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FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Study on farmers' Pest management strategy, knowledge on pesticide safety and practice of pesticide use at Bhaktapur district, Nepal

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Abstract: Nepal being an agricultural country, the majority of the population is involved in agriculture. Pests are one of the major problems in the agriculture sector. Pesticides are being widely used to encounter this problem. This study aims to determine the knowledge level of farmers on pesticides and their use. Specifically, it investigates the pest management strategy, pesticide use, and safety measures used by the farmers. For this study, four municipalities of Bhaktapur district were selected with 100 respondents using a random sample design. Primarily, data collection was done through field observations, interviews, and questionnaires. Various secondary data were also used. Our study showed that farmers in this region were mainly dependent on chemical methods. For technical guidance, several applications, and use rates, farmers preferred the agro vets available in their area. As less care and concern were given to safety measures, it was not given top priority. The study showed that the knowledge of various aspects of pesticides, their use, and safety was inadequate among the farmers.

Subjects: Agriculture & Environmental Sciences; Agriculture; Agriculture & Related Industries

Keywords: Pest management strategy; pesticide; knowledge on pesticide safety; practice of pesticide use

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ABOUT THE AUTHOR

Susan Thapa's research niche includes research in the quantification of causation of high use of pesticides in agriculture and their public health significance. This current paper is a part of the self-funded project activity to access the persistent pesticide contamination in the agriculture field, farmers', environment and their effects on environment and public health. His interest lies in Biostatisitcal analysis and Data Science.

PUBLIC INTEREST STATEMENT

Vegetable farming is growing in popularity among farmers. With the rising purchasing power of consumer, the demand has increased. Likewise, the incidence of pests has also increased in the commercial fields. To curb the insect pest incidence there is a tendency for high use of pesticides. It is important to protect crop from insect pest. Therefore, the main reason for this study was to find out the knowledge and practices of farmers using pesticides in Bhaktapur district.

Back in 2010, one case study was conducted in Bhaktapur to understand the productivity of pesticides in Nepal, where it was concluded that the farmers' attitudes and knowledge about vegetable production and pest management, however, the study was focused only on cole crops (Jha & Regmi, 2009a). Therefore, a study that includes the broad work of not only crucifers but the different vegetables grown in the district is the most.

1. Introduction

Nepal is a land-linked country with diverse bio-climatic zones located in the lap of the Himalayas. The total land area of Nepal is 147,108 sq. km. Agriculture has dominated the economy in Nepal (Tripathi et al., 2020). With almost 54% of people dependent on farming, the sector generates 24.26% of the GDP of the country (Adhikari, 2017). However, due to the loss of crops by pests, the food supply to the populace could not mark the self-sufficiency (Seddon et al., 2002). In Nepal, the total coverage area for vegetable production is at an increasing rate. The total coverage was 208,108 Ha in 2007/08 that increased to 280,807 Ha in 2015/16 (Ghimire et al., 2018). Similarly, the production has also waxed to 3,929,034 Mt in the year 2015/16 with average production standing at 13,992 kg/ha. Bhaktapur is a peri-urban area from where the food products find their place in the market of Lalitpur and Kathmandu. In Bhaktapur 237.1 ha of land is used for the production of vegetables, the production stands at 5847 Mt and average production stands at 24.7 m/ha (Pandey et al., 2017)

In a general and simplest term, those chemicals that obliterate pest is called pesticides. Either it may be a virus or any bacterium, antimicrobial, or disinfectant that puts off, weakens, destroys, pests. It is evident that many farmers are dependent on pesticides, and it is mainly occurring in the developing and underdeveloped countries (Wri, 1998). In a bid to curb the vector-borne disease in agriculture crops and for control of household pests, chemical pesticides are used (Kansakar et al., 2001). A large proportion of farmers do not know the types, levels of poisoning, safety measures, and potential hazards to health (Yassin et al., 2002). Most often, the chemical pesticides used are either chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, and zinc compounds that have a carcinogenic effect on humans (Vainio, 1999). This results in cancer, birth defects, reproductive problems, tumors, and damage to the liver, kidney, and neural organs. In our country and other underdeveloped and developing countries, the overuse of pesticides is linked up to the adverse effect on humans and the environment (2010). Most of the farmers who use pesticides do not know some major issues like types of pesticides, modes of action, hazards to human health, and protection measures.

