Original article

Knowledge, Perception, and Practice of Pesticide Use and Associated Health Among Farmers in Rural Bangladesh

https://doi.org/10.70357/jdamc.2026.v1002.06

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Abstract

Background: Pesticides are widely used in agriculture across South Asia, including Bangladesh, increasing crop production but posing significant risks to environmental health and human well-being. Farmers in developing economies commonly misuse and overuse pesticides. This study sought to the knowledge, perception, and practice of pesticide use and associated adverse health Problems among farmers in a rural area of Bangladesh. **Methods:** This descriptive cross-sectional study was conducted in the Boalmari Upazilla of Faridpur, Bangladesh. A sample of 675 farmers was selected using a purposive sampling technique. Data were collected via face-to-face interviews using a pre-tested questionnaire and analyzed using descriptive statistics (frequency and percentage distribution). The study population was predominantly middle-aged males with low levels of formal education. **Results:** The findings indicate widespread, high-risk pesticide use behaviors. Almost all respondents (99.6%) applied pesticides. A significant majority reported unsafe practices, including mixing different pesticide brands together (82.4%) and increasing the dose over time (84.1%), suggesting a trend of overuse and reliance on personal judgment. The use of Personal Protective Equipment (PPE) was notably low; only 19% wore eye shields, and 44.7% mixed pesticides with bare hands. Furthermore, 62.5% lacked basic training in safe handling. The most frequently reported acute symptoms were eye irritation (40%), headache (17.8%), and skin irritation (12.1%). More than one fifth (22%) of farmers were bedridden and 18% required hospitalization due to pesticide-related health effects. **Conclusion:** Farmers in the study area demonstrate inadequate knowledge regarding safe pesticide handling and proper application practices. This knowledge deficit, compounded by limited access to training, drives unsafe behaviors and results in a high prevalence of acute health symptoms and loss of function. Strengthening farmer education, developing targeted training programs on integrated pest management (IPM) and safe pesticide use, and improving regulatory oversight are essential to mitigating occupational health hazards in rural Bangladesh.

Keywords: *pesticides, PPE, IPM*

Received on: 28.12.25; Revised on: 07.04.2026; Accepted on: 14.04.26

Background

Pesticides are chemical compounds that are used to kill pests, including insects, rodents, fungi and unwanted plants, which are widely used in agriculture.[1] A vast majority of the population in Bangladesh and India is engaged in agriculture and is therefore exposed to pesticides.[2] While pesticides help in increasing crop production, their indiscriminate use adversely affects environment and human health making it an important concern in public health. According to International Labor Organization, as much as 14% of all occupational injuries are due to exposure to pesticides and other agrochemical constituents and 10% of these are fatal.[2] The World Health Organization (WHO) and the United Nations Environmental Program estimated that one to five million cases of pesticide poisoning occur among agricultural workers each year with about 20,000 fatalities.[3] The primary reasons for accidental poisoning among agricultural workers include inappropriate use,

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inadequate knowledge and awareness about pesticide and its storage, protective measures. A literature search revealed that there is a dearth of studies in Bangladesh relating to pesticide use pattern and knowledge and awareness. Pesticides use is a double-edged sword in the battle against pests as it affects human health and also contaminates the environment, Misuse and Overuse of pesticide is very common among farmers of developing economies and Bangladesh is no exception. Developing countries and Bangladeshi farmers have a tendency to ignore technical recommendations and usage on their own experience often leading to indiscriminate application.[4] Yet, some farmers have a genuine problem of insufficient knowledge and information on spraying pesticides in their farms and it causes numerous morbidity effects ranging from headaches, nausea to cramps and body tremors. According to the World Health Organization (WHO) in 2005 the estimated occupational pesticides poisoning affected as many as 25 million of the agricultural workforce each year in developing countries. Acute pesticide poisoning has become a major problem in Sri Lanka. Farmers handling and spraying pesticides using hand sprayers suffer from numerous morbidity effects.[5]

