Research

Farmer's Attitudes on pesticide-use and pest-management practices: A case study of vegetable-cultivators in the vicinity of Lucknow, India

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Abstract
For effective pest management, farmer's awareness of pesticide toxicity and its safe application is crucial. The use of pesticides in vegetables and fruits is increasing day by day. To assess the awareness of the vegetable and cereal growers in Uttar Pradesh, India on the safety and toxicity management of chemical pesticides, a household survey was carried out using a well-structured questionnaire. According to our survey and observation, more than 99% of farmers preferred chemical pesticides to other alternative approaches for controlling pests. Notably, 80% of farmers were unaware of the harmful consequences that chemical pesticides have on human health and the environment. Nearly 40% of farmers had at least some brief training in integrated pest management (i.e., Communicated through the Kisan Mela and agricultural experts), however, none of them were conscious of the negative effects of pesticide residue or appropriate disposal strategies. For technical information on the selection, handling, and use of pesticides, more than 90% of growers seem to be dependent on local pesticide retailers, radio, and television. The report emphasized the necessity of establishing strict pesticide use rules and awareness campaigns on pesticide selection, its disposal methods, and its toxicity to humans, animals, and overall agro-biodiversity.

Keywords: Pesticide toxicity, Pest management, Farmer's awareness, Pesticide exposure, Vegetable, and Cereal growers.

Introduction

Pesticides are chemicals used to keep pests away from crops and plants by killing them or getting ineffective in different ways and means. Because they are toxic substances. pesticides must be handled with adequate care and caution. Poor pesticide management practices and violations of safety rules are common among the farmers and labourers disposing of it in the agricultural and horticultural fields in India. In the past few decades, developing nations have seen a significant shift in their food consumption behaviour (Rijal et al., 2018). Several forms of pesticides used to control agricultural pests and residential pests contaminate daily foodstuffs, and approximately 20% of foodstuffs contain pesticide residues (Kurup, 2009). Fish could get a high intake of mercury from contaminated water if the seed were treated with mercury chloride (fungicide). Similarly, when nitrogenous fertilizers are used in vegetable cultivation, the harvested product contains nitrites and nitrates, which enter the human body (Majumdar, 2010). Furthermore, the banned insecticide residues such as chlordane, aldrin, and heptachlor are also widely used in Indian agriculture due to ignorance or lack of awareness, resulting in the contamination of vegetables, food grains, fruits, etc. with their toxic residues. For example, larger levels of chlorpyriphos in cauliflower and rice, as well as quinalphos in cardamom, than the maximum residue limits have been reported (Mishra, 2011).

Several agricultural pesticides are known to cause diseases and illnesses in humans and cattle, as well as harm the environment and plant diversity in the chronic and acute term (Atreya, 2007). Improper pesticide dosages can lead to accidental poisoning, as well as acute and chronic health impacts (Sharma et al., 2012). Chronic exposure to pesticides can lead to long-term health hazards such as cancer, neurotoxic, genotoxic, dermatosis, and respiratory consequences (Sabarwal et al., 2018). Additionally, farmers in developing nations are exposed to hazardous chemicals due to a lack of technical knowledge on the level of pesticide toxicity and safety precautions to prevent themselves from exposure. (Atreya, 2007; Yassin et al., 2015; Khan et al., 2015). Pesticides are handled incorrectly most often during the mixing and spraying process, during storage, and pesticide disposal (Sharma et al., 2012; Yang et al., 2014).

According to a previous study, 211 metric tons of pesticides are imported annually, with fungicides accounting for the majority (51.38%), followed by insecticides (29.19%) and herbicides (7.4%) (Sharma et al. 2012). On the other hand, a case study from China reported that most farmers were not aware of the right way to dispose of pesticides and had developed the practice of doing so in sensitive regions like streams and rivers (Yang et al., 2014). Unaware of the risks to their health and the environment, many farmers in South Asian nations, such as Pakistan, India, and Thailand, use pesticides that the WHO has categorized as highly hazardous and, in some cases, banned (Schreinemachers et al., 2015; Yadav et al., 2015).

