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PESTICIDE USE ETHICS: DISSEMINATING ENVIRONMENTAL SAFETY VALUES AMONG FARMERS OF PUNJAB (INDIA) THROUGH SENSITIZATION PROGRAMMES

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ABSTRACT

Punjab is the third leading Indian state in pesticide consumption, however, safe use of the pesticides is the most ignored in present day agriculture. The present study was conducted in six villages of south-western Punjab considering the serious consequences of the careless attitudes of farmers towards pesticides. The objectives were to determine the status of safe pesticide use among farmers and to formulate intensive training and awareness programmes to sensitize them and improve their knowledge about pesticide risks. Farmers were randomly selected and surveyed for their knowledge, attitudes and practices in terms of pesticide use on crops before and after an awareness campaign. Numerous interactions through training sessions, street plays, distribution of literature, school quizzes, etc., significantly increased the awareness among farmers on different aspects of safe use of pesticide (11.4–27.3%). However, mission mode plan is required to enhance knowledge and change the attitude of farmers towards pesticide safety, hygiene and sanitation practices.

Keywords: Attitude towards agrochemicals; Pesticide safety; Pesticide protection equipment; Sensitization and awareness

India is the fifth largest producer of pesticides in the world after the China, USA, Japan and South Korea and the fourth largest producer in Asia, with a total production of 93 thousand metric tonnes in 2019–20 (Anonymous, 2020a). However, India's pesticide consumption is one of the lowest in the world a merely 0.6 kg/ha compared with 5–7 kg/ha for the USA and 11–12 kg/ha for Japan. The states of Maharashtra, Uttar Pradesh and Punjab are the leading consumers of pesticides in India, using 52 per cent of the pesticides produced (Anonymous, 2020b), and 70 per cent of pesticides are used for growing *kharif* crops (crop season from May to November), with the majority being applied to rice (26–28%) followed by cotton (18–20%).

Pest control is important for minimising losses, improving yield and increasing the quality of the produce, and the pest management toolbox has always incorporated a variety of pest control methods, such as resistant cultivars, crop rotation and treatment with chemicals. However, pesticides are indispensable in the current agricultural landscape in developing countries and more than half of the Indian population (56.7%) is involved in agriculture and consequently exposed to pesticides while handling, application and storage (Gupta, 2004), which can cause a wide range of human health complications. The ill effects of indiscriminate use of pesticides were initially highlighted in Rachel Carson's book 'Silent Spring' published in 1962, which incited researchers to look for safer and more environment friendly ways of controlling pests. Since then, pesticides have been developed and refined to target selective pest(s) with minimal risk to human health and the environment. However, in reality, it is never certain whether a pesticide will be safe under all circumstances even though the development of toxicity reference levels for pesticides incorporates uncertainty factors that aim to achieve this regulatory standard (Maroni *et al*., 2006; Van der Werf, 1996).

As the complexity and severity of pest outbreaks are worsening for different crops, agro-chemicals are being widely used across various agro-climatic regions. However, while managing these pests, farmers are often unintentionally caught in a pesticide treadmill type situation, which can further increase their dependence on these chemicals. The integrated pest management (IPM) approach, which focuses on a combination of pest management tactics including the judicious use of pesticides, has not been properly implemented in developing countries, so there is still a heavy reliance on agro-chemicals by farmers to protect their crops. Farmers are exposed to these chemicals at a number of stages, such as mixing, application and working in the sprayed fields, which has led to serious concerns about the health risks that are associated with the routine use of pesticides in both the short and long term.

In developing countries, the acute reasons for poisoning episodes include the lack of protective gear, use of banned or restricted toxic chemicals, faulty application techniques, poorly maintained or improper

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spraying equipment, flawed storage practices and frequent reuse of old pesticide containers for food and water storage (Asogwa and Dongo, 2009; Ecobichon, 2001; Ibitayo, 2006). Pesticides enter the human body by being absorbed through the skin, inhaled or ingested and this uptake is likely to be higher in tropical countries because the temperature and humidity are high and so the individual will be hot and sweating (Andreatta, 1998; Anonymous, 2002; Davies *et al*., 1982; Jeyeratnam, 1985; Jeyeratnam, 1995). The frequency and duration of pesticide handling on both a seasonal and lifetime basis also affect the exposure (Fenske and Day, 2005). Finally, the majority of farmers in developing countries are illiterate and unaware of the long-term hazards of pesticide use, which is a major source of occupational injury and illness. This study was conducted in south-western Punjab in the northwest of India with two objectives: (i) to determine the awareness of farmers and farm workers about the safe use of pesticides and (ii) develop an intensive training and awareness programme using different extension tools. The focus was on *kharif* crops namely rice and cotton, as these require a heavy input of plant protection products to manage pests (Gesesew *et al*., 2016).

