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Cognizance level of vegetable cultivators concerning pesticide usage and its sequel on environment

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Abstract
The present study was conducted by KVK, Udalguri, Assam Agricultural University, Assam, India in the year 2023-24 at three vegetable growing villages with 120 vegetable growers to assess the knowledge of the vegetable growers on pesticide usage and their effects. Relevant data were collected with pretested schedule with one dependent and ten independent variables and analyzed using appropriate statistical tools like mean, standard deviation and logit regression. The results displayed that growers were between 40-50 years with less than 1 ha area under cultivation and below 20 years of experience in pesticide uses. Maximum of the growers uses moderately hazardous pesticides. The expenditure on pesticides was very high. Almost all the farmers (94.17 %) obtained their pesticides from authorized dealers and used knapsack sprayers (98.33 %) but did not followed record of spraying. It was very satisfactory to appraise that maximum (72.50 %) growers spray less than 3 times per cropping season. Maximum of the growers (58.33%) followed input dealers as their source of information. All farmers (100 %) had strong insight on the adverse impacts of pesticides on the environment. Variables like education level, land ownership, farm size and training attended on safe pesticide use having *p* value of 0.003, 0.04, 0.001, 0.002 respectively had considerably sway the knowledge level of farmers on the safe usage of pesticides. They also facing health issues. Therefore, in these areas, it is crucial to raise both Integrated Pest Management techniques and other non-chemical ways to lessen the reliance on pesticides.

Keywords: Vegetable growers, Crop protection, Pesticides, Awareness, Logit Regression.

Introduction
In India, the constant increasing population led to a raise in high demand for food. Therefore, there is a demand to increase the production and productivity of agricultural crops along with protection from infestation. Here, chemical measures play an important and foremost role. India, which is an agriculturally based country, the markets are full with wide range of pesticides. But due to improper knowledge and awareness on safe use of pesticides, the improper formulations of agrochemicals were found to contaminate the environment (Gumber *et al.,* 2020) [2].
In India, about 2 percent of its cultivated lands used to produce nearly 13 percent of the world's vegetable production. As per report published in National Horticulture Board, the country produced 208.84 million metric tons of vegetables from an area of 11.35 million hectares in the year 2022-23. But it is very unfortunate to say that fruit and vegetable crops are exposed to a significant number of pesticides and insecticides. The use of pesticides like endosulfan has been banned in the developed countries and in India also it has been temporarily banned by the directive of Honorable Supreme Court of India (Singh *et al.,* 2014) [17].
Among various types of pesticides used in India, the percentage share of insecticides (60.00 %) is the highest followed by the shares of fungicides (19.00 %), herbicides (16.00 %), biopesticides (3.00 %) and others (3.00 %). It is estimated that around 13-14 percent of the total pesticides used in the country is applied to fruits and vegetables, of which insecticides accounted for two-thirds of the total (Sharma *et al.,* 2018) [15]. As vegetable being the good source of income and quicker way to get the return on investment, the growers who are using, are completely unaware that pesticides leave residue behind and specific waiting period is required for each pesticide (Khanal *et al.,* 2022) [6].

Currently, from the human health viewpoint, monitoring pesticide residues in agricultural production is regard as the key measure to assess food safety (Reeves *et al.*, 2019) [11].

Keeping the above facts in mind, the present investigation was carried out with the objectives to investigate the types of pesticides used, per hectare cost incurred in pesticides use, pesticides use practices and management, source of technical information and finally farmer's perception upon effects of pesticides on environment and health.

Research methodology

The research was carried out in Udalguri District of Assam, India having latitude of 26°44'45.66"N and a longitude of 92°5'45.39" located at North Bank Plain Zone of Assam. Three villages *viz*. *Panikhaity*, *Aminpara* and *Ekrabari* were selected purposively considering the high coverage of vegetable cultivation and production and areas where pesticides are predominantly use for crop protection on the vegetables like tomato, chili, cole crops, bottle gourd, okra, potato etc. Forty numbers of commercial vegetable growers were selected randomly as respondents from each three selected villages which make a total of one hundred and twenty numbers of respondents who were classified based on owning operational land holding area i.e small (≤ 2 ha), medium (2-4 ha) and large (≥4 ha).The study used participatory tools for data collection including in-depth interviews and field survey with vegetable growers, agricultural officers and interviews with officials from the plant protection. The secondary documents were compiled from various articles and publications like WHO guidelines to classifications of Pesticides by Hazard, 2019.

