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## EFFECT OF EXCESSIVE USE OF AGROCHEMICALS ON FARMING PRACTICES: BANGLADESH PERSPECTIVES

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### ABSTRACT

Agrochemicals are the part and parcel of modern farming practices. The study attempted to explore the effects of excessive use of agrochemicals on farming practices. A structured questionnaire and face-to-face interview were conducted in collecting data from randomly selected 150 farmers of Satkhira sadar upazila under Satkhira district of Bangladesh during November 2022. The perceived effect of excessive use of agrochemicals was the focus variable whereas the selected socio-economic attributes of the participants were chosen as explanatory variables. The effect of overuse of agrochemicals was assessed employing a 4-point rating scale and ranked by calculating perceived effect index while the independent variables were measured using appropriate scoring techniques and scales. The findings revealed that, majority (48.7%) of the respondents perceived high positive effects of excessive use of agrochemicals on farming practices while a large portion (59.3%) of them perceived medium negative effects. It was also found that, the most positive effect perceived was increase productivity and cropping intensity (91.8%) while the worst effect was perceived as poisonous to human, animal, and soil microorganisms (82.7%). The results also explored that the main cause of overuse of agrochemical is provision of higher yield (94.7%) whereas the best management practice suggested by the farmers was agricultural training (95.3%). However, perceived effect of agrochemical usage was found positively correlated with respondents' educational qualification, farming experience, agricultural training, extension media contact, knowledge, and awareness. So, appropriate strategies along with sustainable farming system is crucial to protect our environment and save our upcoming generations.

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### INTRODUCTION

Agriculture is an engine for the survival of living beings and globally over 75% of the rural population depends on agriculture-based farming practices for their living and livelihood (Lipper *et al.*, 2014). According to the research report of Sarkar *et al.* (2021) all over the world, the cultivable agricultural land is declining rapidly while

the population is increasing at an alarming rate. So, feeding the growing population is a burning question and sustainably producing food is a challenging issue whereas the estimation of FAO (2015) explored that, for feeding the world population, the total agricultural production needs to increase by about 60% by 2050 and the problem is more acute in developing countries like

India and Bangladesh. Conducting farming practices effectively and efficiently could be a useful strategy in eradicating poverty and hunger which is the key indicators of sustainable development (FAO, 2021). To produce more crops from small landholdings and feed the large population, farmers especially in developing countries are applying agrochemicals in their farming practices (Gupta, 2012). Agrochemicals are the chemical compounds (fertilizer, pesticides, hormone, fungicides, insecticides, herbicides etc.) used in farming activities to protect the crops, fisheries and livestock from insects, pests and diseases which enhance the growth and development as well as quality and quantity of farm products (Omari, 2014; Hussain *et al.*, 2009). However, considering the global scenario, there is no alternative to the use of agrochemicals in agricultural practices but the balanced use with optimum doses, and maintaining correct methods at right time has significant effects on farm production (Hurtig *et al.*, 2003) but the requirements and efficiency of agrochemicals depend on the quality of products, application method used, soil health and meteorological characteristics (Gill and Garg, 2014a; Yáñez *et al.*, 2002). However, the demand for agrochemicals is increasing all over the world and more than 50% of them are being used in Asia (FAO, 2019). In developed countries, farming communities applying fertilizers and pesticides properly whereas in the developing world, farmers use excessive agrochemicals in their farming practices (Bahadur *et al.*, 2015) which creates a big problem for the existence of the living beings and affects Sustainable Development Goals (SDGs) drastically. Agrochemicals have both positive and negative effects on farming activities (Önder *et al.*, 2011). Generally, it seems that agrochemicals are increasing production and productivity but in long run, it is destroying our farming resources like soil, water, air, microorganisms, natural enemies, fisheries etc. (Gill and Garg, 2014b). According to Meena *et al.* (2020), more than 95% of the applied pesticides harm non-targeted beneficial soil microorganisms or natural enemies as they are applied constantly throughout the whole field, regardless of the affected zones. It not only creates environmental pollution but also threatens the extinction of lives on Earth. However, indiscriminate use of fertilizers and pesticides is a threat to our ecosystem (Önder *et al.*, 2011) and the residual effects create long-term diseases on human and animal bodies (FAO, 2019; Nakata *et al.*, 2002; Abidin *et al.*, 2018). Globally, every

