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Patterns of Pesticide Use and Associated Factors Among the Commercial Farmers of Chitwan, Nepal

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Supplementary Issue: Pesticide Poisonings in Agriculture

ABSTRACT: Farmers in developing countries are exposed to pesticide hazards due to unsafe handling. This study was conducted to identify the prevailing practices of pesticide use and factors affecting the handling of pesticides among the farmers of Chitwan, Nepal. A cross-sectional study was conducted among 125 farmers. None of the farmers completely followed all the protective measures. About 59% disposed the empty pesticide containers to a nearby water source and 62% preferred house ceilings as a storage place. Males (aOR = 3.99, CI = 1.63–9.78) and older farmers (aOR = 6.18, CI = 2.59–14.72) were more likely to smoke or chew tobacco during the process of spray. Males (aOR = 2.42, CI = 1.03–5.67), literate farmers (aOR = 3.56, CI = 1.51–8.33), and farmers aware of color coding (aOR = 2.67, CI = 1.13–5.67) were more likely to read the labels on pesticide bottles. In spite of an extensive use of pesticides, the farmers were not following proper and safe handling practices, exposing them and the community to a potential pesticide hazard.

KEYWORDS: pesticide, farmers, knowledge, practices, Nepal

SUPPLEMENT: Pesticide Poisonings in Agriculture

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Introduction

Pesticides are widely used throughout the world, especially in agriculture for crop protection.[1–3] Millions of farmers are exposed to danger by hazardous occupational practices and unsafe storage.[4] Exposure to chemical pesticides is one of the most important occupational risks among farmers in the developing countries.[5,6] They can easily come in contact with the pesticides, for example, when mixing the chemicals or when applying them to the crops and when pesticide residues are carried to home.[7] An increased reliance on chemical pesticides has been commonly seen in developing countries such as Nepal where older, nonpatented, more toxic, environmentally persistent, and inexpensive chemicals are used extensively.[1]

The pesticide consumption is increasing by about 10%–20% per year in Nepal.[8] In Nepal, 500 different brands of insecticides, 7 acaricides, 229 brands of fungicides, 6 bactericides, 88 herbicides, 10 rodenticides, and 19 biopesticides are currently used.[4] The application of pesticides in commercial farming is exceptionally high in Nepal.[9,10] The use of pesticide is more intensive in the Terai regions such as Chitwan and Kathmandu valley where agriculture is more commercialized.[11]

Awareness and skills regarding safe and efficient application of pesticides are not adequate at farmers' level, exposing them to the risk of pesticide poisoning.[9,12] Hence, this study was conducted among farmers of Chitwan, Nepal, to understand the practices of pesticide handling during buying, mixing, spraying, storing, and disposing.

Methodology

Study site. Chitwan district is selected for this study purposively because of commercial and intensive vegetable cultivation and high volume of pesticide use. It is one of the highest crop cultivating districts of Nepal.

Study design and selection of participants. A cross-sectional study was conducted from December 2012 to June 2013. Multistage random sampling method was applied to select the participants. In the first stage, four of 39 Village Development Committees (VDCs) of Chitwan were randomly selected by using lottery method. For the lottery method, names of all 39 VDCs were written in a separate, uniform-sized paper, which was folded and put into a bowl. The papers were thoroughly mixed in the bowl. One by one, four papers were taken out. The bowl with papers was thoroughly shaken every time a paper was taken out.

Almost all commercial farmers in Chitwan are registered with District Agriculture Development Office (DADO). Hence, in the second stage, a total list of commercial farmers

of selected VDCs was obtained from DADO. Out of 570 farmers eligible for the study, 125 were randomly selected by systematic sampling technique. The first farmer was selected by using the lottery method, and then using an interval ratio of 4.56, one in every five farmers was selected. Those farmers who were not available in three subsequent visits and/or did not give informed consent were not included in the study, and subsequent farmers were selected from the list using random selection method.