Indiscriminate and excessive use of toxic synthetic pesticides damaged not only the environment and agriculture but also entered into the food chain thereby affecting all living beings.[6] Pesticides, herbicides and fungicides have been introduced during the mid-sixties on a large scale with long-term implications for the productivity of the agriculture in Bangladesh.[7] Initially, the objective of the introduction of pesticides was to prevent the environmental and economic disasters of the field crops and to ensure increased productivity. However, the long-term objective of increasing the crop yield at any expense of sustainability and safety of the environment has resulted in contaminating and continuing unknown, post-disease type of effects on the food chain and the environment and unknowingly the consumers.[8] The indiscriminate use of pesticides has not only destroyed the ecosystem, but also the flora and fauna as well as beneficial insects such as honey bee are affected as well.[9] Bangladesh also exports some of these crops. So, it is important to know about the pesticide residues in these exported crops. Numerous biotic as well as abiotic aspects cause losses to these crops. For this reason, we need to study and utilization of pesticides among farmers in a rural area of Bangladesh.

The study seeks to determine the knowledge, perception and practice of pesticide use as well as adverse health impacts among the farmers in a rural area of Bangladesh. By understanding these local challenges, the research aims to generate evidence-based insights to inform national stakeholders on interventions needed to control pesticide misuse and reduce associated environmental and health hazards.

Methods

Study Design: It was a descriptive type of cross-sectional study

Sample Criteria: The survey was carried out in different village area of Boalmari Upazilla, Faridpur, Bangladesh in July 2022.

Sample size: For the present study, the sample size was 675. It was calculated by minimum sample size formula Z^2pq/d^2. And 10% extra cases were added due to reservation.

Here, Z= 1.96, p=0.5, q=0.5, d= 0.5 (in 95% confidence interval). Therefore, according to the formula the minimum sample size was 384. Its extra 10% is 38. Therefore, minimum sample size was 384+38= 422, but during the data collection period 675 persons were available and all are included in the sample.

Sampling technique: Purposive sampling technique was used for data collection. Farmers in the village of Boalmari was chosen as the sample for the study. The farmers were chosen according to their availability and willingness to participate. The place of data collection was given priority during data collection.

Data collection procedure: Data were collected from the respondents by face-to-face interview. A pre-tested questionnaire was used as the instrument of data collection for the proposed study. Students from the department of Community Medicine of Faridpur Medical College participated in the data collection.

Data collectors went to the five villages of Boalmari Upazilla and each of them visited three selected households. Obtaining informed consent of the respondents each data collector interviewed all the adult persons (>18 years). Each data collector conducted 6 interviews and thereby the total number of interviewers were 678. After completion of data collection, three data were missing that made the total number of samples 675.

Data management: After the interview, completed questionnaires were reviewed for data checking and cleaning. Then the responses were cross checked. After that a master sheet was prepared based on the answers obtained in the study. Finally, responses were coded and entered into the computer.

Data analysis: Descriptive statistics such as frequency, percentage distribution and graphs were used for the analysis of data. In order to see the characteristics of the respondents the univariate analysis was done. The data were entered into computer with the statistical package

for social science (SPSS) software for windows version 16. While describing the findings and the objectives of the study, an analysis plan was followed keeping in view the objectives of the study.

Results

The age distribution of the respondents show that the majority of farmers were between 41–50 years (25.5%) and 51–60 years (25.2%), indicating that pesticide application is predominantly undertaken by middle-aged and older adults. Only 18.1% were aged 30 years or below (Table 1).

The farming population was overwhelmingly male (98.7%), reflecting gendered patterns in agricultural labor in rural Bangladesh. In terms of education, more than one-third of the farmers (37.0%) had no formal education, while 28.1% had completed primary education. Only 5.2% had education above higher secondary level, highlighting generally low educational attainment within this group (Table 1).