year millions of people are being affected with cancer, diabetic, asthma and so many diseases (Alavanja *et al.*, 2004) and the scenario is more acute in developing countries like Bangladesh, which is the densely populated country of world where food production has been increased three times more since her liberation to feed the large population (BBS, 2020). Bangladeshi farmers are using agrochemicals extensively to foster agricultural productivity which is a massive challenge for farm sustainability (Dasgupta and Meisner, 2005). In Bangladesh, the soil organic matter is less than 1% and excessive application of agrochemicals is declining soil fertility and productivity, and the overall environment is getting polluted adversely which is a matter of concern (Bhuiya, 1987).

The farmers are less educated have poor skills, knowledge, and awareness regarding the utilization of agrochemicals and even the concern authorities are not aware of implementing the existing laws to protect against the unfair use of pesticides as increasing production is their main goal. If it continues in such a way, environmental sustainability would be a big question because agriculture individually contributes about 13% emission of greenhouse gases (FAO, 2013) and the future generations must face enormous challenges for their survival. So, it's high time to take appropriate strategies to save our environment and accelerate SDGs accordingly. Contemplating the above situation, the research was carried out to investigate the effects of excessive use of agrochemicals in farming practices.

## MATERIALS AND METHODS

### Study area

For conducting the research, five unions (lowest administrative unit) namely Agardari, Banshdaha, Ghona, Kuskhali and Shibpur of Satkhira sadar upazila under Satkhira district of Bangladesh (Figure 1) were chosen randomly. Satkhira district is well known for cultivating various types of crops as well as fisheries and livestock (BBS, 2020). Before selecting these unions, a comprehensive conversation was performed with the concerned people and authorities by the researcher to contact with the clientele groups.

### Population and sampling design

To select the participants, a random sampling strategy was used. The respondents who were engaged to

various farming practices and whose livelihoods mainly depend on agriculture-based farming activities in Satkhira sadar upazila were considered as the targeted population. A total of ten (10) villages, two (2) from each

union were selected randomly whereas a total number of 15 participants, from each village, were chosen employing a simple random sampling technique which makes the total sample size 150.

