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**Challenges and Strategies to Improve Potato
Competitiveness along with
Potato Value Chain in Bangladesh**

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Abstract

Potato (disambiguation), *Solanum tuberosum*, is a tuberous crop grown throughout the world. It is the world's fourth-largest food crop, following maize, wheat, and rice. Potato is the leading vegetable in Bangladesh. The potential to strategize the ways of enhancing its competitiveness in the value chain remains locked and unexploited due to a host of constraining factors along its value chain, which must be addressed. This paper identifies the underlying constraints and proposes strategic interventions to enhance Potato competitiveness along the value chain in Bangladesh. Secondary data has been obtained from Ministry of Agriculture, Bangladesh Agricultural Research Institute (BARI), Department of Agriculture Extension (DAE), Bangladesh Agriculture Development Corporation (BADC), Bangladesh Firm Seeds Trade Federation of Bureau and Bangladesh Bureau of Statistics. The data were analyzed using statistically. Underlying constraints such as production inefficiencies, market inaccessibility, and inadequate processing facilities and consumers' exploitation through inflated pricing were identified to affect potato value chain performance. Strategic interventions like the adoption of tissue culture technology, rapid multiplication method, top shoot cutting, appropriate irrigation systems and business model aggregator were identified to enhance potato value chain competitiveness. Government was therefore recommended to partner with all stakeholders in order to enhance performance in potato value chain.

Key Words: Agriculture, potato, value chain, constraints, competitiveness, supply chain management.

1. Introduction

Potato is a staple food throughout the world including Bangladesh. In every nook and corner of the world, potato is consumed in various forms. In Bangladesh, too, people consume good amount of potatoes. Potato is a perishable root type of vegetable having short shelf life. Potato is grown throughout the country for domestic consumption but extensively grown in the districts of Munshiganj, Bogra, Jaipurhat, Rangpur, Dinajpur, Thakurgaon, Rajshahi and Naogaon for commercial purpose (DAE Statistics, 2014). Bangladesh is the fourth largest potato producer in Asia (The Independent, 2014). The process of production starts from preparation of the land, arrangements of samplings and/seeds to loans. After the produce is harvested, the growers and/traders need preservation and processing of the produce for off-season use. The marketing of potato in various forms adds value to the product before it is consumed. In the total process, the growers play the role of primary stakeholders, and then come the traders, processing folks, exporters and finally the consumers. The potentials and strategies of enhancing its competitiveness in value chain are under hosts of constraints (Geoffrey et al., 2014). In the chain, the growers are mostly affected in realising their production cost. So, it is recommended to support the primary stakeholders i.e. the farmers in keeping the potential sector that is under imminent threat.

Potato production in Bangladesh is in transition from subsistence to commercial agriculture. Ten per cent of growers use leased land for potato production and 38 per cent use both their own and leased land. Formal farming contract systems are in development mainly in relation to the production of potato varieties for processing, as seed potato or for export. The majority of Bangladesh's potato production is used for direct consumption (Egger, 2014). Farmers in Bangladesh do not get one half of their production cost through selling their produces during harvesting period. To make some profit, growers have to preserve potatoes in the cold storages and thus incur further losses. To preserve their produces farmers and/growers need to spend taka 6 (approximately) and thus cost increases to taka 14 per kg while selling those to the months of September and later (The Independent, 2014). Preservation of potato is another key problem for the growers and a key ingredient of value chain following sequential factors affecting value chain (Table 1 and Fig. 1).

Table 1: Effects of Value Chain in Local Market

Factors of Value Chain	Approximate Cost in Taka (Per kg)	Total Cost in Taka
Production cost	6.00 - 8.00	7.00
Standardization, grading and packaging	1.00 - 2.00	9.00
Preservation in cold storage	4.00 - 6.00	14.00
Transportation cost	1.00 - 2.00	15.00
Intermediate beneficiaries / Catalyst	2.00 - 4.00	18.00
Retailers Profit	2.00 - 5.00	20.00
Retail Price (as on April 2015)	18.00 - 22.00	20.00

Value chain research related to potato is scanty. Most literature and research in the past has focused on potato production and some on marketing. Research on the potato value chain conducted in Bhutan analysed the context of potato production, mapped chain actors, factors affecting value chain and chain relationships. A case study of the potato value chain conducted in Kenya has shown that contract farming can be used to reduce transaction costs and risks, and to improve the organization and governance of value chains by creating stable business relationships. The study also indicated that potato value chain is constrained by a number of market and institutional failures (Emana and Nigussie, 2011). A lack of access to quality inputs means farmers do not grow varieties suitable for processing, and productivity of other varieties is not as high as it could be. It is also hard to obtain quality seed. Supply is low and the right varieties are not always available. Potato requires a large quantity of fertiliser. Lack of adequate and timely supply of chemical fertilisers (especially urea) during the cultivation season affects overall productivity. The main service provided in the potato sector is storage, which is often restricted or expensive. Less than 30 per cent of total potato production is kept in cold storages and every year the average national wastage of production is about 10 per cent. Shipping services are inadequate and underdeveloped, or so expensive that they increase the price of the produce to an uncompetitive level (Egger, 2014).

