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ARTICLE

## Identification of the Discrepancy between Farmers' Practices and Good Agricultural Practices in Crop Husbandry

Mouri Khan Mim Md. Matiul Islam <sup>\*</sup>

Agrotechnology Discipline, Khulna University, Bangladesh

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ABSTRACT

Good agricultural practices (GAP) are important for producing safe food minimizing health risks. The study was conducted at Dumuria upazila of Khulna district in Bangladesh to identify the discrepancy between farmers' practices and GAP. Data were collected from purposively selected 100 respondents. Majority (63%) of the farmers had medium knowledge of the practices under GAP and 82% of the farmers had a highly favorable attitude towards GAP. The practice index was calculated and obtained score of each practice was deducted from 100 for measuring the discrepancy. Farmers (93%) did occasional practice regarding planting materials and the 100% discrepancy was identified in 'keeping a record of planting materials if obtained from another farm', and 96.50% discrepancy in 'keeping a record of seed quality'. Most (91%) of the farmers' practices regarding fertilizers and soil additives were often, and 96.50% discrepancy was identified in 'record keeping of the source, product name, date, the quantity obtained'. The farmers (80%) did the practices related to irrigation often and 96% discrepancy was identified in 'frequency of required water testing'. The respondents (92%) did the practices under 'chemicals' often and 99.50% discrepancy was identified in 'keeping record of chemicals', and in 'keeping record of application for each crop'. In the case of harvesting and handling the produce 97% farmers did the practices often and 100% discrepancy was identified in 'using shatter proof lights in packing house', and 96% discrepancy in 'training of workers in personal hygiene'. Farmers had severe problems regarding GAP (94%), and 'not being able to understand the necessity of GAP' ranked 1st. Farm size had a significant negative correlation with 'fertilizers and soil additives' related practices, 'knowledge on GAP' had a significant positive correlation with 'chemicals' and 'harvesting and handling the produce' related practices. GAP should be practiced for minimizing the discrepancies.

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\*Corresponding Author:

Md. Matiul Islam,

Agrotechnology Discipline, Khulna University, Bangladesh;

Email: [matiul\\_rubel@ku.ac.bd](mailto:matiul_rubel@ku.ac.bd), [matiul\\_rubel@yahoo.com](mailto:matiul_rubel@yahoo.com)

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## 1. Introduction

The production of safe food is essential for protecting consumers from the hazards of food borne illnesses and is important both in the domestic food business as well as for increasing competitiveness in export markets. Hazards may occur at different stages of the food chain starting right from the primary production, e.g., residues above permitted levels, microbial contaminants and heavy metals. So, it is important to address food safety right from food production at farm level<sup>[1]</sup>.

Good agricultural practices (GAP) are a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability<sup>[1]</sup>. The concept of GAP has evolved out of, and expands on, such production recommendations. Consumers and hence the food industry and the development community are every day more concerned that food – more and more of which comes through processing and supermarket chains – is safe to eat. They also increasingly care that commodities are produced in ways that are in harmony with the environment and social values (e.g., at least the minimal needs of farm workers are met, international agreements on child labor are respected, etc.)<sup>[2]</sup>.

GAP is important because it reinforces responsible farming methods from site selection and land preparation to harvesting and handling. According to the Food and Agriculture Organization of the United Nations<sup>[3]</sup>, GAP applies available knowledge to address environmental, economic, and social sustainability for on-farm production and post-production processes, resulting in safe and healthy agricultural products.

To meet the consumer demand GAP certification was introduced. GAP certification is a process done by an independent certifying body to guarantee that production processes or products of farms meet GAP standards. Here, GAP certified food will ensure the food was produced in a farm where good agricultural practices were applied. There are many GAP certification systems around the world. Every system has their own standards considering the local situation, availability of resources etc. GLOBALG.A.P. is one of them. Some other GAP certification programs include Canada GAP in Canada, NZGAP in New Zealand, PhilGAP in Philippines, SALM in Malaysia, etc. Different countries have their own set of standards for GAP while maintaining the critical criteria for food safety. Many countries have their standard equivalent to GLOBALG.A.P.

The GAP process embraces actions, technologies and

systems that are accepted as most effective for optimal management of soil and water, and for crop and livestock production, from the point of view of microbiological and chemical safety, with the added dimensions of environmental, economic and social sustainability. Deviations from such farming systems especially in wetland ecologies could compromise soil productivity leading to reduced crop yields and environmental quality<sup>[4,5]</sup>. The details of a GAP protocol for a commodity in a given production environment cannot be generalized, and it is prescriptive from a central information source like FAO, but it must be adapted locally (taking into consideration in local conditions and in market requirements, if any) based on general underlying principles or norms<sup>[2]</sup>.

The Food Safety Act (2013)<sup>[6]</sup> of Bangladesh has been enacted with a view to assuring the availability of safe food through the proper practice of scientific procedures through coordination of food production, import, processing, storage, supply, marketing and sales related activities, the establishment of an efficient and effective authority by repealing related existing acts and reframing act. In Bangladesh certification of produce at the national level on the basis of GAP has not started yet. Formulation of “Good Agricultural Practices (GAP) Policy (2020)<sup>[7]</sup>” is one of the major steps reaching towards certification of produce.

To implement GAP, first of all it is needed to understand the present situation of farmers’ practices at their farm. Realizing the present situation helps to measure the effort needed in different sector to implement GAP. For this identifying the discrepancy between farmers’ practices and GAP is an important step. Identifying the discrepancy will help to prioritize practices that will reduce the discrepancy and will result in good quality food production.