Table 1: Socio-demographic characteristics of the farmers using pesticides in Boalmari, Faridpur, July 2022 (N=675)

Variables	Frequency (n)	Percentage (%)
Age group		
≤30	122	18.1
31-40	132	19.6
41-50	172	25.5
51-60	170	25.2
>60	79	11.7
Gender		
Male	666	98.7
Female	9	1.3
Education Status		
Higher secondary	35	5.2
Secondary	200	29.6
Primary	190	28.1
No education	250	37.0
Years of Farming		
< 20 years	294	43.6%
21-40 years	325	48.1%
>40 years	56	8.3%

Table 2: Knowledge regarding the pesticide use among the participants (N=675)

Attributes	Frequency (n)	Percentage (%)
Knowledge regarding information supplied with the pesticides		
Present	514	76.1
Absent	161	23.9
Knowledge regarding applicators risk level		
No risk at all	119	17.6
Small amount of risk	225	33.3
Medium amount of risk	203	30.1
Large and significant risk	73	10.8
Dangerous and very toxic	42	6.2
Do not know anything about risk	13	1.9
Basic training for safe handling		
Present	253	37.5
Absent	422	62.5
Basic Training for application		
Present	260	38.5
Absent	415	61.5

The majority of the farmers (76.1%) reported having knowledge about the information provided with pesticide products, suggesting that most respondents are at least aware of the basic instructions or safety details accompanying pesticides. However, a considerable proportion (23.9%) lacked this knowledge, indicating gaps in safety awareness (Table 2)

Perceptions of risk related to pesticide application varied widely. While one-third (33.3%) believed pesticide use carries only a small amount of risk, nearly the same proportion (30.1%) recognized a medium amount of risk. Conversely, 17.6% perceived no risk at all, and 1.9% reported having no knowledge of risk, reflecting underestimation of pesticide hazards among some farmers. A smaller but important proportion (17.0%) acknowledged higher levels of danger, identifying pesticides as either significantly risky (10.8%) or very toxic (6.2%) (Table 2).

Table 3: Practice of pesticide use among the respondents (N=675)

Apply pesticides during farming	Frequency (n)	Percentage (%)
Yes	672	99.6
No	3	0.4
Mix different brands of pesticides together		
Yes	556	82.4
No	119	17.6
Way of changing the dose of pesticides over the time		
Increase	568	84.1
Decrease	31	4.6
No change	76	11.3
Cross-crop pesticide use		
Yes	276	40.9
No	399	59.1
Utilize IPM		
Yes	279	41.3
No	396	58.7
Wear eye shield while mixing pesticide		
Yes	128	19.0
No	547	81.0
Pesticide mixing process		
With bare hands	302	44.7
Wear gloves	36	5.3
With stick	289	42.8
With stick and gloves	48	7.1
Procedure of cleaning nozzle		
Boling without washing	49	7.3
Boiling with washing	85	12.6
Cleaning with wire without washing	89	13.2
Cleaning with wire without washing	361	53.5
others	91	13.5
Changing cloths after spray		
Yes	634	93.9
No	41	6.1
Taking bath after spray		
Yes	658	97.5
No	17	2.5
Spraying in windy weather		
Yes	259	38.4
No	416	61.6
Spraying while eat or drink		
Yes	259	38.4
No	416	616
Site of washing pesticide bottle		
In pond	272	40.3
Distant from pond	403	59.7

Training indicators showed substantial gaps in preparedness for safe pesticide use. Only 37.5% of farmers had received basic training in safe handling, and 38.5% had received basic training on proper application techniques. More than 60% lacked training in both areas, highlighting a critical need for structured training programs to promote safe pesticide handling and reduce occupational health risks. (Table 2)

Almost all respondents (99.6%) reported applying pesticides during farming, highlighting the widespread reliance on chemical pest control. Risky mixing practices were common: 82.4% mixed different pesticide brands together, and 84.1% reported increasing the dose of pesticides over time, suggesting a trend of overuse or reduced pesticide effectiveness. (Table 3)