In-depth research has been conducted on food handlers' knowledge, attitudes, and behaviours (KAP) in terms of food safety (Rebouças et al., 2016; Al-Shabib et al., 2016; Zanin et al., 2017; Bou-Mitriet al., 2018). However, very few studies have employed observation to look at how people handle food (Da Cunha et al., 2014; De Souza et al., 2018). Self-reported practices may not accurately reflect actual food-handling behaviour since they may bring respondent bias into the study results (Bou-Mitri et al., 2018; Ncube et al., 2017). The farmer's awareness about pesticide toxicity and its safe application are available in other countries but very few studies have been reported in India. In the present study, it is attempted to assess the awareness of vegetable and cereal growers of pesticide toxicity and its safe application in the agriculture field and also assess the awareness of farmers about the adverse health effects of chemical pesticides.

Material and methods

Data collection and analysis

The present case study was conducted in the capital city of the Indian state of Uttar Pradesh, Lucknow is about 631 square kilometres in area and has a population of about 3.854 million, making it the most populous city. Data were collected from randomly selected 228 respondents consisting of 159 (69.74%) males and 69 (30.26%) females. Well-structured questionnaires were developed in English to collect the information. After that, the surveys were given out for individual administration. Those respondents who wanted to complete the surveys in English but were unable to do so were given questionnaires that had been translated into their native tongue (Hindi). The respondents were divided into groups by sex, age, land holding, area, and educational attainment following their sociodemographic parameters (Figure 1). The present study mainly focused on the awareness of vegetable and cereal growers about the understanding of agrochemical uses, sources of information, pesticide toxicity, storage, and handling. SPSS and Microsoft Excel were used to analyze the results that had been gathered (version 16).

Statical analysis

All parameters obtained undergo descriptive statistics and frequency distribution analysis. The connection between sociodemographic features, exposure to pesticides, and other qualitative variables was examined using a Chi-square test ($p < 0.05$). Microsoft Excel (Microsoft Corp., Redmond, WA, USA) and SPSS ver. 21 (IBM Corp., Armonk, NY, USA) were used to analyze the data.

Result and discussion

Demographic and socioeconomic data

The majority of respondents belonged to the 19–30 (48%) age category, followed by people who were 31–45 years, 45–60 years, < 18 years old, and >60 years old (Figure 1). Compared to older farmers, the involvement of younger farmers (19–30 years old) in the cultivation of vegetables and cereals provides a significant opportunity to experience new and safer pest management techniques (Rijal et al., 2018). More than 48% of the surveyed farmers had education levels below the 10th standard, followed by graduation (25%), intermediate (12th grade) (12%), higher education (10%), and post-graduate degrees (5%). More than 84% of the farmer's population belongs to the rural areas which consider agriculture as their primary occupation, of which 16% of farmers belonging to the peri-urban areas had another occupation besides agriculture. In this case study, only 4% of farmers had a land holding above 4 hectares, while 52% of farmers had land holding below 1 hectare followed by 38% between 1–2 hectare land holding and 6% of farmers had land holding between 2-4 hectare (Figure 1).

