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Farmers' Perception On The Impact Of Pesticides In The Vegetable Value Chain In Bangladesh

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Abstract – The increasing use of chemical pesticides across the country to ensure good crop yields in Bangladesh have posed risks to food safety, human health and the environment. A cross-sectional study was conducted in four Upazilas of four different districts, namely Khetlal Upazila under Joypurhat district, Mithapukur Upazila under Rangpur district, Narsingdi Sadar Upazila and Jashore Sadar Upazila and data were collected from those areas. Pre-tested questionnaires, KII checklists and FGD questions were used to collect data from the field. Interviews revealed that 89.50% of farmers did not use formal personal safety equipment (PSE). As a result, farmers faced different types of health hazards like itching (65.20%) and headache (64.30%) followed by body pain (58.55%). Besides, 72.30% of farmers considered that pesticides killed a certain group of beneficial organisms which is harmful to the ecosystem. Moreover, 64.50% of farmers believed that pesticides reduced soil fertility and 79.20% wondered that pesticides contaminated water and kill fish and other aquatic species when they reach the water bodies.

Keywords – Pesticides, impact, environment, personal safety equipment and value chain.

I. INTRODUCTION

Agriculture plays a key role in the overall economic development of Bangladesh contributing 13.32% to its GDP (BBS, 2020). More than 60 different types of vegetables grows in Bangladesh. Vegetables are cultivating in small homesteads and large agricultural land both for own consumption and commercial purpose. Pesticide is applying in vegetable and other agricultural fields to control dangerous pests and diseases. In this context, the objective of the study was to assess the farmers' perception on the impact of pesticides in the vegetable value chain in Bangladesh.

The primary objective of using pesticides is to increase productivity and improve food security while the secondary objective is to increase the living standards of the farmers (Delcour *et al*., 2015). Due to a lack of knowledge and awareness, more than 90% of farmers of Bangladesh use pesticides without knowing their actual requirements and/or effectiveness (Anonymous, 2008). Farmers and agricultural workers of Bangladesh are highly vulnerable to various diseases as they apply pesticides in crop fields without taking any personal protection equipment (Matthews, 2008). Pesticide exposure can cause a variety of human health problems, both chronic and acute for retailers, farmers, spray men and consumers. As a result, farmers face different types of health problems such as difficulty in breathing, fever, headache, and nausea (Adhikary, 2012). On the other hand, pesticides can affect aquatic plants, decrease dissolved oxygen in the water and also can cause physiological and behavioral changes in fish populations (Scholz *et al.,* 2012). Due to the indiscriminate use of pesticides and lack of knowledge and awareness of farmers on the hazardous effect of pesticides, the problem becomes severe (Chowdhury *et. al.,* 2012). Pesticide contaminated water creates a great threat to aquatic forms of life- like plants, fish, frogs and different organisms. Non-target organisms such as bees, beetles, earthworms, termites, ant

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colonies and other amphibians have been affected negatively by pesticide use. So, IPM, biological control for pests and diseases and Good Agricultural Practices (GAP) should be implemented to produce safe and quality vegetables and protect the environment from pollutions.

II. METHODOLOGY

The survey was conducted in Khetlal Upazila under Joypurhat district, Jashore Sadar Upazila under Jashore district, Mithapukur Upazila under Rangpur district and Narsingdi Sadar Upazila under Narsingdi district to collect data from the fields. A purposive sampling procedure was followed to select the respondent farmers. A total of 310 farmers (78 from each of Khetlal, Jashore Sadar and Mithapukur and 76 from Narsingdi Sadar Upazila), 30 vegetable traders and 20 input retailers were interviewed for this study. Besides, 50 consumers were interviewed in the study areas and in Dhaka cities to know their opinion on safe vegetable and food safety and the nature of vegetable consumption.

