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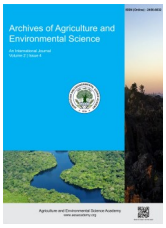

ORIGINAL RESEARCH ARTICLE

Assessing farmers' knowledge of good agricultural practices in vegetable farming: A study in northern Bangladesh

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ABSTRACT

Producing vegetables safely, sustainably, and of high quality requires good agricultural practices (GAP). This study thoroughly examined vegetable farmers' knowledge of GAP, identified the factors influencing their level of knowledge, and explored the problems they encounter in applying GAP in vegetable production in the Rangpur district of northern Bangladesh. Data were collected using a pre-tested questionnaire from 240 randomly selected vegetable farmers in the Kursha Union of Taraganj sub-district in Rangpur district. Farmers' knowledge was evaluated using six levels of Bloom's Taxonomy, while multiple and stepwise regression analyses identified key influencing factors and their impact. In addition, the Problem Facing Index (PFI) was applied to rank the problems faced by them in implementing GAP. The results indicated that only 3.3% of participants had good knowledge, whereas 46.7% had moderate knowledge, and 50% had poor knowledge. Among the ten examined socio-economic and personal factors of the farmers, educational level, agricultural training experience, and contact with extension media significantly affected farmers' GAP knowledge. Contact with extension media was the strongest predictor, accounting for 66.7% of the variance in knowledge levels. Regarding implementation issues, 53.3% of respondents reported high problems, followed by 40% experiencing medium problems. The top three problems included a lack of GAP training, a limited understanding of GAP standards, and inadequate knowledge of integrated pest and disease management. The study highlights the need for strengthening extension services and providing targeted training programs to improve farmers' knowledge and promote effective adoption of GAP in sustainable vegetable farming.

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INTRODUCTION

Bangladesh, home to 169.4 million people within 148,460 square kilometers (Chaki *et al*., 2023), is witnessing rapid growth in vegetable production as farmers increasingly shift from traditional rice cultivation to high-value vegetable farming. This transition is primarily driven by changing climate patterns and the adoption of more intensive, economically profitable cropping systems (Haque & Hoque, 2021). As a result, the country has nearly doubled its production in the last ten years (Rahman *et al*., 2020), yielding almost 20 million metric tons over the 2020–2021 period and positioned as the globe's third-largest producer of vegetables (Bangladesh Bureau of Statistics, 2022). However, the intensification of vegetable cultivation has raised food safety concerns. Many farmers focus on maximizing yields, without adequate attention to safety, often relying heavily on agrochemicals like pesticides and fertilizers (Begum *et al*., 2025; MoA, 2020). The excessive use of pesticides presents considerable health hazards to both agricultural workers and consumers, including reproductive disorders, neurological issues, and organ damage (Hassaan & El Nemr, 2020; Dewan, 2014). Beyond human health, it also contributes to environmental degradation by

contaminating soil, water, and non-target organisms (Malkanthi *et. al*., 2021). Additionally, fertilizer use has surged from 15 kg/ha in 1970 to 279.22 kg/ha in 2014, leading to soil contamination and heavy metals accumulation, which threaten food safety and public health (FAO, 2016; Kumar & Dev, 2017; Bangladesh Bureau of Statistics, 2018; Rahman & Zhang, 2018). The significance of food safety has grown in recent years as a result of its substantial influence on the health of consumers and the steady expansion of the local and global food trade (Oo, 2016). Therefore, it is crucial to apply GAP in farming and post-production activities to ensure a harmless product supply (Vijayakumar *et al*., 2021; Malkanthi *et al*., 2021). GAP is a set of rules, regulations, and technological recommendations applied at various levels of agricultural production, processing, and transportation, which promotes the efficient and responsible use of inputs such as pesticides, chemical fertilizers, water, etc., alongside environmentally sustainable management practices. The ultimate goals are to ensure food safety, protect human health, conserve the environment, enhance product quality, and improve working conditions (FAO, 2016; Kilic *et al*., 2020).

