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Diversity of Potato Varieties, Farmers Choices and Production Constraints in the Selected Areas of Bangladesh

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Abstract

This study investigated the diversity of potato varieties, farmers' choices and the underlying reasons for such preference by collecting data from selected areas of Bangladesh. Production constraints of this crop were also identified. The survey was conducted among 553 farmers selected randomly from the 14 most potato-producing districts under four administrative divisions namely Rangpur, Rajshahi, Dhaka and Barishal of the country. A total of 33 potato varieties was reported, of which 24 were high-yielding and 9 were local. The highest number of varieties was reported in the division of Rangpur (29), followed by Rajshahi (16), Dhaka (7) and Barishal (4). Among the reported varieties, the most popular ones were BARI Alu-7 (Diamant), BARI Alu-25 (Asterix), BARI Alu-8 (Cardinal), BARI Alu-29 (Courage) and BARI Alu-13 (Granola). Farmers primarily preferred high-yielding varieties for cultivation, while local varieties were mostly chosen for their taste. About 90% of the farmers faced various constraints during cultivation of potato and the most cited one was "Disease infection" (61.8%) followed by "Insect infestation" (51.2%). Farmers' responses regarding their choice of variety and production constraints faced by them showed considerable variation among the selected divisions which might be related to local geographical conditions, agricultural practices and socio-economic attributes of the farmers. This study aids policymakers in developing better strategies to boost potato production in Bangladesh.

Keywords: Cultivation, Diseases, Farmer, Potato, Varieties

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Introduction

Potato (*Solanum tuberosum* L.) is one of the most important staple food crops in many countries of the world. It is a good source of carbohydrate, vitamins, trace elements, and high-quality protein to human diet (Barbas et al., 2023; Beals, 2019; Robertson et al., 2018; Furrer et al., 2017; Zaheer and Akhtar, 2016). The crop helps not only to achieve food security but also contribute in income generation in the developing countries (Alamgir et al., 2020; Shaheb et al., 2015). Furthermore, due to its wide distribution across the world and a greater production rate compared to other crops, potato has the potentials to fulfill the increased demand of food supply in the developing countries including Bangladesh (FAOSTAT, 2020; Devaux et al., 2020).

In Bangladesh, a total of 10.09 million tons of potato was produced in 4.58 lac hectares of land showing the yield of 23.91 t/ha in the year 2023 (BBS, 2024). Potato is an important cash crop in Bangladesh where the crop ranked 4th after rice, wheat and maize. In terms of production, potato holds the 7th position in the world and the 3rd in Asia. Potatoes represent about 48.13% of total vegetables in Bangladesh (BBS, 2023). However, when compared with the developed countries, yield of this crop in the country is far beyond its maximum potentials. Therefore, it is important to identify the knowledge gaps in farmers' cultivation practices and production constraints of potato in Bangladesh.

Potatoes are assumed to be introduced in the Indian subcontinent by the Portuguese navigators in the 17th century (Banglapedia, 2021). Since then, nearly 200 potato varieties were introduced from various parts of the world and registered in Bangladesh, of which 106 were developed by Tuber Crops Research Centre, Bangladesh Agricultural Research Institute (BARI) (Rahman et al. 2022) and 94 by other different companies and organizations (MoA 2024). These exotic varieties, termed High Yielding Varieties (HYVs), were developed with desired traits such as tolerance to disease and abiotic stresses (e.g. salinity and heat), export potentials and processing quality. Different government agencies such as Bangladesh Agricultural Development Corporation, BARI, Department of Agriculture Extension (DAE) and Seed Certification Agency along with some other non-government and private organizations are working to develop potato varieties. However, many of these varieties became unpopular among the farmers although the underlying reasons are not investigated yet (Haque et al., 2012). Nevertheless, such information is crucial for policy implications in the context of improvement of potato cultivation in Bangladesh.

Potato production has been hampered by a number of factors including disease and insect attack, lack of quality seeds and non-judicious use of agrochemicals, dearth of

storage and marketing facilities, and farmers' demotivation due to inappropriate price after harvesting in Bangladesh (Nasif et al., 2018; Monjil and Ulfat, 2020; Dey et al., 2010). However, these studies are limited by their small sample sizes within a constrained geographical area and they also lack comprehensive documentation of farmers' perspectives. Therefore, the objectives of the study were to identify the potato varieties cultivated by the farmers, reasons for preferring a variety and also to identify the constraints faced by the farmers from different geographical regions of Bangladesh.