Single pesticide applied to multiple crops was reported by 40.9% of farmers, indicating non-target use of pesticides that may increase environmental and health risks. Only 41.3% practiced Integrated Pest Management (IPM), reflecting limited adoption of safer and more sustainable pest-control approaches (Table 3). Use of personal protective equipment (PPE) was notably low. While mixing pesticides, only 19% wore eye shields, and 44.7% mixed pesticides with bare hands. Only a small proportion used gloves (5.3%) or combined gloves and sticks (7.1%), demonstrating unsafe handling practices. (Table 3)

Cleaning methods for spray nozzles also showed variation, with more than half (53.5%) using wire with washing, while others relied on boiling or dry cleaning. Despite poor mixing and handling practices, most farmers reported good post-spray hygiene: 93.9% changed clothes after spraying and 97.5% took a bath. However, unsafe practices persisted during spraying, with 38.4% spraying in windy weather and an equal proportion eating or drinking during spraying—behaviors that increase exposure. Environmental contamination risks were also evident, as 40.3% washed pesticide containers in ponds. (Table 3)

The perceptions influencing pesticide-use decisions varied among respondents. Nearly half of the farmers (45.9%) reported relying on suggestions from others when choosing or applying pesticides, indicating a strong dependence on peer advice rather than formal guidance. Uncertainty about pesticide effectiveness for specific pests was the second most common perception (28.7%), suggesting limited technical knowledge about pest–pesticide compatibility. A smaller proportion (8.3%) expressed doubts about the quality of certain pesticides, while 7.3% reported imitating other applicators' practices. Additionally, 9.8% cited other unspecified reasons. Overall, the findings reflect a reliance on informal sources of information and highlight gaps in knowledge regarding pesticide quality and effectiveness. (Table 4)

Table No. 4: Perception of the farmers about mixing different pesticides

Perceptions	Frequency (n)	Percentage (%)
Unsure about the quality of a certain pesticide	56	8.3
Uncertain about the effectiveness of a certain pesticide for a particular pest	194	28.7
Imitating other applicators	49	7.3
Following the suggestion of others	310	45.9
Other reasons	66	9.8

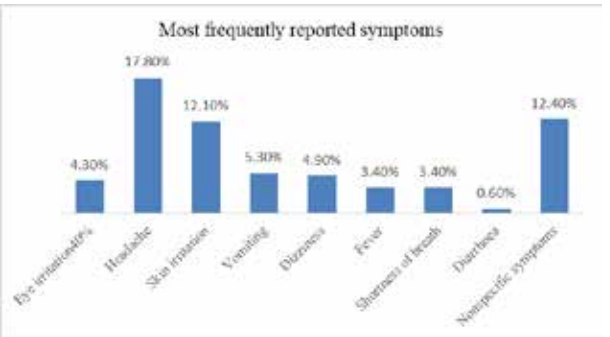

Figure 1: Reported symptoms due to pesticide exposure among the participants (N=675)

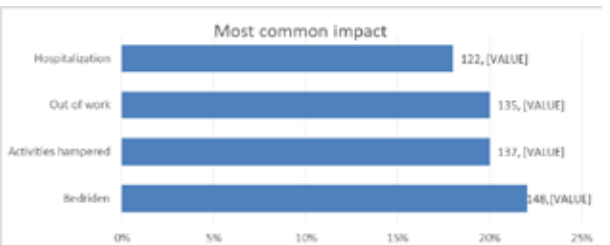

Figure 2: Health impact due to pesticide exposure (N=675)

Discussion

The findings indicate that pesticide-using farmers in Boalmari are predominantly middle-aged males with low levels of formal education and limited structured training on pesticide safety. Similar demographic patterns have been documented across rural South Asian agricultural communities, where farming is largely male-dominated and characterized by low educational attainment.[10,11] Low literacy levels may hinder the ability to interpret pesticide labels, safety instructions, and hazard symbols, increasing the likelihood of improper handling and unsafe practices.

Although the majority of farmers reported having some knowledge of the information supplied with pesticides, more than one-third lacked adequate understanding of the associated health risks. This aligns with global evidence showing that farmers often underestimate the toxicity and long-term health effects of pesticides, even when they are frequent users.[12,13] Misconceptions such as perceiving pesticides as low-risk or harmless—are particularly concerning, as they may lead to inadequate use of personal protective equipment and unsafe application methods.