Recommended classification of pesticides on degree of hazardous, 2019 (WHO)

WHO Class		LD 50 for the rat (mg/kg body weight)	
I a	Extremely hazardous	< 5	< 50
I b	Highly hazardous	5–50	50–200
II	Moderately hazardous	50–2000	200–2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present (acute hazard)	5000 or higher	

A pre-tested questionnaire was designed comprised of questions with respect to the objectives of the investigation. The data generated were coded, entered and analyzed using simple tabular, mean, standard deviation, cost and return and percentage analysis. A logistic regression model is employed to study the level of knowledge of growers regarding accurate and safe use of pesticides.

Pi = (b 0 + b 1 X 1 + ... + b n X n + mi) /1 + e (b 0 + b 1 X 1 + ... + b n X n + mi)

Dependent variable: Total safe use of pesticides, knowledge1= acceptable (above the mean), 0= low (below the mean).

Results and discussion

Socio economic background of farmers: Table 1 revealed that majority of the growers (38.33 %) were within the age group of 40-50 years with majority (57.50 %) having farming as their primary occupation and 60.83 percent of farmers are educated up to primary level only. Maximum of them (40.00 %) having below 20 years of experience in using pesticides in their farms. The area under cultivation of the majority (63.33 %) of the farmers were less than 1 ha and the house hold size ranges between 5-9 members of maximum (61. 67 %) of farmers with the monthly income less than Rs. 3000.00.

Table 1: Socio-economic background of respondent farmers (*n* = 120)

Variables	Frequency	Percentage
Age of the farmers (yrs)		
20-30	20	16.67
30-40	37	30.83
40-50	46	38.33
>50	17	14.17
Primary occupation		
Farming	69	57.50
Farming + Trading	51	42.50
Years in experience in using pesticides		
<20	48	40.00
20-30	43	35.83
>30	29	24.16
Level of education		
Illiterate	31	25.83
Primary	72	60.83
Up to class 8	10	8.33
Matriculate	5	4.17
Higher secondary	2	1.67
Household size (Nos.)		
<4	18	15.00
5-9	74	61.67
>9	28	23.33
Area under cultivation (ha)		
< 1 ha	76	63.33
Between 1-2 ha	27	22.50
> 2 ha	17	14.17
Monthly income level (Rs.)		
<30000	74	61.67
30000-50000	31	25.83
>50000	15	12.50

Types of pesticides used on different pest and diseases of vegetable crops: The data displayed in Table 2 shows the record of pesticides used by the vegetable growers. Altogether seventeen types of pesticides are being applied by the growers in the study area. It was established that no extremely hazardous (Ia) pesticides were applied by the farmers in the vegetable growing area. Only one pesticide (Monocrotophos, highly hazardous: I b) was applied on the crops of potatoes and tomatoes to prevent pest like Aphid, Leaf Hopper, Thrips etc. To escape from diseases like blights, Canker, gall midge, pesticides which are moderately hazardous (II) i.e Copper Oxychloride 50 % WP, Chlorpyriphos Cypermethrin 50% EC, Emamectin Benzoate 1.9% E.CandFipronil 40% + imidacloprid 40% WG etc. are mostly used on potato, tomato, chili, cole crops etc. followed by pesticides which are acute hazard (U) like Mancozeb, Chlorantraniliprole 18.5% w/w SC and Carbendazim etc. used to avoid attack of Borers & caterpillars, root rot diseases on bitter gourd, okra, chili, pea. Only one not listed pesticide, Tolfenpyrad.15% EC was used on cabbage and okra to beat Diamond Black Moth (DBM), Aphid, Thrips. Similar findings were found in the study done by Sarma *et al*. (2020) and Mubushar *et al*. (2019) [9].

