farmers had no spare area except a roomed house and mixed pesticides in the same living room.

The study showed that the most commonly self-reported symptoms of pesticide toxicity were skin rash 72.5%, headache 70, nausea 46.7%, and dizziness 31.6%. This is similar to a study done among farm workers in the West Bank, Palestine, where self-reported symptoms of pesticide toxicity included skin rash 37.5%, headache 37%, excessive sweating 24.9%, and diarrhea 21.3% (Dey, 2010). The differences between the two studies may be due to variations in pesticide use practices and the safety precautions taken during application (Zyoud et. al., 2010).

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This study showed associations between socio-demographic characteristics and health effects. It was found that gender, marital status, training on pesticides, and years of pesticide use were significantly associated with health effects among farmers (p-value $<0.05$). A similar association was shown in a study performed among farmers in Uganda.(Kiwango et. al., 2018). It was found that knowledge of health impacts was significantly associated with health effects among farmers (p-value $<0.05$), which was similar to the findings of a study conducted among farmers in northwestern Jamaica (Ncube et.al., 2011). Similarly, consulting shopkeepers or specialists, mixing pesticides, and using PPE were associated with health effects among farmers (p-value $<0.05$), Which was similar to the findings of a study on farm workers on the west bank, of Palestine. (Zyoud et. al., 2010).

## Conclusions

The majority of the farmers were older males and more educated than they were five years old. The majority of farmers used pesticides; the duration of pesticide use was more than five years; and training on pesticide use and hygiene practices among farmers was limited. Farmers were aware that pesticides affect human health and the color code of pesticide containers. Farmers read labels on pesticides; however, farmers use bare hands to mix

pesticides. Farmers determine the wind direction before pesticide use. The use of the Personal Protective Equipment (PPE) is prevalent. Half of the farmers had health problems; skin rashes and headaches were major health problems. Training on pesticides and years of pesticide use were associated with health effects among farmers which means that there was a significant association between training on pesticides and years of pesticide use with the health effects of farmers. Farmers who had no training in pesticides and more than five years of pesticide use had a high proportion of health effects. Unhygienic practices of pesticides and the use of PPE were significantly associated with health effects among farmers, and there was a significant association between the mixing of pesticides and health effects. Compared with farmers who used gloves, those who used bare hands had a higher proportion of health effects. Similarly, the use of PPE was associated with health effects. There was a high proportion of health effects among farmers who did not use PPE.

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