In-depth key informant interviews (KII) were conducted with the representatives of input supply companies, officials of the Department of Agricultural Extension (DAE), and the officials of the Plant Protection Wing of DAE to collect related information. Moreover, a total of 8 Focus Group Discussions (FGDs) were conducted with mixed participants of farmers, traders and input retailers to acquire detailed information related to the vegetable value chain and to further validate the data collected from the field survey. One FGD contained 12 participants. After data collection, the filled-in questionnaires were reviewed, checked thoroughly and cleaned to avoid any possible inconsistency and mistakes. The verified data were categorized, coded and analyzed using computer software SPSS version 22.0. The computer- generated analytical outputs were presented in the tabular forms and figures (pie chart, multiple bar diagram). Both inferential statistics (correlation, Chi-square) and descriptive statistics (mean, SD, frequency, percentage) were followed for comparisons.

III. RESULTS AND DISCUSSION

A. Farmers' general practice in applying pesticides

i) Farmers' access to input and associated services

During interviews, the farmers told that they required different types of inputs like seeds, fertilizer and pesticides and purchase the inputs from local input retailers. Along with inputs, farmers mostly got the extension services from the input retailers while purchasing inputs. Data obtained from the questionnaire-based interview revealed that farmers purchased pesticides both from nearby and district retailers. It indicates that most of the farmers (98.4%) purchased pesticides from nearby retailers and 16.6% of farmers purchased from district retailers (Fig. 1A). The field survey suggested that the majority of the farmers (64.1%) purchased pesticides 3-4 times per month, while 24.4% of farmers purchased pesticides 5-6 times per month (Fig. 1B). Pesticides purchase frequency is related to the application frequency in a crop season. A survey report showed that about 37% of Bangladeshi farmers applied pesticides once in their crop field, 31% applied twice and the rest of the farmers applied 3-5 times in a crop season (Rahman, 2003). Most of the farmers (90.60%) received extension services from the nearby retailers while purchasing pesticides. The second highest source of extension service was government extension officers (41.60%) (Fig. 1C). Several case studies indicated that farmers were dependent on seeking advice from pesticide retailers on pesticide selection and use (Robinson *et al.,* 2007). A report suggested that to select the appropriate pesticide, dosage, application methods and times of application, most of the farmers relied on their own experience and depended on pesticide retailers (Chowdhury *et al.,* 2013). Data obtained from the field survey presented that the majority of the farmers (70.30%) collected extension advice on pest and disease control followed by 67.10% on the dosage rate of pesticides, and 60.30% on precautionary measures while handling pesticides (Fig. 1D).

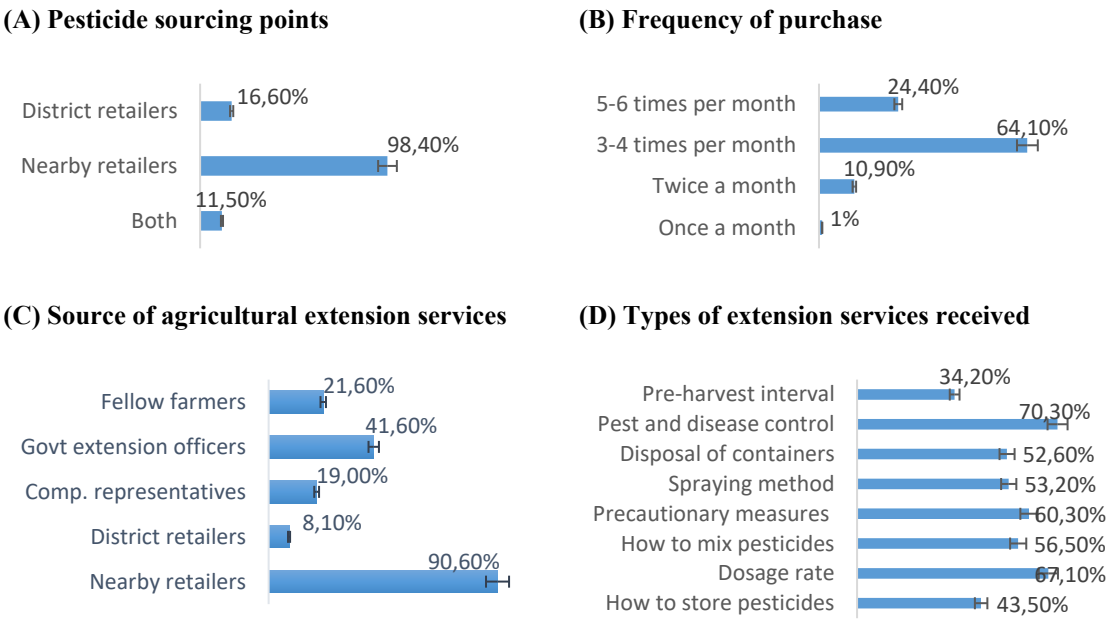
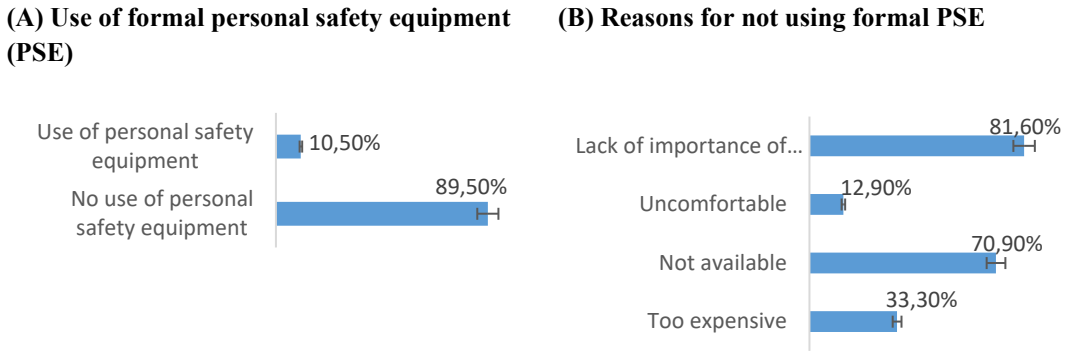