Data collection. A semi-structured interview schedule was developed with the help of previous studies carried out in Uganda, Bolivia, and Nepal.[13–15] Data were collected by face to face interview. The data collection was done by the researcher herself. The semi-structured interview schedule was first developed in English and then translated to Nepali language. Data were collected for information on demography, knowledge on pesticide color coding, training received, habit of reading the label on pesticide bottle, hygienic practices, personal protective equipment (PPE) worn during handling of pesticides, and on the methods of mixing, spraying, and disposing of unused pesticide. Observation was carried out to identify the storage practices of pesticide, using an observation checklist.

The use of a long-sleeve shirt, hat, face mask, hand gloves, goggles, long pant/trousers, boot, and gown was considered as use of PPE in this study.

Pilot testing was done on the basis of convenience among 15 farmers (nearly 10% of the sample size). The pilot testing was done in an area that was altogether different from the four sampled study areas. The respondents included in the pilot testing were excluded from the study. After the pilot testing, necessary and appropriate modifications were done to the questionnaire (eg, incorporating additional questions and making necessary changes in language).

Data analysis. Data were entered using EpiData 3.1 software and analyzed using SPSS 16. Descriptive, bivariate (chi-square test and Fisher's exact test), and multivariate (binary logistic regression) statistical analyses were carried out. Descriptive results were expressed as frequencies and percentages. Fisher's exact test was applied for some variables when expected frequency in each cell was less than 5. Those variables that were significant at P value ≤ 0.05 were modeled into multivariate analysis. In multivariate analysis, the odds ratio was adjusted by controlling the confounders, and statistically significant variables were presented in a tabular form.

Smoking/chewing tobacco during the process of spray was adjusted with age, sex, and food consumption during spray. Reading of label on pesticide bottle was adjusted with sex, education, awareness on color coding, observing weather condition during spray, and time interval of entry into field post pesticide spraying. Food consumption during spray was adjusted with age, area of land used for cultivation, average year of pesticide use, smoking/chewing habit during the process of spray, and taking children along to the fields while spraying.

Inclusion and exclusion criteria. The person who was predominantly involved in farming was selected as a respondent. Only those farmers who were using pesticides (inorganic or inorganic plus organic) within a year of this study and were engaged in commercial farming were included in this study. Farmers who applied only organic pesticides were excluded from the study. Those farmers who were not available in three subsequent visits and/or did not give informed consent were not included in the study.

Ethical issues. Ethical approval for the study was taken from Institutional Research Committee (IRC) of Chitwan Medical College. The research was conducted in accordance with the principles of the Declaration of Helsinki.

Only those farmers who acknowledged and gave informed consent were included. The data were kept confidential.

Operational definition. Commercial farmers: Farmers who had at least 5 kattha land, fully engaged in farming, and did not have any other job.

Pattern of pesticide use: Handling practices of pesticides during mixing, spraying, disposing, and storing.

Properly school educated: Attended education in school and received academic certificate.

Read and write (formally educated): Those who could read and write but did not attend school.

Results

General parameters. Most of the farmers (84%) were in the age group of 25–54 years. The male to female ratio was 1.23. Half of the Nepalese farmers owned less than 12 kattha (1 kattha = 60 m^2) of land, which was used for farming. A total of 74 farmers were properly school educated, 47 could read and write (formally educated), and the rest were illiterate. Most of the farmers (90%) were married. The farmers were using pesticides for an average period of 13 years. In all, 68 of 125 farmers exclusively utilized inorganic pesticides, while others used both inorganic and organic pesticides for farming (Table 1). Among 125 participants, three (2.4%) farmers were not available in three subsequent visits, whereas five (4%) participants refused to give consent.

Awareness of farmers. A total of 43 of 125 farmers had received a formal training regarding the handling of pesticides. Fifty-one farmers were aware of the color coding mark pertaining to pesticide level (Table 1). Seventy-two farmers carefully checked for labels on the pesticide bottle. Out of the 72 farmers, 94% read the manufacture and expiry dates and 70% carefully followed dosage, titers, and methods, while 30% only looked for the danger sign of pesticides.

Spraying practices. Almost all farmers (96%) sprayed pesticides during the flowering periods: 41% farmers began spraying from the early stages of crops and 33% farmers admitted using pesticides before harvesting, transplanting, and storing. Most of the farmers (85.6%) sprayed pesticide up to four times a month. Around 10% of them used to repeat spraying from 5 to 9 episodes a month, while the rest (4%) sprayed for even up to 15 episodes a month.