Table 2: Types of pesticides used on different pest and diseases of vegetable crops

Sl. No.	Chemical Name	WHO class*	Disease/pest	Crop
1	Monocrotophos	I b	Aphid, Leaf Hopper and Thrips, Gray Weevil, Ball worms,	Potatoes, peanuts, tomatoes
2	Copper Oxychloride 50% WP	II	Blights, Leaf spot, Canker, Fruit rot, Downy mildew	Potato, tomato, Chili, Citrus, Cabbage,
3	Chlorpyriphos Cypermethrin 50% EC	II	Hispa, gall midge, stem borer of paddy, aphid, boll worms,	Vegetables
4	Mancozeb	U	Seed and Rhizome treatment	Potato, Tomato, Chili
5	Chlorantraniliprole	U	Moth and butterfly caterpillars or larvae, as well as some beetles and "true" bugs like aphids and spittlebugs.	Tomatoes, pigeon peas.
6	Tolfenpyrad.15% EC	-	Diamond Black Moth (DBM), Aphid, Thr	Cabbage, okra
7	Chloropyriphos 50 % + Cypermethrin 5 % w/w	II	Aphids, Jassids, Thrips, Whitefly	Tomato, potato, Chili, Blackgram
8	Emamectin Benzoate 5%	II	Caterpillar	Okra,Cabbage, Cauliflower
9	Emamectin Benzoate 1.9% E.C	II	Lepidoptera, Diptera, Homoptera, Thysanoptera, Coleoptera and insects	All Vegetables,
10	Indoxacarb 14.5 EC	II	Cutworms, Pink Bollworms, Spotted Bollworms,	Black gram, tomato, Cabbage
11	Fipronil 40% + imidacloprid 40% WG	II	White grub, cut worm	Chili, cabbage
12	Spinetoram 11.7% SC	U	Thrips, Bollworm, Fall Armyworm, Fruit borer	Chili, tomato,
13	Lambda Cyhalothrin 5% EC	II	Borers, GLH, Gall midge, Hispa, Thrips	Okra, onion, brinjal, tomato,
14	Cypermethrin 25% EC	II	Bollworm, Thrips, Epilachna Beetle	Okra, Brinjal
15	Acetamiprid 20% SP	II	Aphid, jassid, whitefly, thrips	Okra, chili, citrus, brinjal, potato
16	Chlorantraniliprole 18.5% w/w SC	U	Fruit Borers & caterpillars, Stem borer, Termite Early shoot borer and top borer	Bitter gourd, okra, chili
17	Carbendazim	U	Sigatoka disease, root rot, damping off	Brinjal, cucurbits,

Cultivation cost and share of pesticides (%) in few major vegetable crops: It was disclosed from the data of Table 3 that highest was proclaimed in cabbage (13.27 %) then next was cauliflower (12.97 %) followed by bottle guard (12.47 %) with the amount of Rs. 7782.12, Rs. 7625.22 and Rs. 5245.32 spent on pesticides/ha respectively. Minimal share (6.87 %) was noticed in chili with minimum cost of cultivation (Rs. 44523.08/ha). The fundamental cause for boom in percent percentage of insecticides price may be associated with boom out breaks and incidences of illnesses and bug pest resurgence. Recently, a number of brand-new insecticides advertised, which are especially priced (maximum of them are slim spectrum insecticides) but not economic to the small and medium farmers. It was also realized that the net returns of these heavy pesticide consumer vegetables are low (cabbage: Rs. 281674.9, cauliflower: Rs. 273764.54) when compared with the net return of low pesticide consumer vegetable like potato (Rs. 442769.04) and brinjal (Rs. 399846.33).

Table 3: Cultivation cost and percentage share of pesticides in few major vegetable crops

Crops	Cultivation cost/ ha	Expenditure on pesticides/ha	% share of pesticide cost	Gross Return/ha	Net Return/ha
Brinjal	52482.88	6235.26	11.88	452332.21	399846.33
Bottle gourd	42051.32	5245.32	12.47	266666.67	224615.35
Tomato	78523.22	6756.23	8.60	1117464.78	1038941.56
Okra	45287.65	3985.23	8.80	245332.85	200045.20
Chilli	44523.08	3056.88	6.87	208556.22	164033.14
Potato	78556.21	7153.32	9.11	521325.25	442769.04
Cabbage	58652.18	7782.12	13.27	340327.17	281674.99
Cauliflower	58798.23	7625.22	12.97	332562.77	273764.54
Bitter gourd	78532.54	8623.77	10.98	300823.66	222291.12