Figure 1 Farmers' fucnctionality on pesticide sourcing points, frequency of purchase, source and types of extension services and scope of vegetable marketing.

ii) Farmers' perceptions on handling of pesticides

During the interview, all the farmers (310) were asked about the use of personal safety equipment (PSE) and opinions of the respondents indicated that 89.50% of farmers did not use formal personal safety equipment while handling pesticides (Fig 2A). In response to the questionnaire-based interview, 81.60% of respondents told that due to lack of knowledge on the importance of using PSE, they did not use it. On the other hand, 70.90% of farmers told that personal safety equipment was not available in their areas and due to lack of availability, they did not use it (Fig. 2B). Dasgupta *et al.* (2007) found that only 4% of farmers in Bangladesh formally trained in pesticide use or handling techniques and over 87% of farmers openly admitted to using little or no protective measures while handling and applying pesticides in crop fields. In addition, 67.70% of farmers told that they used towel/ordinary cloth to cover their face while applying pesticides in the field. Besides, 63.90% farmers opined that they used full sleeve shirts while spraying pesticides in the crop field (Fig. 2C). A study was conducted on the adoption of health technologies and health outcomes in Bangladesh and it was found that the majority of the sampled farmers (56%) found Personal Protection Equipment (PPE) to be unnecessary, the second reason was lack of availability in their areas and the third reason was discomfort while wearing the PPEs in the hot tropical climate (Shamma and Hendrik, 2016).



