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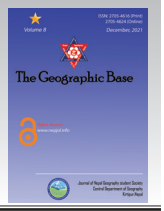

Farmer's Awareness on Pesticide Waste Management and Role of Pesticides in Water Contamination in Bahawalpur, Punjab, Pakistan

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Abstract

This study emphasizes the awareness and training of farmers on sustainable agricultural practices for restrictive use of pesticides to reduce water pollution caused by pesticides in rural areas. For this assessment, 150 feasible farmers were selected randomly using a convenient sampling technique. Data was collected through interviews (n=30) and questionnaires (n=120). Data was scrutinized in SPSS software. To examine freshwater contamination with pesticides, freshwater samples were collected from open water bodies (5 wells) in the area of tehsil Hasilpur (29.6902° N, 72.5796° E) and Qaimpur of Bahawalpur, Punjab, and analyzed for eight pesticides which are frequently used. ECD: Electron Capture Detector was used to detect the organochlorine pesticides, herbicides, and various halogenated hydrocarbons. NPD: Nitrogen Phosphorus Detector was used to detect nitrogen- or phosphorus-containing compounds. Approximately 80% of farmers revealed that they never got any training or informative

sessions for pest management other than using chemical pesticides. The remaining 20% were trained by some private non-toxic pesticide manufacturing firms operating in Pakistan. Although non-significant cooperation from the government bodies of the state, the correlation among respondents' profiles and the extent of training they have received in total was positive. Results for pesticide contamination were astonishing as 6 out of 8 pesticides were detected in water samples with alarming concentrations of Carbofuran (23.1µg/l) and Monocrotophos (8.3µg/l) which can be fatal for animals and humans in prolonged usage. The use of pesticides in a preventive and sustainable way gives more protection against pests and minimizes pollution such as water pollution or air pollution, etc., caused by the chemicals (pesticides). Hence such sustainable practices must be adopted for better production and conservation of the environment.

Introduction

Pakistan is an agricultural state, and around 60.8 % of the population has an income source directly related to agriculture. Although Pakistan is changing towards a more industrialist state, roughly 25.6% of the GDP is contributed by the agriculture sector and provides the income 44.6% of the rural sector (GoP, 2016).The majority of farmers use pesticides chemicals to protect the crops from harmful pests and diseases, which leads to chemical and biological contaminations in groundwater, vegetables, fruits, and other agricultural products and bye products. Solely for crop protection from diseases and yield gains (Grube et al., 2011), a wide range of chemicals is produced commercially including growth promoters, flower-inducing hormones, bactericidal or static antibiotics, and insecticides that fall in the category of pesticides (Xiao, 2010). Studies have revealed that pesticides usage has been increasing day by day in developing countries, including Pakistan to the extent of 9-12% or even more per hectare (Schreinemachers & Tipraqsa, 2012). Insecticides (73%) are a major chunk of whole pesticide consumption in Pakistan while the rest of them are herbicides for 13%, fungicides for 9%, acaricides for 4%, and fumigants for just 1% (PPSGDP, 2002).

In recent years, the concern has been grown that pesticides waste must be disposed of properly or could act as a menace for human health and the environment (Buczynska & Szadkowska, 2005). A complete set of guidelines must be followed for safe and adequate disposal of pesticide residues, empty bottles, and expired ones to minimize their hazardous effect on animals and humans (Nesheim et al., 2005). The leftover chemicals in bottles may be enough for causing illness in humans or animals. Hence, they need to be disposed of, properly. The alternative techniques like biocontrol, implying pest enemies that are ecofriendly for pest control and elimination, can also help trim down

the pesticide's usage and discourage pest's population and no particular harm to humans and the environment (Östman et al., 2003). Notable findings of a national project immensely focused on the sustainability of profitable cotton production in an environment-friendly way using alternative pest control methods were a 25% increase in yield and net profit of 3905 Pkr (39.13%) (Mallah & Korejo, 2007).

Precautionary instructions for the safe and practical application of pesticides were fever adopted by farmers and their labor. Lack of infrastructure, tools and minimized safety efforts leads to intoxication, allergic reactions, and sometimes poisoning. Such mishaps include economic factors and zero interest in changing traditional mindsets (Khan et al., 2016). Large numbers (Approx. 3 million) of acute poisoning cases in humans associated with pesticides are reported, with almost 220,000 deaths annually. These chemicals also breach down to groundwater making it poisonous. Almost 90% of these cases occur in developing countries, which roughly consume 20% of global pesticides (WHO, 1990).

Methods and Materials

Study area

This study was conducted in district Bahawalpur lies at 28.5062° N latitude, 71.5724° E longitude, and 702 feet above sea level (Fig. 1). Sampling through a survey using the cluster sampling technique in tehsil Hasilpur and Qaimpur was finalized between 2nd- 9th of December 2020.