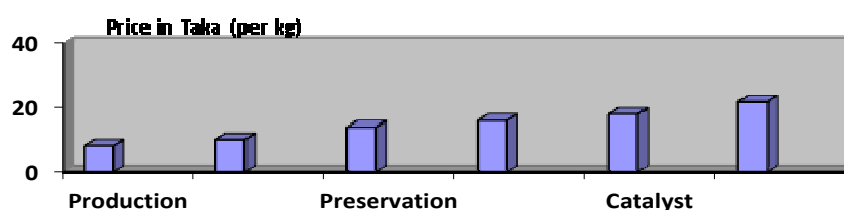


Fig. 1: Effects of Value Chain in Local Market

2. Materials and Method

Secondary data obtained from online sources and government agencies mainly in the fields of agriculture, horticulture and their statistical records. Mentionable ones are Ministry of Agriculture, Bangladesh Agricultural Research Institute (BARI) Gazipur, and Department of Agriculture Extension (DAE) Khamar Bari Dhaka, Bangladesh Agriculture Development Corporation (BADC), Bangladesh Firm Seeds Trade Federation of Bureau and Bangladesh Bureau of Statistics (Fig. 2). The data were analyzed statistically.

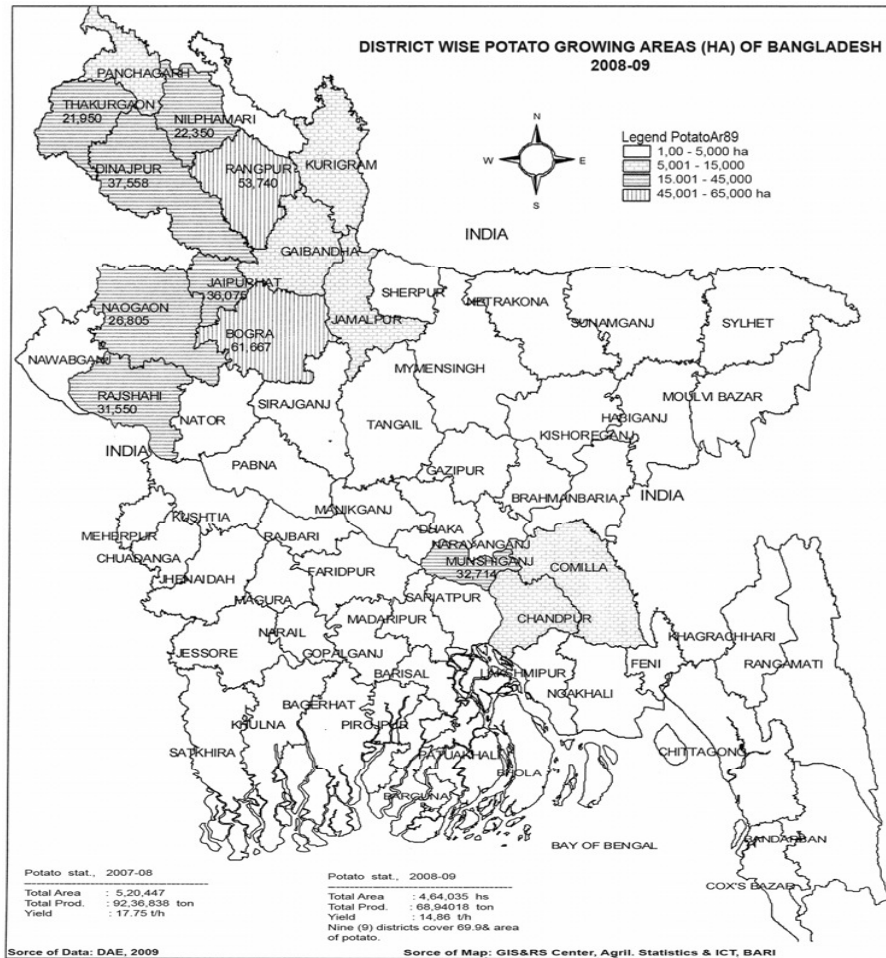


Fig. 2: Potato Growing Areas (ha) of Bangladesh, 2008-09

3. Results and Discussions

3.1. Constraints and Intervention in Potato Value Chain

Constraints and probable remedies are discussed in the specific functions of value chain namely production, marketing, processing and consumptions.

Production

Potato production involves a series of activities from seed processing to nursery raising, land preparation, planting, irrigation, field management practices and harvesting. Potato is grown throughout the Bangladesh and potato production season in Bangladesh is from November to January. Early varieties can also be planted from mid- October if the land is free. Commonly potato is cultivated between two major rice harvesting season that is Aman and Boro; hence production of rice is not hampered by the production of potatoes. It has been observed that two major kinds of varieties are cultivated across the country; one is local variety (deshi) and High Yielding Variety (HYV). Agriculture scientists of BARI have innovated/developed a good number of varieties (HYV). Farmers and growers viewed that the local varieties are smaller in size, costlier in local market, has longer shelf life but yield is much lesser than HYV and prone to various diseases. On the other hand, HYV is larger in size, has better market across the country, more yield but relatively shorter shelf life and less susceptible to various diseases. The varieties of potato, its common diseases, remedial measures and various fertilizers being used are shown in the Table 2:

Table 2: Potato Varieties, Common Disease and Treatments

Varieties of Potatoes	Common Disease	Treatments	Fertilizer
<u>HYV</u>			
BARI -8 (Cardinal)	Late blight	Secure/meldew/Acrvet	Urea
BARI -13(Granola)	Potato leaf roll	Admire/Malathion	TSP
BARI -25(Asterix)	Potato Virus X	Staple bleaching	MP
BARI -28(Lady roseta)	Potato Virus Y	powder	Gypsum
BARI -29(Carage)	Potato Virus S	Bavistin 0.1%	Boric
Diamant or Diamond, Patrones,	Bacterial wilt	Bleaching powder 1%	Acid
Manila	Stem canker	Boric Acid 3%	Mgs 04
Origo, Binella, Heera	Black leg	Admire/Melathion	Cowdung
Elvira, Ultra, Provento,	Scab		
<u>Local Variety</u>			
Kufrishundari.	Potato Aphid		
	Cutworm		
Shilbilati, Indurkani, Lalpkari, Pakri,	Tuber moth		