### Objectives of the Study

Considering the facts, this study was conducted at Dumuria upazila of Khulna district in Bangladesh to identify the discrepancy between farmers’ practices and good agricultural practices (GAP) in crop husbandry. The specific objectives of the study were:

- i. To determine the extent of application of GAP and identification of the discrepancy in implementing GAP.
- ii. To determine the extent of problems against implementing GAP.
- iii. To explore the relationships between the selected characteristics of the respondents and the practice extent of GAPs.

## 2. Methodology

An ex-post facto explanatory cross-sectional research design was used for the study. The study was quasi-exper-

imental in nature and tried to predict the relationship of the selected characteristics of the farmers with their extent of practicing good agricultural practices.

The study was conducted at different villages of Dumuria upazila under Khulna district of Bangladesh. The distinct feature of the study area is that the people of the area mainly depend on farming for their livelihood. Farmers of Dumuria upazila were active in crop cultivation (both grain crops and vegetables) and fish culture but they were more active in vegetable cultivation. All the farmers who were involved in crop cultivation of the study area under Dumuria upazila were considered as the population of the study. Out of them 100 farmers were selected purposively as sample of the study. An interview schedule was prepared for collecting valid and reliable information from the farmers. Before final data collection, the interview schedule was pretested with 5 farmers of Dumuria upazila for checking suitability of the statements added in it.

Reviewing related studies, the researcher considered 10 characteristics of the respondents (age, educational qualification, family size, farming experience, farm size, family income, training received, organizational participation, cosmopolitanism and extension media contact) and eight GAP related criteria (planting materials, fertilizers and soil additives, water [irrigation], chemicals [plant protection products or other agro and non-agrochemicals], harvesting and handling produce, problem regarding GAP, knowledge on GAP and attitude towards GAP) for the study. For this study GAP related practice issues and the standard practices listed under them were taken from “*A Scheme and Training Manual on Good Agricultural Practices (GAP) for Fruits and Vegetables*” published by FAO in 2016 (FAO, 2016)<sup>[1]</sup> under the criteria of ‘Food Safety Module (FSM)’ to measure the extent of practice and identify the discrepancy in practicing GAP.

Data analysis was done by using a micro-computer with SPSS and MS Excel. Simple statistics like frequency counts, percentage, range, mean and standard deviations were used in the interpretation of descriptive data. A five points Likert type scale was used to measure the attitude of respondents towards GAP. Spearman rank correlation was used in order to explore the relationships between the concerned variables, throughout the analysis. At least five percent (0.05) level of significance was used as basis of rejecting a null hypothesis.

The researcher converted all qualitative data to quantitative form by means of applying some appropriate scoring technique. A coding plan (*a numeric code was as-*

*signed for a practice before entering data in the data-analyzing software*) was developed and code numbers were given to each category of measurements. The extent of practicing a GAP was determined based on practice index. The practice score was determined by using the following formula,  $PS = N1 \times 4 + N2 \times 3 + N3 \times 2 + N4 \times 1 + N5 \times 0$ ; where, PS = Practice score, N1 = Number of respondents did the practice regularly, N2 = Number of respondents did the practice often, N3 = Number of respondents did the practice occasionally, N4 = Number of respondents did the practice rarely, N5 = Number of respondents did the practice not at all. The possible range of practice score was 0 to 400.

After determination of PS, the practice index was determined by following formula:

$$(\%) \text{ Practice Index} = \frac{\text{observed practice score}}{\text{possible highest practice score}} \times 100$$

Practice index 100 means the full application of the practice. So, for measuring the discrepancy practice index of each practice was deducted from 100. Discrepancy (%) = 100 – Practice index.

The severity of a problem was determined based on problem severity index (PSI). The PSI was determined by using the following formula,  $PSS = N1 \times 3 + N2 \times 2 + N3 \times 1 + N4 \times 0$ , Where, PSS = Problem severity score, N1 = Number of respondents who marked the problem as highly severe, N2 = Number of respondents who marked the problem as severe, N3 = Number of respondents who marked the problem as less severe, N4 = Number of respondents did not mark the problem at all. The possible range of problem severity score (PSS) was 0 to 180. After determination of PSS, the severity index of the problem was determined by following formula:

$$(\%) \text{ Severity index of the problem} = \frac{\text{observed problem score}}{\text{possible highest problem score}} \times 100$$

### 3. Results and Discussion

#### 3.1 Measuring the Extent of Application of GAP and Identification of the Discrepancy in Implementing GAP

##### 3.1.1 Knowledge on GAP (Good Agricultural Practices) in the Study Area

Data presented in Table 1 show that 63% of the respondents had good knowledge on GAP, 20% and 17% had excellent and low knowledge. The knowledge score ranged from 6 to 16 with a mean of 11.64 and standard deviation 2.16.

**Table 1.** Distribution of respondents on the basis of knowledge on GAP

Categories	Score	N=100	Mean ± SD ( $\bar{x} \pm \sigma$ )	Range	
		%		Min.	Max.
Low	<10	17.0			
Good	10-13	63.0	11.64±2.16	6.00	16.00
Excellent	>13	20.0			

Here farmers’ knowledge is mainly on the practices under GAP. No farmer was aware of the literal term named “GAP”. Respondents’ medium knowledge cannot guarantee higher practice of GAP. Respondents’ knowledge level indicates that there is much discrepancy of information in farmers’ level. It may be due to less information from extension personnel and low level of extension media contact. Training might significantly increase the knowledge of farmers on GAP.

Scientists have found that growers positively changed their knowledge and opinions on key food safety principles and regulations, which provides evidence that extension programming is an effective method to educate small growers<sup>[8]</sup>.

### 3.1.2 Attitude towards GAP in the Study Area

Results of Table 2 indicate that most (82%) of the respondents had highly favorable attitude towards GAPs. Eighteen percent of the respondents had favorable attitude. The score ranged from 46 to 60 with a mean of 51.45 and standard deviation 2.35.