Pesticide use practices and management by vegetable growers: It was disclosed from Table 4 that 94.17 percent of the farmers gathered their pesticides from authorized dealers while only 5.83 percent procured their pesticides from the open market. Similar findings were revealed in the research done by Shetty *et al.* (2010) [16]. It was very satisfactory to appraise that maximum (72.50 %) growers spray less than 3 times per cropping season followed by 21.67 percent who spray 3-4 times and only 5.83 percent sprays in excess of 4 times. The motives can be that the farmers are no longer comply with the present-day choicest dose or range of sprays as in line with advice due to the fact the advocated dosages are no longer powerful to govern the incidences of pests and diseases in agro-ecosystems and additionally a number of the foremost pests have advanced resistance to insecticides generally utilized in those areas. 90.83 percent of the growers apply single pesticide without combination followed by only 9.17 percent who mixed two pesticides together without taking into account of their compatibility or active ingredients. For application, knapsack sprayer was mostly used by maximum growers (98.33 %) and most pesticides were applied in morning time (46.67 %) followed by 38.33 percent of farmers having no definite time of application. These findings are parallel with the findings of Sefa *et al.* (2015) [13]. Maximum (80.83 %) growers spray on plant tops and only 8.33 percent spray on targeted pest and diseases which was very disappointing. It was also exposed that 55.83 percent of growers sprayed pesticides with the direction of wind flow to minimize inhaling pesticides and skin contact. The results are comparable with the findings of Sefa *et al.* (2015) [13]. 100percent of the farmers used nasal mask as protective equipment followed by gloves (9.17 %), hats (5.00 %) and boots (1.67 %). Here it can be discovered that farmers were not aware much about the adverse effects and protective measures during the application of pesticides. Similar findings were found in the study done by Williamson *et al.* (2008) [18], Saethre *et al.* (2011) [12] and Ahouangninou *et al.* (2012) [1]. Further, 43.33 percent of the surveyed growers stored their pesticides in separate and safe places and 61.67 percent stored a diary to account essential statistics and farm reviews throughout the cropping season.

Table 4: Pesticide use practices and management by vegetable growers (*n* = 120)

Survey Questions	Frequency	Percentage	Mean	SD
Source of buying pesticides				
Authorized dealer	113	94.17	45.23	12.15
Open market	7	5.83	2.81	1.00
No. of spray application per crop				
<3	87	72.50	35.61	14.23
3-4	26	21.67	9.82	4.5
>4	7	5.83	2.74	3.2
Pesticides combination				
1 type	109	90.83	41.52	16.23
2 types	11	9.17	3.57	3.00
Types of applicators				
Knapsack Sprayer	118	98.33	46.98	20.01
Motorized Sprayer	2	1.67	0.80	1.53
Pesticides application time				
Morning	56	46.67	17.35	10.10
Afternoon	6	5.00	1.70	1.20
Evening	12	10.00	5	1.00
No definite time	46	38.33	18.52	25.42
Position of spray				
Above plant top	13	10.83	5.60	1.50
At plant top	97	80.83	36.21	12.00
Targeted pest and diseases	10	8.33	3.62	5.64
Pesticides spraying techniques				
Opposite to wind direction	25	20.83	10.41	9.81
Walk forward	15	12.50	5.32	5.32
In the wind direction	67	55.83	24.12	8.10
Walk backward	13	10.83	4.78	4.78
Protective measures during spraying				
Gloves	11	9.17	26.47	5.60
Nasal Mask	120	100.00	114.00	41.23
Hats	6	5.00	15.30	14.10
Boots	2	1.67	14.37	10.23
Pesticides storage				
In safe area	52	43.33	20.32	11.80
In toilet	14	11.67	4.52	6.40
In kitchen	13	10.83	5.00	3.10
No storage	41	34.17	17.08	9.80
Maintain records of spraying				
Yes	46	38.33	17.57	14.10
No	74	61.67	25.65	5.60

Source of technical information on pesticide usage: Table 5 displayed that 58.55 percent received information on pesticides and their uses from input dealers (rank I) due to closer proximity and higher accessibility of input dealers over extension services followed by own decisions (16.67 %) with rank II.A very few farmers, 14.16 percent who seeks the agricultural extension officers as a source of information. Only 1.67 percent of them received information from package of practices. The reasons may be that the farmers have no patience to go through package of practices and need instant solutions to their problems and also, they have good rapport and trust on input dealers. These findings are in line with the findings of Mubushar *et al.* (2019) [9].