The rife in the use of pesticides to control pests is a problem in developing countries (Wri, 1998). In a bid to curb the vector, borne disease in agriculture crops, and for control of household pests, chemical pesticides are used (Kansakar et al., 2001). The number of farmers depending on pesticides continues to increase. The data of CBS verify that particularly vegetable growers continue to use pesticides that have been increasing from 7.1% in 1991/92 to 16.1% in 2001/2002 (Ghimire et al., 2018). However, the number of cereal crop growers using pesticides is growing steadily. The percent of pesticide users among the maize growers increased meagrely (Pandey et al., 2017). Notwithstanding all the facts, the use of pesticides has risks to human health and the environment (Travisi et al., 2006).

The data from PPD (Plant Protection Directorate) show that as many as nine pesticide groups which have seven subgroups of Insecticides were imported between the year 1997 to 2003 (Diwakar et al., 2008). Nepal uses almost 142 g/ha amount of pesticides, which when compared to other country is statistically low. The data shows that among imported and used pesticides from 2056/57 (1999) to 2060/061 (2003) were fungicides, bactericides, acaricides & seed treatment groups. In the year 2056/57 (Vainio, 1999) & 2057/58 (2000), no amount of biopesticides was imported and consumed, however between 2058/59 (Kansakar et al., 2001) to 2060/061 (2003) plant regulators were not imported and consumed (Diwakar et al., 2008).

Vegetable farming is growing in popularity among farmers. With the rising purchasing power of consumers, the demand has increased. Likewise, the incidence of pests also has increased in commercial fields (Jha & Regmi, 2009a). To curb the insect pest incidence there is a tendency for high use of pesticides. It is important to protect the crop from an insect pest. Therefore, the main reason for this study was to find out the knowledge and practices of farmers using pesticides in the Bhaktapur district. My study was focused on evaluating the status of pesticide use, and assessing farmer knowledge on

safe pesticide handling at four municipalities of Bhaktapur. The information obtained from the study was help in improving awareness to the government, policy formulators, and concerned stakeholders to conduct related training and awareness campaigns for addressing the pressing issue that ultimately may help farmers in future and related stakeholders such as agricultural technicians, and extension agents to conduct training or awareness programs for addressing specific needs.

2. Materials and methods

The study was conducted in four municipalities of Bhaktapur in spring 2018. The study area was near the capital city, Kathmandu. The area has a temperate monsoon climate with high relative humidity throughout the year.

2.1. Field survey

A household survey in all municipalities of Bhaktapur was conducted in spring 2018. Altogether, 100 representative households were individually interviewed. Sampling was carried out by using a random sampling method. A set of semi-structured questionnaires was prepared that covered mainly the demographic characteristics, pest management strategy, knowledge on pesticide safety, and practice of pest management. Besides that, informal discussion with experienced farmers was also carried out. The general information on the respondent and their hold-like education, family size, main occupation, caste, the total area of land, etc. was also included in the questionnaires.

2.2. Sampling technique and sample size

From four municipalities: Madhyapur Thimi, Suryabinayak, Changunarayan, and Bhaktapur municipalities, 100 respondents were selected by a simple random sampling technique.

3. Data collection

The data was collected primarily through field observations, interviews, and questionnaires and secondarily through various sources such as reports, books, and journals related to the subject matter of study.

3.1. Primary data

The general information about the respondents and their demographic information like education, family size, ethnicity, main occupation, and landholding was accounted for.

Focus group discussion with the concerned farmers was carried out to give a clear view of their perceptions, opinions, beliefs, and attitudes towards cultivation practices.

3.2. Secondary data

The necessary data required for the study were collected from various books, journals, magazines, research papers, annual reports, publications, statistical information of Agriculture sectors published by MOAD, Plant Pathology Division NARC, and internet materials. Libraries of NARC, HICAST, etc. were frequently used for the data collection.

3.3. Data processing and analysis

The raw data were recorded and stored in MS-Excel. Primarily, the data was collected by conducting household survey. The gathered information through questionnaires was entered and analyzed by using R-studio software and results were finalized by doing Chi-square test and presenting them in the tabular form.