Respondents’ highly favorable attitude towards GAP indicates that they are able to understand basic quality points of GAP. They understood that related practices of GAP were beneficial for farm practice, health and would result in increased profit.

GAP training program in Narsingdi under AFACI-GAP project found farmers positive and favorable interest towards GAP<sup>[9]</sup>.

**Table 2.** Distribution of respondents on the basis of attitude towards GAP

Categories	Score	N=100	Mean ± SD ( $\bar{x} \pm \sigma$ )	Range	
		%		Min.	Max.
Less favorable	12-24	0			
Moderately favorable	25-36	0	51.45±2.35	46.00	60.00
Favorable	37-48	18.0			
Highly favorable	49-60	82.0			

### 3.1.3 Extent of Application of GAP (Good Agricultural Practices) in the Study Area

Table 3 shows that the highest portion of the respondents (93%) did occasional level of practice related to planting materials followed by 5% and 2% had often and rare level of practice. There was no respondent who did the practices regularly. The score ranged from 4 to 16 with a mean of 10.30 and standard deviation of 2.15. Most of the respondents’ practice was occasional and no one did the practices regularly which means their practice related to planting materials was not so good.

In case of fertilizers and soil additives most (91%) of the respondents did the practice often and 9% did the practice occasional. The score of data ranged from 17 to 30 with a mean of 23.30 and standard deviation 2.31. There was no respondent who did the practices regularly. Respondents did these practices often. As higher production of crops significantly depends on efficient application of fertilizers and soil additives, farmers may have followed these practices more often for better production.

In case of water (irrigation) from Table 3 it is found that the highest portion of the respondents (80%) did the practices often with a mean of 17.40 and standard deviation 1.68. Respondents did these practices more often and there were also respondents who did these practices on regular basis. Farmers were more sincere in case of water (irrigation) because irrigation water can affect soil status by increasing soil salinity, metal contamination etc.

In chemicals related practices data presented in Table 3 show that 92% of the respondents did the practices often. Data ranged from 42 to 64 with a mean of 51.26 and standard deviation 5. Respondents did these practices more often and there were also respondents who did these practices on regular basis. Farmers were more sincere in case of chemicals handling and applying because it is needed for proper outcome of chemicals in case of management of pest, insect, parasites and diseases.

In case of harvesting and handling produce from Table 3 data show that 97% of the respondents did the practices often with a mean of 66.60 and standard deviation 5.96. Data score ranged from 46 to 75. But there was no respondent who did the practice regularly. Though most of the farmers did the practices often but there was no farmer who was regular in the practices. That means farmers need more training, information and initiative from extension personnel to develop their harvesting and handling produce related practices.

### 3.2 Planting Materials Related Practices

From Table 4 highest 100% discrepancy was identified

in 'record of planting materials if obtained from another farm' (practice 0%, ranked 6<sup>th</sup>). That means farmers did not practice it at all. 'Record of seed quality' had 96.50% discrepancy (practice 3.50%, ranked 5<sup>th</sup>). In case of 'Record of fertilizers and chemicals used' 94.75% discrepancy was identified (practice 5.25%, ranked 4<sup>th</sup>). Formal record keeping was not done often but farmers keep rough record for benefit cost analysis.

Table 4 shows that avoiding cultivation of toxic materials ranked 1<sup>st</sup> (100%) in adopting planting materials related GAPs. 'Checking visible signs of pest and diseases' and 'Seed treatment by approved additives/pesticides' hold the 2<sup>nd</sup> (98.75%) and 3<sup>rd</sup> (51.50%) rank.

Researchers have found that farmers didn't know the botanical name and variety name<sup>[10]</sup>. They were also not sure that the seed chosen for cultivation was physically free from pest, disease, weeds and foreign and inert matter.

### 3.3 Fertilizers and Soil Additives Related Practices

From Table 5 highest 96.50% discrepancy was identified in the practice of record keeping of 'the source, product name, date, quantity obtained' (practice 3.50%, ranked 10<sup>th</sup>) followed by 'To minimize the risk of heavy metal contamination to produce' had 94.50% discrepancy (practice 5.50%, ranked 9<sup>th</sup>), 'Application of fertilizers and soil additives based upon soil analysis' had 93.50% discrepancy (practice 6.50%, ranked 8<sup>th</sup>), 'Assessment of the chemical and biological risks related to fertilizers and soil additives' had 92% discrepancy (practice 8%, ranked 7<sup>th</sup>). These practices were less practiced by the respondents. Record keeping of 'The source, product name, date, quantity obtained' can be practiced easily as most of the farmers were literate. Though this practice was less practiced but most of the farmers keeps rough record of information for benefit and cost analysis.

Table 5 shows that 'separate storage of organic and inorganic fertilizers from harvested farm produce' ranked 1<sup>st</sup> in practicing. 'Avoiding untreated organic materials in case of significant risk of contaminating produce is identified, record for treated organic materials' and 'If significant hazards identified, measures taken to minimize the risk of contamination to produce' hold the 2<sup>nd</sup> and 3<sup>rd</sup> rank.

Authors have found that although the soil testing has become mandatory to know the soil health condition nearly about 62% of the farmers have not done the testing of their soil<sup>[10]</sup>. Nearly about 90% farmers didn't know the physical, chemical nature and also about nutrients present in the soil.

### 3.4 Water (Irrigation) Related Practice

From Table 6 highest 96% discrepancy was identified in 'where water testing is required, frequency of testing' (practice 4%, ranked 6<sup>th</sup>). Respondents who used river water or other sources of water they knew about water testing but they were not much interested in doing so. The one who did rarely, most of them were involved in fish culture in the same field.