Source: (Begum et al., 2013)

In 2014-15 total of 9,328,187 metric tons of various potatoes have been produced in 476,791 hectares of land of which eight major districts contribute 68.30% of production. Although Munshiganj ranks third in the area wise cultivation of potato i.e. 37,600 hectares of land which is 7.89% of total cultivation but it has the highest production of 1,241,552 metric tons which is 13.31% of total production. Munshiganj also has the highest yield of 33.02 metric t ha⁻¹ while the national average yield is 19.56 t ha⁻¹. In the district of Bogra, potato is cultivated in 61,701 hectares of land which is 12.94% of total cultivation and has the production of 1,126,043 metric tons that makes 12.07% of production. Then, comes Rangpur (10.08%), Jaipurhat (8.10%), Dinajpur (8.003%), Rajshahi (7.92%), Naogaon (4.41%) and Thakurgaon (4.38%). Other districts have productions less than 100 thousand metric tons of potato per year. The least potato cultivated districts are Narail, Magura, Khulna, Bagerhat, Barishal, Jhalokati, Faridpur, Razbari, Madaripur, Gopalganj, Barguna, Noakhali, Feni and Lakshmipur falls (Table 3) within the southern coastal plains where the problem of salinity exists. The other low production districts are 03 Hill districts and few others having low lying areas like Natore and Pabna. These 19 (nineteen) districts produces only 1.81% of total production in total 8,965 hectares of land (DAE, 2015) and observed its production trend are increasing (Table 4 and Fig. 3). However, these districts have potentials of potato production and the potato cultivable land could be expanded with the support of irrigation during the potato season. The salinity can be eradicated by some means of desalination or by preserving rain waters in localized reservoirs.

Table 3: District wise Potato Cultivation, Production and Yield in Year 2014-15

Ser	Area	District	Cultivation (Hectare)	Production tons	Yield t ha ⁻¹	Varieties
1	Dhaka	Dhaka	2,216	49,084	22.15	Diamant
2		Narayanganj	4,000	96,240	24.06	Cardinal
3		Gazipur	258	5,524	21.41	Malta
4		Narsingdi	1,965	32,619	16.60	Astarix
5		Munshiganj	37,600	1,241,552	33.02	Petronix
6		Manikganj	2,363	49,907	21.12	Elga
7		Tangail	3,816	67,658	17.73	
Total			52,218	1,542,583	29.54	
8	Mymensing	Mymensingh	4,665	66,989	14.36	Challisha
9		Jamalpur	4,283	64,549	15.05	Cardinal
10		Sherpur	3,838	71,464	18.62	

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11		Netrokona	1,940	29,119	15.01	
12		Kishoreganj	4,890	79,560	16.27	
Total			19,616	311,592	15.88	
13	Comilla	Comilla	14,734	303,668	20.61	Diamant
14		Chandpur	12,188	246,076	20.19	Cardinal
15		Brhamanbaria	1,815	29,185	16.08	Malta
Total			28,737	578,929	20.15	
16	Sylhet	Sylhet	1,398	21,110	15.10	Diamant
17		Moulvibazar	2,008	28,152	14.02	Cardinal
18		Habiganj	1,631	29,358	18.00	Malta
19		Sunamganj	1,364	21,142	15.50	Laxmipecha
Total			6,401	99,762	15.59	
20	Chittagong	Chittagong	4,437	64,913	14.63	Dohazari
21		Cox's Bazar	2,250	33,593	14.93	Diamant
22		Noakhali	230	3,616	15.72	Cardinal
23		Feni	443	7,088	16.00	
24		Lakshmipur	360	5,760	16.00	
Total			7,720	114,969	14.89	
25	Rangamati	Rangamati	290	4,365	15.05	
26		Khagrachari	524	8,698	16.60	
27		Bandarban	746	11,876	15.92	
Total			1,560	24,939	15.99	
28	Rajshahi	Rajshahi	36,915	738,669	20.01	Cardinal
29		Naogaon	23,190	411,623	17.75	Astarix
30		Natore	855	15,578	18.22	Lalpakri
31		ChapaiN'ganj	1,365	23,342	17.10	
Total			62,325	1,189,211	19.08	
32	Bogra	Bogra	61,701	1,126,043	18.25	Lalpakri,
33		Jaipurhat	39,735	755,362	19.01	Pakri
34		Pabna	815	12,575	15.43	Granola,
35		Sirazganj	2,885	44,573	15.45	Diamant Romana, Cardinal
Total			105,136	1,938,554	18.44	
36	Rangpur	Rangpur	49,475	940,520	19.01	Kufri,
37		Gaibandha	9,445	151,309	16.02	Petronis,
38		Kurigram	5,446	109,301	20.07	Pakri,
39		Lalmonirhat	4,950	79,844	16.13	Deshi
40		Nilphamari	22,605	361,906	16.01	Bograi, Granoula, Shada, Diamant, Romana, Cardinal, Elvira, Carriage,