4. Results and discussions

4.1. Demographic and socioeconomic status

The questionnaires were prepared in such a way that the age group was categorized into five categories: a) 11–20 years b) 21–30 c) 31–40 years d) 41–50 years e) 51 and above. Table 1 shows that 19% of farmers belong to the 21–30 years age group, 27% of people belong to 31 to 40 years

Table 1. Demographic and socioeconomic status

Variables	Category	Frequency	Chi-square	P-value
Age	21–30	19		
	31–40	27	7.04	0.07
	41–50	19		
	51 and above	35		
Ethnicity of the respondents	Newar	48		
	Kshetriya	23	67.1	9.29E-14
	Brahmin	22		
	Dalit	4		
	Madhesi	3		
Education of the respondents	Illiterate	8	62.1	1.05E-12
	Primary Education	49		
	Secondary Education	20		
	Intermediate education	19		
	University level educaiton	4		
Main occupation of the respondents	Agriculture	43	17.84	0.0004746
	Agriculture and service	21		
	Business	20		
	Others	16		

age group, 19% of people belong to 41–50 years age group, and the remaining 34.5% of farmers belong to the above 51 years, age group. The majority of surveyed farmers belong to the 41–50 age group. Moreover, the educational status of the respondents was divided into five categories as illiterate, primary, secondary, intermediate, and university level education. The data showed that the majority of the respondents had only attended primary education. Some of the farmers (8%) were illiterate. Only a few farmers had attended a university-level education (4%). This showed that most of the people were directly dependent on agriculture as their education status was low. Involvement of farmers with a higher level of education aids in increasing agriculture productivity and decreases fragmentation of land to some extent (Guo et al., 2015). The majority of the respondents interviewed pursued agriculture as their prime occupation. However, some of the respondents had agriculture as a secondary occupation (21%) while being involved in the service sector.

4.2. Pest management strategy

The respondents used different types of pest management strategies. Twelve percent of respondents used a cultural method only, while 13% of people used a biological method to control pests. Thirty-five percent of respondents, with the highest proportion, used chemicals with other methods whereas 28% of people used chemicals only as part of the pest management strategy. Several papers corroborate the dependence on pesticides as a resort for the management of pests. Some papers have pointed out Dhading and Chitwan district as having a high dependence on pesticides (Atreya, 2005; Koirala & Tamrakar, 2008)

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Table 2. Pest management strategy

Variables	Category	Frequency	Chi-square	P-value
Pest management strategy	Cultural	12	23.3	0.0001103
	Mechanical	13		
	Biological	12		
	Chemical	35		
	Chemical with others	28		
Crop wise pesticide use	Cereal	34	31.76	1.27E-07
	Fruit	10		
	Vegetable	56		
Decision of spray	Before pest emergence	43	6.02	0.04929
	After damage is seen	23		
	After pest emergence	34		

The farmers in Bhaktapur did not follow the simple principle of economic threshold values in practicing spray decisions in the field. As shown in Table 2, the study found that 35% of farmers spray pesticides after the damage is seen in the plants, whereas 24% of farmers responded that they spray pesticides after pest appearance. Similarly, 23% of farmers responded that they use pesticides before the pest and damage are seen. The use of pesticides and insecticides before the emergence of pests adds cost to the farmers, which ultimately increases the incidence of diseases and decreases the profit of the farmer (Hoy et al., 2015).

4.3. Pesticide use pattern and safety measures

To the questionnaire on how many times do they use pesticides? Thirty-seven percent of respondents said they spray 1–4 times per season. Thirty-four percent of respondents said they spray pesticides 4–8 times, whereas 28% of respondents said they spray pesticides more than 8 times per season.

The study found that the majority of farmers depend on agro-vet for the recommendation of pesticides. A major chunk, 72%, depends on agro-vet's recommended dose of pesticides to use. Only 10% responded they use 1–3 ml/lit whereas eight percent responded they use 6 ml/L of pesticides. Similarly, 10% of respondents used 3–6 ml/l of pesticides. Similarly, results were shown in a case study conducted in Kenya (Manfre & Nordehn, 2013).