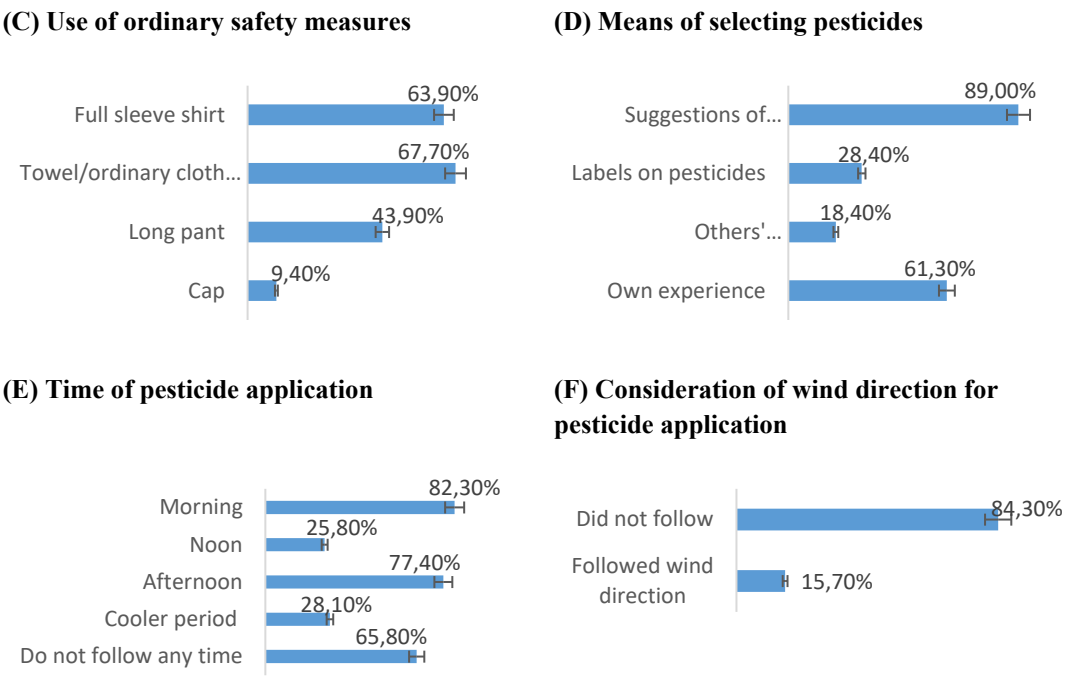


Figure 2 Farmers' perceptions on the usage of formal and ordinary safety measures, selection and time of pesticide application and consideration of wind direction.

Data obtained from the field survey revealed that 89.00% farmers purchased pesticides based on the suggestions from pesticides sellers and 61.30% farmers purchased by their own experience (Fig. 2D). Opinions of the farmers as reflected from the questionnaire-based interview indicated that 82.30% of farmers applied pesticides in the morning and 77.40% of farmers applied in the afternoon. But, 65.80% of farmers did not follow any timetable while applying pesticides (Fig. 2E). The morning hours sometimes provide the best weather conditions for spraying pesticides. Spray operators should monitor and record wind directions, wind speed, temperature and humidity before and during spraying of pesticides. When the temperature is high and humidity is low sprays may evaporate and plants often also stress under conditions and making spray less effective and farmers will be financial losers (Schreinemachers *et al.*, 2016). While interviewing, farmers were asked about the wind direction and most of the farmers (84.30%) told that they did not follow wind directions while applying pesticides in the crop field. Only 15.70% of farmers responded that they followed wind directions before applying pesticides in the crop field (Fig. 2F). According to Fishel & Ferrel (2019) a careful farmer and spray man will try to apply pesticides whenever the wind is blowing away from sensitive areas, especially where people are working or children are playing. Besides, careful farmers will apply pesticides towards wind direction to reduce loss of efficiency and cost of production.

B. Effect of pesticides on vegetable value chain

i) Pesticides on farm economy

Opinion of the farmers, as reflected from the questionnaire-based interview revealed that 84.8% of respondent farmers applied pesticides in their field after seeing pest/disease infestation. On the other hand, 46.10% of farmers applied pesticides in their crop fields during the initial attack of pests and diseases. (Fig. 3A). A similar study was conducted in Chittagong region and it was found that most of the farmers (80%) applied pesticides at the beginning of the initial attack and later on a routine basis. In response to the interview, 85.7% farmers told that pesticides had positive effects in controlling specific pests and diseases and 70.1% farmers reported that pesticides enhanced crop growth. Besides, 58.1% of farmers believed that pesticides stopped flower and fruit dropping (Fig. 3B).

A study in the U.S. showed that without pesticides application, yields of most fruits and vegetable crops would fall by 50-90% (Gianessi and Nathan, 2005). In this field survey, 85.20% of farmers thought that pesticides played an important role in increasing crop yield if right pesticides were applied in their fields. Similarly, 72.30% of farmers indicated that applying pesticides in right

time is important to increase crop yield (Fig. 3C). In the field survey with questionnaire-based interview, 90.0% of farmers told that when incorrect pesticide was applied in the field, it could not control pests and diseases and they became financial losers. Besides, 70.60% of farmers responded that if they did not follow proper application timing, pesticides did not work well and had to apply again and again (Fig. 3D). Donald (2006) suggested that when any pesticide was applied, light, temperature, moisture, bacteria, soil and water pH etc. needed to take in to account.