						Shangeeta
Total			91,921	1,642,879	17.87	
41	Dina- jpur	Dinajpur	43,000	748,630	17.41	Same as Bogra
42		Thakurgaon	21,800	408,750	18.75	
43		PonchoGor	9,505	149,133	15.69	
Total			74,305	1,306,513	17.58	
44	Jessore	Jessore	2,720	60,112	22.10	Cardinal Astarix Lalpakri Diamant
45		Jenidah	1,510	36,542	24.20	
46		Magura	85	1,530	18.00	
47		Kushtia	2,040	43,309	21.23	
48		Chuadanga	1,670	40,080	24.00	
49		Meherpur	1,025	24,723	24.12	
Total			9,050	206,296	22.80	
50	Khulna	Khulna	425	6,800	16.00	Cardinal Kufri Diamant Shundari
51		Bagerhat	580	9,860	17.00	
52		Shatkhira	3,560	64,116	18.01	
53		Narail	20	380	19.00	
Total			4,585	81,156	17.70	
54	Barishal	Barishal	940	19,101	20.32	-
55		Pirojpur	1,150	19,550	17.00	
56		Jhalokati	380	8,740	23.00	
57		Patuakhali	1,285	25,893	20.15	
58		Barguna	1,020	22,440	22.00	
59		Bhola	5,320	106,453	20.01	
Total			10,095	202,177	20.03	
60	Farid- pur	Faridpur	368	9,200	25.00	-
61		Madaripur	495	13,137	26.54	
62		Gopalganj	210	4,757	22.65	
63		Razbari	179	3,562	19.90	
64		Shariatpur	1,870	57,970	31.00	
Total			3,122	88,626	28.39	
Grand Total (National)			476,971	9,328,187	19.56	

Table 4: Potato Production and Its Use in Last Five Years in Bangladesh

Year	Production (tons)	Total Land (hectares)	Average Production (t ha ⁻¹)	Exports (tons)	Stored in Cold Storage	Processed (tons)
2010	8,400,000	472,000	17.80	35,000	280,000	8,000
2011	8,326,000	460,000	18.10	48,000	310,000	11,000
2012	8,205,000	430,000	19.80	65,000	334,000	12,000
2013	8,603,000	444,000	19.37	88,000	360,000	8,000
2014	8,950,000	462,000	19.37	107,000	380,000	13,000
2015	9,328,187	476,791	19.56		under process in current year	

(Krishi Diary, 2010, 2011, 2012, 2013, 2014 current data provided by DAE)

Production inefficiencies are manifested mainly by poor agronomical practice especially on nutrient management, irrigation, support, pruning, weeding, pest and disease management and harvesting. Each of the stages has significant expenditures to bring the product. Production cost in an acre of land approximated by the Agriculture Economics Division of BARI in their Annual Report of 2013-14 shows following Table 5.

Table 5: Production Cost and Benefit Cost Ratio

Description	Cost (Taka)
Variable Cost (Seed, Fertilizer, Irrigation, Insecticides, Pesticides, Hired Labour)	66,983
Fixed Cost (Land rent and family labour)	16,912
Total Cost	83,895
Yield (kg)	10,604
Production Price (Taka per kg)	12.79
Gross Profit	135,625
Net Return	51,730
Benefit Cost Ratio (BCR)	1.62

Source: (Annual Report, Agricultural Economic Division, BARI 2013-14)

Marketing

Price of potato in Bangladesh is lowest in the region, the price of per kg potato is taka 35 in India and Sri Lanka, taka 22 in Nepal, taka 20 in Pakistan, and taka 143 in Thailand; whereas in Bangladesh it is being sold within the range of taka 8 to 10 during the season (The Independent, 2014). In Bogra, one of the major potato producing districts, production cost of one kg potato is taka 8, whereas farmers had to sell one kg of potato at taka 4-6 in the wholesale market during the harvesting period. However, after reaching the capital, the potato price rises and as on February 2015 it ranges from taka 10 to taka 12 in various kitchen markets. In the chain, there are syndicates and catalysts working to make profit with minimum burden. While transporting the potato from the fields to the markets in Dhaka costs taka 1.00 - 2.00 depending on the distance. Out of the total cost of transportation a significant amount goes to illegal toll collectors including various transport workers' associations and law enforcing agencies.

The cause of low price in local market is production exceeds the local demand. Presently, the domestic market demand (quantity demanded) is roughly about 6,500,000 tons which is less than 70% of production. Another 11-12% is used as seed for further production. From the given data, it is assumed that 15-20% of the total production can be exported without affecting local demand. However, with increased production and expansion of cultivable area the quantity of export can also be multiplied within a short span of time. Potato is being exported to countries like Singapore, Malaysia, Hong Kong, Saudi Arabia, UAE, England and other EU countries and quantity exported are also increasing rapidly (Fig. 4). The export market is also in the process of expansion. Recently, market has been opened in Russia, having a huge demand of billion tons per year. Agriculture ministry and exporters made an estimation of additional 100,000 tons of export to Russia; meaning the export will be doubled in the year 2015 and the demand will be increasing geometrically. There are two major requirements of export; phyto sanitation certification of cultivable land (measures requiring removal or destruction of infected or infested plant material likely to form source of re-infection or re-infestation) and fumigation of the produce before being shipped (Lemon, 2015).

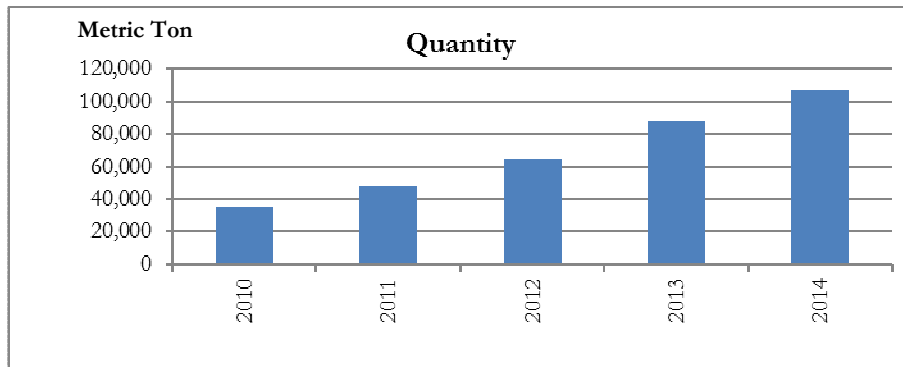


Fig. 4: Potato Exports in Last 5 Years

Processing

Potatoes are grown once in a year during November to January but consumed around the year. To facilitate the consumption around the year potatoes are stored in various means. Potatoes are traditionally preserved at home in small quantities. For large quantities traders and farmers are preserving potatoes in cold storage. There are total 380 cold storages in the country located mostly in potato cultivation areas having the capacity of

preserving 500,000 metric tons. There are four methods other than cold storages to preserve potato for off-season use.