MATERIALS AND METHODS

Study sites and data collection

The study was carried out in six villages of Faridkot district of Punjab: Killa Nau, Sukhan Wala and Tehna in 2015–16 and Sikhan Wala, Behlewal and Khara in 2016–17. Primary data was collected directly from 594 randomly selected farmers and farm workers/labourers (hereafter 'farmers') with the help of a pre-tested questionnaire. Different individuals were surveyed before and after an awareness campaign with a focus on the pesticide use intensity on crops such as cotton, rice and vegetables.

Survey questionnaire

The data was collected through the use of a pre-tested questionnaire that was handed out to the farmers and then collected by the field investigators. The survey questionnaire was designed to collect information on the awareness of farmers about pesticide usage patterns. Pre-coded options that were based on existing secondary research, pilot surveys and the general perception of farmers towards pesticide safety (Fig. 1) were used in the schedules. Specific information that was collected from individual schedules was then served to the farmers.

To measure the knowledge, attitudes, precautions taken during pesticide use and awareness of ill effects among the respondents, binary scoring was undertaken, using one for complete awareness and 0 for no awareness. The farmers' knowledge was assessed using 30 different questions on pesticide safety (Fig. 1), such as (i) their knowledge about coloured labels, brands and recommendations, (ii) the precautions they take during the mixing and spraying of pesticides, (iii) any consideration of the weather conditions before spraying, (iv) the disposal of expired or leftover pesticides, (v) the storage of pesticides, (vi) their knowledge about the adverse effects of pesticides on the environment and natural enemies and (vii) their knowledge about antidotes and when to seek medical help (see Fig. 1 for examples of some of the questions). The responses of farmers were recorded against the appropriate statement and classified into two groups that were separated by the mean of the measure being assessed. Data were then compiled and the mean and percentage scores were calculated for each parameter and analysed using Z-Test two proportions test at 5 per cent significance level.

The survey was distributed to randomly selected farmers prior to the awareness campaign (see below) and 120 randomly selected farmers (from previously surveyed 594) after the campaign. Among both the pre- and post- selected farmers, 20 per cent illiterate farmers were considered deliberately to a real evaluation of sensitization and awareness programme. The data were then compiled to determine the overall effectiveness of the various extension activities that aimed to enhance pesticide safety awareness.

Awareness campaign

To identify the needs of training and awareness programmes, farmer fields in selected villages were visited regularly and the way in which pesticides were sprayed was noted. A scale was established by the surveyor and scientists involved in this research that considered the relative importance of each question and the farmers were then categorised into five classes according to their knowledge level: (i) ≤10% (very low), (ii) >10–30% (low), (iii) >30–50% (intermediate), (iv) >50–75% (high) and ≥75% (very high).

After analysing the data, several aspects that needed to be included in a training programme were identified (Fig. 1) and awareness campaign was carried out. This campaign comprised door-to-door visits, field days, training camps, radio and television talks, field demonstrations of spray technology, literature distribution, street plays, and sensitising school children through quizzes, documentaries, etc. and was formulated and implemented in the selected villages to educate the farmers about the safe use of pesticides and its benefits. During the meetings with farmers, protection gear kits were distributed to a few individuals through a lottery in order to sensitise and lure them to use this protective equipment. Approximately, 900