Table 6 shows that 'avoiding untreated sewage water, treated water maintaining regulations' ranked 1<sup>st</sup> (100%), 'free from harmful contaminants' ranked 2<sup>nd</sup> (95.75%), 'in case of identification significant risk, use of safe alternative water source or treated water' ranked 3<sup>rd</sup> (95%).

Researchers found that no farmer has tested or analyzed the water for its quality like salt concentration, sodium absorbing rate, presence of bicarbonates, boron, etc.<sup>[10]</sup>. Water was also not analyzed to check the presence of heavy metals and pesticides in the water supplied to the crops.

### 3.5 Chemicals (Plant Protection Products or Other Agro and Non-agrochemicals) Related Practice

From Table 7 highest 99.50% discrepancy was identified both in 'Record of chemicals (chemicals used, supplier, date and quantity obtained, date of manufacture/expiry)' and 'Record of application for each crop (reason, dosage, date, name of operator)' (practice 0.50%, ranked 17<sup>th</sup>), 'Records of chemicals in storage' had 93.50% discrepancy (practice 6.50%, ranked 16<sup>th</sup>), 'Harvesting as per the pre harvest interval period mentioned on the label' had 89.50% discrepancy (practice 10.50%, ranked 15<sup>th</sup>), 'IPM' recorded 70.75% discrepancy (practice 29.25%, ranked 14<sup>th</sup>). In case of record keeping practices, it can be done by the farmers. They do not practice it because they don't mark it as necessary but they keep rough record for benefit cost analysis. Though farmers know about the directions and necessity of 'Harvesting as per the pre harvest interval period mentioned on the label', they do not practice as much as needed but it very important to minimize the health risk related to chemical residues. For keeping out insect, pest they apply chemicals more often even before harvesting.

Table 7 shows that 'pesticides permitted under country's regulations' and 'pesticides purchased from registered/licensed suppliers' both ranked 1<sup>st</sup> (100%), 'storing chemicals in original container/replaced container with legible label, dosage, withholding period' ranked 2<sup>nd</sup>, 'well storage of chemicals' ranked 3<sup>rd</sup>.

**Table 3.** Distribution of respondents on the basis of different GAP characteristics

Characteristics	Categories	Score	N=100	Mean ± SD ( $\bar{x} \pm \sigma$ )	Range	
			%		Min.	Max.
Planting Materials	Rare	≤6	2.0	10.30±2.15	4.00	16.00
	Occasional	7-12	93.0			
	Often	13-18	5.0			
	Regular	>18	0			
Fertilizers and Soil Additives	Rare	≤10	0	23.30±2.31	17.00	30.00
	Occasional	11-20	9.0			
	Often	21-30	91.0			
	Regular	>30	0			
Water (Irrigation)	Rare	≤6	0	17.40±1.68	12.00	22.00
	Occasional	7-12	2.0			
	Often	13-18	80.0			
	Regular	>18	18.0			
Chemicals (Plant protection products or other agro and non-agrochemicals)	Rare	≤19	0	51.26±5.00	42.00	64.00
	Occasional	20-38	0			
	Often	39-57	92.0			
	Regular	>57	8.0			
Harvesting and handling produce	Rare	≤26	0	66.60±5.96	46.00	75.00
	Occasional	27-52	3.0			
	Often	53-78	97.0			
	Regular	>78	0			

**Table 4.** Planting materials related practice indices

Serial	Statement	Practice Score	Practice Index (%)	Rank	Discrepancy (%)
i.	Record of fertilizers and chemicals used	21	5.25	4 <sup>th</sup>	94.75
ii.	Record of seed quality	14	3.50	5 <sup>th</sup>	96.50
iii.	Checking visible signs of pest and diseases	395	98.75	2 <sup>nd</sup>	1.25
iv.	Seed treatment by approved additives/pesticides	206	51.50	3 <sup>rd</sup>	48.50
v.	Avoiding cultivation of toxic variety	400	100	1 <sup>st</sup>	0
vi.	Record of planting materials if obtained from another farm	0	0	6 <sup>th</sup>	100

**Table 5.** Fertilizers and soil additives related practice indices

Sl.	Statement	Practice Score	Practice Index (%)	Rank	Discrepancy (%)
a	Assessment of the chemical and biological risks related to fertilizers and soil additives	32	8.0	7 <sup>th</sup>	92
b	If significant hazards identified, measures taken to minimize the risk of contamination to produce	385	96.25	3 <sup>rd</sup>	3.75
c	Application of fertilizers and soil additives based upon soil analysis	26	6.5	8 <sup>th</sup>	93.50
d	To minimize the risk of heavy metal contamination to produce	22	5.5	9 <sup>th</sup>	94.50
e	Recommended application practices at appropriate stage of crop growth	379	94.75	4 <sup>th</sup>	5.25
f	Avoiding untreated organic materials in case of significant risk of contaminating produce is identified, record for treated organic materials	388	97	2 <sup>nd</sup>	3
g	Avoiding untreated human sewage	371	92.75	5 <sup>th</sup>	7.25
h	Handling of fertilizers and soil additives to minimize the risk of contamination to production sites and water sources	358	89.50	6 <sup>th</sup>	10.50
i	The source, product name, date, quantity obtained	14	3.50	10 <sup>th</sup>	96.50
j	Separate storage of organic and inorganic fertilizers from harvested farm produce	389	97.25	1 <sup>st</sup>	2.75

**Table 6.** Water (irrigation) related practice indices

Sl.	Statement	Practice Score	Practice Index (%)	Rank	Discrepancy (%)
i.	Free from harmful contaminants	383	95.75	2 <sup>nd</sup>	4.25
ii.	Assessment of the source of water	233	58.25	5 <sup>th</sup>	41.75
iii.	Where water testing is required, frequency of testing	28	4.0	6 <sup>th</sup>	96
iv.	In case of identification significant risk, use of safe alternative water source or treated water	380	95.0	3 <sup>rd</sup>	5
v.	Avoiding untreated sewage water, treated water maintaining regulations	400	100	1 <sup>st</sup>	0
vi.	Maintaining irrigation equipment as per manufacturers guidelines	322	80.50	4 <sup>th</sup>	19.50

Scientists have found that most of the farmers were using the chemical pesticides for the crop protection <sup>[10]</sup>. Only about 10% of farmers are using the bio-pesticides or bio-control methods for the eradication of the pests. No farmer knew the use of the smallest effective dosage on the basis of crop protection protocol.