Table 1. Characteristics of the farmers.

CHARACTERISTICS	NUMBER	PERCENTAGE
Age		
16–24	6	4.8
25–34	34	27.2
35–44	44	35.2
45–54	27	21.6
55–64	9	7.2
≥65	5	4
Sex		
Male	69	55.2
Female	56	44.8
Land owned		
<12	61	49
13–19	18	14
20–29	20	16
30–40	22	18
>40	4	3
Education		
Illiterate	4	3.8
Formally educated	47	37
Proper school educated	37	59.2
Marital status		
Married	111	88.8
Single	14	11.2
Average duration of use of pesticides 13 Years		
Training status of farmers regarding handling of pesticides	Once	2–5 times
Number of trained farmers	33	10
	Total	43
Farmers being aware of color coding of pesticides	**Total 51**	
Note: MD = most dangerous & LD = least dangerous Multiple response answers*	Correct answer	
	MD	LD
	46	27

Table 2. Safety/hygienic practices followed by farmers (n = 125).

SAFETY/HYGIENIC PRACTICES OTHER THAN PPE	FREQUENCY	PERCENTAGE (%)
Changing clothes after spraying	115	92
Avoid taking children in the field during spraying	114	91.2
Avoid eating food items during spraying	113	90.4
Follow the wind direction during spraying	113	90.4
Avoid walking in spray cloud	109	87.2
Clean or wash sprayer after use	91	72.8
Wash whole body immediately after spraying	90	72
Avoid spraying at rainy time	87	69.6
Avoid spray a hot sunny mid-day	85	68
Avoid smoke or chew tobacco during spraying	80	64
Walk backward while spraying	38	30.4
Wash hand immediately after spraying	18	14.4
Wash hand immediately after mixing	10	8
Wash hand before eating	8	6.4
Adjust of PPE according to the label	3	2.4
Wash hand before smoking	1	0.8
Avoid walking in just treated crop	1	0.8

Table 2 lists the safety practices followed by the farmers. Less than one-third of the farmers followed safe recommended practices (walking backward while spraying, washing hands immediately after spraying, etc.). Very few farmers (0.8%8%) used PPE as per recommendation, avoided walking in crop freshly treated with pesticide, and washed hands immediately after handling pesticide and before smoking and eating.

Protective gadgets worn. In all, 52 (41.6%), 43 (34.4%), and 36 (28.8%) farmers used face mask, long-sleeved shirt, and hand gloves for personal protection, respectively. A few farmers (15%) also covered other body parts using gowns, long trousers, hats, and boots while spraying.

Methods for dosage measurement. Only 1% of farmers measured the dosage of pesticide with a weighting balance. 96% of farmers measured the dosage of the requested pesticide with a spoon/cup/jar or whatever was available in their premises, while 50.4% measured roughly with their hands.

Storage place for pesticides. 78 farmers preferred to use house ceilings over animal shed area (54), food storage room (13), kitchen and sleeping room(18).

Mixing of pesticides. Figure 1 depicts that 74% of farmers used the field to mix pesticides, 58% mixed pesticides besides a water source, 41% mixed the pesticides outside the premises of the house, and 14% mixed the pesticides inside the living room.

Disposal of pesticides. Figure 2 shows that 74 farmers disposed pesticide bottles in a nearby water source, while 68 farmers sold it to rag pickers.

Figure 3 shows significant association of training received with PPE worn by the farmers ($\chi^2 = 5.86$, $P = 0.039$)*Fisher's exact test.

Table 3 shows that farmers who got training regarding handling of pesticide were more aware of color coding of pesticide. Similarly, farmers owning >20 kattha were more likely to wash sprayer after spraying and observe weather condition before spraying.