Survey analysis

A descriptive survey was conducted to collect the data on farmers' awareness of pesticides waste management by dividing concerned areas into clusters for ease in the sampling process. One distinct village that does not fall in the clustering technique was selected through a convenient sampling process. A total of 160 farmers contributed to this study for data as 30 were interviewed according to a pre-constructed questionnaire and 130 filled the questionnaire. The literacy rate of the farmers was not high so the questionnaires were also self-filled after narrating the questions. Originally 130 questionnaires were collected, out of them eight were incomplete so those were excluded from the data analysis.

Statistical Package for Social Sciences (SPSS 20) was used to analyze the data. A brief statistical and descriptive analysis was performed to visualize categorical percentages, sheer determinants, incidence rates, and variable dependent correlative values to understand their possible interdependent and independent associations.

Water contamination detection

Five different villages were selected from water sampling with a water table below 3 meters. Water from those wells was collected which were more

frequently used by locals. The total number of chosen wells was 5. Samples were collected in standard sterile vails avoiding cross-contamination. Properly documented and labeled samples were transported adopting standardized methods to the laboratory for analysis to detect contamination. Electron Capture Detector (ECD) and Nitrogen Phosphorus Detector (NPD) were used to detect the organochlorine pesticides, halogenated hydrocarbons, and nitrogen or phosphorus-containing compounds.

Results and Discussion

Socio-economic statuses of the farmers

The Ages of the responding members are presented in figures 1, 2, and 3. A major chunk of the responding community falls in the 40-49 years age bunch (36.4%) followed by 30-39 years age bunch

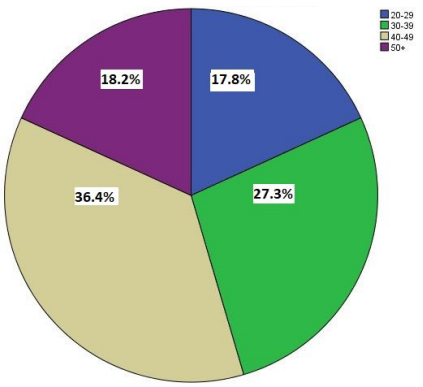

Figure 1. Age of respondent

(27.3%). Young lads aged between 20-29 years make 17% of the whole responding community and 18% of senior members aged above 50 years. (Muddassir et al., 2019) carried out a similar research and uncovered comparative outcomes interrelating between age factor and their behavior towards agricultural norms. (Figure. 2) conveys the data of education levels of the respondents related to agriculture activities. It can be seen a majority of the farmers are illiterate (45.5%) while 27.3% of farmers had just basic schoolings. The number of farmers with advanced education was observed low nearby as just 18.2% and 9.1% respondents had graduate degrees in agricultural sciences. As far as pesticide using experience is concerned, current investigation has publicized that members with long working experience of 11-15 years were of the major chunk (35.3%) and 33.4% responding members were using pesticides for 5-10 years. Just 11.2% of respondents have experienced over 20 years in utilizing pesticides as pest killers in agriculture, while roughly 20% of farmers said they have experienced over the long-term yet under 20 years, so they fall in the group 16-20 years of involvement with pesticide use.

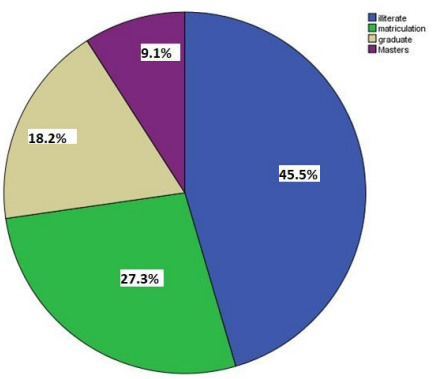

Figure 2. Education level of respondent

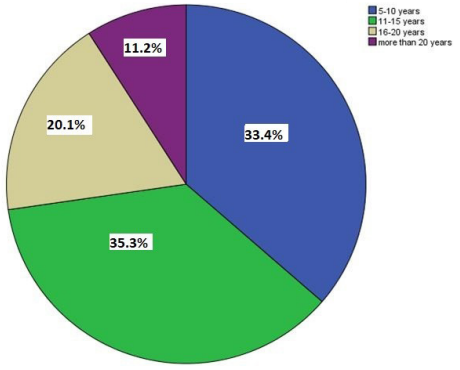

Figure 3. Experience of respondent

Training received by the farmers

(Table. 1) shows the information on training received by respondents on pesticides management. Approximately 80.2% of the respondents (farmers) had not received any training by any organization on the best ways to utilize pesticides safely, 10.5% of farmers received training once or twice, 6.2% 3-4 times, and only 3.1% of farmers have received training more than four times. A study by (Oliveira et al., 2012) found that adequate training could drastically reduce health risks linked with pesticide usage. An investigation carried out in the UK on hazard evaluation about safe pesticide usage by farmers showed that key factors influencing the adoption of new technologies and techniques were their behavioral and socio-economic aspects (Remoundou et al., 2014).