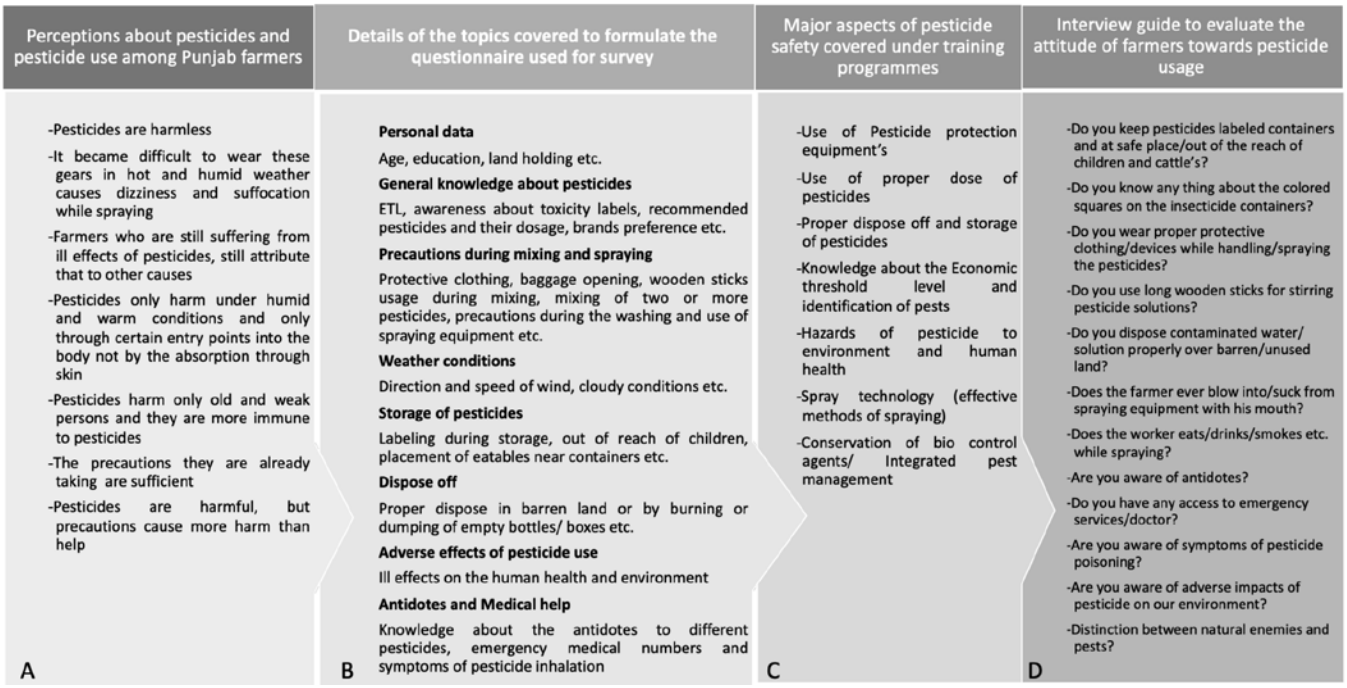

Fig. 1. Schematic flow of the activities carried out under major heads to create awareness among the farmers and farm workers A- Perception about pesticide safety based on initial pilot studies and which was taken as base to formulate questionnaire in B and based on data generated, the programme was formulated for training and awareness in C and finally the post awareness and trainings impact was evaluated on the basis of questions in D.

farmers participated in this campaign, although it was difficult to ascertain the number of individuals who were reached by the literature distribution, radio talks and street plays. In addition, four pesticide dealers' training sessions were organised to educate the safe use of pesticides and motivating them to disseminate the acquired knowledge among farmers. To increase the effectiveness of the campaign, a seminar was organised so that students at the village school could be educated on Earth day and live demonstrations using videos and safety gear dummies were arranged during a farmers' meeting on the Punjab Agricultural University campus and at Regional Research Stations at Faridkot and Bathinda.

RESULTS AND DISCUSSION

The surveyed farmers were between 18 and 65 years of age (mean = 33 years), with the majority falling in the 21–30 year (33.3%) and 31–40 year (27.9%) age groups. Most of the farmers (79.5%) had received some form of education with only 1.7 per cent graduates and 27.8 per cent having a primary level education (i.e. up to Vth standard) (Fig. 2).There was wide variation in terms of landholding, with the majority of farmers owning their own piece of land and also having acquired additional land through a rental or lease system. However, the majority of farmers fell in the semi-medium and medium category on the basis of landholdings, with very few (6.62%) owning 10 ha of land or more (Fig. 1).