### 3.6 Harvesting and Handling the Produce Related Practice

From Table 8 highest 100% discrepancy was identified in 'Shatter proof lights in packing house' (practice 0%, ranked 26<sup>th</sup>) followed by 'Applying specific test on produce if required' had 99.75% discrepancy (practice 0.25%, ranked 25<sup>th</sup>), 'Construction of sewage, waste disposal and drainage systems to minimize contamination' had 99.50% discrepancy (practice 0.50%, ranked 24<sup>th</sup>), 'Training workers in personal hygiene' had 96% discrepancy (practice 4%, ranked 23<sup>rd</sup>), 'Calibrating measuring devices for ensuring correct measurement' had 95.25% discrepancy (practice 4.75%, ranked 22<sup>nd</sup>), 'Availability of toilets and hand washing facilities to workers and maintaining hygienic condition' had 92.25% discrepancy (practice 7.75%, ranked 21<sup>st</sup>). Respondents were not aware of shatter proof lights and their packing houses were also not well made. Construction of sewage, waste disposal and drainage systems to minimize contamination can also be done easily by the farmers by taking proper initiative. 'Training workers in personal hygiene' and 'Availability of toilets and hand washing facilities to workers and maintaining hygienic condition' are critical points for ensuring food safety. More intensive care needed in this sector.

Data presented in the Table 8 show that 'Keeping household and farm animals out of the production site' ranked 1<sup>st</sup>, followed by 'Avoiding containers used for chemicals and other dangerous substances', 'Keeping vehicles clean and in good condition for transporting', 'Storing goods separately avoiding contamination', 'Storing in cool places, avoiding overloading and covering to reduce moisture loss' ranked 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> respectively. Though these practices were high, more care needed to fulfill the standard.

Researchers have found in their research that no farmer had ever gone for residue analysis when chemical pesticides were used for crop protection <sup>[10]</sup>.

### 3.7 Identification of Problems regarding GAP

Data presented in the Table 9 show that most (94%) of the respondents had faced severe problems during practicing GAPs followed by 6% had faced highly severe problems.

Most of the farmers faced severe level of problems that means same scale of initiative can be taken to reduce the problems against GAP.

From Table 10 it is found that in case of problem against GAPs 'Not being able to understand the necessity of GAP' ranked 1<sup>st</sup> followed by 'Unavailability of information of GAP' ranked 2<sup>nd</sup>, 'Lack of Govt. policy' ranked 3<sup>rd</sup>, 'Less information from extension personnel' ranked 4<sup>th</sup>, 'Costly processes' ranked 5<sup>th</sup>.

Many respondents knew the proper form of a lot of practices but they didn't adopt them because they found it unnecessary. To persuade the farmers, the necessity of implementing GAP for food safety, economic development and environmental sustainability need to be made clear before the farmers. Unavailability of information of GAP is also a major problem. More extension work needs to be done in this sector. Lack of government policy is one of the major problems implementing GAPs. Government need to start GAP certification system and set standard and regulations in farm practices to ensure food safety.

### 3.8 The Selected Characteristics of the Respondents and Relationship of Those Characteristics with Practicing Extent of GAPs

#### 3.8.1 Selected Characteristics of the Respondents

The selected characteristics include age, educational qualification, family size, farming experience, farm size, monthly family income, training received, organizational participation, cosmopolitanism and extension media contact of an individual. On the basis of selected characteristics distribution of respondents is shown in Table 11.

Table 11 shows that the highest proportion (52%) of the respondents was middle aged. Young farmers were 26% and old farmers were 22%. The age of the farmers ranged from 23 to 70 years with a mean of 45.52 years and standard deviation 12.10.

Middle aged respondents were more involved in farming. Young and old people were less involved. The reason behind young people being less interested in farming can be the insecurity of not earning expected amount.

Researchers have found middle aged farmers (60.0%) were highly involved in farming followed by young aged (20.0%) and old aged farmers (20.0%) <sup>[11]</sup>.

Most of the respondents (34%) belong to secondary level of education compared to 29%, 22%, 13%, 1% and 1% of the respondents belong to primary, can sign only, higher secondary, undergraduate and postgraduate level of education. The score ranged from 0.5 to more than 16 with a mean of 5.97 and standard deviation of 4.16.