Table 4 shows that male and >44 years farmers were more likely to smoke/chew tobacco during the process of spraying. Farmers who were aware of color coding, literate, and who observed weather condition before spraying were more likely

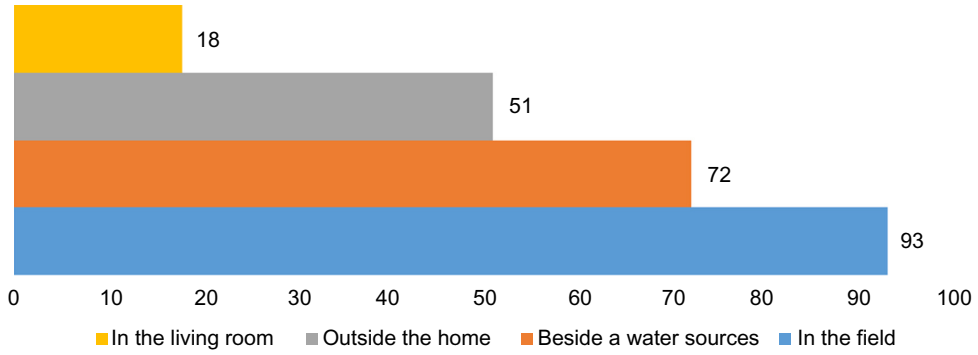

Figure 1. Place chosen for mixing pesticides (n = 125).
Note: Multiple response answers*

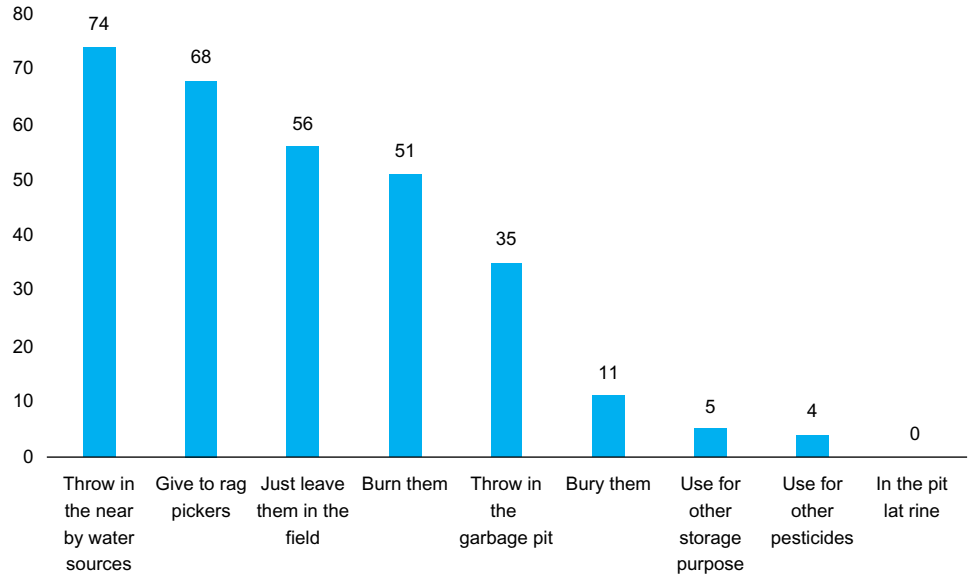

Figure 2. Disposal technique of pesticides bottle (n = 125).
Note: Multiple response answers*.

Table 3. Predictors of safe handling pesticides.

TRAINING	AWARE OF COLOR CODING		UNADJUSTED ODDS (95% CI)	*P* VALUE
	NO	YES		
No	62 (75.6%)	20 (24.4%)	1•	<0.0001
Yes	12 (27.9%)	31 (72.1%)	8.008 (3.473–18.467)	
LAND (KATTA)	**WASH SPRAYER AFTER SPRAYING**			
	NO	**YES**		
≤20	29 (34.1%)	56 (65.9%)	1	0.015
>20	5 (12.5%)	35 (87.5%)	3.625 (1.283–10.244)	
LAND (KATTA)	**OBSERVE WEATHER CONDITION BEFORE SPRAYING**			
	NO	**YES**		
≤20	23 (27.1%)	62 (72.9%)	1	0.019
>20	3 (7.5%)	37 (92.5%)	4.575 (1.285–16.294)	

Note: •Reference category.