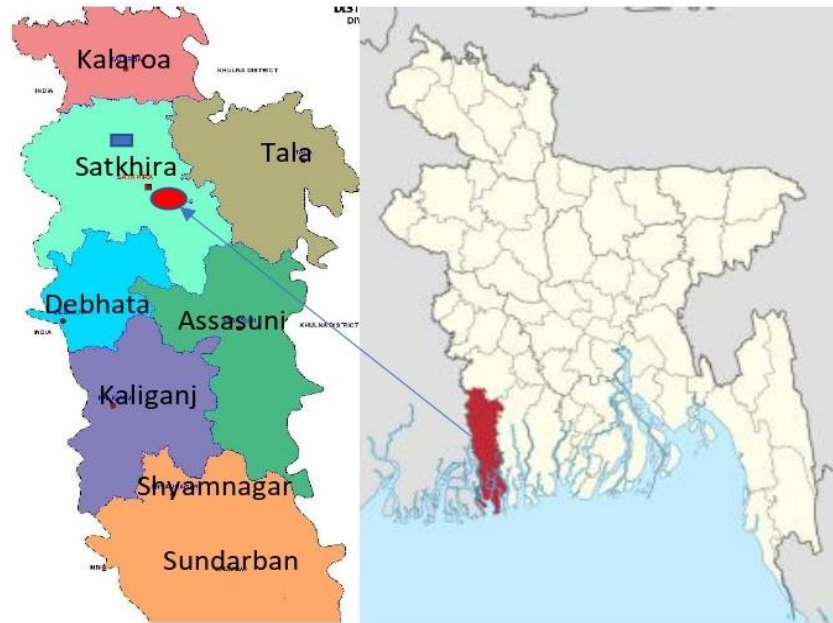


Figure 1. Map of the Study Area

### Methods of data collection

Before collecting data employing the personal interview method, five Focus Group Discussions (FGDs) were performed with 50 respondents (10 in each session) consisting of farmers, input dealers, and Sub Assistant Agriculture Officer (SAAO) to develop a basic understanding of the perception and usage of agrochemicals. Besides, five Key Informant Interviews (KIIs) with input dealers, NGO officers, model farmers and Agriculture Extension Officer (AEO) were also performed for getting in-depth information. Finally, by conducting primary interviews with twenty-five (25) respondents, the interview schedule was revised and improved further. Face-to-face interview was carried out with the sampled participants (150) using a structured questionnaire during November 2022.

### Measurement of variables and analysis of data

The effect of excessive use of agrochemicals was treated as a focus variable, while the selected socio-economic attributes of the clientele groups like age, educational qualification, farm size, farming experience, agricultural

training, extension media contact, organizational participation, knowledge, attitude, and awareness were considered as explanatory variables. The explanatory variables were measured using appropriate scoring techniques with suitable scales. For measuring the focus variable, a total number of 14 statements (7 positives and 7 negatives) were identified through FGDs, KIIs and existing literature.

A 4- point rating scale such as strongly agree, moderately agree, somewhat agree, or not at all agree was utilized correspondingly and the score given against the rating scale were 3, 2, 1, and 0, respectively. As a result, the theoretical score varied from 0 to 42, where 42 denoting a high effect perceived and 0 indicating no effect perceived. Based on the effect score, the respondents were categorized into three groups namely low, medium, and high.

Moreover, a Perception Effect Index (PEI) was calculated using the following formula (Billah *et al.*, 2021; Rahman *et al.*, 2021) to understand the relative proportion of the statements related to perception concerning the effect of excessive use of agrochemicals in farming practices. PEI

helps to identify the most critical effect and make a rank order of them.

$$PEI = N_1 \times 3 + N_2 \times 2 + N_3 \times 1 + N_4 \times 0$$

Where,

PEI = Perception Effect Index

$N_1$  = No of the participants rated the effect of agrochemicals as strongly high,

$N_2$  = No of the participants rated the effect of agrochemicals as moderately high,

$N_3$  = No of the participants rated the effect of agrochemicals as somewhat high,

$N_4$  = No of participants rated the effect of agrochemicals as not at all high,

The PEI score varied from 0-450, where 0 mentions no effect whereas 450 implies the highest effect of excessive use of agrochemicals as perceived by the farmers. Moreover, the percentage of PEI score was performed using the following formula (Hamid *et al.*, 2020):

$$\% \text{ Perception Effect Index (PEI)} = \frac{\text{Observed perception index score}}{\text{Possible highest perception index score}} \times 100$$

In addition, the relationship between farmers' socio-economic attributes and the effect of excessive use of agrochemicals in farming practices was measured by using correlation analysis. The collected data were properly cleaned, coded, and analysed using Statistical Package for Social Science (SPSS) version 27. For categorizing and describing the variables, descriptive statistics like frequency, number, range, percentage, mean, standard deviation (SD), and rank order was performed accordingly.

## RESULTS AND DISCUSSION

### Socio-economic attributes of the respondents

The results indicate that the majority (80.7%) of the respondents belonged to the middle and old aged group, and this is perhaps, the younger generation is getting