The survey found that 72% of farmers used masks only as protective equipment while they are spraying pesticides, which is shown in Table 3. Only 6% of farmers responded that they use the proper protective equipment that includes aprons, gloves, goggles, and body coverings. Likewise, Table 3 shows that 22% of farmers were ignorant about safety they used no equipment while they spray pesticides. A study conducted in India found that the discomfort to use protective equipment was the primary reason for not using protective equipment (Singh & Gupta, 2009). The majority of farmers responded that they depend on agro-vet as the source of technical information. Sixty-seven percent of farmers depend on agro-vet for technical information, whereas only 13% of farmers depend on DADO or agriculture service center for technical information. This shows agro-vet has a high influence on farmers to adopt any techniques. A study conducted in 2018 in the

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Table 3. Pesticide use pattern and safety measures

Variables	Category	Frequency	Chi-square	P-value
Number of application	1 to 4 times	37	0.34545	0.8414
	4 to 8 times	34		
	>8 times	29		
Pesticide use rate	1 to 3 ml	10	117.92	2.20E-16
	4 to 6 ml	10		
	>6 ml	8		
	Agro-vet recommendation	72		
Protective equipment used	Mask only	72	71.12	3.60E-16
	Use all protective gear	6		
	Do not use at all	22		
Source of technical information	Agriculture service centre/DADO	13	93.2	2.20E-16
	NGO/INGOs	4		
	Agro-vet	67		
	Self	16		
Protecting pollinators and bees	Spray after 4 pm	10	89.76	2.20E-16
	Spray before 4 pm	12		
	Spray safe pesticides	12		

Chitwan district also found a tendency among farmers to depend upon the agro-vet for the information (Rijal et al., 2018).

The majority of respondents reported they did not care about the period of the spray of pesticides. Sixty-seven percent of respondents reported they spray pesticides when they want to whereas very few populations cared for the pollinators. Twelve percent of respondents said they use safe-level pesticides. Insects and bees are responsible for nearly 80% of pollination; therefore, it is important to protect pollinators, mainly bees (R.B. Thapa, 2006).

If a farmer does not know about banned pesticides, he can use those pesticides which have a severe impact on human and environmental health. The majority of farmers did not know about the banned pesticides. Only 12% of farmers knew about banned pesticides. A study carried out in Lebanon showed similar results (Salameh et al., 2004), where almost 80% of farmers did not know about banned pesticides. Knowledge of the class of pesticides was also inadequate. Over 90% of farmers did not know the class of the pesticides. A cross-sectional study carried out in Uganda also showed a close result with the study carried out in Nepal (Oesterlund et al., 2014). The farmers' knowledge of good agricultural practices was found to be inadequate. The majority of farmers did not know about the Good Agricultural Practices. Only 30% of farmers said they know Good Agricultural practices. The lack of knowledge on good agricultural practices might be the cause of increasing dependency on the use of the pesticide in the field, which eventually increases the resistance to the pesticides against the harmful pests. Furthermore, it causes the increase in pesticide residue in the soil.

Farmers did not follow the waiting period. Table 4 demonstrates that only 27% of farmers followed the waiting period. The pesticide residues become higher if there is a less waiting period and harms the health of the consumer as well as the farmers (Koirala et al., 2010). However, a recent study carried out showed that farmers tend to follow waiting periods in the Dhading District of Nepal (Bhandari et al., 2020). The study conducted in Dhading showed that most of the farmers practice 3–5 days of the waiting period. Likewise, the 3-year study carried out in Nepal also showed an increase in knowledge about the waiting period (Adhikari, 2017). The study revealed that very few farmers knew of natural enemies and biological predators. Only 18% said they know of natural enemies. This lack of knowledge of natural enemies increases the tendency to depend on harmful chemicals. The high use of chemicals is detrimental to farmers', consumers', and ultimately environmental health (Atreya et al., 2012; Bhandari, 2014; Dickin et al., 2016).