1. Home storage - preservation in normal temperature at home.
2. Diffuse light store - storage built with reduced light.
3. Evaporative cooling store.
4. Community store - jointly by community people.

There are as many as 15-17 potato processing industries in Bangladesh and few more are in the making. These processing industries are producing starch, chips, crisps, French fries, flakes etc. Chips and crisps are also prepared domestically as well. Standardization and grading are important steps before processing the potato. Separating good potato from affected, spotted and sick ones are primary steps and then grouping them in various sizes based on its use facilitates both processing and preservation.

Potato has 2 to 3 months of natural shelf life provided those are kept in a cool place with utmost care. Hence, the produce kept outside the cold storage doesn't increase cost as that of preserved in cold storages. Efforts are underway to increase natural shelf life of potato to facilitate marketing up to a period of 3 to 4 months after harvesting. Traditional storages in the farmer's house may also be improved; for this the farmers are to be trained. Special attention must be given in storing potato particularly in keeping the produce in the same room where the members of farmer's family reside. It is harmful for both human and the potato to be in the same chamber.

Consumptions

Out of the total production of potato, about 74.50% is consumed by the domestic consumers mostly as vegetables. About 10-12% is preserved as seed potatoes while 4.25% is preserved in cold storages for off-season use, 1.07% is exported and only 0.15% is processed in various local industries (Fig. 5). Potatoes may also be kept frozen in the form of French fry or mashed potato to be consumed at a later time. It can also be dried in the form of potato powder, potato flakes, potato flour and chips. Potatoes can also be preserved in cans or tins besides direct consumption by cooking, boiling and grilling. Sumptuous snaking items and desserts are prepared from potatoes in various parts of world including Bangladesh. Potatoes can be used as additives with other food dishes too. Low cost potatoes can also

be used as animal feed.

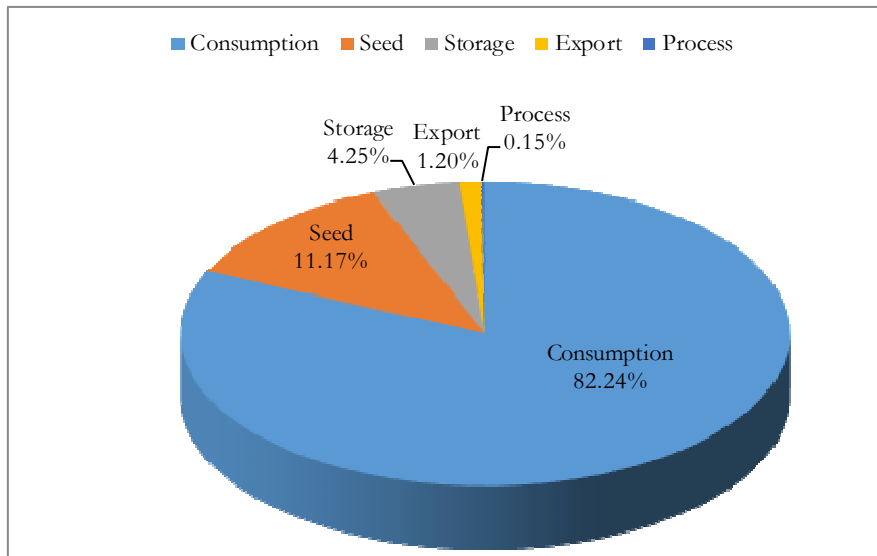


Fig. 5: Use of Potatoes

Growth of population in Bangladesh puts additional requirements of food while cultivable lands are decreasing in the country. This scenario shows that annually Bangladesh has to produce additional 0.274 million tons of food to maintain pace with the needs of population growth. The increased demand for food would have to be met with less land, less water, less labour and less pesticides due to increasing population and pressure on ever shrinking and degrading land and water resources. Food security is the major challenge for the government of a country like Bangladesh. To enhance the food security, potato strategy can be a viable and dependable option.

3.2. Strategies to enhance competitiveness in potato value chain

- Problems of potato cultivation and suggestions
- Tissue culture
- Rapid multiplication method (sprout cutting and top shoot cutting)
- Irrigation in right time

- Diversified use of potato
- Standardization and grading
- Preservation technology enhancements
- Business model for aggregator in the value chain

Problems of Potato Cultivation and Suggestions

A research carried out by Uddin et al. (2010) identified various problems of potato cultivation based on the observation of grassroots farmers. Problems of potato cultivation are given below in Table 6.

Table 6. The Major Problems of Farmers for HYV Potato Cultivation during 2008-2009

Items	Yes	Percentage and Rank	Mean	Std.
Non-availability of quality seeds timely	26	11.94(3)	21.60	7.29
High price of fertilizer	28	12.78(2)		
Lack of irrigation facilities and high cost	21	9.86(5)		
Lack of credit facilities	27	12.50(2)		
Insect pest and disease problem	29	13.33(1)		
Labor crisis	5	2.22(8)		
Lack of storage facilities	15	6.81(7)		
Marketing problem	19	8.89(6)		
Lack of cash capital	23	10.42(4)		
Others (specify if any)	24	11.25(3)		
Total	216	100		

Among the problems of potato cultivation (Table 6), ‘Insect-pest and disease’ tops in the ranking followed by ‘high price of fertilizer’, ‘non-availability of quality seeds timely’ and so on. Lack of quality seed, lack of cash money, higher price of inputs, lack of storage facility, lower price of product at harvesting period and lack of adequate labor in the production period are the major problems (Uddin et al., 2010).