**Table 7.** Chemicals (plant protection products or other agro and non-agrochemicals related practice indices

Sl.	Statement	Practice Score	Practice Index (%)	Rank	Discrepancy (%)
i.	Pesticides permitted under country's regulations	400	100	1 <sup>st</sup> =	0
ii.	Pesticides purchased from registered/licensed suppliers	400	100	1 <sup>st</sup> =	0
iii.	Mixing of two or more chemicals unless recommended by technically competent personnel	385	96.25	5 <sup>th</sup>	3.75
iv.	Application of dosage recommended by competent authorities	369	92.25	6 <sup>th</sup>	7.75
v.	Disposal of surplus chemicals to avoid contamination	266	66.50	13 <sup>th</sup>	33.50
vi.	Withholding periods for the interval between chemical application	368	92.0	7 <sup>th</sup>	8
vii.	Harvesting as per the pre harvest interval period mentioned on the label	42	10.50	15 <sup>th</sup>	89.50
viii.	Maintaining equipment for applying and checking for effective operation	352	88.0	9 <sup>th</sup>	12
ix.	Washing equipment after use and disposal of water to avoid contamination to produce	295	73.75	12 <sup>th</sup>	26.25
x.	Well storage of chemicals	392	98.0	3 <sup>rd</sup>	2
xi.	Disposal of empty chemical containers	315	78.75	10 <sup>th</sup>	21.25
xii.	Storage of liquid chemicals above powder	313	78.25	11 <sup>th</sup>	21.75
xiii.	Storing chemicals in original container/replaced container with legible label, dosage, withholding period	393	98.25	2 <sup>nd</sup>	1.75
xiv.	Disposal of obsolete or expired chemicals	390	97.50	4 <sup>th</sup>	2.50
xv.	Record of chemicals ( chemicals used, supplier, date and quantity obtained, date of manufacture/expiry)	2	0.50	17 <sup>th</sup> =	99.50
xvi.	Record of application for each crop (reason, dosage, date, name of operator)	2	0.50	17 <sup>th</sup> =	99.50
xvii.	Records of chemicals in storage	26	6.50	16 <sup>th</sup>	93.50
xviii.	Handling of non-agro chemicals to avoid risk of food safety	357	89.25	8 <sup>th</sup>	10.75
xix.	IPM	117	29.25	14 <sup>th</sup>	70.75

**Table 8.** Harvesting and handling produce related practice indices

Sl.	Statement	Practice Score	Practice Index (%)	Rank	Discrepancy (%)
i.	Harvested produce not placing directly on the soil, or on the floor of the handling, packing or storage areas	202	50.50	20 <sup>th</sup>	49.50
ii.	Using of equipment, containers and materials that will not contaminate produce and easy to clean	369	92.25	6 <sup>th</sup>	7.75
iii.	Avoiding containers used for chemicals and other dangerous substances	394	98.50	2 <sup>nd</sup>	1.50
iv.	Maintaining equipment and containers to minimize contamination and keeping them separately away from chemicals, fertilizers, soil additives	363	90.75	7 <sup>th</sup>	9.25
v.	Checking of containers and equipment for soundness and cleanliness	332	83.0	14 <sup>th</sup>	17
vi.	Calibrating measuring devices for ensuring correct measurement	19	4.75	22 <sup>nd</sup>	95.25
vii.	Buildings and structures used for growing, packing, handling and storage of produce constructed and maintained to minimize the risk of contaminating produce	219	54.75	18 <sup>th</sup>	45.25
viii.	Grease, oil, fuel and farm machinery segregated from handling, packing and storage areas	360	90	8 <sup>th</sup>	10
ix.	Construction of sewage, waste disposal and drainage systems to minimize contamination	2	0.50	24 <sup>th</sup>	99.50
x.	Shatter proof lights in packing house	.0	0	26 <sup>th</sup>	100
xi.	Storing separately the equipment and tools that may be sources of physical hazards	344	86.0	12 <sup>th</sup>	14
xii.	Cleaning and sanitizing equipment, tools and containers	286	71.50	15 <sup>th</sup>	28.50
xiii.	Appropriate cleaning and sanitizing chemicals	253	63.25	17 <sup>th</sup>	36.75
xiv.	Keeping household and farm animals out of the production site	398	99.50	1 <sup>st</sup>	0.50
xv.	Taking measures to prevent the presence of pests around handling, packing and storage areas	341	85.25	13 <sup>th</sup>	14.75
xvi.	Maintaining baits and traps to minimize the risk of contamination	350	87.50	10 <sup>th</sup>	12.50
xvii.	Training workers in personal hygiene	16	4.0	23 <sup>rd</sup>	96
xviii.	Availability of toilets and hand washing facilities to workers and maintaining hygienic condition	31	7.75	21 <sup>st</sup>	92.25
xix.	Disposing sewage minimizing direct and indirect contamination	269	67.25	16 <sup>th</sup>	32.75
xx.	Quality of water applied to edible parts of produce equivalent to drinking water	217	54.25	19 <sup>th</sup>	45.75
xxi.	Chemicals applied for post harvest maintaining regulations	356	89	9 <sup>th</sup>	11
xxii.	Applying specific test on produce if required	1	0.25	25 <sup>th</sup>	99.75
xxiii.	Storing goods separately avoiding contamination	380	95.0	4 <sup>th</sup>	5
xxiv.	Storing in cool places, avoiding overloading and covering to reduce moisture loss	379	94.75	5 <sup>th</sup>	5.25
xxv.	Avoiding placing containers filled with produce in direct contact with soil (if there is significant risk)	348	87.0	11 <sup>th</sup>	13
xxvi.	Keeping vehicles clean and in good condition for transporting	390	97.50	3 <sup>rd</sup>	2.50

**Table 9.** Distribution of respondents on the basis of problems faced during Good Agricultural Practices

Categories	Score	N=100	Mean ± SD ( $\bar{x} \pm \sigma$ )	Range	
		%		Min.	Max.
Less severe	≤10	0			
Severe	11-20	94.0	17.49±1.95	12.00	22.00
Highly severe	>20	6.0			

**Table 10.** Problems' indices regarding the GAPs

Sl.	Statement	Score	Index (%)	Rank
i.	Unavailability of information of GAP	290	96.67	2 <sup>nd</sup>
ii.	Costly processes	191	63.77	5 <sup>th</sup>
iii.	Lack of clean water for irrigation and other farm practices	79	26.33	9 <sup>th</sup>
iv.	Not being able to understand the necessity of GAP	281	98.67	1 <sup>st</sup>
v.	Shortage of land to build necessary infrastructures	69	23.0	10 <sup>th</sup>
vi.	Low possibility of getting adequate price of products	88	29.33	8 <sup>th</sup>
vii.	Less information from extension personnel	204	68.0	4 <sup>th</sup>
viii.	Lack of Govt. policy	268	89.33	3 <sup>rd</sup>
ix.	Adequate research is not conducted	91	30.33	7 <sup>th</sup>
x.	Illiteracy among the farmers	175	58.33	6 <sup>th</sup>

The mean of educational qualification 5.97 means the respondents' educational qualification was very low. 22% of them can sign only which means they are illiterate. Respondents having higher level of education were also very low. As they do not have well institutional literacy it increases the possibility of low practices of GAP.