Materials And Methods

Study area and sampling design

Respondents for this study were selected from a list of 21 districts those were previously recorded as the most potato producing in Bangladesh (BBS, 2017). Among these districts, two thirds (14) were selected randomly to capture the heterogeneity among potato cultivating farmers, land types (e.g. flooded or non-flooded) and geographical distribution (e.g. latitude, longitude and altitude) in the survey area. The selected districts included Panchagarh, Thakurgaon, Nilphamari, Lalmonirhat, Kurigram, Dinajpur and Rangpur under the division Rangpur; Joypurhat, Naogaon and Bogura under the division Rajshahi; Manikganj, Munshiganj and Shariatpur under the division Dhaka and Bhola under the division Barishal (Figure 1). The geographical information including latitude and longitudinal coordinate values, sub-districts (locally known as *upazila*) selected for collecting data and number of respondents for each district are presented in Table 1.

A quantitative approach was followed to collect data from the selected farmers. From each of the selected districts, five most potato producing sub-districts were selected. Then, eight farmers from 8 different unions (a village level administrative unit of the local government of the country) were selected from a list of farmers prepared by the assistance of Upazila Agriculture Officers at the office of Department of Agriculture Extension. Thus, 40 farmers from each district and 560 farmers in total were selected from all 14 districts. However, finally, it was possible to collect data from 553 farmers. Due to start of lock-down situation owing to Covid-19 pandemic, the interviewers could not fulfill their target of 40 interviews in the district Bhola; instead, 33 were surveyed.

Table 1. Geographical description of the districts, sub-districts (*upazila*) and number of farmers per district selected for data collection in the present study.

Division	Districts	Upazila	Geographical coordinates		Number of farmers selected
Rangpur	Panchagarh	Panchagarh sadar, Boda, Atowari, Debiganj, Tentulia	25°18'-25°57'N 88°56'-89°32'E	&	40
	Thakurgaon	Thakuraon sadar, Pirganj, Horipur, Baliadangi, Ranishonkoil	25°40'-26°10'N 88°05'-88°36'E	&	40
	Nilphamari	Nilphamari sadar, Dimla, Domar, Joldhaka, Kishorganj	25°48'-26°03'N 88°44'-88°59'E	&	40
	Lalmonirhat	Lalmonirhat sadar, Aditmari, Hatibandha, Patgram, Kaliganj	25°46'-26°33'N 89°01'-89°36'E	&	40
	Kurigram	Kurigram sadar, Ulipur, Fulbari, Rajarhat, Rowmari	25°23'-26°14'N 89°27'-89°54'E	&	40
	Dinajpur	Dinajpur sadar, Birol, Chirirbondor, Khansama, Birganj	25°10'-26°04'N 88°23'-89°18'E	&	40
	Rangpur	Pirganj, Pirgachha, Kaunia, Mithapukur, Bodorganj	25°18'-25°57'N 88°56'-89°32'E	&	40
Rajshahi	Joypurhat	Joypurhat sadar, Kalai, Khetlal, Akkelpur, Panchbibi	24°07'-24°43'N 88°17'-88°58'E	&	40
	Naogaon	Naogaon sadar, Atrai, Raninogor, Bodolgachhi, Potnitola	24°32'-25°13'N 88°23'-89°10'E	&	40
	Bogura	Bogura sadar, Shibganj, Shahjahanpur, Dupchachia, Kahalu	24°32'-25°07'N 88°58'-89°45'E	&	40
Dhaka	Manikganj,	Manikganj sadar, Singair, Horirampur, Ghior, Shibaloy	23°42'-23°55'N 89°58'-90°07'E	&	40
	Munshiganj	Munshiganj sadar, Gajaria, Tongibari, Louhajong, Srinagar	23°23'-23°38'N 90°10'-90°43'E	&	40
	Shariatpur	Shariatpur sadar, Vedorganj, Noria, Jajira, Damudda	23°01'-23°27'N 90°13'-90°36'E	&	40
Barishal	Bhola	Bhola sadar, Borhanuddin, Lalmohon, Tojumoddin, Doulotkhan	22°32'-22°52'N 90°32'-90°44'E	&	33