Table 5: Source of technical information on pesticide usage (*n* = 120)

Sl. no	Source of Information	Frequency	Percentage	Rank
1	Input dealers	70	58.33	I
2	Own Decision	20	16.67	II
3	Agricultural Extension Officers	17	14.16	III
4	Progressive farmers	11	9.17	IV
5	Package of practices	2	1.67	V

Farmer perception regarding the outcomes of pesticides on environment: Table 6 interprets the farmer's perception on the effects of pesticides on environment and it was found that all (100 %) growers perceived that use of pesticides pollutes water bodies (rank I). 65.83 percent said that it destroys soil health (rank II) followed by effecting the non-targeted animals like birds, insects (10.00 %). Very few (2.50 %) are having the knowledge that it kills under water animals also.

Table 6: Farmer's perception regarding the outcome of pesticides on environment (*n*=120)

Sl. no	Farmer's perception	Frequency	Percentage	Rank
1	Pollute rivers and streams etc.	120	100.00	I
2	Destroy soil health by reducing its quality	79	65.83	II
3	Harmful effect on non targeted organism	12	10.00	III
5	Cause air pollution	5	4.16	V
6	Killing under water animals	3	2.50	VI

Regression analysis of farmer's knowledge on pesticide usage: Farmers' knowledge and practices about pesticide usage were evaluated using 14 statements. It was concluded from Table 7 that the outcome of the multinomial logit model, which signifies that 4 out of 10 variables are significant at the 0.05 and 0.01 levels. Nagelkerke's R2 is 0.53, denoting that the explanatory variables interpret regarding 53 percent of the variation in farmer's knowledge on safety precautions and measures during pesticide usage. The farmer's education level (0.003**) has a significant mark on the knowledge of farmers at the 0.01 level which implies that educated farmers are having better knowledge on the harmful consequences of pesticides. Again, farmer's land ownership (0.04*) and farm size (0.001**) significantly sway their likelihood of having good knowledge of precautionary measures in using pesticides at the 0.05 and 0.01 levels respectively. It may be because the farmers holding own land have access to better understanding of the consequences of pesticides on mankind and soil than those who lease land for farming and are unconcerned about their own health and only concerned with maximizing earnings from the rented land. This study exposed that the farmers, who own land, regard their lands as a precious property and use pesticides wisely and follows safeguards. Therefore, trying to get in touch with proper extension services and institutes like KVKs and attend maximum trainings as much as possible. This finding is in contrast with the result of Rahman (2003) [10] who confirmed that the usage of pesticides expanded with the expansion of own farm land of Bangladeshi farmers. The effect of training

(0.002**) is significant at the 0.01 level in getting better knowledge on appropriate practice of pesticides. Extension service as a supplier of information indicates non-significant (0.12ns) in the regression model. This is probably because of the fact that the farmers depend on their fellow farmers for getting knowledge and information in alternate to the extension services supplied by the agriculture department. Again, majority of farmers in the study area possess small area for cultivation (<1 ha) and are not susceptible to pesticides for long term and do not have much knowledge indicating a non-significant relationship (0.23ns) in the regression model. Experience in pesticide usage experiences indicates a non-significant relationship (0.27ns) because most of the farmers have less than 20 years of exposure in applying pesticides and therefore, they learn about the negative effects of pesticides which end up in adopting safety measures. This result is contradicting the judgements of Khan *et al.* (2015), who declared that pesticide usage experiences significantly motivated the use of safety equipment and the goodwill to pay to escape pesticide threats.

Further, it was revealed that age is negatively related to knowledge of the vegetable growers regarding pesticides with value -1.93. The reason may be the high aged farmers were less educated and hence having less knowledge. Occupation (0.25) and annual income (0.21) of farmers are positively related but non-significant with the knowledge on safe pesticide usage.