In vegetable farming, GAP encourages sustainable farming practices to produce high-quality, safe vegetables (Siebrecht, 2020). Farmers who follow GAP not only make food safer but also gain better markets and trade opportunities (MoA, 2020). Farmers' comprehension of GAP is crucial for the successful implementation of these standards within agricultural systems (Dewi *et al*., 2022). Insufficient awareness and a lack of technical expertise can lead to various pitfalls, including the improper application of agrochemicals, inefficient management of resources, and inadequate post-harvest handling procedures. These issues can significantly diminish agricultural productivity, contribute to environmental degradation, and pose serious food safety risks (Liu *et al*., 2018). Conversely, vegetable growers who are well-informed about GAP are better positioned to adopt these practices effectively, leading to higher crop quality, better market access, and greater sustainability—contributing to safer food and improved livelihoods (MoA, 2020; Dewi *et al*., 2022; Olaniran *et al*., 2023; Kharel *et al*., 2023). As a result, a thorough assessment of farmers' knowledge levels regarding GAP, along with identifying the problems they encounter, is crucial for developing targeted interventions to encourage the adoption of these practices. By addressing existing knowledge gaps among the vegetable growers and the barriers to implementation, this research seeks to develop strategic frameworks that can enhance the integration of GAP into daily agricultural operations in vegetable cultivation.

While a substantial body of research on GAP exists globally, with significant contributions from scholars like Laosutsan *et al.* (2019), Sennuga *et al.* (2020), Ntawuruhunga *et al.* (2020), Malkanthi *et al.* (2021), Xu *et al.* (2022), and Nawi *et al.* (2023), the research landscape in Bangladesh remains sparse. Among the few relevant studies are those by Uddin *et al.* (2024) and Hoque *et al.* (2024), which have begun to explore these issues. However, a notable gap persists; no prior research has specifically assessed the knowledge levels of Bangladeshi farmers concerning GAP in vegetable cultivation. In light of this context, this study aims to explore the extent of knowledge vegetable farmers possess about GAP in vegetable cultivation; to identify the personal and socio-economic factors that influence their knowledge levels of GAP; and detailing the specific problems faced by vegetable farmers in their efforts to practice GAP effectively.

MATERIALS AND METHODS

Location of the study

The Taraganj Upazila in northern Bangladesh of Rangpur District served as the location of the study. Taraganj Upazila was deliberately chosen for its notable role in vegetable production, ranking alongside other prominent vegetable-producing upazilas in the Rangpur district (The Financial Express, 2019). Within Taraganj, Kursha Union was specifically chosen as the study's focal point (Figure 1) due to its extensive agricultural activities and diverse cultivation of a wide range of vegetables. Key crops include potatoes, cauliflowers, brinjals, bitter gourds, beans, and green chilies, all of which have been verified by local agricultural extension officers through field assessments. The Union also hosts several Partner Field Schools (PFSs) that actively promote Good Agricultural Practices (GAP), further reinforcing its suitability as a representative and strategic site for this research.

Procedure of population determination and sample selection

The research focused on vegetable farmers located in Kursha Union. To achieve a representative and credible sample, the study collaborated with Sub-Assistant Agriculture Officers (SAAOs), who possess extensive knowledge and strong connections within the local agricultural community. As a result of this partnership, 638 vegetable farmers were identified. Using the Qualtrics sample size calculator, a sample size of 240 farmers was determined, based on a confidence level of 95% and a margin of error of 5% (Qualtrics, 2025). Subsequently, a simple random sampling method was applied to select the participants from the identified population.