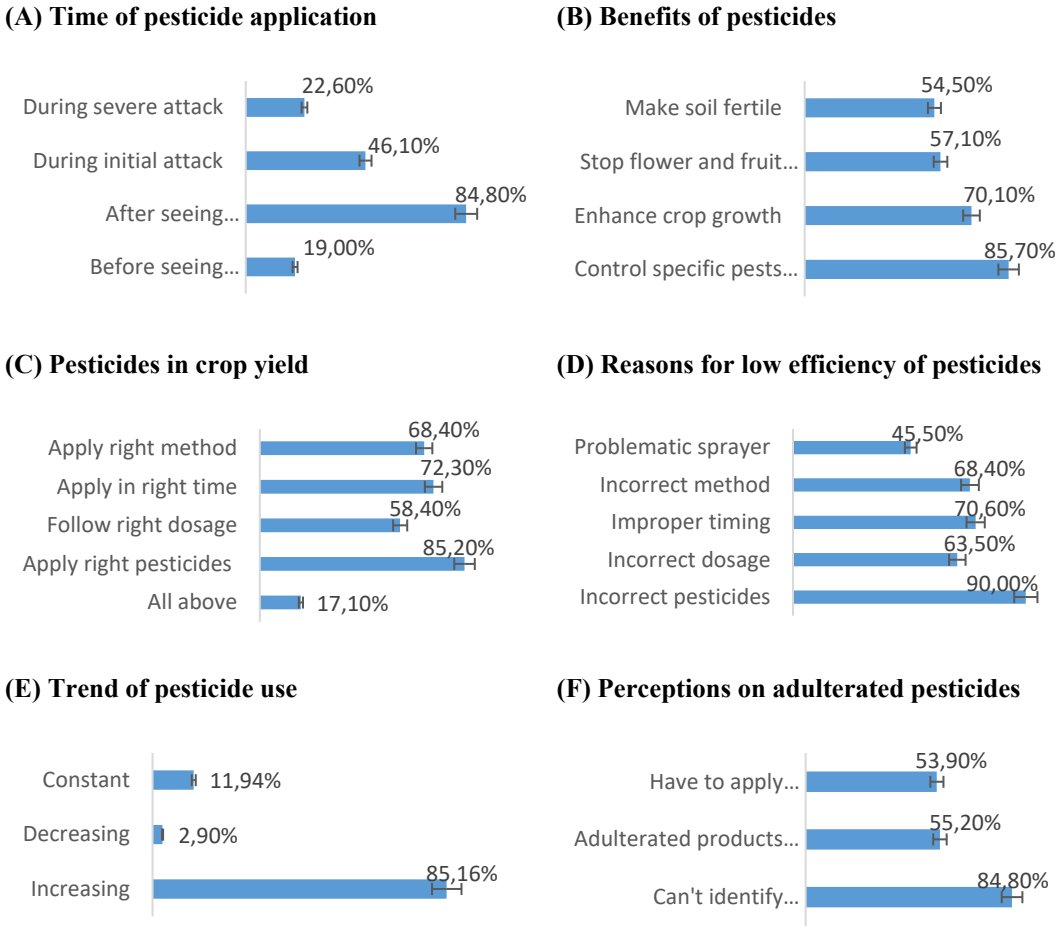


Figure 3 Variability in time of application, benefits, efficiency and trend of pesticidese useand perceptions on adulteratedpesticides.

In response to the interview, 85.16 % of farmers believed that pesticides using trend was increasing and 11.94% of farmers thought that pesticides using trend was constant (Fig. 3E). While interviewing, 84.8% of farmers told that they couldn't identify adulterated pesticides and 55.20% of farmers told that adulterated products did not work well. On the other hand, 53.9% of farmers opined that farmers had to apply low-quality products frequently (Fig. 3F).

ii) Potential health hazards of farmers from pesticide application

Farmers in the study areas realized that pesticides could cause many serious health problems. Data obtained from the interview showed that farmers faced different types of health hazards after applying pesticides. The majority of the farmers faced problems in itching (65.20%) and headache (64.30%) followed by body pain (58.55%), stomach pain (41.60%) and skin irritation (41.36%) (Fig. 4A). A comprehensive study report from Oman and Ghana explored health symptoms due to pesticide exposure were skin irritation (70.3%), burning sensation (39.2%), headache (33.8%), vomiting (29.7%), abdominal pains (20.0%), cough (57.6%) and salivation (21.6%) (Esechie and Ibitayo, 2011; Arcury *et al.*, 2007).