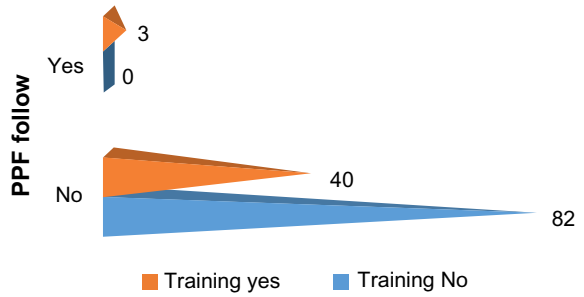

Figure 3. Bivariate analysis*Fishers exact test.

to read label on pesticide bottles. Farmers who were >44 years old, brought their small children along with them to the field during spraying, and owned >20 kattha land were more likely to consume food simultaneously while spraying.

Discussion

In this study, we sought to ascertain the pattern of pesticide-handling practices among the farmers. We found that more than half (68/125) of the farmers were involved solely in handling inorganic/chemical (mixing, spraying, and disposal) of pesticides. The number of farmers involved in handling pesticide was equally large creating an increased chance of exposure among them. As per age, there was an early adulthood involvement in farming and handling pesticides, thereby increasing the overall exposure duration of pesticides.

This study was similar to the study by Recena et al.[16], which also reported a low level of education among the farmers. Farmers who are illiterate and formally educated are at higher risk while using pesticides, possibly due to difficulties in understanding the instructions and following safety precautions.

Table 4. Predictors of safe handling of pesticide.

	SMOKING/CHEWING TOBACCO DURING SPRAY*		UNADJUSTED OR	ADJUSTED OR (95% CI)	*P*-VALUE
	NO	YES			
Sex					
Female	46 (82.1%)	10 (17.9%)	4.735	1•	0.002
Male	34 (49.3%)	35 (50.7%)		3.997 (1.633–9.784)	
Age					
15–44	66 (78.6%)	18 (21.4%)	7.071	1	<0.001
>44	14 (34.1%)	27 (65.9%)		6.187 (2.595–14. 722)	
	READING LABEL ON PESTICIDE BOTTLE**				
	NO	YES			
Awareness on color coding					
No	40 (54.1%)	34 (45.9%)	3.44	1	0.043
Yes	13 (25.5%)	38 (74.5%)		2.511 (1.027–6.136)	
Education					
Illiterate	31 (67.4%)	15 (32.6%)	5.36	1	0.001
Literate	22 (27.8%)	57 (72.2%)		4.577 (1.913–10.950)	
Observe weather condition before spraying					
No	17 (65.4%)	9 (34.6%)	3.31	1	0.33
Yes	36 (36.4%)	63 (63.6%)		3.126 (1.094–8.934)	
	FOOD CONSUMPTION DURING SPRAY***				
	NO	YES			
Age					
15–44	82 (97.6%)	2 (2.4%)	13.226	1	0.50
>44	31 (75.6%)	10 (24.4%)		7.518 (1.010–58.88)	
Taking child during spray					
No	107 (93.7%)	7 (6.1%)	12.738	1	0.002
Yes	6 (54.5%)	5 (45.5%)		16.413 (2.755–97.768)	
Land used for cultivation					
≤20	81 (95.3%)	4 (4.7%)	5.062	1	0.047
>20	32 (80%)	2 (20%)		5.081 (1.020–25.302)	

Notes: *Adjusted with age, sex, and food consumption during spray. **Adjusted with sex, education, awareness on color coding, observing weather condition during spray, and field entry hours after spray. ***Adjusted with age, land used, average year of pesticide use, smoking/chewing habit during spray, and bring child during spray. •Reference category.

In this study, around one-third of farmers had received proper training on handling of pesticides, which was higher than that in the studies by Jors et al.[13] (25%), Oesterlund et al.[14] (31%), and Atreya[17] (8%).

In this study, 40% of farmers were unaware of the color coding on the pesticide bottle, which was similar to the study by Oesterlund et al, but lower than the study by Jors et al, (71%) (2006) study.[13,14] Farmers, who received training, were more wise and aware about the color coding pattern of pesticides.[17]

In this study, 40% of farmers looked for the pesticide label on the bottle while purchasing. Among them, none had the habit of reading instructions completely as given. The reason may be due to lack of awareness and low level of education prevailing among the farmers.