Training plays a vital role in shaping the knowledge of farmers. If the farmer is trained on the regular interval there is less chance that the farmer commits any sorts of activities that are detrimental to his and environmental health. The study showed that only 27% of farmers received training regularly. A study carried out showed similar results in Nepal (Atreya, 2007). Many studies have shown positive results in farming activities after receiving training on the regular basis (Gautam et al., 2017; Huang et al., 2012; Noor & Dola, 2011). Protective gears play an important role in preventing harmful chemicals from entering the body. The study showed that only 29% of people use protective gear while spraying pesticides. The study carried out in Indonesia showed

Table 4. Various practices, knowledge to subside use and exposure to harmful pesticides, and technical knowledge of pesticide application among vegetable growers in Bhaktapur, Nepal

Variable	Frequency		Chi square	P-value
	Yes	No		
Knowledge on Banned Pesticides	18 82		40.96	1.554e-10
Knowledge on class of Pesticides	10	90	64	1.244e-15
Knowledge on Good Agricultural Practices	30	70	16	6.334e-05
Knowledge on importance of IPM	45	55	1	0.3173
Understanding toxicity and level of pesticides	31	69	14.44	0.0001447
Knowledge on waiting period	27	73	21.16	4.225e-06
Understanding on importance on Natural Enemies	18	82	40.96	1.554e-10
Recent Training on Agricultural Practices	27	73	21.16	4.225e-06
Use of Protective gears while spraying pesticides	29	71	17.64	2.669e-05
Technical advice from agro-vets	88	12	57.76	2.961e-14
Follow Integrated Pest management practices	28	72	19.36	1.083e-05
Crop rotation	31 69		14.44	0.0001447

a similar result (Yuantari et al., 2015). The study showed there was no significant relationship between knowledge and attitudes towards using protective equipment and practice. Likewise, a study carried out in Nepal showed that 30% of people do not use any form of personal protective equipment (PPE) (Koirala et al., 2010).

The study showed that 45% of people had received training on IPM, whereas only 28% of people were following some sort of IPM practices. The study revealed that only 18% of farmers knew natural enemies. Likewise, only 31% of farmers practice some sort of crop rotation. Furthermore, 88% of farmers depend on the agro-vet for technical advice. This clearly shows the communication gap between government workers and farmers. A similar result was seen in Nepal in a study carried out in 2014 (Bhandari, 2014). The IPM program, which started in 1997 with the support of FAO, has now been implemented in 62 of 75 districts with an intensive program in 17 districts. There are 131 IPM groups and 3667 farmer field schools in the country (Gc & Keller, 2013). Various studies have shown encouraging results among farmers after learning Integrated Pest Management in Nepal and Asia (Bartlett, 2005; C.B. Thapa, 2017; Ghimire & Kafle, 2014). Despite the encouraging results, a lower number of farmers are adopting IPM in Nepal (C.B. Thapa, 2017). The lower adoption rate is recorded but the actual causation of a decrease in adoption rate is not reported yet in Nepal. There could be various causes like low confidence rate in non-chemical pesticides, the slow effect of the biocontrol agents, lack of proper training facilities and monitoring of the training, information gap between farmers and government officials.

5. Conclusion

In developing nations, protecting crops from insects, pests, and disease is a major problem in the production of food. Farmers consider pesticides as the panacea to overcome the infestation of pests and disease. The study in Bhaktapur accessed the farmers' knowledge of pesticide use and handling and evaluated their current pest management technique. The survey found that the majority of the farmers' knowledge on several facets of pesticides like handling, selection, harmfulness, use is very inadequate. The high use of pesticides has the potential to increase the health risk to both farmers and consumers. It was found that farmers use pesticides without deliberating the usefulness of natural enemies. Similarly, it was found that they do not consider their safety as if they do not use any protective equipment while spraying pesticides. The presence of a government extension program to enhance the farmers' knowledge of pesticide safety was insufficient. The dependency on agro-vet to resolve the problem on plants verifies the situation. The study also underscores the importance of educating farmers on various areas of use of pesticides, and the ramification of unscientific uses.

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Highlights

- Most of the farmers are unaware of various aspects of pesticides, its use and safety were inadequate among the farmers
- This study aimed to find the farmers' pest management strategy, knowledge on pesticide safety and practice of pesticide use at Bhaktapur district, **Nepal**
- The study reveals that education and training significantly affect the awareness of the use of pesticides and their safety.

The study reveals that farmers mostly depend on chemical pesticides and agro-vet recommendations.

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