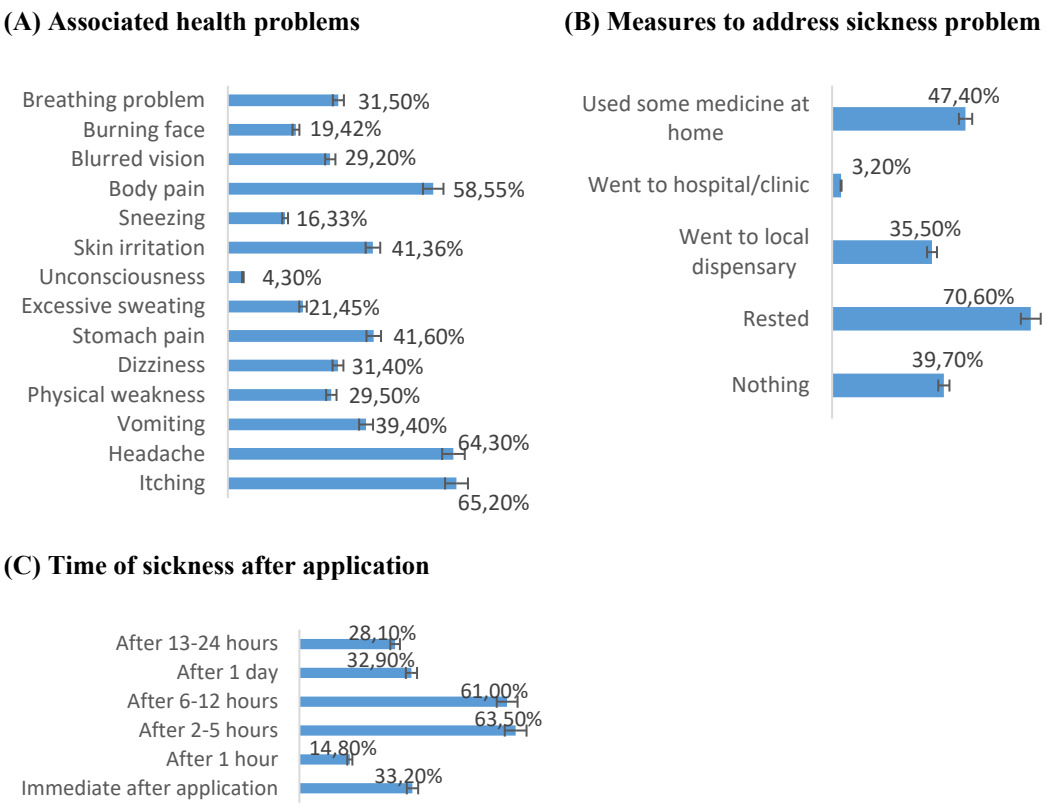


Figure 4 Farmers' experience of associated health problems while handling and applying pesticides.

Opinions of the respondents as reflected from the interview carried out in the study areas showed that 70.60% of farmers took rest at home when they felt sick. It was also found that 47.40% of farmers used some medicine at home to recover from the sickness (Fig. 4B). The questionnaire- based interview revealed that 63.50% of farmers felt sick after 2-5 hours and 61.00% fallen sick after 6-12 hours of application (Fig. 4C).

iii) Farmers' perceptions on environmental pollution

As per the opinions of the respondents, 72.30% of farmers told that pesticides killed a certain group of microorganisms, which was bad for the ecosystem. Besides, 64.50% of farmers told that pesticides reduced soil fertility and 61.90% of farmers believed that pesticides created problems in the breakdown of soil organic matter (Fig. 5A). Numerous studies had been undertaken which highlight these adverse impacts of pesticides on soil microorganisms and soil respiration (Dutta *et al.*, 2010; Sofo *et al.*, 2012; Xie *et al.*, 2011; Sebiomo *et al.*, 2011).