The low proportion of farmers who received training on safe handling and proper application is and other LMICs, where formal agricultural extension and safety education programs are often insufficiently implemented.[14] Evidence suggests that training interventions significantly improve farmers' safety behaviors, reduce acute poisoning episodes, and promote environmentally responsible pesticide use.[15]

The research findings paint a picture of widespread, high-risk pesticide use, which is unfortunately consistent with patterns observed globally among farmers in developing regions.[16,17] The near-universal application of pesticides mirrors the pervasive reliance on chemical control found in countries like Ethiopia, where approximately 99% of households use at least one chemical pesticide.[18]

The reported practice of increasing the dose over time and mixing different brands reflects a reliance on personal judgement rather than scientific guidance, a common phenomenon documented elsewhere.[19] This behavior is often driven by a lack of formal training and a false belief that "more is better" for pest control, accelerating pesticide resistance and increasing unnecessary chemical load.[19,20] The low adoption of Integrated Pest Management (IPM) is a critical finding, confirming that the promotion of sustainable alternatives remains a challenge, as studies have shown that pro-pesticide policies often lead to the erosion of traditional and safer pest management practices.[21] The most concerning finding the low use of Personal Protective Equipment (PPE) is highly comparable to findings in other low- and middle-income settings[17,21,22]

The extremely low usage of gloves and eye shields highlights that dermal and ocular exposure is a primary route of contamination. A systematic review of PPE use found that while long-sleeve clothing and hats were more common, low-cost but critical items like goggles and gloves had the lowest rates of use globally.[23] The reasons often cited in these comparative studies include discomfort especially in hot climates, cost, and a lack of awareness of the necessity of PPE.[24, 25]

The reported prevalence of acute symptoms particularly eye irritation and headache are consistent with the most common short-term effects of pesticide exposure reported worldwide.[26,27] Being the most common

symptom directly aligns with the extremely low eye shield usage and corroborates the high incidence of conjunctival inflammation and ocular surface damage frequently reported in agricultural workers.[27]

Symptoms like headache and dizziness are classic neurological signs of acute poisoning, especially from commonly used organophosphate and carbamate pesticides.[21,26] Other studies have also identified headache as a highly prevalent symptom, sometimes exceeding 50% of respondents in similar farming populations.[27] Crucially, the high rates of required hospitalization and resulting loss of productivity underscore the significant economic and public health burden that acute pesticide poisoning places on agricultural communities, a cost often underestimated in benefit-cost analyses of pesticide use.[21]

Overall, these findings highlight the urgent need for targeted educational programs, routine training on safe pesticide handling, clearer labeling, and strengthened agricultural extension services. Improving farmers' knowledge and risk perception could play a critical role in reducing occupational pesticide exposure and protecting long-term health outcomes in rural farming populations.

Limitations of the study

The study's findings face several limitations primarily stemming from methodological constraints, including selection bias due to the pre-selected study area and the use of a purposive sampling technique, which severely restricts the generalizability of the results to the broader population. Further hindering the research was the relatively short study period for the entire process (collection through interpretation), compounded by logistical difficulties such as remote and hard-to-reach study areas with poor communication and transport facilities, potentially leading to incomplete data collection from these remote sectors.

Conclusion

The study demonstrates that farmers in the study area have limited access to training and extension support contributes to unsafe behaviors, including inadequate use of protective measures and poor field hygiene. Reported symptoms—such as skin and eye irritation, respiratory problems, headaches, dizziness, chest pain, and abdominal discomfort—indicate substantial but under-documented health risks associated with pesticide exposure. Hot-weather fieldwork further exacerbates these risks. Strengthening farmer education, developing targeted training programs on integrated pest management and safe pesticide use, and improving regulatory oversight are essential to reducing occupational health hazards and informing future pesticide policy reforms in Bangladesh.

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