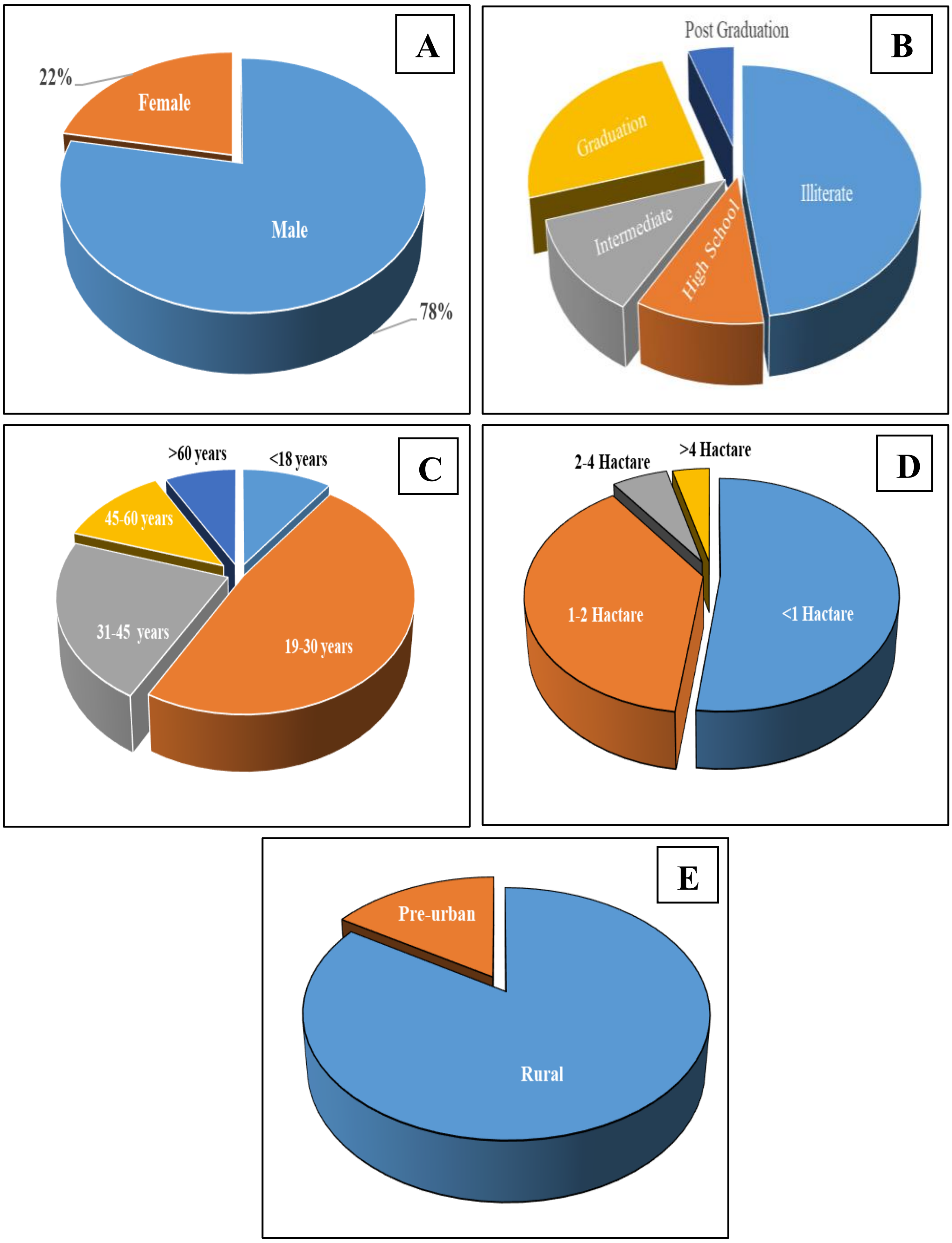

Figure 1: Demographic data of respondents participating in this case study (N=208) according to (A) Gender (Chi-square- 251.2, P value- <0.001), (B) Education (Chi-

square- 125.4135, P value- <0.001), (C) Age (Chi-square- 115.0288, P value- <0.001), (D) Land Holding (Chi-square- 318.28, P value- <0.001), and (E) Area (Chi-square- 140.8077, P value- <0.001)

Farmer's Knowledge of agrochemical and their Source of Information

The majority of the respondents (64%) use the pesticide level recommended by the dealer and the agriculture expert (Table 1), whereas 32% utilize the level recommended on the agrochemicals' bottle and packet. Almost no farmers use pesticides at levels below those recommended on the label by industry professionals in agriculture. Our case study showed that many respondents (88%) applied pesticides in the cultivation of vegetables and cereals using a conventional approach (i.e., hand-driven spray machine), whereas only 10% adopted the more contemporary way (i.e., knapsack sprayer). According to (Mainali et al., 2010), the production of vegetables and cereals is highly dependent on chemical pesticides. Given the high importance of vegetables as a commodity, this tendency is advancing quickly throughout most global vegetable and cereals output (Rijal et al., 2018). Most farmers (78%) spray the pesticide 2 and >3 times in the agricultural fields where they cultivate their vegetables and cereals. Chemical pesticides should not be applied 2-3 times in agricultural fields because this results in unnecessary spending and pesticide overuse. Only 22% of farmers, however, spray chemical pesticides 1 time in their agricultural fields (Table 1). An earlier study found that higher levels of education and pest management training decrease the probability of pesticide overuse (Atreya, 2005, 2007; Khan et al., 2015). However, age, education level, and pesticide use frequency were not significantly correlated with one another in this study.