involved in either education or non-agricultural activities and the findings are similar to Rahman *et al.* (2021). The literacy rate was found 62.7% which is lower than the national level (74.9%) and Xu (2004) explored that farmers having poor education, there is a greater chance of applying illegal pesticides markedly, leading to extremely intense pesticide residues. It was also exposed that almost two-third (64.7%) of the respondents belong to small farm holdings which is smaller than national (84.5%) farming categories (DAE, 2018). Moreover, the majority (55.3%) of the respondents had medium annual income whereas a large portion (62%) of them did not receive any agricultural training but the research report of Dongmei (2006) showed that agricultural training is very effective to know the residual effects of the pesticide. In addition, it was found that about half (51.3%) of the respondents had a medium farming experience which is alike to the findings of Chowdhury *et al.* (2011). However, the majority (56.7%) of them did not maintain extension media contact for farming activities and about three-fourths (76%) of them had no connection with any organization. The research findings of Gupta (2012) explored that the majority of the farmers did not communicate with extension agents for conducting farming practices. Nonetheless, a significant portion (46%) of the respondents had medium knowledge and almost half (48.7%) of them had a less favourable attitude towards the effects of excessive use of agrochemicals whereas about two-third (67.3%) of them were unaware regarding the effects of excessive use of agrochemicals on farming practices which a matter of concern and presented in Table 1. Many authors (Hurtig *et al.*, 2003; Omari, 2014) argued that farmers having a low level of awareness regarding the residual effects of agrochemicals leads to excessive use of it in farming practices.

Table 1. Salient features of the selected socio-economic attributes of the respondents.

Socio-economic variables	(%)	Respondents (N=150)			
		Mean	SD	Min.	Max.
Age (years)					
Young ( $\leq 35$ )	19.3				
Middle (36-55)	42.7	39.85	9.23	23	61
Old ( $> 55$ )	38.0				
Educational qualification (year of schooling)					
Illiterate (0)	37.3				

Primary (1-5)	40.7	6.28	2.13	0.0	16
Secondary (6-10)	15.3				
Higher secondary (>10)	6.7				
Farm size (ha)					
Small ( $\leq 1.0$ )	64.7				
Medium (1.01-2)	21.3	---	---	---	---
Large (>2)	14.0				
Agricultural training received (days)					
No training (0 days)	62.0				
Short training (1 -7 days)	19.3	3.96	1.34	0	25
Medium training (8-14 days)	12.7				
Long training (> 14 days)	6.0				
Farming experience (years)					
Low experience ( $\leq 10$ )	23.4				
Medium experience (11-20)	51.3	13.24	5.14	4.0	38
High experience (>20)	25.3				
Extension media contact (scale score)					
No contact (0)	56.7				
Low ( $\leq 10$ )	23.3				
Medium (11-20)	11.3	12.65	5.42	0	26
High (>20)	8.7				
Organizational participation (scale score)					
No participation (0)	76.0				
Low participation (up to 7)	15.3	8.35	2.34	0	18.00
Medium participation (8-14)	6.0				
High participation (>14)	2.7				
Knowledge (scale score)					
Poor knowledge ( $\leq 7$ )	40.7				
Medium knowledge (8-14)	46.0	11.48	2.02	4.0	20
High knowledge (> 14)	13.3				
Attitude (scale score)					
Less favourable attitude ( $\leq 17$ )	48.7				
Moderately favourable attitude (18-34)	37.3	22.87	7.35	12	45
Highly favourable attitude (> 34)	14.0				
Awareness (scale score)					
Not aware (0)	67.3				
Somewhat aware ( $\leq 10$ )	18.0	12.34	2.45	0	27
Moderately aware (11-20)	9.3				
Highly aware (> 20)	5.4				

Source: Field survey (2021)

### Farmers' perception regarding agrochemicals usage

Table 2 reveals that the most used agrochemical was fertilizer (100%) followed by insecticides (94.7%), growth hormones (88%) etc. which reveals the extent of agrochemical usage by the respondents. The majority (40.7%) of the respondents didn't know whether the

agrochemical providers are authorized or not while over half (57.3%) of them opined that, agrochemicals are highly expensive, and the result is almost similar to Bhandari (2014). The findings also explore that almost two-thirds (64%) of the participants stored agrochemicals in a safe place whereas most of them

(94.7%) stored the remaining ones for further usage which is a good sign for balanced and sustainable use of it. It was also found that a large portion (83.3%) throw empty containers here and there which is truly a great threat to the environment. It is a matter of sorrow that, most (87.3%) of them didn't use protective equipment while applying agrochemicals which is responsible for human ailment indeed. However, Mekonnen and Agonafir (2002) stated that using personal protective equipment during pesticide application reduces the chance of getting affected with various diseases. In

addition, among all other health-related problems, the majority (78%) of the respondents suffer from headaches which is indeed a matter of concern. Alavanja *et al.* (2004) reported that the common symptoms of pesticide application among farmers were tiredness, headaches, body pains, skin rashes, fatigue, respiratory problems, nausea, dizziness, vomiting, cramps, etc. and in extreme cases death, whereas several studies (Hardell *et al.*, 2002; Gildea *et al.*, 2010) explored that excessive exposure to agrochemicals may lead to chronic diseases like asthma, cancer etc.