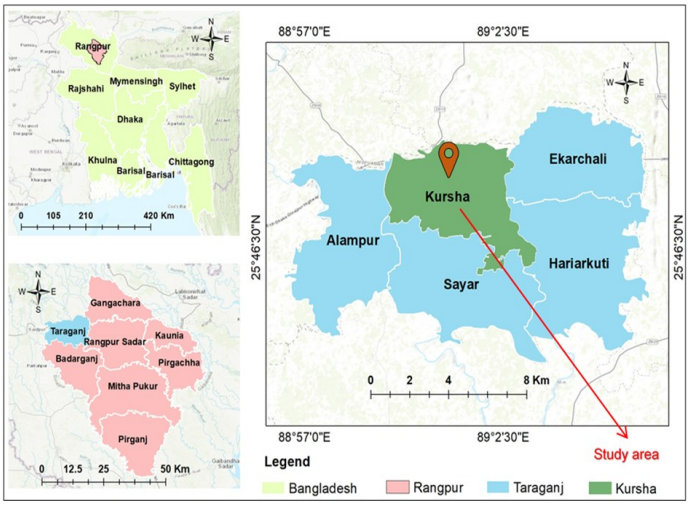

Figure 1. *Geographical location of the research area.*

Gathering of data

The data collection process began with two Focus Group Discussions (FGDs), each involving 10 vegetable farmers from the study area. These FGDs provided valuable contextual insights into local vegetable practices and the challenges faced in adopting Good Agricultural Practices (GAP). The findings from these discussions informed the development and refinement of the questionnaire, ensuring its relevance, clarity, and appropriateness to the study context. The questionnaire was then pretested with 10 vegetable farmers outside the final sample. Based on their feedback, necessary modifications were made to improve question clarity and structure. Finally, primary data were gathered from 240 vegetable producers via personal interviews employing the structured questionnaire from January to March 2025. The questionnaire was organized into three main sections: (i) personal and socio-economic characteristics of the respondents; (ii) farmers' knowledge of GAP, the core variable of the study; and (iii) the problems encountered in implementing GAP in vegetable farming. Additionally, relevant secondary information was gathered from books, journals, official reports, and credible online sources to support and complement the study findings.

Measurement of farmers' knowledge of gap in vegetable cultivation

This study concentrated on farmers' knowledge of GAP in vegetable growing. To assess this, a structured set of questions was developed based on Bloom's (1956) six levels of the cognitive domain, as later revised by Anderson & Krathwohl (2001). These levels—remembering, understanding, applying, analyzing, creating, and evaluating—were systematically integrated into the questionnaire to ensure a comprehensive evaluation of respondents' knowledge. Each level had three open-type questions, and the importance, difficulty, and depth of knowledge of each level were used to determine the score. Each respondent was asked to answer 18 questions in total. Questions related to remembering and understanding levels were each given a score of 2. In contrast, those about applying and analyzing levels were given a score of 3 each, and finally, questions focusing on evaluating and creating levels were given a score of 4 each. The scores for remembering and understanding ranged from 0-6, for applying and analyzing from 0-9, and for evaluating and creating from 0-12. Thereby, the cumulative knowledge score across all levels for a respondent may vary from 0 to 54. The participants were classified into three categories according to their total score: poor knowledge (up to 18), moderate knowledge (19-36), and good knowledge (over 36). A comparable method was followed by Kabir *et al.* (2022) and Sheheli *et al.* (2023). Additionally, the average percentage score for each level among the total respondents was calculated using the formula adopted by Farouque *et al.* (2025).

Average percentage score of a knowledge level = (M/H) ×100

Where,
M = Mean score obtained by the respondents for a particular level; H = Highest possible score for that level

This calculation allowed for a standardized comparison of respondents' performance across different levels, providing a more straightforward interpretation of their relative achievements.

Measurement of the independent variables

As independent variables, ten different socioeconomic and individual features of vegetable growers were chosen. The relevant methods and scales listed in Table 1 were used to measure them.

Evaluation of the factors influencing farmers' knowledge of GAP

A comprehensive multiple linear regression analysis was undertaken to pinpoint the critical factors that shape vegetable growers' knowledge of Good Agricultural Practices (GAP). Furthermore, a stepwise multiple regression analysis was employed to rigorously assess the contribution of each significant factor to the variations in farmers' understanding of GAP. The regression model utilized in this study is constructed as follows:

$$Y = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3\ X3 + \beta 4\ X4 + \beta 5\ X5 + \beta 6\ X6 + \beta 7\ X7 + \beta 8\ X8 + \beta 9\ X9 + \beta 10\ X10 + e$$

Where,
Y is the dependent variable (farmers' understanding of GAP in vegetable farming), β0 is the regression coefficient, X = Independent variables viz., X_1 = Age, X_2 = Educational level, X_3 = Household size, X_4 = Area under vegetable cultivation, X_5 = Household income, X_6 = Vegetable cultivation experience, X_7 = Agricultural training experience, X_8 = Credit received, X_9 = Organizational involvement, X_{10} = Extension media contact, and e = Error term

Table 1. Measurement of independent variables. Ha=Hectare, BDT=Bangladeshi Taka.