Data collection

A semi-structured questionnaire was used to collect data from the field. A total of 10 well trained Research Assistants were engaged in data collection. Demographic profiles and socio-economic characteristics such as age, marital status and literacy level of the farmers were collected. A respondent who could read and write his or her name was considered as literate and who could not do so were illiterate. Open-ended questions were used to collect data on potato variety cultivated in the study area, causes of preferring a variety for cultivation and the problems faced by the farmers. Field level data collection was done during the months of February and March in the year 2020.

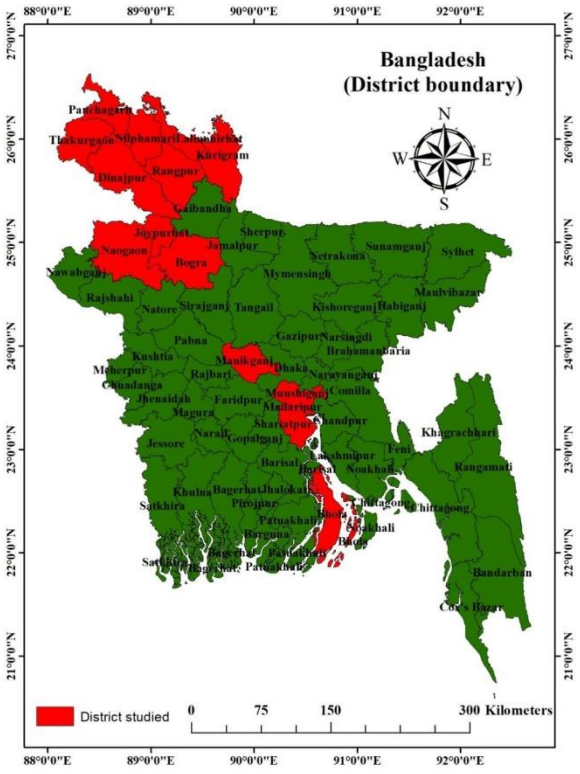

Fig. 1. Map of Bangladesh showing the study area including the districts (red in color) taken under the survey.

Results and Discussion

Socio-demographic profiles of the respondents

Average age of the respondents was 44.5 years although it varied slightly among the four administrative divisions with the lowest value (42.8 years) in Dhaka and the

highest (48.8 years) in Rajshahi. Among the farmers participating in this survey, 94.8% were married and 5.2% were unmarried (Table 2). The majority of the farmers (84.1%) were literate. There was slight variation in marital status among the divisions with the highest married respondents in Barishal (100%) followed by Rajshahi (97.6%), Rangpur (93.6%) and Dhaka (93.4%). However, farmers were found with varied schooling backgrounds including Higher secondary, Secondary, Bachelors and Masters Degrees (data not presented).

Socio-economic conditions of farmers influence their choice of agricultural practices. Previous studies reported a positive association between potato production and socio-economic condition of the farmers in Bangladesh (Hossain et al., 2024) indicating that farmers with relatively higher literacy level were engaged more in the cultivation of potato. Data of the present study revealed that farmers of the study area were of active age group. The majority of the farmers of active age group with considerable literacy levels could play a pivotal role in achieving sustainable agriculture if they were properly trained and motivated towards environmentally friendly good agricultural practices (Yu et al., 2022; Tong et al., 2024).

Table 2. Socio-demographic profiles of the potato growing farmers under the selected administrative divisions Rajshahi (n=124), Rangpur (n=280), Barishal (n=28) and Dhaka (n=121) in Bangladesh.