Table 2. Farmers' perception regarding agrochemicals and their balanced use.

Variables/ Indicators	N= 150	Percentage (%)
<b>Commonly used agrochemicals*</b>		
Fertilizer	150	100
Insecticides	142	94.7
Herbicides	114	76.0
Fungicides	83	55.3
Nematicides	47	31.3
Growth hormones	132	88.0
<b>From whom do you buy these agrochemicals</b>		
Authorized dealers	55	36.7
Unauthorized dealers	34	22.6
I don't know	61	40.7
<b>Cost of agrochemicals</b>		
Highly expensive	86	57.3
Moderately expensive	41	27.4
Low expensive	23	15.3
<b>Storage system*</b>		
Hanging outside home	88	58.7
On top of the house	67	44.6
In a safe place	96	64.0
<b>Remaining agrochemicals management*</b>		
Stored and used for another application	142	94.7
Apply although not required	76	50.6
Pour into bushes/homestead gardening	64	42.7
<b>Disposal of empty containers*</b>		
Throw here and there	125	83.3
Burnt/ Buried	74	49.3
Use for household purposes	39	26.0
<b>Use of protective equipment</b>		
No	131	87.3
Yes	19	12.7
<b>Health impacts*</b>		
Abdominal pain	43	28.7
Allergy	58	38.6

Dizziness	89	59.3
Dermatitis and pink eye	75	50.0
Fever	35	23.3
Headache	117	78.0

Source: Field survey (2021), \*Multiple responses

### Causes of excessive use of agrochemicals

Table 3 indicates that there are so many causes accelerating the overuse of agrochemicals by farmers in their farming practices and among them, the most perceived influential cause was the provision of higher yield (94.7%) which is the main target of most of the developing nation of the world (FAO, 2015) followed by protecting crops and animals from insects, pests and diseases (90%), lack of proper training (82.7%),

maximum utilization of land (73.3%) etc. and the result is almost similar to Xu *et al.* (2008) who reported that, producing more crops is the main target of using excessive pesticides along with lack of awareness, and training. Zhao and Zhang (2007) argued that, commercialization was the influential factor behind excessive use of agrochemicals. However, the low influential cause opined by the respondents was poor monitoring and supervision (44%).

Table 3. Causes affecting excessive use of agrochemicals.

Causes enhancing overuse of agrochemicals *	N=150	Percent
Provision of higher yield	142	94.7
Protecting crops and animals from insects, pests, diseases	135	90.0
Lack of proper training	124	82.7
Maximum utilization of land	110	73.3
Maintaining soil fertility	94	62.7
Lack of awareness	89	59.3
Feeding the growing people	87	58.0
Producing quality and fresh products	82	54.7
Easy access to agrochemicals	76	50.6
Poor monitoring and supervision	66	44.0

Source: Field survey (2021), \*Multiple responses

### Effects of excessive use of Agrochemicals in farming practices

Agrochemicals have both positive and negative as well as short-term and long-term effects on the environment and ecosystem (Önder *et al.*, 2011). Most positive effect of overuse of agrochemicals was found in the case of increasing productivity and cropping intensity (91.8%) followed by promoting growth and development (88.2%), ensuring quality products (83.1%) etc. while the less positive significant effect was maintaining soil fertility (56.8%) (Table 4). According to Aktar *et al.* (2009), the regular application of pesticides exaggerates

agricultural production, however, misuse of these chemicals is a serious impediment to farming practices. The worst effect was perceived as poisonous to human, animal, and soil microorganisms (82.7%), succeeded by accelerated environmental pollution (72.7%), residual effect on human health (68.7%), etc. although the less adverse impact perceived was altered food quality (30%). Many authors (Meena *et al.*, 2020; Nakata *et al.*, 2002; Okoffo *et al.*, 2016; Babu *et al.*, 2003) argued that the application of pesticides is harmful to the total farming system and excessive use has serious residual effects on the whole biodiversity.