Respondents' characteristics	Measuring units
Age	Years
Educational level	"1" denotes each year of education; "0" denotes no education.
Household size	Numbers (No)
Area under vegetable cultivation	Ha
Household income	BDT; 1000 BDT = 1 unit
Experience in vegetable cultivation	Years
Agricultural training experience	Days
Credit received	BDT; 1000 BDT = 1 unit
Organization participation	Scale score
Extension Media Contact	Scale score

Measurement of problems farmers facing while using GAP

FGDs and a review of pertinent literature helped identify a total of 12 major issues. The degree of difficulties each farmer encountered when using GAP was assessed using a four-point rating system: severe problem (scoring 3), medium problem (scoring 2), low problem (scoring 1), and not at all (scoring 0). As a result, a problem's individual score could be anywhere from 0 to 36, where 0 denotes no problem and 36 the most serious problem. Three groups were created from the respondents' total score: low problem (up to 12), medium problem (13–24), and high problem (above 24). Mithun *et al.* (2018), Das *et al.* (2020), and Kowsari *et al.* (2022) all employed a similar design.

The Problem Facing Index (PFI) was used to rate the problems in order to determine which ones were the most important. The following formula was used to calculate the PFI for each problem (Mithun *et al.*, 2018; Das *et al.*, 2020):

$$PFI = (Ph \times 3) + (Pm \times 2) + (Pl \times 1) + (Pn \times 0)$$

PFI stands for Problem Facing Index, whereas Ph, Pm, Pl, and Pn represent the number of vegetable farmers with high, medium, and low issues, respectively, and the number of vegetable farmers without problems.

Analysis of data

Inferential statistics, such as multiple linear regression and stepwise regression, and descriptive statistics, such as frequency, percentage, mean, and standard deviation, were performed using the Statistical Package for the Social Sciences (SPSS v.25).

RESULTS AND DISCUSSION

Socioeconomic and individual features of the respondents

Table 2 outlines the personal and socio-economic characteristics of the surveyed vegetable farmers. With an average age of 49.62 years, middle-aged farmers made up the majority (57.5%). In terms of education, the most significant proportion (41.7%) had completed secondary education. A majority of the farmers (38.5%) had small-sized households, and the average household size was 5.89. Small farmers made up the vast majority (96.7%), with an average area under vegetable cultivation of 0.62 hectares. In terms of income, 43.3% of those surveyed were classified as having a low income, with an average annual income of BDT 191,130 and a standard deviation of 101,390 BDT, indicating a considerable variation in income. Nearly half of the respondents (48.3%) had over 20 years of experience in vegetable cultivation, with a mean of 24.23 years, indicating strong practical knowledge in vegetable cultivation. Training exposure was limited, as 60% of the farmers had received no formal training. Most respondents (70%) also reported not receiving any agricultural credit. Participation in agricultural or community organizations was low, with 56.7% reporting no involvement. Additionally, a large majority (76.7%) had low levels of contact with agricultural extension media, suggesting limited access to farming information and support.

Knowledge of farmers of GAP in vegetable cultivation

Figure 2 depicts the allocation of farmers based on their overall GAP knowledge score. The results reveal that 50% of the respondents fell into the poor knowledge category, indicating limited overall awareness of GAP among half of the surveyed farmers. In contrast, 46.7% demonstrated a moderate level of knowledge, suggesting that a significant portion of the farmers possess a general but incomplete understanding of GAP, lacking consistency in knowledge or depth across all areas. Notably, only 3.3% of farmers were classified in the good knowledge category, reflecting a tiny group with advanced comprehension and the ability to apply GAP effectively. This overall distribution highlights a clear knowledge gap among the majority of vegetable growers about GAP.