Figure 1. Training received by farmer

Types of trainings	Number of trainings			
	1-2	3-4	More than 4	No. training
Safety measures regarding pesticides use	10.5%	6.2%	3.1%	80.2%
Pesticide storage	9.5%	4.7%	4.3%	81.5%
Safe disposal of empty container/bottles	13.2%	5.2%	4.3%	77.3%
Pest counting	52.3%	27.6%	8.4%	11.7%
Alternative pest controlling methods	20.1%	8.9%	4.3%	66.7%

A majority (2/3rd) of the responding population were unaware of alternative management and safe eradication of pests without affecting crop yields. The most noteworthy record of respondents (farmers) who had received training on alternative pest control methods was 20.1%, and they have received a couple of less training. The respondents who received training 3-4 times and more than 4 times were 8.9% and 4.3% respectively. A study by (Mancini, 2019) in India, revealed that cases of acute self-poisoning could be reduced dramatically up to 50% by adopting alternates of pesticides for pest management.

Knowledge of respondents on pesticide usage

The information and observations of farmers about the risks related to pesticides usage play a certain role in implementing pesticide safety mechanisms (Jin et al., 2017). According to a study (Shetty et al., 2010), knowledge and information acquired by farmers through proper education result in the adoption and promotion of protective methods for pesticide usage. Not only the knowledge and information, but the confidence level of a farmer in using pesticides by taking protective measures is also crucial as found by (Jensen, 2012). (Figure. 4) and (figure. 5) show the respondents' responses (farmers) to the question of the side effects of pesticides on human health and animal death. The farmers' knowledge levels were categorized on a three splits scale i.e., (never=1, always=2, and never=3). It is found, in this study, that approximately 50% respondent had the knowledge that inappropriate usage of pesticide chemicals always leads toward severe health problems, around 40% respondents said that inappropriate usage sometimes leads to problems and approximately 10% said that improper usage never caused any kind of health issues. Whereas, in the response to the question, can pesticide chemicals on digestion be the reason for the death of a human or animal? More than 2/3 of the respondents, 73.4% to be precise, said that pesticides on ingestion always caused death to animals and humans. In contrast, 22.7% of respondents (farmers) stated that ingestion of pesticides leads to death sometimes, while just 3.9% of respondents stated that improper usage of pesticide chemicals did not lead to deaths to humans or animals. The current study's findings are nearly equal to the results of the study on pesticides (Gaber & Abdel, 2012). In their study, they also found that the majority of the respondents, approximately 82%, were well aware of the harmful impacts of pesticide chemicals on human health.

Co-relation among respondents' profiles and training received

Table 2 shows the Spearman correlation between the respondent's profile and their total training, showing a significant direct relationship between them.

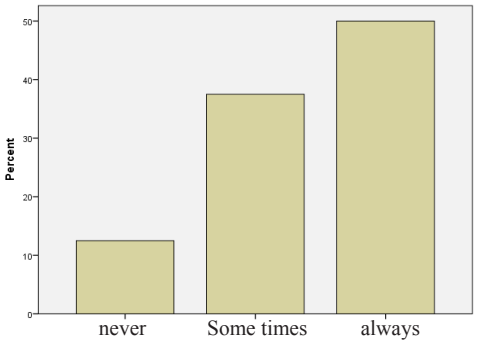

Figure 4. Effects on human health

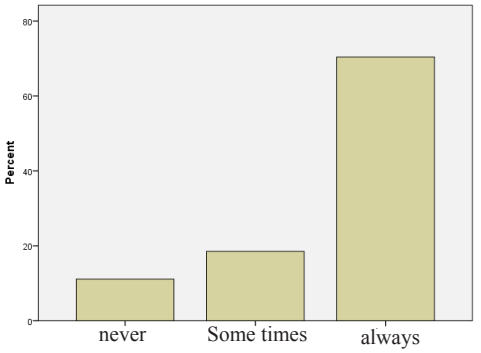

Figure 5. Death related to pesticides

The factors of responding members correlated to training received by farmers in adopting alternate pest management methods as age factor relates as 0.872**, education received as 0.864**. At the same time, experience is related as 0.840**. These results verified that farmers having training sessions were more aware of alternate pest management methods than those under their traditional canopy.