Table 7: Suggestions to Overcome the Constraints for Potato Cultivation

Items	Yes	Percentage and Rank	Mean	Std.
Good seed	10	20(2)		
Fertilizer in cheaper rate	14	28(1)		
New HYV	14	28(1)		
Training	3	6(3)		

Withdrawal of old seeds	1	2(6)		
Powerful insecticide	2	4(4)	4.58	5.97
Timely availability of MV of needed crops	1	2(6)		
Government purchase center	1	2(6)		
Price should be increased at the time of harvest	2	4(5)		
High quality fertilizer and insecticide	1	2(6)		
Cultivate self -land	1	2(6)		
Total	50	100		

Suggestions and opinions, which were stated by the farmers to overcome the problems and increase the potato production indicated that ‘New HYV’ and Fertilizer in cheaper rate’ ranked 1st (jointly) while ‘Good seed’ (ranked 2nd) and ‘Training’ (ranked 3rd) were also identified as important suggestions (Table 7; Uddin et al., 2010).

Tissue Culture Technology

In Bangladesh, nearly 462,000 hectares of land produced 895,000 metric tons of potato in 2014 averaging 19.37 tons per hectare which is not conducive rate (Krishi Diary, 2014). Virus attack is the main cause of lesser/reduced production and degeneration of Potato. BADC and government sources provide only 5% of potato seed while 95% is served by the private growers. Seed potatoes used by the private growers are susceptible to virus attacks. Tissue culture technology has the remedy to such vulnerabilities and degenerations. It also helps in achieving rapid growth of potato. ‘Nucleus seed’ and ‘minituber’ can be produced using this technology (Hossain et al., 2008). Virus free Invitro-plantlet or aphid free micro-tuber sprouted in a net bag for the first time to have the seed potato is known as mini tuber or nucleus seed potato. It’s an intermediate stage of developing mini tuber in laboratory and breeders seed potato production in the field. This mini-tuber has two methods i.e. mini-tuber from Invitro-plantlet and mini-tuber from micro-tuber.

Rapid Multiplication Method

This method can be applied in two different form: sprout cutting and top shoot cutting. For sprout cutting the seed potato should be taken out of cold storage at least before 40-45 days and then kept in a dark chamber for 30 days and rest 15 days under a shadow. In this process a single potato may deliver 4-7 shoots of 2-5 cm length having further 3-5 branches. Those should be placed for germination in a sand bed for 4-7 days for obtaining seedlings of 4-7 cm length. The other method ‘top shoot cutting’; top shoots

of 3-5 cm length to be extracted by cutting after 20-25 days of plantation. From a single plant one can extract shoots every after 10-12 days. This shoots are treated with Butyric Acid and Naphthalene Acid before planting it in a sand bed.

Irrigation System

Potato cultivation needs proper nursing and intimate care. The root of potato does not go deep into the soil as such adequate watering is essential. Absolute wet or dry soil is not conducive for production/cultivation. It is also prescribed that the water should be used from subsurface sources. Arrangements for draining out excess water are essential. Depending on the weather and type of soil, irrigation is required at least 3 to 4 times as follows in Table 8:

Table 8: Suggested Irrigation Schedule

Number of Irrigation	Period/ Stage	Prescribed gap
First	Germination	Immediately after plantation of seed
Second	Stallone	After 25-30 days
Third	Growth	After 40-45 days
Fourth	Maturity	After 60-65 days

Diversified Use of Potato

Potato plays an important role in meeting the food and nutrition requirement throughout the world. Potato is a very cheap and easy source of calories. In a country like Bangladesh lands are scarce, while the population is increasing rapidly for which production of food grains/crops need to be increased. If the consumption of potato could be diversified other than as vegetable, the load on other food grains can be reduced. The mis-conception of higher calories in potato should be eliminated before making any venture in using potato as substitute. Currently, per head potato consumption in Bangladesh is about 40 kg/person. (Abdullah et al., 2008). A comparative state of various ingredients of rice, wheat and potato are shown in Table 9.

Table 9: Comparative State of Ingredients of Potato, Rice and Wheat

Ingredients	Potato (1kg tuber)	Rice (250 gm)	Wheat (250 gm)
Calories	970	865	900
Carbo-hydrate	226	198	174
Protein	16	16	30
Oil	0.9	1.0	4.3

Fibre	4.3	0.5	4.8
Minerals	6.0	1.8	6.8
Calcium	100	23	120
Phosphorus	400	358	1065
Iron	8	8	8
Vitamin A	240	0	73
Thiamine	1.00	0.5	1.23
Riboflavin	0.10	0.13	0.73
Niacin	12	10	11
Vitamin C	143	0	0

Source: (Abdullah et al., 2008)

Potato can be consumed in many other forms such as;

- Frozen form such as French fry, mashed potato.
- Dried potato like mashed potato powder, potato flakes, potato flour, chips, crisp.
- Direct consumption by cooking, boiling and grilling.
- Preserving in cans/tins.
- Snaking items and desserts.
- Used as additives with other food dishes.
- Used as animal feed.

During the harvesting period price of potato remains low and as such potato for processing should be purchased at that period (Abdullah et al., 2008).