During questionnaire-based interviews, 79.20% of farmers told that when pesticides came in contact with the water they killed fish and other aquatic organisms. Besides, 71.9% of farmers responded that pesticides killed frogs (Fig. 5B). Pesticides could get into water in several ways and killed the aquatic species (Singh and Mandal, 2013; Larson *et al.*, 2010).

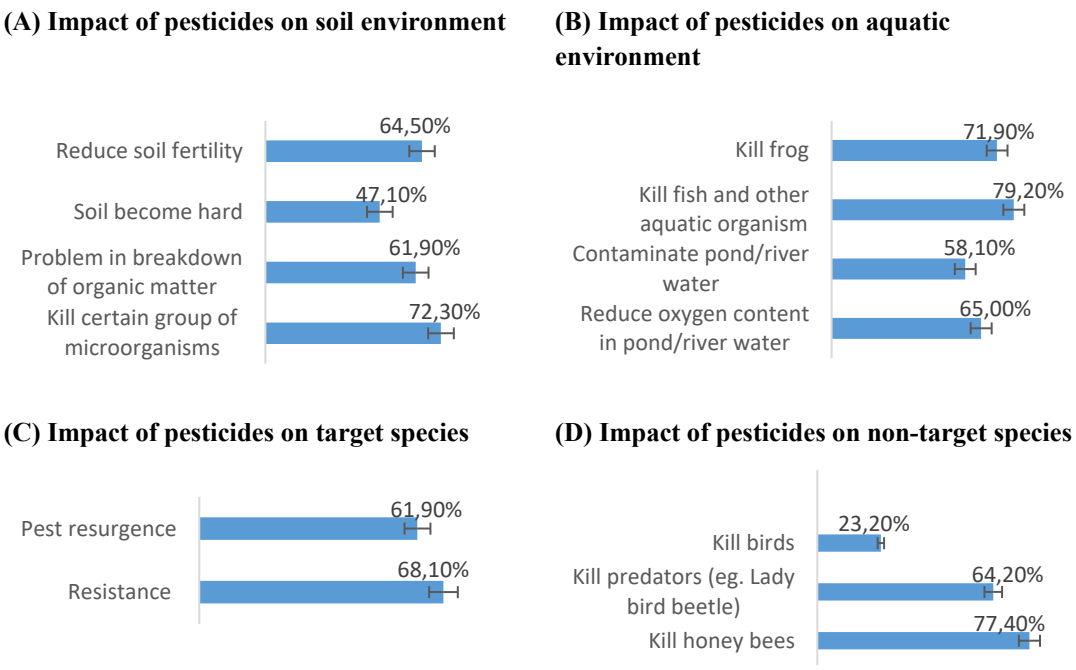


Figure 5 Farmers' perception on pesticides impacting soil and water environment, and species in the ecosystem.

According to interview findings, 68.10% of farmers told that pesticides created resistance power in many targeted pests species and pesticides did not work to control these pest species. Besides, 61.90% of farmers responded that after application of pesticides pests and diseases were controlled for a certain period of time and again pests appeared in the field (Fig. 5C). The intensive use of pesticides had led to the development of resistance to many targeted pests and diseases in the world (Tabashnik *et al.*, 2009).

As per the opinions of the respondents, 77.4% of farmers told that pesticides killed honey bees and spiders. Besides, 64.2% of farmers thought that pesticides killed predators (ladybird beetle) when they applied pesticides in crop fields (Fig. 5D). The adverse effects of hazardous pesticides on non-target arthropods, earthworms and organisms had been reported widely (Ware, 1980; Pelosi *et al.*, 2013; Reinecke and Reinecke, 2007).