Table 2. Correlation among respondents

Spearman correlation			P-Value
Total Trainings	Age	0.872**	0.00
	Education	0.864**	0.00
	Experience	0.840**	0.00

**Correlation is significant at the 0.01 level

Water contamination due to pesticides

The laboratory analysis showed the presence of pesticides particles in the freshwater samples. The percentages of pesticide detections for December 2020 are shown in Table 3. Residues detected in water samples appeared to have such frequencies as endosulfan with 8%, carbofuran with 51%, methyl parathion with 5.4%, and monocrotophos with 34%, while the rest of cypermethrin and carbosulfan did not appear in the sample analysis report. A high concentration of carbofuran could be due to the conversion of carbosulfan and its excessive use on sugar cane crop (12-16 kilograms per acre) and its degradation rate (50 days half-life) in low water table areas.

The relationship among a concentration of detected pesticides and their distance from the mixing points are shown in the table 4. Those who were near to mixing site 0-30m had a positive influence of chemical contamination. These mixing sites were near to water bodies for ease of water availability and thus had positive relation. Although the level of contamination is under advisory levels, continuous and prolonged exposure can cause slow poisoning, leading to chronic malfunctions. Posing a prolonged treatment, preventive measures must be adopted to cope with rising issues.

Table 3. Methods for detection, concentration percentages and contamination

Pesticides	Method detection limit (µg/l)	Detected in December 2020 (%)	detection (µg/l)	Maximum Contaminant level (µg/l)	Lifetime HAL (µg/l)	USEPA Cancer Group category
Bifenthrin	0.02/ECD-GC	18.2	4.7	n.d		C (possible)
Carbosulfan	2.5 NPD-GC	N.D.	N.D	n.d		
Cypermethrin	7.0 ECD-GC	N.D.	N.D			
E-Cyhalothrin	0.02 ECD-GC	14.5	2.9	n.d		D
Carbofuran	0.2 ECD-GC	51	23.1	40.0	40.0	E
Endosulfan	0.001 ECD-GC	8	2.8	6.0		
Methyl parathion	0.001 NPD-GC	5.4	5.6		2.0	D
Monocrotophos	0.001 NPD-GC	34	8.3	6.0		

ECD: Electron Capture Detector, NPD: Nitrogen Phosphorus Detector, n.d: Not Determined.
N.D.: Not detected or below the detection limit.

Table 4. Methods for detection, concentration percentages and contamination

Pesticides	Distance from well to pesticide mixing, storage and loading site		
	0-30m	>30m	Not on the site or farm
Bifenthrin	18.2%		
E-Cyhalothrin	14.5%		
Carbofuran	31.4%	6.8%	6.8%
Endosulfan	6.9%		
Methyl parathion	0%		
Monocrotophos	17.2%	8.2%	3.6%

Conclusion

Farmers of the study area are either illiterate or have very basic education and fall in the age group from 30 to 49 years, hence their familiarity with alternative methods of pest control is not as good as others. They never adopt alternative methods for pest controlling to coup with insects, pests, and plant disease, however, they were aware of, as results revealed, the harmful effects of pesticides and chemicals and on other species as well as human health. Very low number of farmers of the areas had received training about alternative methods, sustainable pesticide usage, and chemical waste management. Especially in the district of Bahawalpur, in southern Punjab, it is necessary to educate the farmers and

provide them with standard dumping facilities for such chemicals that are inevitable for use to help eradicate or diminish their effects on the biosphere. Initiatives for reducing chemical usage in agriculture by providing alternate ways to control pests must be adopted.

Although chemicals pesticides were detected in freshwater (wells) in this study, their concentrations are not yet alarming as they didn't surpass the standards set for drinking water by USEPA. Concentration values of concerned pesticides except Carbofuran and Monocrotophos did not exceed the level set by MCL. Moreover, the well contamination is not only caused during the months of July, August, and September due to excessive use of pesticides but its detection in winter season indicates that there are some other factors that correlates with other factors including improper dumping of chemical wastes and open well contaminations.

Farmers are using conventional practices and are neither aware of pesticide-based contaminations nor willing to adopt biocontrol techniques for pest control. Farmer's capability and willingness to adopt alternatives of pesticides was observed during a casual conversation with farmers and understanding their needs for training so that the projects could be altered accordingly for better outcomes. These sessions concluded with crucial demand for the launching of such training-based projects with swift and enduring benefits. Training programs are crucial for farmers in the Bahawalpur district, especially the tehsil Hasilpur and Qaimpur. Government should encourage both parties to shift accordingly by providing them with subsidies and other benefits. And also, by discouraging the myths associated with biocontrol/ alternative methods. Moreover, approaches intended to diminish the likely pollutions of water by pesticides should be created and carried out swiftly.

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