Standardization and Grading of Potato

Standardization and grading of potato is missing in Bangladesh. Standardization means separating good potato from affected ones and grading means grouping them into various sizes. Grading facilitates in selecting the right kind/size for right purpose/use. Standardization and grading helps everyone in the value chain starting from the grower/producer to the consumer. In Bangladesh, major portion of the potatoes are consumed domestically as vegetable. Hence, potato lower in grades and smaller in size can be utilised at a lower price. When a trader or grower can segregate bigger and better sizes then those will have sold at a much higher price; because those will be exported or processed and used as seeds. Grading may be done as follows:

- For export and processing 40-90 mm sizes and above.
- Medium size for seed potato i.e. 28-40 mm and 41-55 mm.

- For direct consumption, smaller sizes that does not fall in upper categories.

The grading can be done by two methods i.e. by using trays of desired sizes and by using filters (net). Through grading potatoes are classified and price is fixed accordingly. Smaller sizes can be sold at lower price thus the domestic consumers will be benefitted (Hossain and Ali, 2000).

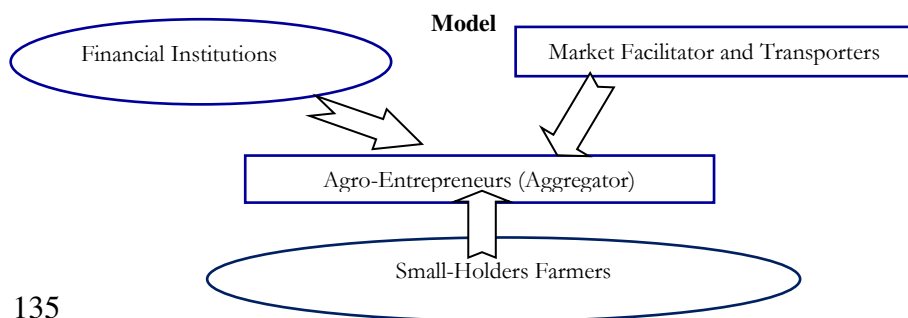
Preservation Technology Enhancements

For the last couple of years, thousands of potato farmers of Bangladesh have been facing huge losses due to various factors, including low demand and a shortage of preservation facilities. Potato preservation demands certain special care as it is very sensitive to put it in a longer period. For a healthy preservation, potato plants should be pulled out of the soil leaving the potato under the soil for 7-8 days. Thereafter, harvesting and cleaning should be done carefully so that potatoes are not injured anyway. Desired temperature and humidity must be maintained in the cold storage to prevent potatoes from getting spoiled or squeezed. Thinly knitted jute sacks to be used for potato packaging so that sufficient amount of air can pass through it. Cold storages must be clean and hygienic having separate chambers for pre-heating and pre-cooling. Potatoes designated for preservation should be kept in pre-cooling room at 2-4-degree temperature for 48-72 hours. Similarly, before taking out the preserved potatoes in normal atmospheric temperature the produce should be pre-heated at 15-18 degrees for 48-72 hours. Even after that the potatoes from cold storages should be kept under shadow and in relatively cool place (Hossain and Ali, 2000).

Business Model for Aggregator in the Value Chain

To improve the competitiveness of the potato value chain another strategy could be promoting agro-entrepreneurs as aggregators. These breed of agro-entrepreneurs, will be key in solving the current issues and challenges in potato value chain. Fragmented cultivation in small and dispersed fields/farmers with low productivity levels reassures big companies and village catalysts to influence small farmers. Hence, small farmers should be organized in a manner that it becomes expensive for large companies and catalysts to provide direct services to many small holder farmers to materialize their ill motives of making large profit depriving the poor farmer. This will dispirit side selling tendency of small holder farmers and

access to rural finance to support the chain operations and expenses. The aggregators will make it costly and risky for large companies and catalysts to establish agreements to provide inputs now, procure later. This will rather facilitate banks and financial institutions to finance farmers in these value chains at a much lower rate and convenient terms. The model should focus on working with 100 to 500 progressive, small holder farmers, and eventually growing to 1,000 and even over with good management where applicable. The agro-entrepreneur should ideally be a leading producer in the commodity, or a can be risk taking enterprise, or acting for/or a larger agribusiness. The agro-entrepreneurs also act as conduits for agricultural finance to smallholder farmers from the financial institutions. The aggregator should be financially stable and should have made profits in the previous years of being in business. They should also have the belief in building shared values with farmers and other actors along the chain which will translate to good business for aggregator and the others actors too. High performing agro-entrepreneurs, including social entrepreneurs, can be effective partners in increasing the probability of small farmers' success and repayment of loans. It is important to note that the agro-entrepreneurs should have solid track record of commercial agro-enterprise operations including stable record of procuring from small producers and providing or organizing the needed mix of technical and input supply services, strong management and organizational skills. Aggregator should be able to put the pieces together for a growing number of small farmers, committed to adding value to small farmers in ways that will increase their productivity, quality and earnings. Ability to justify to the financial institutions about its work to establish cost effective partnerships will boost the confidence of small farmers. This model has been successfully tried and implemented in Kenya and contracted successful large scale farmers who have doubled up their benefits. In some parts of Kenya, the model has also been implemented by established producer associations who aggregate and market the produce collectively to processing companies and also to traders targeting the fresh produce markets in Nairobi (Seigi et al., 2014).



4. Conclusion

A value chain is a chain consisting of the input suppliers, producers, processors and buyers that bring a product from its conception to its end use. A value chain approach to development seeks to address the major constraints at each level of the supply chain, rather than concentrating on just one group (e.g., producers) or on one constraint. Constraints often include a lack of technical, business or financial support services, lack or a difficult regulatory framework, poor public infrastructure, a lack of information about end markets, and/or inadequate coordination between firms. A study of potato value chain analysis and development in Ethiopia outlined 'Constraints in potato value chain and suggested solutions' (Emana and Nigussie, 2011) are also applicable for Bangladesh and those are attached as Table 10. To conclude, combating with the above bottlenecks and implementing strategic measures of competitiveness along the potato value chain will be vital in poverty alleviation which will help in transforming potato subsistence production to market oriented production.