Scientists have found major proportion (55.0%) of respondents had secondary level of education while (24.2%) farmers had primary level of education, (11.7%) of respondent had higher secondary level of education <sup>[11]</sup>.

Most of the farmers had medium family (46%). About

38% of the farmers had small family and only 16% of the farmers had large family. The number of family members ranged from 2 to 12 with a mean 5.15 and standard deviation 1.81.

Farmers' family size is also low with a mean 5.15. Large family is very low. This means number of joint family is decreasing in rural area or children number is low in nuclear family.

Researchers have found maximum numbers (56.7%) of families in selected areas were medium in size followed by small size (21.7%) and large size (21.7%) family <sup>[11]</sup>.

**Table 11.** Distribution of respondents according to their personal socioeconomic characteristics

Characteristics	Categories	Score	N=100		Mean ± SD ( $\bar{x} \pm \sigma$ )	Range	
			%			Min.	Max.
Age (years)	Young	≤35	26.0		45.52±12.10	23.00	70.00
	Middle	36-55	52.0				
	Old	>55	22.0				
Educational Qualifications (schooling years)	Illiterate	0	0		5.97±4.16	0.50	17.0
	Can sign only	0.5	22.0				
	Primary	1-5	29.0				
	Secondary	6-10	34.0				
	Higher secondary	11-12	13.0				
	Undergraduate	13-16	1.0				
	Postgraduate	>16	1.0				
Family Size (number of members)	Small	≤4	38.0		5.15±1.81	2	12
	Medium	5-6	46.0				
	Large	>6	16.0				
Farming Experience (years)	Low	≤10	21.0		20.56±10.37	5.00	55.00
	Medium	11-20	35.0				
	High	>20	44.0				
Farm size (ha)	Landless	≤0.02	0		0.64±0.78	.06	5.06
	Marginal	0.02-0.2	26.0				
	Small	0.21-1.0	56.0				
	Medium	1-3	15.0				
	Large	>3	3.0				
Income (BDT month <sup>-1</sup> )	Low	<15000	45.0		20540±17005.59	9000	100000
	Medium	15000-25000	32.0				
	High	>25000	23.0				
Training received	Yes		46.0				
	No		54.0				
Training Participation (number)	Low	≤6	28	60.9	2.35±0.97	1.00	5.00
	Medium	7-12	18	39.1			
	High	>12	0	0			
Organizational involvement	Yes		44	44.0			
	No		56	56.0			
Organizational Participation (score)	Low	≤6	44	100	1.11±0.39	1.00	3.00
	Medium	7-12	0	0			
	High	>12	0	0			
Cosmopolitanism (score)	Low	≤5	58.0		4.68±2.02	2	11
	Medium	6-10	40.0				
	High	>10	2.0				
Extension media contact (score)	No	0	0		40.77±9.82	23	66
	Rare	1-24	3.0				
	Occasional	25-48	66.0				
	Often	49-72	31.0				
	Regular	>72	0				

Data presented in the Table 11 show that maximum farmers had high farming experience (44%). About 35% of the farmers had medium farming experience. Only 21% of the farmers had low farming experience. Farming experience of the farmers ranged from 5 to 55 years with a mean 20.56 years and standard deviation 10.37.

High farm experience indicates respondents are well aware of the classical farm practices and they are involved in farming for a long time. High farm experience also helps the farmer to understand the cause and effect of different practices.

Authors have found majority of respondents (72.5%) had high farming experience <sup>[11]</sup>.

Most of the farmers' farm size was small (56%). The farm size of the respondents' ranged from 0.06 ha to 5.06 ha with a mean of 0.64 ha and standard deviation 0.78.

If the farm size is small farmers can't earn their expected amount even with trying their best. To help the situation of the farmers increasing the farm size is also important. Small farm size may help in adopting GAP but it will hinder the process in case of getting benefit from the farm. Because adopting GAP more or less increases the input cost. But if the farm is small then the input cost may not result in expected benefits.

Researchers have found more than half (54.2%) of the respondents had small farm size and only a few portion of respondents (2.5%) had large farm size <sup>[11]</sup>.

Data presented in Table 11 showed that highest portion of the respondents (45%) had low income, 32% had medium income and 23% had high income with a mean and standard deviation of 20,540 and 17,005.59 respectively. The minimum and maximum incomes were 9,000 BDT and 1,00,000 BDT.

The mean income of the respondents is very low (20,540 BDT). Nowadays fulfilling the daily expenses of a family with that income is very difficult. As a result they are losing their interest in farming and looking for new ways of earning. On the other hand with low income farmers are more likely to avoid practices that will cost them or will delay the outcome of input (harvesting as per harvest interval period mentioned on the label).

Only 46% of the respondents received training. Among them 60.9% had low level of training and 39.1% had medium level of training. On the other hand only 44% of the respondents had organizational involvement and all of them had low level of participation.