C. Findings of FGDs and KIIs

Multi-location investigations (FGDs) revealed that due to the lack of knowledge and awareness about the use and effectiveness, the farmers in the study areas used pesticides excessively and judiciously. As a result cost of production increased and farmers became financially losers. KIIs suggested that the untrained or illiterate farmers did not know the adverse effects of agrochemical use on human health and environment. Farmers were not much aware of pesticide toxicity and protective measures that must be taken care of while handling, carrying, mixing, applying and storing. It was also found that farmers had lack of awareness on appropriate health and safety measures, such as wearing Personal Protection Equipment (PPE) while handling and applying and applying pesticides in the field, and proper disposal of empty pesticide containers, which was essential to avoid risks to health and environmental degradation. FGDs and KIIs recommended that for better health and environment, farmers should follow proper guidelines of safe and judicious use of pesticides, and there should be the adoption of effective legislation to supply quality pesticides and prevent indiscriminate use of pesticides.

Table 1 Coefficient of correlation showing relationship between each of the selected characteristics of the farmers and their impact on environment

Dependent variable	Selected characteristics of the farmers	Observed correlation coefficient value (r)	Table value (p-value)	
			At 0.05 level	At 0.01 level
Environment	Age	0.136*	0.017	
	Education	0.473**		0.000
	Farm size	0.123*	0.015	
	Family member	0.096 NS	0.09	
	Annual family income	0.249**		0.000
	Income from vegetable cultivation	0.170*	0.021	
	Agricultural experience	0.163**		0.004
	Extension support service	0.269**		0.000
	Positive effects of pesticides	0.285**		0.000
	Training	0.126*	0.028	
	Experience in pesticide uses	0.115*	0.044	
	Negative effects of pesticides	-0.290**		0.000

NS Not Significant; * Significant at 0.05 level of probability; **Significant at 0.01 level of probability

It was found that there was a positive correlation between environment and education, annual income, agricultural experience, extension support service and positive effects of pesticides and the p-value was <0.05 and statistically significant. There was also a positive correlation between environment and age, farm size, income, training and experience in pesticide use. The p-value was <0.05 and it was statistically significant. So, there was a positive correlation between each of the selected characteristics of the farmers and their effects on the environment. There was only a negative correlation between the environment and the negative effects of pesticides (Table 1).

Table 2 Coefficient of correlation showing relationship between each of the selected characteristics of the farmers and their impact on health

Dependent variable	Selected characteristics of the farmers	Observed correlation coefficient value (r)	Table value (p-value)	
			At 0.05 level	At 0.01 level
Health	Age	0.210**		0.000
	Education	0.515**		0.000
	Farm size	0.057*	0.014	
	Family member	0.055NS	0.339	
	Annual family income	0.276**		0.000
	Income from vegetable cultivation	0. 190*	0.027	

Agricultural experience	0.209**		0.000
Extension support service	0.277**		0.002
Positive effects of pesticides	0.165**		0.004
Training	0.195**		0.001
Experience in pesticide uses	0.166*	0.038	
Negative effects of pesticides	-0. 265**		0.000

NS Not Significant; * Significant at 0.05 level of probability; **Significant at 0.01 level of probability

It was also found that there was a positive correlation between health, age, education, family income, farming experience, extension support service, positive effects of pesticides and training, and the p-value was <0.05 and statistically significant. There was also a positive correlation between health and farm size, income from vegetable cultivation and pesticides using experience, and the p-value was <0.05 and statistically significant. There was only a negative correlation between the health and negative effects of pesticides (Table 2).

IV. Conclusion

The research findings showed that due to a lack of awareness and proper knowledge, farmers face wide spectrum of human health hazards ranging from short-term impacts such as headache, body pain, itching and nausea to chronic impacts like cancer, reproductive harm and endocrine disruption. It was also found that pesticides kill a certain group of microorganisms in soil and water, which create an adverse effect on the ecosystem. Moreover, farmers did not use formal personal safety equipment while applying and handling of pesticides, which was harmful to their physical health. KII and FGDs recommended that indiscriminate use of pesticides could be minimized by educating commercial growers and sharing agricultural information about pesticide regulations and safe food production. Besides, farmers should follow proper guidelines of safe and judicious use of pesticides to reduce the adverse impact of pesticides on the vegetable value chain. In addition, extensive promotions toward the application of IPM approaches, organic farming and GAP should be developed to control pests and diseases and produce safe and quality vegetables.

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