Table 7: Result of logit regression model of farmer's knowledge in regard to pesticide usage {Dependent variable: usage of pesticides, Knowledge 1=acceptable (above the mean), 0=low (below the mean)}

Explanatory Variables	β	Std Error	Wald	df	p value
Age	-1.93	1.56	1.23	1	0.44ns
Education level	2.09	0.68	5.7	1	0.003**
Occupation	1.22	1.45	2.23	1	0.25ns
Annual income	1.23	1.10	2.53	1	0.21ns
Land ownership	2.34	0.87	5.28	1	0.04*
Farm size	4.37	1.56	8.91	1	0.001**
Cultivated area	-1.90	0.91	2.67	1	0.23ns
Pesticide use experience	-1.21	0.84	2.15	1	0.27ns
Training attended	3.98	1.48	9.89	1	0.002**
Extension services as source of information	-1.45	1.73	3.47	1	0.12ns
Constant	2.25	2.48	0.00	1	1.00ns
-2 log likelihood	211.23				
Nagelkarke's R^2	0.53				
Accuracy of prediction of classes	82%				
Significance level	**(p<0.001), *(p<0.05), ns=non-significant				

Major health issues faced by the farmers after using pesticides: According to WHO estimates published in 1990 (World Health Organization 1990), around 3 million poisoning cases with 220,000 mortalities occur year after year. About 99 percent of these deaths occur in developing countries (Karalliedde *et al.*, 2001) [3]. An estimated 14 million people have been killed from amidst using pesticides since the advent of the Green Revolution in the 1960s (Karunarathne *et al.*, 2020). Fig.1 revealed the different types of health hazards and acute symptoms as reported by the farmers. The symptoms of vomiting/Nausea were observed in 59.17 percent of the respondents followed by the symptoms of headache as reported by 51.67 percent of farmers. The same result was found in the study done by Lamichhane *et al*. (2019) [8]. The symptoms of excessive sweating were observed in 49.17 percent of respondents followed by visual disturbance and burning sensation as mentioned by 46.67 percent and 45.83 percent of farmers respectively. Only 36.67 and 20.83 percent of farmers had gone through the symptoms of skin irritation and dizziness respectively. Therefore, the Indian government should give more attention and awareness on practicing Integrated Pest management strategies among farmers. Our country, which has abundant native plants biodiversity, can adopt essential oils as green pesticides. In toxicological tests, they are comparatively non-hazardous to fishes and mammals. Essential Oils as "green/safer pesticides" can indeed be beneficial in management of pests in agriculture (Kumar *et al.*, 2022) [7].

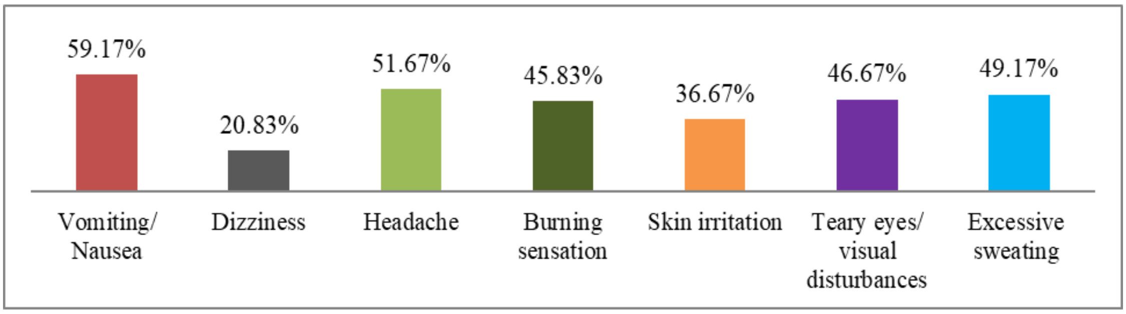

Fig 1: Self-reported major health hazards (symptoms) faced by the farmers after using pesticides

Conclusion

The risks that pesticides pose to human health and the environment have sparked widespread concern about their safety. Currently, the excessive and unregulated use of these chemicals has become a pressing issue across all segments of society. Studies reveal that vegetable growers are applying numerous pesticides, investing significant amounts of money to purchase them, yet often ignoring the recommended dosages.

Although these farmers possess considerable awareness and understanding of the environmental hazards associated with pesticide use, they tend to disregard this knowledge in practice. To address these challenges, it is essential to implement awareness programs that educate farmers on the responsible use of agricultural chemicals and the importance of safety precautions during spraying. Farmers should also be encouraged to adopt integrated nutrient management and integrated pest management techniques. Furthermore, the government should take proactive steps to establish laboratories dedicated to testing for chemical residues in agricultural produce.

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Disclaimers
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Conflict of interest
The authors confirm the absence of any conflicts of interest.