Table 1: Farmer's knowledge about the agrochemical and their source of information (N=208)

Particulars	**Number and Percentage of Farmer's**	**Chi-Square (χ^2)**	**P Value**
	Level of Pesticide use	217.5	<0.001
According to the Packet/bottle label	66 (32%)		
Greater than the instruction	0		
Less than instruction	9 (4%)		
According to pesticide dealers/ Agriculture Expert	133 (64%)		
Using Method/Equipment for Pesticide Application		444.8077	<0.001
Hand-driven spray machine	183 (88%)		
Hand Sprinkling	4 (2%)		
Knapsack Sprayer	21 (10%)		
Injection	0		
Frequency of pesticide application in the field		24.9654	<0.001
Once	46 (22%)		
Twice	79 (38%)		
Thrice	54 (26%)		
More than 3 times	29 (14%)		
Source of information about the safe use of pesticide		134.7308	<0.001
TV/Radio	116 (56%)		
Newspapers/Magazines/Books	9 (4%)		
Kisan Mela	21 (10%)		
Others (Agriculture Expert/ Pesticide Dealers etc.)	62 (30%)		

Farmer's Attitude and Understanding of Pesticides

For safe application, it is essential to read the pesticide label and follow the directions. However, our survey study found that most farmers (78%) were unaware of any potential negative effects of pesticides, while the remaining 22% were aware of those risks and harmful effects. This contrasts with previous research that showed that about 12% and 12.3% of respondents in Pakistan and Nepal, respectively, were unaware that chemical pesticides do not pose any risk at all (Khan et al., 2015; Rijal et al., 2018) (Table 2). Due to less awareness and knowledge about pesticide toxicity, about 74 % of farmers in this surveyed study bought the pesticide without a label on the chemical pesticide bottle (Mainali et al., 2010) (Table 2). In this study, just 8% of farmers correctly identified the pesticide toxicity colour codes that are printed on the pesticide bottle label. Lack of knowledge regarding pesticide handling and pest control had led to the continuous use of the same pesticide without taking pesticide resistance issues into account. To manage the target insect, about three-fourths of respondents (78%) frequently use the same pesticide during the same growing season (Table 1). Additionally, it is possible that the repetitive use of the same pesticide, which led to pesticide resistance, was a result of the comparatively high costs of new insecticides, the lack of diversity in pesticide active ingredients, and a lack of understanding of resistance management (Rijal et al., 2018).

Table 2: Farmer's attitude and understanding of pesticide toxicity, storage, and handling (n=208)

Particulars	**Number and Percentage of farmers**		**Chi-Square** (χ^2)	**P Value**
	Yes	**No**	381.5	<0.001
Pesticides indispensable for high crop yield	208 (100%)	0		
Awareness of pesticide toxicity levels	162 (78%)	46 (22%)		
Ability to understand the level of toxicity, reading the sign on the label	96 (46%)	112 (54%)		
Ever bought/purchased pesticides without a label	54 (26%)	154 (74%)		
Knowledge about pesticides that are banned or restricted for use	46 (22%)	162 (72%)		
Knowledge about the reason for banning or restricting pesticides			330.9231	<0.001
Highly toxic	42 (20%)			
Not effective	4 (2%)			
Expensive	0			
Don't know	162 (78%)			
Sign marks which signify the most dangerous pesticides			164.2967	<0.001
Don't know	79 (38%)			
Blue colour coding	0			
Red colour coding	17 (8%)			
Yellow colour coding	0			
Green colour coding	0			
Skull and bone pictorials	87(42%)			
Smell indicates the danger	25 (12%)			
Place used to store agrochemicals used in agricultural pesticides			206.7154	<0.001
Living area	0			
On the top of the house	87 (42%)			
Animal House	13 (6%)			
Locked up in a safe place near the field	108 (52%)			