Farmers' involvement in training needs to be improved for better implementation of GAPs. Training helps to improve farmers' view of perspective and abilities to do an

operation more efficiently. The one who received training, most of them had low level of training. This is not sufficient for improving farm practices.

Most of the respondents (58%) low level of cosmopolitanism. 40% and 2% of them had medium and high level of cosmopolitanism respectively. The score ranged from 2 to 11 with a mean of 4.68 and standard deviation 2.02.

Higher level of cosmopolitanism helps to broaden the outlook of the farmers where low level of cosmopolitanism limits the farmers' point of view. Low level of cosmopolitanism can also act as an agent for not adopting good quality practices in farm operations.

Data from Table 11 showed that highest number of respondents (66%) had occasional level of extension media contact followed by 31% had often and 3% had rare level of extension media contact. The score ranged from 23 to 66 with a mean of 40.77 and standard deviation 9.82.

### 3.8.2 The Relationship between the Selected Characteristics of the Respondents and the Extent of Practicing GAP

From Table 12 it is found that age had significant negative correlation with chemicals related practices at 1% level of significance and harvesting and handling produce related practices at 5% level of significance.

These means with the increase of age, extent of practice decreased. This may occur due to young peoples' higher interest in adopting good practices for better outcome, young peoples' high literacy rate, more extension media contact etc.

Table 12 showed that farm size had significant negative correlation with fertilizers and soil additives related practices at 1% level of significance. That means with the increase of farm size, practicing fertilizers and soil additives related GAPs decreased. With the increase of farm size, needed fertilizers and soil additives also increases. As a result respondents' practice extent decreases. It may be caused due to increased amount of laborers, shortage of infrastructure related to practice, unwillingness of farmers to maintain every detail in large scale.

Results of Table 12 show that 'knowledge on GAP' had significant positive correlation with 'chemicals' and 'harvesting and handling produce' at 1% level of significance. That means with the increase of "knowledge on GAP", practicing rate also increased among the respondents.

Here 'knowledge on GAP' is farmers' knowledge on the standard form of practices. If farmer is aware of the standard practices he is more or less likely to practice them in his farm for better production.

**Table 12.** Relationships between the selected characteristics of the respondents and the extent of practicing GAP

Selected Characteristics	Coefficient of Correlation				
	Planting Materials	Fertilizers and soil additives	Water (Irrigation)	Chemicals	Harvesting and Handling Produce
Age	0.063	0.043	-0.006	-0.263**	-0.202*
Educational Qualification	-0.013	0.089	0.118	-0.107	-0.026
Family size	-0.134	0.064	0.086	-0.069	-0.305
Farming experience	0.081	0.118	0.043	-0.109	-0.112
Farm size	0.183	-0.262**	0.080	-0.142	-0.008
Family income	0.147	-0.286**	0.069	-0.073	0.039
Training received	-0.247	-0.023	-0.196	-0.244	-0.130
Organizational participation	0.054	-0.186	0.119	-0.081	-0.252
Cosmopolitanism	0.064	0.051	-0.153	0.120	-0.012
Extension media contact	-0.064	0.022	0.073	-0.050	-0.033
Knowledge on GAP	-0.037	0.064	-0.035	0.437**	0.422**
Attitude towards GAP	-0.001	0.055	0.085	-0.008	-0.081

#### 4. Conclusions

Most of the farmers had medium knowledge on the practices under GAP and majority of the farmers showed highly favorable attitude towards GAP. Farmers' practices regarding planting materials were mostly occasional. Highest discrepancy was identified under planting materials in 'keeping record of planting materials if obtained from another farm' followed by 'keeping record of seed quality' and 'keeping record of fertilizers and chemicals used' practice. Farmers are not keeping records in details and they don't understand the necessity of record keeping. Most of the farmers' practices regarding fertilizers and soil additives were often and the highest discrepancy was identified in record keeping of 'the source, product name, date, quantity obtained' followed by 'to minimize the risk of heavy metal contamination to produce', 'application of fertilizers and soil additives based upon soil analysis', 'assessment of the chemical and biological risks related to fertilizers and soil additives'. The highest portion of the farmers did the practices related to water (irrigation) often and the highest discrepancy was identified in 'where water testing is required, frequency of testing'. The majority of the respondents did the practices under chemicals (plant protection products or other agro and non-agrochemicals) often and the highest discrepancy was identified in 'record of chemicals (chemicals used, supplier, date and quantity obtained, date of manufacture/expiry)' and 'record of application for each crop (reason, dosage, date, name of operator) followed by 'records of chemicals in storage', 'harvesting as per the pre harvest interval period mentioned on the label' and 'IPM'. In case of harvesting and handling produce almost all of the farmers did the

practices often and highest discrepancy was identified in 'shatter proof lights in packing house' followed by 'applying specific test on produce if required', 'construction of sewage, waste disposal and drainage systems to minimize contamination', 'training workers in personal hygiene', 'calibrating measuring devices for ensuring correct measurement', 'availability of toilets and hand washing facilities to workers and maintaining hygienic condition'.

The majority of the respondents had severe problem regarding practicing GAP. In case of problem regarding GAP, the most faced problem by the farmers was 'not being able to understand the necessity of GAP' followed by 'unavailability of information of GAP', 'lack of government policy', 'less information from extension personnel' and 'costly processes'.

Thus, it could be concluded that, the favorable attitudes of the farmers should be utilized to motivate them to practices GAPs for safe food production, and moderate amount of knowledge could be increased through specially designed training programs on GAPs.

#### Authors' Contributions

1.	Mouri Khan Mim	Data collection, data analysis, manuscript writing
2.	Md. Matiul Islam*	Research design, research supervision, data analysis, manuscript editing

#### Conflict of Interest

There is none competing for the interests regarding the submitted manuscript, and the conducted research, except the authors mentioned in the author list.

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