Although most of the farmers had been involved in agriculture for a decade or more, they had a low level of awareness regarding the safe use of pesticides and the implications that can arise from a careless attitude towards these chemicals. The pre-campaign survey revealed that only 28.9 per cent of the farmers surveyed agreed that it was important to follow proper instructions while mixing and spraying pesticides, while 26.8 per cent of farmers stored pesticides safely before and after use, with the remainder not considering this safety aspect and often using empty containers in their home or farm for storing water, animal feed, etc. (Table 1). Furthermore, only 21.0 per cent of the farmers were familiar with the concept of evaluating the economic threshold levels (ETLs) of insect pests before deciding to spray and were mindful of the state university recommended doses of a particular pesticide for use on their crops, while nearly a quarter of them consulted and considered the weather advisory before carrying out spraying. Finally, only 9.4 per cent of farmers were well informed about where to go for medical help and antidotes in the case of pesticide poisoning. It was also found that farmers did not consider covering different body parts as a protection measure during the spraying and mixing of pesticides, with the use of

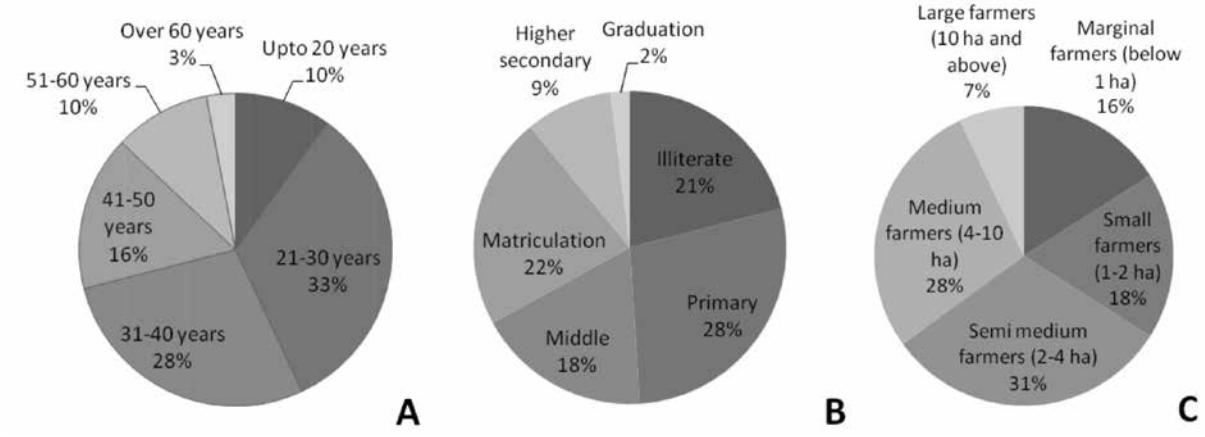

Fig. 2. Basic demographic information of the farmers/farm workers surveyed during 2015-16 and 2016-17; A-Age; B-Education level; C-Land Holdings

different protection measures varying from 1.5 to 63.0 per cent. Instead, they considered that the low dosages that are used today would not pose any health hazards. It became evident that a considerable number of the respondents covered their heads and nose/mouth with cloth, particularly a part of their turban (head gear), while spraying. However, those who did not wear a turban carried out spraying without taking any precautionary measures. Thus, the preliminary survey report indicated that the surveyed farmers had a very low perception of the risk of using hazardous pesticides in agriculture.

Most of the farmers in south-western Punjab follow a rice/cotton-wheat cropping pattern, i.e. harvest two crops per year. However, some are engaged in growing vegetable crops, taking advantage of their proximity to cities and towns, and a small number only plant one crop per year due to a lack of quality irrigation water and high salinity. During the *kharif* season, the hot and humid weather is usually conducive for the multiplication of insects and diseases. Consequently, the main crops (rice, cotton, brinjal, okra and cucurbits) become heavily infested by pests, compelling the farmers to regularly spray pesticides. The majority of the farmers surveyed (61.8%) were relatively young (21–40 years old) and had a level of education that was below matriculation. Although most of the workers had 5 years or more experience, but the majority had not received any training or technical information on pesticide safety and most could not read or understand the instructions on pesticide packages, which are often not written in vernacular languages. Education level is considered one of the major determinants of avoiding exposure to harmful chemicals (Blanco-Muñoz and Lacasaña, 2011; Weinberger and Srinivasan, 2009). However, individuals who are aware of the risks of exposure never bother to read pesticide labels/instructions because of their long-term experience with pesticides and generally careless attitude (Jallow *et al*., 2017).