Table 4. Effects of overuse of Agrochemicals in farming practices.

Positive effects*	PEI Score	% PEI	Rank
Increase productivity and cropping intensity	413	91.8	1
Promote growth and development	397	88.2	2

Ensure quality products	374	83.1	3
Increase farm income	341	75.8	4
Prevent the expansion of diseases	324	72.0	5
Kill insects and weeds	292	64.9	6
Maintain soil fertility	256	56.8	7
<b>Negative effects*</b>			
Poisonous to human, animal, and soil microorganisms	372	82.7	1
Accelerate environmental pollution	327	72.7	2
Residual effect on human health	309	68.7	3
Contaminate surface and ground water	261	58.0	4
Increase soil contamination and degradation	207	46.0	5
Destroy beneficiary organisms, wild fish varieties	192	42.7	6
Alter food quality	135	30.0	7

**Source:** Field survey (2021), \*Multiple responses

Figure 2 indicates the extent of the effects of excessive use of agrochemicals and in case of positive effect, 48.7% of farmers perceived high effect of agrochemicals application on farming practices while in the event of negative effect, the majority (59.3%) of them perceived

medium effect of overuse of agrochemicals and a little portion experienced low effect in both cases. Many authors (Cooper and Dobson, 2007; Dinham and Malik, 2003; Leyk *et al.*, 2009), agreed that the effects of agrochemicals are gradually drawing global attention.

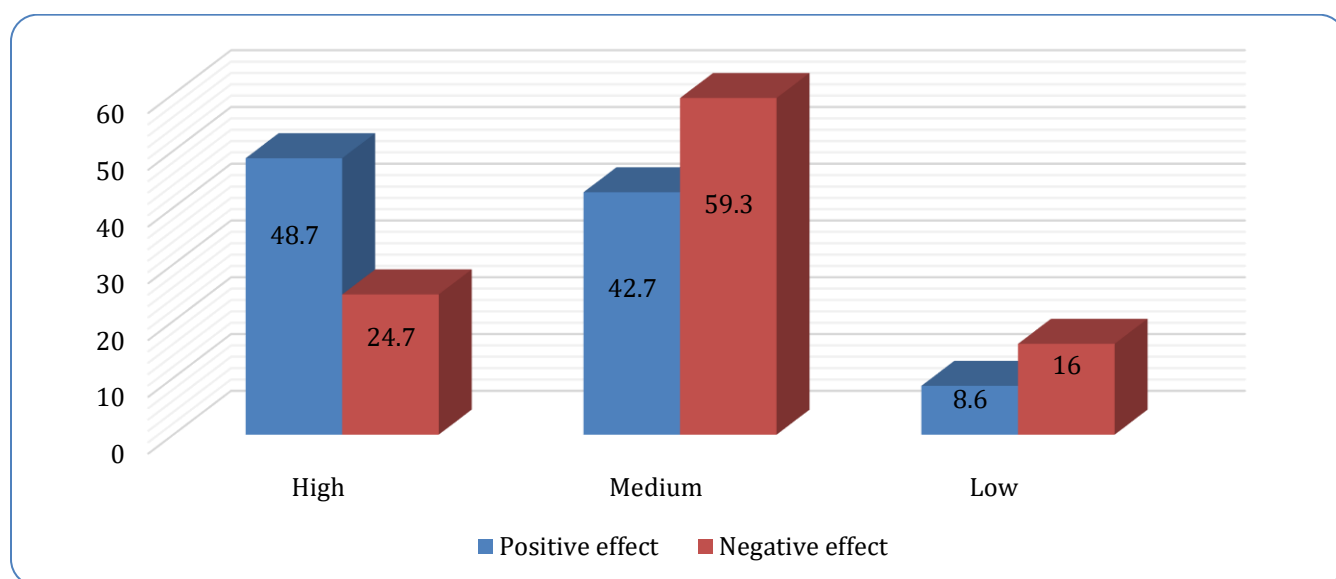


Figure 2. Extent of Perceived Effect of Use of Agrochemicals.