Response	% of farmers					Number of farmers
	Rajshahi	Rangpur	Barishal	Dhaka	Average	
Age						
Age (year)	44.2	42.8	44.5	48.8	44.5	553
Marital status						
Married	97.6	93.6	100.0	93.4	94.8	524
Unmarried	2.4	6.4	0.0	6.6	5.2	29
Literacy level						
Literate	91.1	83.6	75.0	80.2	84.1	465
Illiterate	8.9	16.4	25.0	19.8	15.9	88

Potato varieties cultivated by the farmers

A total of 33 potato varieties were reported from the study area (Table 3). Among these varieties, most (24) were high yielding and of exotic origin while the rest of 9 were of local origin. The number of local varieties reported in the present study was lower than the total number of that (27) reported across Bangladesh (Banglapedia, 2021). This gap in the number of local varieties between present study and previous

report might be due to the limitation of sampling size because some areas such as the hill tracts, North-east and South-western parts of the country were not included in the present study (Banglapedia, 2021). The highest number of varieties were reported in the division Rangpur (29), followed by Rajshahi (15), Dhaka (7) and Barishal (4). The number of local varieties was also higher in the division Rangpur (9) followed by Rajshahi (3). One BARI variety was reported as nonspecific since farmers could not tell the specific name of the variety. The higher number of potato varieties in the northern region than other parts of Bangladesh might be related to a combination of factors including favorable climate, suitable soil conditions and early season for cultivation. Moreover, the northern districts also have a long history of potato cultivation, which might have led to a greater diversity of varieties being adopted and adapted over time.

Data of the present study demonstrated that potato cultivation in Bangladesh was captured mostly by the use of HYVs. Farmers' choice of "High yield" as an attribute during cultivation of potato was the underlying cause of such widespread preferences of these varieties in the country. Some studies investigated the yield performance of both exotic (Eaton et al., 2017; Alam et al., 2003) and local (Solaiman et al., 2015) potato varieties of Bangladesh. Regeneration potentials of some selected HYVs was also assessed recently in Bangladesh (Molla et al., 2022). However, there is no current report on the status of potato varieties being cultivated by the farmers and the underlying reasons for preferring such varieties for cultivation. The findings of the present study demonstrated the scenarios of field level varieties which were cultivated by the farmers under the divisions of Rangpur, Rajshahi, Dhaka and Barishal of Bangladesh.

The use of HYVs in agriculture renders environmental concerns since these varieties are chemical input intensive (Ricciardi et al., 2021; Rahman and Hossain, 2003). Therefore, HYVs require relatively more chemical inputs to boost up yield by protecting crops from pest attacks. However, use of fertilizers and pesticides causes threats to biodiversity through polluting the natural environment and erosion of genetic diversity. Following biological control measures and using potato varieties resistant to pest and disease attacks could help protect the natural environment and biodiversity (Brühl and Zaller, 2019). The present study also suggests taking necessary actions in order to conserve local varieties for further improvement of crop plants.

Table 3. Potato varieties cultivated by the farmers under different administrative divisions of Bangladesh.

Sl.	Name of variety	Type	Farmers' response about the variety			
			Rajshahi	Rangpur	Barishal	Dhaka
1	BARI Alu-7 (Diamant)	HYV	√	√	√	√
2	BARI Alu-25 (Asterix)	HYV	√	√	-	√
3	BARI Alu-8 (Cardinal)	HYV	√	√	√	√
4	BARI Alu-29 (Courage)	HYV	√	√	-	√
5	BARI Alu-13 (Granola)	HYV	√	√	-	-
6	BARI (Non-specific)	HYV	-	√	-	-
7	BARI Alu-44 (Elgar)	HYV	-	√	-	√
8	BARI Alu-54 (Musica)	HYV	√	-	-	-
9	BARI Alu-10 (Kufri Shindhury)	HYV	-	√	-	-
10	BARI Alu-28 (Lady Roseta)	HYV	√	√	-	√
11	BARI Alu-9 (Mondial)	HYV	-	√	√	-
12	BARI Alu-65 (Rosa Gold)	HYV	-	√	-	-
13	BARI Alu-17 (Raja)	HYV		√	√	-
14	BARI Alu-4 (Ailsa)	HYV	-	√	-	-
15	BARI Alu-43 (Atlas)	HYV	-	√	-	-
16	BARI Alu-104 (Kumarika)	HYV	-	√	-	-
17	Claire	HYV	√	-	-	-
18	BARI Alu-33 (Almira)	HYV	√	-	-	-
19	BARI Alu-31 (Sagita)	HYV	-	√	-	-
20	BADC Alu-3 (Santana)	HYV	-	√	-	-
21	BARI Alu-22 (Saikat)	HYV	-	√	-	-
22	BARI Alu-34 (Laura)	HYV	-	√	-	-
23	BARI Alu-91 Carolus)	HYV	-	√	-	-
24	BARI Alu-1(Heera)	HYV	√	-	-	-
25	Lal Pakhri	Local	√	√	-	√
26	Sada Chollisha/Deshi Sada Alu	Local	-	√	-	-
27	Sheel Bilatee /Goma Bilatee	Local	-	√	-	-
28	Rumana	Local	√	√	-	-
29	Pachnai/Patnai	Local	√	√	-	-
30	Jam alu	Local	√	√	-	-
31	Deshi Chitol/Pahari Chitol	Local	-	√	-	-
32	Gutichokra	Local	-	√	-	-
33	Deshi Pakri	Local	-	√	-	-