It was observed that during the spraying schedule, farmers normally worked for eight hours or more per day with intermittent breaks and did not take any protection measures, such as the use of proper clothes, gloves, goggles and a mask. It was also commonly observed that their clothes and bodies became wet from leaking knapsack pumps when they carried them on their backs. Prior to spraying, the workers were often exposed to the pesticides while opening, pouring, mixing and loading them via their naked hands and other parts of the body, and pesticide exposure was further increased by the use of inappropriate practices, such as cutting/tearing packets with the teeth. It was a common belief among the farmers that washing would clear the chemical contamination from the body, with most being unaware that the chemicals could be absorbed through the skin or inhaled. Farmers in countries with high ambient temperatures usually cite discomfort as the main reason for not using safety equipment (Jallow *et al*., 2017). Therefore, there is a need to increase the awareness among applicators and to bring some attitudinal change towards their conventional practices.

The improper storage of pesticides also needs to be addressed to reduce the exposure of farming families. While respondents claimed that they kept the pesticides away from consumables, they were never stored under lock and key. Similarly, Alam and Wolff (2016) showed that nearly half of 8,500 smallholder farmers in 26 countries rarely or never locked pesticides away. This troubling attitude can be ascribed to farmers' lack of technical knowledge and training on safe pesticide use. In addition, farmers demonstrated poor practices in terms of the disposal of empty pesticide containers, as reported previously (Alam and Wolff, 2016; Blanco-Muñoz and Lacasaña, 2011; Gesesew *et al*., 2016; Jallow *et al*., 2017; Jin *et al*., 2015; Matthews, 2008;

Table 1. Farmers' knowledge about safe use of pesticide before and after campaign

Questions category		Pre-campaign knowledge level N=594		Knowledge category	Post-campaign knowledge level N=120		Knowledge category	Z value (p= 0.05)
		N	%		N	%		
Knowledge about ETL, toxicity labels, brands and recommendations		125	21.0	Low	58	48.3	Intermediate	6.245*
Proper Protection Equipment's								
I	Use of shirt or jacket with long sleeves	09	1.5	Very Low	04	3.4	Very Low	1.359
Ii	Wears full pants	137	23	Low	30	25	Low	0.457*
Iii	Wears a hat/turban	374	63	High	84	70	High	1.466*
Iv	Covers nose and mouth with cloth or mask	202	34	Intermediate	66	55	High	4.332*
V	Wear boots	06	0.1	Very low	06	01	Very Low	3.101*
Precautions during mixing and spraying of pesticides		172	29.0	Low	56	46.7	Intermediate	3.796*
Weather conditions		152	25.6	Low	58	48.3	Intermediate	4.987*
Dispose off		145	24.4	Low	43	35.8	Intermediate	2.591*
Storage of pesticides		159	26.8	Low	46	38.3	Intermediate	2.554*
Knowledge about the adverse effects of pesticides on environment and natural enemies		76	12.8	Low	42	35.0	Intermediate	5.973*
About antidotes and medical help		56	9.4	Very low	27	22.5	Low	4.075*

*Significant at p=0.05

Weinberger and Srinivasan, 2009) with respondents stressing that they always wash the empty pesticide containers before reuse. Another challenge was the unsafe disposal of expired, leftover pesticides and pesticide wash over (after cleaning the equipment), which was carried out near water bodies or irrigation channels. Finally, most of the applicators consumed food and drinks or smoked during pesticide work and did not shower regularly. Such an attitude contributes to the total body burden of pesticide, which must be improved through the provision of better facilities and infrastructure.

After the crop season, the same questions were put forth to a new group of randomly selected farmers to determine the outcome of the awareness campaign. This showed that there was significant improvement of around 11.4–27.3 per cent with respect to the various aspects of pesticide use and safety awareness. Farmers were more receptive to the concept of the ETL of insect pests, toxicity signs/labels on containers and the pesticide recommendations for particular crops, as indicated by the 27.3 per cent increase in positive responses to the questions after the awareness campaign (Table 1). Furthermore, variable positive acceptance levels were observed among the farmers when inquired about other aspects of imparted knowledge. The biggest concern was around the use of protective clothing while mixing and spraying chemicals, which still had a low compliance among the farmers, sometimes resulting in accidental poisoning–and this was worsened by the general ignorance about antidotes and first aid precautionary measures. The reasons that were cited for a reluctance to adopt these practices were quite varied, such as hot and humid weather, a lack of comfort in spraying and a careless attitude towards pesticides (Table 1). The lack of information about emergency medical help was particularly worrying as only 22.5 per cent of those surveyed knew where to rush a patient to when they required urgent medical attention. In addition, waste water from washing the spray equipment, empty packets/containers and unused pesticide solutions found their way into irrigation channels or open spaces near the pump sets on the farms, which were often used by children and cattle for drinking water, roaming, etc. It was also observed that the awareness programme did not significantly change the mind set of farmers towards using empty pesticide containers for the storage of household and farm products, as indicated by the minimal change (11.4%) in favourable feedback.