Government to partner with financial institution and private entrepreneur to enable the farmer's affordability in quality inputs, storage facility, technological support and advisory support. Government should also provide soft loan and assistance in the form of providing fertilizer, pesticides, fumigation, phytosanitation treatments/tests and facilitating exports. Food diversification and enforcement of grading and standardization should also be pursued by government. Standardization and grading of potato would enhance and benefit all stake holders along the potato value chain.

Table 10: Constraints of Potato Value Chain & Suggested Solutions (Emanaand Nigussie, 2011)

Constraints in potato value chain and suggested solutions

Potato Value Chain Functions	Constraints	Possible Interventions by the project
Input Supply (Seed Potato)	Impurity of potato seed (high dormancy, mixed variety)	<ul style="list-style-type: none"> Creating awareness about seed potato production, sorting, grading, quality control, Support Construction of Affordable DLS; establish and introduce potato seed certification and distribution mechanisms
	Lack of improved potato variety	<ul style="list-style-type: none"> Establish seed potato producing farmers groups, cooperatives; Strengthen capacity of research centers engaged in Potato variety development
	Absence of formal potato seed supply	<ul style="list-style-type: none"> Set-up suitable potato seed supply system involving relevant stakeholders; Create market linkage between potato seed producers and buyers
	Use of small size potato for seed	<ul style="list-style-type: none"> Teach farmers on merits and demerits of using small size potato; Advise producers on proper potato seed size to use and demonstrate on farmers plot
Input Price (Seed Potato)	Exorbitant potato seed price	<ul style="list-style-type: none"> Increase potato seed multiplication centers
Input(Fungicide)	Lack of know-how on fungicide application to potato by producers	<ul style="list-style-type: none"> Train potato producers on appropriate application of fungicide to potato
Input supply (Fertilizer)	Adulteration of fertilizer by private traders	<ul style="list-style-type: none"> Put in place good M & E system to check for expiry date of chemical fertilizers; Awareness raising for farmers about fertilizer quality
	Low awareness of the optimum fertilizer rate on Potato	<ul style="list-style-type: none"> Teach farmers on effect of using fertilizer below recommendation rate ; Advise on proper rate to use and demonstrate on farmers plot impact of using appropriate rate
	Untimely supply of fertilizer	<ul style="list-style-type: none"> Strictly follow cropping calendar in agricultural input supply Teach input supply planning for input suppliers at various levels Advocate for consideration of irrigated cropping in input supply planning and delivery
		<ul style="list-style-type: none"> Introduce quality based pricing
	Poor road to access rural potato growing areas	<ul style="list-style-type: none"> Construct feeder roads; Support community to construct cost effective feeder roads
	High transport cost	<ul style="list-style-type: none"> Mobilize group sells to achieve economies of scale
	Inadequate ware and seed potato storage facility	<ul style="list-style-type: none"> Establish DLS for seed potato and suitable storage for ware potato as well
	Lack of weighing scale at rural areas	<ul style="list-style-type: none"> Avail standard weigh scale at affordable price
Production		
	In adequate potato management practice	<ul style="list-style-type: none"> Train producers on appropriate potato management practice;
	Late blight diseases, rodents, termites attack on potato	<ul style="list-style-type: none"> Develop appropriate harvesting technology; Train farmers on appropriate time of potato planting in different locations
	High perishability of potato	<ul style="list-style-type: none"> Introduce modern potato transportation equipments; Create SME and Producers partnership for manufacturing and marketing of potato transportation equipments

Challenges and Strategies to Improve Potato Competitiveness along with Potato Value Chain in Bangladesh

Ware Potato Marketing	Large number of brokers in the market	<ul style="list-style-type: none"> • License the brokers; • Provide business ethics training
	Lack of real time market information	<ul style="list-style-type: none"> • Create access to market information • Support Potato price information provision through FM radios to producers
	Lack of suitable transportation equipments	<ul style="list-style-type: none"> • Manufacture suitable potato transportation equipments; • Awareness creation of transporters and others involved on the issue
Potato Processing	Lack of potato processing technology	<ul style="list-style-type: none"> • Establishing factories that use potato; • Encourage establishment of SMEs on potato processing; • Expand potato production and create awareness and linkage
	Lack of awareness on potato value addition through processing	<ul style="list-style-type: none"> • Introduce potato processing facilities; • Promotion on potato processing and value addition through processing
	Small sized potato is not convenient for processing to consume at household level	<ul style="list-style-type: none"> • Introduce potato value addition by introducing knowledge like using it for livestock feed; • Promotion to large scale processors on processing potato to extract starch from it
Potato Consumption	Cereal based food habit	<ul style="list-style-type: none"> • Campaign on changing food habit to vegetables and fruits from predominant cereals based;
	Limited knowledge on recipes/dishes that could be made from potato by consumers	<ul style="list-style-type: none"> • Introduce home economics education to farmers and consumers;
	High potato price at slack production season (e.g. April-May)	<ul style="list-style-type: none"> • Increase efficiency of potato marketing; • Establish good ware potato marketing and distribution system
	Taste and preference variability by location	<ul style="list-style-type: none"> • Communicate consumers preference to producers; • Improve potato extension system
	Potato could not be stored in the soil for long period and consumption is limited to only 2 - 3 months	<ul style="list-style-type: none"> • Establish ware potato stores at strategic locations
Trading	Lack of proper potato sorting facilities	<ul style="list-style-type: none"> • Training to farmers and traders on potato sorting ;

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