Does not matter place / anywhere	0		
The leftover pesticidal solution is -		69.56154	<0.001
Stored and used for another application	33 (16%)		
Pour into bushes/ rivers/streams	70 (34%)		
Sell it to another farmer	8 (4%)		
Apply even though it is not needed	76 (36%)		
Dispose of it near the field on the soil	21 (10%)		

Table 3: Farmer’s attitude toward the importance of wearing personal protective equipment (PPE) (N=208)

Particulars	**Number and Percentage (%) of farmers**	**Chi-Square (χ^2)**	**P Value**
Use of PPE (like gloves, masks, goggles, etc.) while mixing or spraying		120.7692	<0.001
Yes	162 (78%)		
No	46 (22%)		
Eat, drink or smoke while mixing or spraying		281.6193	<0.001
Always	4 (2%)		
Sometimes	21 (10%)		
Never	183 (88%)		
Take a shower immediately after mixing or spraying		322.352	<0.001
Always	191 (92%)		
Sometimes	17 (8%)		
Never	0		
Wash work clothes separately after mixing or spraying		299.7356	<0.001
Always	187 (90%)		
Sometimes	13 (6%)		
Never	8 (4%)		
Have suffered from acute pesticidal toxicity after mixing or spraying		23.83768	<0.001
Always	37 (18%)		
Sometimes	92 (44%)		
Never	79 (38%)		

Although many farmers lacked a comprehensive understanding of product labelling and properties, they nonetheless used PPE when handling pesticides. 78% of farmers who participated in the poll utilized facemasks in addition to other PPE including gloves, long sleeve shirts, shoes, or all of them. The effectiveness and applicability of PPE, however, are unknown. (Table 3). About 92% of respondents clean themselves immediately after applying the pesticide in the agricultural field. while a huge population of respondents (66%) suffers from acute pesticidal toxicity (i.e., eyes and skin irritation, sore throat and cough, respiratory tract irritation, headache, vomiting, diarrhoea, allergic sensation, etc.) after the pesticide application. Due to a lack of knowledge of pesticide toxicity and storage more than 36% of farmers apply the pesticide even though it is not needed in the agricultural field while about 34% of farmers pour into the bushes, rivers, and streams and 10% of farmers dispose it on near agricultural field soil. According to a similar study carried out in two rural farming regions in China, farmers discard leftover pesticides in vulnerable locations including public lands and water supplies (Yang et al., 2014; Rijal et al., 2018).

Conclusion

The main obstacles to the commercial production of vegetables and cereals in developing nations like India are the control of insects, pests, and diseases. Chemical pesticides are a useful tool for farmers to control pests. The current study aims to examine farmers' existing pest management strategies in commercial vegetable and cereals production, health effects as well as their understanding of pesticide use and handling. The study found that most farmers have very little understanding of a variety of pesticide-related topics, including their use, varieties, characteristics, selection, and general handling. Pesticide overuse can lead to increased health risk hazards and costs for both farmers and consumers. The government's agricultural extension program appears to have no impact on farmers' knowledge about pesticide use, and farmers depend largely on their neighbourhood pesticide distributors for technical advice. Weak pesticide regulation and enforcement systems are to blame for poor pesticide safety and use conditions. This study also stressed the significance of comprehending farmers' local circumstances and teaching farmers about a variety of pesticide-related topics, including use, disposal, and the effects of inappropriate and illegal use. To minimize any adverse effects on the environment and public health, governments will utilize this information to prioritize their activities and properly regulate the availability and application of agrochemicals. Farmers, private pesticide sellers, consultants, regional and national government agricultural organizations, and other pesticide enforcement authorities must work together to solve these problems.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors contributions

Pradeep Kumar: Investigation, Conceptualization, Methodology, Formal analysis, Validation, Data curation, Writing - original draft.; **Dipti:** Investigation, Formal analysis, Validation, Data curation.; **Rana Pratap Singh**: Project administration, Supervision, Writing - review & editing, Resources.

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Data availability

All relevant data are within the paper and its supporting information file

Compliance with ethical standards

Ethical Approval: Not applicable

Consent to Participate: Not applicable

Consent of Publish: Not applicable

Conflict of interest

The author declares no conflict of interest.

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