The six villages that were included in this study were involved in a thorough awareness campaign

to educate the farmers on the safe use of pesticides. The farmers and their families were sensitised through meetings, a door-to-door campaign and the distribution of a pesticide safety booklet (Singh *et al*., 2019) and a pamphlet depicting 'Dos and Don'ts'. Additionally, children were shown documentaries on the subject and given prizes for participating in quizzes. Some farmers were also given safety kits through a lottery system and others were shown how to make low-cost protective clothing/equipment from the waste material. Participation in the training programmes increased the level of knowledge about safety precautions while handling pesticides. Farmers acknowledged that they had a higher awareness of safety issues after the campaign and tried to incorporate this into their day-to-day operations to better protect themselves. They were informed that spraying should be performed after considering the wind direction and other weather conditions, as spraying under unfavourable conditions would take the chemical off target, and were also cautioned against spraying during the daytime (around noon) in hot and humid weather, as this usually leads to the rapid evaporation of the chemical formulations.

The outcomes of this study will help regulatory agencies to make policy recommendations that are aimed at preventing or reducing the health and environmental hazards associated with pesticides. The agencies should make necessary provisions to ban the sale and use of Class I insecticides classified as hazardous by WHO. Besides, a possibility to include personal protective equipment or safety gear along with pesticide by a pesticide company should be looked into. The knowledge gaps that are highlighted in this study could also be used to improve the training programmes for farmers in future. The agricultural extension service should play a pivotal role in training farmers by providing up-to-date, accurate and easy to understand information. The best way to reach every farmer, which seems impossible through in person by extension worker, is the use of mobile phone. The mobile phone based voice messages in peak pesticide usage times in the cropping cycle can be helpful in disseminating the timely information. This technique witnessed good success in our previous studies (Gaur *et al*., 2016; Singh *et al*., 2018). Since some farmers are unable to read and write, a more interactive and meaningful training model is required–for example, using pictograms to depict pesticide labels and risk factors. An introduction to pesticide safety in primary education will also help in propagating safe use of pesticides. Some mock activities that deal with pesticide safety and poisoning would help farmers to understand how preventive measures should be adopted to reduce the risk of exposure.

Since pesticide dealers play a pivotal role in the dissemination of pesticide and fertiliser information to farmers (Jallow *et al*., 2017), it is critical that they have expertise in pesticide safety and risk communication. In addition, retailers should be competent in handling pesticides and should understand the hazards associated with their use so that they can advise farmers and other end-users (Alam and Wolff, 2016; Jin *et al*., 2015; Matthews, 2008; ZyoudSa'ed *et al*., 2010). To this end, an agro-chemical safety certification programme/diploma should be put in place for pesticide applicators and dealers, whereby only those who are certified are allowed to sell, handle or apply pesticides. Educating farmers and pesticide retailers about the pesticide regulatory frame work, including banned or restricted pesticides, is of utmost importance, as a lack of information around this is likely to contribute to an increased risk to farmers, non-target organisms and the environment. In addition to farmers' training, priority must be given to implementing existing pesticide laws and regulations at all levels through the strict surveillance and monitoring of activities. Promoting area- and crop-specific IPM practices will reduce farmers' dependence on pesticides. Today, well-established agro-ecological methods of pest management which forgo chemical pesticides must be promoted among farmers.

To conclude, this study provided an overview of the unsafe pesticide handling practices and safety knowledge that is prevalent among farmers in south western Punjab. The findings can help with the formulation of educational and policy recommendations that aim to prevent or reduce the hazards associated with agro-chemicals, particularly among farmers with small land holdings.

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Authors' contribution

Conceptualization and designing of the research work(SS, SP); Execution of field experiments and data collection (AS, HS, SP, SS); Analysis of data and interpretation (HS, SS, SP, PR); Preparation of manuscript (SP, SS, PR).

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