"√", cultivated and "-", not cultivated by the farmers

Farmers' choice of potato variety for cultivation

Among the potato varieties reported from the study area, 5 were found to be preferred as first choice for cultivation by more than 85% of the farmers for various reasons (Table 3). Among the varieties, the two most popular varieties were Diamant (32.6%) and Asterix (32.4%) followed by Cardinal (8.7%), Courage (6.0%) and Pakhri (5.4%). When the farmers were asked to answer the question which trait they would prefer most in choosing a potato variety for cultivation then "High yield" was the most cited response for the most widely cultivated varieties such as Diamant (74.4%), Asterix (72.1%), Cardinal (75.0%) and Courage (60.6%). Interestingly, among these five varieties a local variety Pakhri was preferred by the farmers for its "High price" (High market demand) (60.0%) and "Taste" (46.7%). Four HYVs namely Granola, Elgar, Musica and Rosagold were preferred for their early maturity (shorter life span) and another local variety named Bangla Citer Gol Alu was preferred for its tolerance to water logging (data not presented).

Results of the present study demonstrated that Diamant and Asterix were reported by the farmers as the most popular compared to other varieties. Eaton et al., (2017) also reported Diamant and Asterix as the most popular varieties in their study conducted in the northern district Nilphamari of Bangladesh. Nasif et al., (2018) reported Diamant as the first preferred variety (65.4%) followed by Cardinal (29.6%) and Granula (25.8%) in their study that included ten different districts across Bangladesh. However, other studies did not investigate the reasons for what potato varieties were chosen by the farmers. Results of the present study demonstrated that "High yield" was the most preferred attribute among the farmers for cultivation of majority of the potato varieties in the study area. This finding thus suggested that farmers might consider cultivation of potato as a source of income. A considerable number of farmers showed interests on choosing local variety such as Pakhri for its "High market demand" and "Taste". The trait "Taste" was also preferred by the farmers who used to cultivate local varieties namely "Deshi Chollisha", "Patnai" and "Deshi Cital" (data not presented). Varieties with some traits such as 'Taste', 'Short life span' and 'Tolerant to water logging" should be conserved because genes associated with these traits could be used for the improvement of varieties through modern molecular techniques.

Table 4. Farmers' opinion about the underlying reasons for prefer a potato variety for cultivation in the study area of Bangladesh. * Indicates multiple response.

Sl.	Name of variety	Reason of first preference as opined by farmers (%)												Frequency (%)*
		High price	High yield	Taste	High demand	Resistant to disease	Short duration	Water log tolerant	Disease resistant	Good looking	Good seed quality	Long lasting	Drought tolerant	
1	Diamant	20.0	74.4	21.7	30.6	15.6	4.4	0.6	0.6	3.9	0.0	2.2	0.0	32.6
2	Asterix	44.1	72.1	16.8	41.9	25.7	9.5	0.6	1.1	4.5	1.1	2.8	0.0	32.4
3	Cardinal	39.6	75.0	25.0	29.2	14.6	8.3	2.1	0.0	2.1	0.0	2.1	0.0	8.7
4	Courage	36.4	60.6	42.4	39.4	12.1	36.4	0.0	0.0	0.0	0.0	0.0	0.0	6.0
5	Pakhri/Lal Pakhri	60.0	23.3	46.7	30.0	10.0	30.0	10.0	0.0	0.0	0.0	26.7	0.0	5.4