### Correlation between dependent and independent variables

The correlation analysis indicates that amongst the selected socio-demographic attributes; respondents' educational qualification, farming experience, agricultural training, extension media contact, knowledge and awareness had a positive and significant association to the perceived effect of excessive use of agrochemicals in farming practices (Table 5). Bhandari

(2014) found that awareness and education assist farmers in perceiving the effects of agrochemical usage while according to Dongmei (2006), farmers' education and training are highly associated with the perceived effect of abuse and misuse of agrochemicals. According to Tripathi and Mishra (2016), education, the number of schools going children and ownership of TV/radio is positively significant to the perceived impact of agrochemical usage.



Table 5. Correlation coefficient between focus and explanatory variables.

Independent variables	Correlation Co-efficient (r)
Age	0.032
Educational qualification	0.485**
Farm size	0.027
Farming Experience	0.254*
Agricultural training	0.563**
Extension media contact	0.249*
Organizational participation	0.025
Knowledge	0.537**
Attitude	0.130
Awareness	0.307*

Dependent variable: Effect of excessive use of agrochemicals

\*\* and \*= Significant at 1percent and 5 percent level of significance respectively

### Management practices in the sustainable and balanced use of agrochemicals

The optimum and balanced application of pesticides is important for many reasons. The findings indicated that the most beneficial program that can help farmers in the optimal use of agrochemicals in a balanced way is agricultural training (95.3%), followed by good agricultural practices (83.3%), a campaign on awareness and motivation (74.7%), Integrated Pest Management (IPM) (72.7%) etc. while the less significant management practice opined by the respondents is the

use of beneficial microbes (28%) and presented in Table 6. Many authors (Hruska and Corriols, 2002; Jors, 2004) argued that by utilizing alternative and ecologically sound methods, the need for pesticides can be reduced up to 50% without decreasing yields and this could help reduce the chance of environmental pollution and poisonous effects on biodiversity. Likewise, De *et al.* (2014) explored that, IPM practice, biological control and genetic control are very essential in the sustainable farming systems as they are easily available, cost-effective, and demonstrate a wide range of bioactivity.

Table 6. Management practices in effective and efficient use of agrochemicals.

Management practices *	N=150	Percentage
Agricultural training	143	95.3
Good Agricultural Practices (GAP)	125	83.3
Campaign on awareness and motivation	112	74.7
Integrated Pest Management (IPM)	109	72.7
Application of biofertilizer and bio-pesticides	94	62.7
Application of compost	89	59.4
Access to extension services	87	58.0
Application of organic pesticides	77	51.3
Use of perching	76	50.6
Proper monitoring and supervision	68	45.3
Integrated Nutrient Management (INM)	53	35.3
Use of beneficial microbes	42	28.0

Source: Field survey (2021)

### CONCLUSIONS AND RECOMMENDATIONS

It is evident from the research findings that farmers perceived more positive effect of the overuse of agrochemicals compared to negative one and this is due to low educational qualification, lack of training, awareness, knowledge, and poor access to extension

services. It also exposes that to produce more crops from small landholdings and feed the growing population, farmers are using agrochemicals excessively. Among the socio-economic characteristics, farmers' educational qualification, farming experience, agricultural training, extension media contact, knowledge and awareness are

significantly associated with the effects of misuse and abuse of agrochemicals in farming practices. It also demonstrates that various management initiatives like training to the farmers, supporting good agricultural practices, awareness program could be highly beneficial regarding optimal and sustainable use of agrochemicals in farming practices. An especial campaign regarding enhancing farmers' awareness, knowledge, and attitude should be conducted effectively and efficiently, and extension services need to be pluralistic. It is high time to take appropriate initiatives by the researchers, policymakers, concern authorities and even by farmers against excessive use of agrochemicals to protect our planet and save our upcoming generations.

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