The low GAP knowledge among most farmers can be attributed to their limited exposure to extension services and lack of participation in training programs, as indicated by their socioeconomic and individual characteristics. Both extension media contact and training programs play a crucial role in helping farmers understand new practices, their benefits, and proper

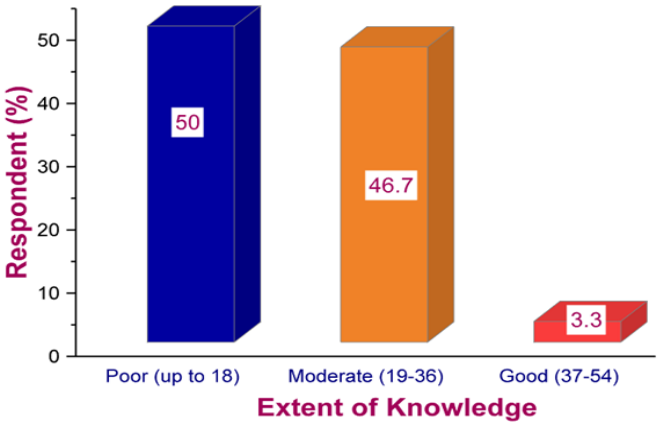

Figure 2. *Allocation of the farmers based on their knowledge of GAP.*

Table 2. Socioeconomic and individual features of the respondents.

Features	Majority Respondent Category	Respondents (%)	Mean	SD*
Age	Middle (36-55)	57.5	49.62	10.49
Educational background	Secondary (6-10)	41.7	6.37	4.48
Household size	Medium (5-7)	35.8	5.89	2.1
Area under vegetable cultivation	Small (0.21-0.99 ha)	96.7	0.62	0.27
Household income	Low (less than 150 BDT)	43.3	191.13	101.39
Experience in vegetable cultivation	High (above 20)	48.3	24.23	11.81
Training in farming	No training (0)	60	1.63	2.48
Credit received	No credit	70	11.83	24.68
Organizational participation	No participation (0)	56.7	0.97	1.63
Extension media interaction	Low (up to 15)	76.7	14.39	6.2

*SD = Standard deviation.

methods (Billah *et al.*, 2024). In the absence of such exposure, farmers are less likely to acquire comprehensive knowledge, which explains why most respondents demonstrated poor to moderate understanding of GAP. Supporting this, Rahman & Connor (2022) reported that farmers who had more frequent access to extension services achieved significantly higher yields and profits due to increased knowledge and continuous exposure to improved practices. Similarly, Bhuiyan & Maharjan (2022) showed that Farmer Field Schools (FFS), a form of hands-on training, effectively enhanced farmers' practical knowledge, leading to increased productivity and income.

Percent response to different levels of bloom's taxonomy

The knowledge of the vegetable growers of GAP was measured using Bloom's taxonomy. The average percentage scores of respondents across the six cognitive levels of knowledge were calculated to determine their relative performance. The results are presented in the graph (Figure 3). The findings show that farmers demonstrated a moderate ability to remember and understand information, as reflected in their scores for remembering (50.5%) and understanding (56.67%). This suggests a reasonable grasp of fundamental GAP concepts. This is a positive foundation for further learning and capacity-building. However, their proficiency declined significantly at higher-order cognitive levels, with lower scores in applying (38.89%), analyzing (40.33%), and evaluating (30.83%), indicating limited ability to use GAP knowledge in practical contexts or critically assess GAP. This gap between knowledge and practice indicates a need for more hands-on, experiential training. The lowest performance was observed in the creating level (24.42%), which highlights a restricted capacity for innovation and independent adaptation of GAP. Overall, the findings suggest that while farmers have a basic understanding of GAP, training programs need to go beyond information delivery and focus on building practical, analytical, and creative skills to ensure regular application of GAP in their vegetable farming. Farouque *et al.* (2025) reported a similar pattern in Narsingdi, Bangladesh, where farmers' knowledge of eco-friendly vegetable cultivation was highest at the remembering and understanding levels, but lowest at the creating level.