Consraints faced by the potato growing farmers

Farmers mentioned a total of 11 different kinds of constraints faced by them in potato culitvation (Table 5). Among these problems, the most frequently cited one was disease infection (61.8%) followed by pest infestation (51.2%), unexpected rainfall (28.4%), low price of produced potato at the time of harvest (8.2%), lack of quality seeds (5.9%), inadequate irrigation facility (2.9%), dearth of cold storage facility (1.8%) and unavailability of fertilizers and pesticides (1.4%). Moreover, inadequate fund was mentioned by 3 farmers (0.5%). Further, each one farmer opined foggy weather and labor crisis as problems they faced during cultivation of potato.

Number of farmers citing problems faced by them showed variation among the divisions. Although the farmers of Barishal division mostly cited disease infection (89.3%) and pest attack (89.3%) as problems, relatively less number of them in Rangpur and Dhaka divisions mentioned these as problems. Unexpected rainfall was cited as a problem by the farmers with a large variation among the divisions with the highest in Rajshahi (49.2%) followed by Barishal (42.9%), Dhaka (17.4%) and Rangpur (3.9%). Low price of produced potato at the time of harvest was also considered as a problem by the farmers although variation was seen among the

divisions with the highest in Dhaka (23.1%) and none in Barishal. On an average, about 6% of the farmers mentioned unavailability of seeds as a problem although the studied regions showed variation in availability of seeds with the highest in Rangpur (11.8%) followed by Rajshahi (6.5%), Barishal (3.6%) and Dhaka (1.7%).

Insect infestation has been a serious threat to the production of potato in many countries including Bangladesh (Tiwari et al., 2020; Dey et al., 2010). Data of the present study also reported disease outbreak as the top most problem faced by the farmers in the country. Disease infestation and pest attack reported more frequently

in Barishal and Rangpur divisions underscored the importance of better management practices in these two districts to tackle these problems.

Other challenges faced by the potato farmers included lack of good quality seed, use of indigenous varieties, pathogenic agents, poor management practices and unfavourable weather (Shaheb et al., 2015; Ahmed et al., 2013; Uddin et al., 2010; Chowdhury and Chowdhury, 2015). Additionally, some unique problems such as unexpected rainfall and foggy weather were reported in the present study. These problems in agriculture might arise as consequence of global climate change.

Table 5. Farmers' opinion about the constraints faced by them during cultivation of potato in the the study area of Bangladesh

Sl.	Problems	% Farmers opined*					Frequency (%)
		Rajshahi	Rangpur	Barishal	Dhaka	Average	
1	Disease infestation	39.5	76.1	89.3	42.1	61.8	61.8
2	Pest attack	12.9	72.1	89.3	30.6	51.2	51.2
3	Unexpected rainfall	49.2	3.9	42.9	17.4	28.4	28.4
4	Low price of produced potato	0.8	8.9	0.0	23.1	8.2	8.1
5	Unavailability of seeds	6.5	11.8	3.6	1.7	5.9	6.0
6	Lack of irrigation facility	1.6	0.4	3.6	5.8	2.9	2.9
7	Lack of cold storage facility	0.0	2.5	0.0	5.0	1.9	2.0
8	Lack of fertilizer/pesticides	0.0	1.1	3.6	0.8	1.4	1.5
9	Lack of adequate funds	2.4	0.0	0.0	0.0	0.6	0.5
10	Labor crisis	0.0	0.4	0.0	0.0	0.1	0.2
11	Foggy weather	0.0	0.4	0.0	0.0	0.1	0.2
12	No problem	10.5	7.1	0.0	21.5	9.8	10.0

* Multiple response

Conclusion

Potato cultivation in Bangladesh was captured mostly by the use of HYVs. Results also revealed that the northern part of the country including the division Rangpur was rich in potato variety. Most of the farmers preferred "High Yield" as a trait in choosing a variety for cultivation. Disease infestation, pest attack and unexpected rainfall were the most frequently cited problems by the farmers. Moreover, farmers' responses regarding variety choice and production constraints varied among the four administrative divisions selected for the study. Appropriate measures should be taken to tackle the problems faced by the farmers considering the local geographical condition, agricultural practices and socio-economic attributes of the farmers.

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