Farmers started spraying pesticide at an early stage of the crop and also during the flowering/fruiting period in order to increase production. Most of the farmers (86.6%) sprayed pesticide even up to four times a month. This showed that there was an extensive practice of spraying pesticide. The reasons for starting an early and frequent spray may be due to farmer's easy access, cheap cost, weak legislation, and lack of awareness among farmers regarding hazardous effects of pesticides.[1] This may also be due to the false perception that early and regular spray of pesticides would be more effective and easier in controlling crop pests.[1] A study by Naidoo et al.[18] also revealed that farmers had an inappropriate and irrational use of pesticide.

Our study found that farmers had not been using adequate personal protective measures during pesticide application, and none of the farmers used a complete set of PPE as recommended. A study conducted in Nepal by Shrestha et al reported that 66.6% of farmers did not wear any form of personal protective measures due to lack of knowledge and poor affordability.[19] Atreya in 2008 revealed that very few Nepali farmers used safety gear during handling pesticides.[20] Another study by Atreya et al.[21] in 2012 reported that only 10% of farmers used face mask. The cloth face mask worn by our farmers was to get rid of bad odors; they did not have the knowledge that face masks protect against pesticide exposure. In reality, Cloth face mask does not protect against vaporized pesticide.[22,23] A study in Nepal by Neupane et al.[15] showed that farmers were not completely following the PPE measures.

The safety and hygienic practices of handling pesticides such as washing hands before eating, avoiding backward walking while spraying, and avoiding walking in recently treated crop were poorly followed by the farmers.

Almost all farmers followed the wind direction during spraying. However, a study by Atreya et al.[21] revealed that very few farmers followed the wind direction while applying pesticides. This finding in our study may be due to the fact that not following wind direction may create problems such as lack of proper spray in targeted crop, bad odors to sprayer, difficulty in spraying, and breathing difficulty to sprayers.

A total of 38% of the farmers had a habit of smoking or chewing tobacco during the process of spraying, which was unacceptable. A study by Yassin et al.[24] also revealed that farmers were unaware of the safety precautions of pesticide poisoning.

Almost all farmers (96%) used the available home utensils such as spoon, cup, or jar, while half of them used their hands to roughly estimate the dosage. It was an irony that only 1% of farmers followed the standard regime for dose calculation. This may be attributed to the farmer's recklessness and incomplete explanation provided by Junior Technical Assistant (JTA) and local retailers while purchasing.

Farmers also had the habit of mixing and disposing pesticide containers in a nearby water source, which was completely unacceptable. A study by Sharma et al.[25] in 2012 revealed that Nepalese also place pesticide into rivers and streams in order to catch fish. These pesticides easily find their way in the blood streams of human beings through the mouth, nose, intact skin, and the eyes. This finding shows that unsafe disposal practices of pesticides can lead to adverse acute and chronic health effects among those exposed.

Conclusion

Age, sex, education, knowledge on color coding, and training received played a significant role in handling pesticides. In spite of regular use, farmers were lacking practices on safe handling (buying, mixing, spraying, storing, and disposing) of pesticides, leading to an increased potential risk of pesticide poisoning. Hence, there is an urgent need to educate and create awareness regarding safe handling of pesticides. Rules and regulations on use of safe handling of pesticides should be made stringent in the country.

Strengths and Limitations

- Very few studies have been published till date regarding the pesticide handling and associated factors in Nepal.
- We have used the regression model for in-depth analysis of factors determining the farmer's characteristics and associated variables regarding unsafe handling of pesticide.
- Our limitation would be that it is a descriptive study. This study does not cover a large population and hence a proper estimation of the problem is not possible.

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Author Contributions

Involved in conceptualizing the study, reviewing the literature, designing protocol, developing questionnaire, data

collection, analysis, and preparing the manuscript: GK. Guided and supervised GK throughout the study: AS. All authors reviewed and approved of the final version.

Supplementary Material

ANNEXURE

Questionnaire for Farmers.

Conceptual Framework

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