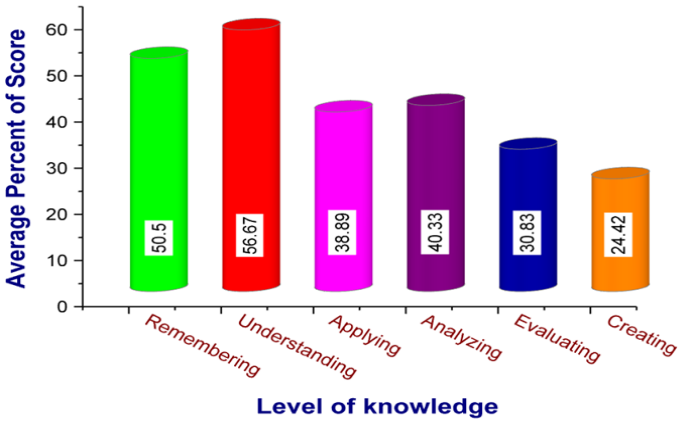

Figure 3. *Level of farmers' knowledge of GAP.*

Factors affecting the knowledge of vegetable farmers of GAP

Multiple linear regression analysis

Among the ten selected variables, educational level ($t = 5.676$, $p < 0.05$), agricultural training experience ($t = 4.755$, $p < 0.05$), and extension media contact ($t = 10.315$, $p < 0.05$) emerged as significant predictors (Table 3). Multicollinearity was evaluated using the Variance Inflation Factor (VIF), which had a maximum value of 2.585, indicating it was not an issue. The model's F-test value was 86.12 ($p < 0.01$), and the adjusted R-squared was 0.782, meaning these variables accounted for approximately 78.2% of the variance in farmers' knowledge of GAP.

The findings revealed that educational level significantly influenced farmers' knowledge of GAP, with each additional unit of education correlating to a 0.474-unit increase in GAP knowledge. This is supported by Joshi *et al.* (2019), who found that education increased GAP awareness among banana farmers in Chitwan, Nepal. Likewise, Uddin *et al.* (2024) emphasized the positive link between education and interest in GAP in their study. Research by Mithun *et al.* (2020) suggests that education can enhance technical expertise and problem-solving skills. Educated farmers are more inclined to adopt sustainable farming practices such as GAP (Rizzo *et al.*, 2024), leading to better retention of technical knowledge and a proactive approach to seeking further information (Ninh, 2021).

Table 3. Summary of the linear multiple regression analysis.

Explanatory variables	Unstandardized coefficients		Standardized coefficients Beta	t- value	Sig.	Multicollinearity statistics	
	B	Std. Error				Tolerance	VIF
(Constant)	10.636	1.944		5.470	.000		
Age	-0.024	0.037		-0.653	.515	0.387	2.585
Educational level	0.474	0.084	-0.032	5.676	.000	0.420	2.383
Family size	-0.303	0.156	0.266	-1.943	.053	0.551	1.814
Area under vegetable cultivation	-1.526	1.211	-0.079	-1.261	.209	0.565	1.770
Vegetable farming experience	-0.015	0.029	-0.051	-0.514	.607	0.494	2.024
Annual family income	0.003	0.003	-0.022	0.762	.447	0.472	2.117
Agricultural training experience	0.647	0.136	0.034	4.755	.000	0.526	1.902
Credit received	0.000	0.011	0.199	-0.022	.983	0.842	1.188
Organizational participation	0.114	0.165	-0.001	0.694	.489	0.805	1.242
Extension media contact	0.609	0.059	0.023	10.315	.000	0.439	2.275

n=240, R=0.889, R^2=0.791, Adjusted R^2=0.782, F value=86.12

Agricultural training experience positively affected GAP knowledge, with each unit increase in training correlating to a 0.647-unit rise in knowledge. Training programs provide farmers with practical skills and a better understanding of sustainable practices, thereby improving their ability to implement GAP effectively (Rasanjali *et al.*, 2021; Dewi *et al.*, 2022). Joshi *et al.* (2019) emphasized the importance of training for raising awareness of GAP, and Rijal *et al.* (2025) noted that training additionally aided in the implementation of GAP among vegetable growers in Nepal. Furthermore, media contact through extension significantly improved GAP knowledge; a one-unit increase in media exposure resulted in a 0.609-unit rise in knowledge. Regular interaction with agricultural extension services and various media platforms provides timely access to updated farming information, which is crucial for effective GAP adoption (FAO, 2023). Similarly, Rijal *et al.* (2025) found that extension services significantly promoted GAP adoption among farmers in Nepal.