Declaration
The author(s) confirm that this work is wholly original and has not been published elsewhere.

References
1. Ahouangninou C, Martin T, Edorh P, Siddick I A, Bio-Bangana S, Samuel O, Onil S, St-Laurent L, Dion S. Fayomi B. Characterization of health and environmental risks of pesticide use in market-gardening in the rural city of Tori-Bossito in Benin, West Africa. Journal of Environmental Protection. 2012;3(3):241-248.
2. Gumber K, Sidhu A. Trending nano-formulated pesticides: A review. Indian Journal of Agricultural Sciences. 2020;90(3):11-17.
3. Karalliedde L, Eddleston M, Murray V. The global picture of organophosphate insecticide poisoning. In: Organophosphates and Health. Imperial College Press, London. 2001;pp. 431-471.
4. Karunarathne A, Gunnell D, Konradsen F, Eddleston M. How many premature deaths from pesticide suicide have occurred since the agricultural green revolution? Clinical Toxicology (Phila). 2020;58(5):1-6.
5. Khanal D, Neupane A, Dhital A, Paudel K, Shrestha M, Upadhyaya N. Knowledge, skills and behavior towards chemical pesticide among vegetable growers, vegetable sellers and consumers of Rupandehi District, Nepal. Nepalese Horticulture. 2022;16:73-80.
6. Khan AA, Muhammad Z, Muhammad M, Inamullah LK, Muhammad B, Fazal R, Nadia B. The role of agricultural extension services in tomato production in district Mansehra, Khyber Pakhtunkhwa. *ARPN* Journal of Agricultural and Biological Science. 2015;10(5):200-205.
7. Kumar S, Mahapatro GK, Yadav DK, Tripathi K, Koli P, Kaushik P, Sharma K, Nebapure S. Essential oils as green pesticides: An overview. Indian Journal of Agricultural Sciences. 2022;92(11):1298-1305.
8. Lamichhane R, Nishant L, Subedi S, Singh SB, Yadav BK. Use of pesticides and health risk among farmers in Sunsari District, Nepal. Nepal Health Research Council. 2019;17(42):66-70.
9. Mubushar MM, Aldosari FO, Baig MB, Alotaibi BM, Khan AQ. Assessment of farmers on their knowledge regarding pesticide usage and biosafety. Saudi Journal of Biological Sciences. 2019;26:1903-1910.
10. Rahman S. Profit efficiency among Bangladeshi rice farmers. Food Policy. 2003;28(5–6):487-503.
11. Reeves WR, McGuire MK, Stokes M, Vicini JL. Assessing the safety of pesticides in food:How current regulations protect human health. Advances in Nutrition. 2019;10(1):80-87.
12. Saethre MG, Svendsen NO, Holen B. Pesticide residues analysis of three vegetable crops for urban consumers in Benin-Human and environmental consequences of abuse and misuse of synthetic pesticides. Acta Horticulturae. 2011;1007:393-400.
13. Sefa VA, Bediako EA, Kenyon L, Micah JA. Pesticide use practices and perceptions of vegetable farmers in the cocoa belts of the Ashanti and Western Regions of Ghana. Advances in Crop Science and Technology. 2015;3(3):2329-8863.
14. Sarma GK, Sarma RK, Deka N, Hazarika JK. A study on the use of agricultural chemicals in tomato cultivation in Assam, India. Journal of AgriSearch. 2020;7(4):241-246.
15. Sharma D, Choudhury PP. Pesticide use and their residue management in vegetables. Technical Bulletin No. 74, ICAR-IIHR, Hessaraghatta, Bangalore-560089. 2018;33p.
16. Shetty PK, Murugan M, Hiremath MB, Sreeja KG. Farmers' education and perception on pesticide use and crop economies in Indian agriculture. Journal of Experimental Sciences. 2010;1(1):3-8.
17. Singh JP, Jaiswal AK, Monobrullah MD. Impact of some selected insecticides and bio-pesticides on incidence of predators, parasitoid and productivity of lac insect, *Kerria lacca*. Indian Journal of Agricultural Sciences. 2014;84(1):64-72.
18. Williamson S, Ball A, Pretty J. Trends in pesticide use and drivers for safer pest management in four African countries. Crop Protection. 2008;27:1327-1334.

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