Stepwise regression analysis

To investigate the contributions of each significant variable in explaining variation in farmers' knowledge of GAP, stepwise multiple linear regression analysis was performed (Table 4). The analysis indicated that contact through extension media was the most influential factor, accounting for 66.8% of the total explained variance. This was followed by an agricultural training experience, which contributed an additional 9.6%, while educational level had a comparatively minimal influence, explaining only 2.4% of the variance. These findings suggest that although all three factors contribute to enhancing farmers' knowledge of GAP, extension media contact has a substantially greater impact, underscoring the importance of consistent and accessible information dissemination. A study by Rahman & Connor (2022) also indicated that farmers with regular exposure to extension services and media are more likely to adopt sustainable practices and improve productivity.

Problems faced by farmers in practicing GAP in vegetable cultivation

As shown in Figure 4, most respondents (53.3%) reported experiencing a high level of problems in practicing GAP, followed by 40% with a medium level, and only 6.7% with a low level. The results agree with Hoque *et al.* (2021), who documented that farmers in Bangladesh faced moderate to high levels of obstacles in crop farming. The problems encountered by vegetable farmers in implementing GAP were ranked using the Problem Facing Index (PFI) as presented in Figure 5. The most prominent problem identified was '*lack of training on GAP standards and procedures*', which was ranked first. Only a limited number of farmers had undergone formal instruction in GAP at the Partner Field School (PFS). This lack of structured training hinders the practical application of GAP principles. Comprehensive training programs are thus essential to bridge the gap between theoretical knowledge and field-level implementation (Rijal *et al.*, 2025; Mithun *et al.*, 2020). The second most critical problem was '*inadequate knowledge of GAP standards and procedures.*' A significant percentage of respondents had an inadequate understanding of essential GAP elements, such as the safe and prudent application of pesticides, hygiene protocols, soil and water stewardship, post-harvest management, and documentation methods. Hasan *et al.* (2025) similarly found that the lack of knowledge about GAPs was the second-biggest obstacle for vegetable growers in Narsingdi, Bangladesh, in implementing them.

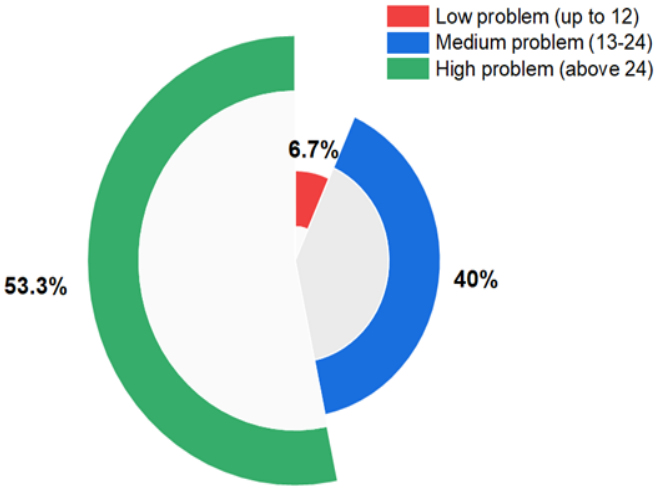

Figure 4. *Distribution of farmers based on the problems faced in implementing GAP.*

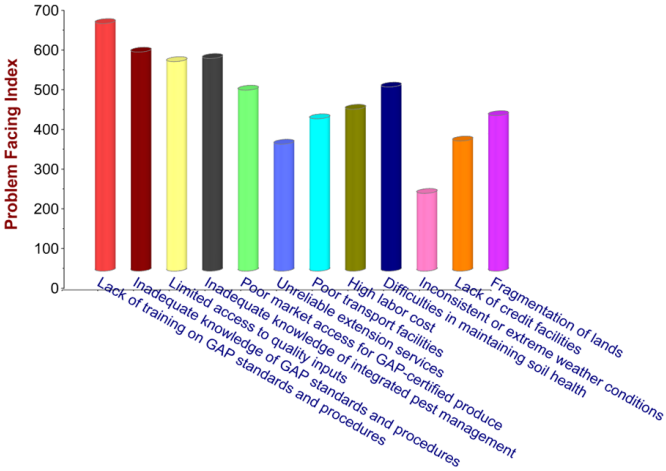

Figure 5. *Problem facing index of the problems faced by farmers while practicing GAP in vegetable cultivation.*

Table 4. Summary of the step-wise regression analysis.

Model	Combination of the factors	Multiple R	Adjusted R2	Variation explained (percent)
1	Constant + Extension media contact	0.818	0.668	66.8
2	Constant + Extension media contact + Agricultural training experience	0.870	0.754	9.6
3	Constant + Extension media contact + Agricultural training experience + Educational level	0.884	0.778	2.4

The third-ranked problem was 'inadequate knowledge of integrated pest management (IPM).' Most farmers reported a strong reliance on conventional chemical pesticides due to limited awareness of IPM strategies and the lack of suitable biological or ecological alternatives. Rahman (2022) conducted a study on vegetable farmers' perceptions of integrated pest management (IPM) and observed that farmers' general understanding of several IPM approaches was limited in his study location in Bangladesh. *'Limited access to quality inputs'* emerged as the fourth-ranked problem. Farmers reported difficulties obtaining essential resources such as certified seeds, organic fertilizers, and biopesticides. This may be attributed to high input costs, lack of local availability, or supply chain limitations, which restrict farmers' ability to apply GAP-compliant practices consistently. Quddus & Kropp (2020) also found that local markets in lagging areas of Bangladesh have inadequate supplies of fertilizer and pesticides. The fifth-ranked problem was *'difficulties in maintaining soil health, ' a* key component of GAP compliance. Many farmers lacked adequate knowledge in this area, relying heavily on chemical inputs, applying insufficient organic matter, having limited access to soil testing services, and practicing unsustainable crop management techniques such as mono-cropping.

Conclusions and recommendations

GAP holds the potential to significantly enhance the sustainability, efficiency, and safety of vegetable cultivation in Bangladesh. This in-depth study specifically examined the levels of knowledge among vegetable farmers in a region renowned for its vibrant vegetable production. The results were striking: nearly half of the farmers surveyed (50%) exhibited poor levels of understanding about GAP, while a substantial 46.7% displayed only a moderate grasp. Alarmingly, a mere 3.33% of the farmers demonstrated a good level of knowledge, underscoring a significant gap in advanced awareness and technical proficiency regarding GAP. Further analysis using Bloom's taxonomy showed that while farmers had a reasonable ability to remember and understand GAP concepts, their performance declined markedly in higher-order cognitive domains—namely, applying, analyzing, evaluating, and creating. This lack of knowledge can be primarily attributed to insufficient targeted training programs, limited extension media contact, such as mass awareness campaigns, and a dearth of group discussions, etc., about GAP practices in the area. Key factors influencing farmers' knowledge of GAP included educational background, agricultural training experience, and contact with extension media. Notably, these factors explained 78.2% of the variation in farmers' understanding of GAP, with contact with extension media being the most influential (66.8%), suggesting that frequent contact with agricultural extension services and exposure to different media channels give farmers timely access to up-to-date, valuable information, which is essential for successfully adopting GAPs. Over half of the farmers (53.3%) reported facing significant difficulties when trying to implement GAP. The main problems involved a lack of comprehensive training on GAP standards and procedures, limited knowledge of these essential standards, and inadequate understanding of integrated pest management strategies needed for effective farming. To address these pressing issues, coordinated efforts from the Department of Agricultural Extension (DAE), non-governmental organizations (NGOs), and various stakeholders are crucial. These entities should focus on providing tailored training, conducting practical demonstrations, and organizing outreach activities such as field days and field schools related to GAP. Such initiatives can significantly enhance farmers' knowledge, eliminate challenges, and empower them to effectively apply GAP principles in their vegetable farming practices, ultimately leading to more sustainable and productive agriculture.

DECLARATIONS

Author contribution statement: Conceptualization: S. Sheheli and S. Saad; Methodology: S. Sheheli, S. Saad, and M.N.A.S.M.; Validation: S. Sheheli and M.N.A.S.M.; Data Collection: S. Sheheli and S. Saad; Data Analysis: S. Saad; Writing -original draft preparation: S. Sheheli and S. Saad; Writing-review and editing: M.N.A.S.M. All authors have read and agreed to the published version of the manuscript.

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