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## Article

# Analyzing the value chain for vegetables in the North-Eastern part of Bangladesh

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## MARKETING | RESEARCH ARTICLE

# Analyzing the value chain for vegetables in the North-Eastern part of Bangladesh

Md. Mostafizur Rahman<sup>1,2\*</sup>, Swarup Barua<sup>1</sup>, Deyi Zhou<sup>2</sup>, Teng Li<sup>2</sup> and Md. Shaikh Farid<sup>1</sup>

**Abstract:** This paper aims to explore the value chain of vegetables with the explicit objectives of observing actors' performance in the chain and examining vegetable supply factors in the market. The primary data were gathered from 150 value chain actors in the North-Eastern part of Bangladesh, using simple random and purposive sampling techniques. The major actors were input suppliers, producers, local traders (*Paiker-1/Bepari*, *Arathdar*, and *Paiker cum retailers*), and retailers. Input supply, production, marketing, and consumption were the typical value chain activities. Before reaching the end-users, a minimum value has been added to the products. A local trader named *Paiker-1/Bepari* governed the chain. They had a capital advantage over the other traders. The regression models' outcomes showed that marketable supply was significantly affected by the quantity of production and distance to market in tomato, cabbage, and cauliflower. However, in the case of beans, it was considerably affected by output, remoteness from the marketplace, and access to training.

**Subjects:** Agriculture and Food; Supply Chain Management; Marketing Management

**Keywords:** vegetables; value chain; market supply; Bangladesh

## 1. Introduction

A value chain is the complete series of actions that generate and shape value at every step of any product. The total quantity provided by the farm is the total amount made up all over the farm. It can also be demarcated as a set of actors and an a planned system (Donovan et al., 2015). It is made up of a chain of actors, from input providers, producers, and processors, to exporters and customers involved in the events essential to transport the agricultural produce from its beginning to its final usage (Kaplinsky & Morris, 2001). Vegetable value chain analysis is crucial as an a systematic method for understanding the policy environment, which organizes resource allocation inside the domestic economy, despite its predominant usage as an analytic tool for understanding how farms and countries participate in the global market. Vegetable farming is becoming ever

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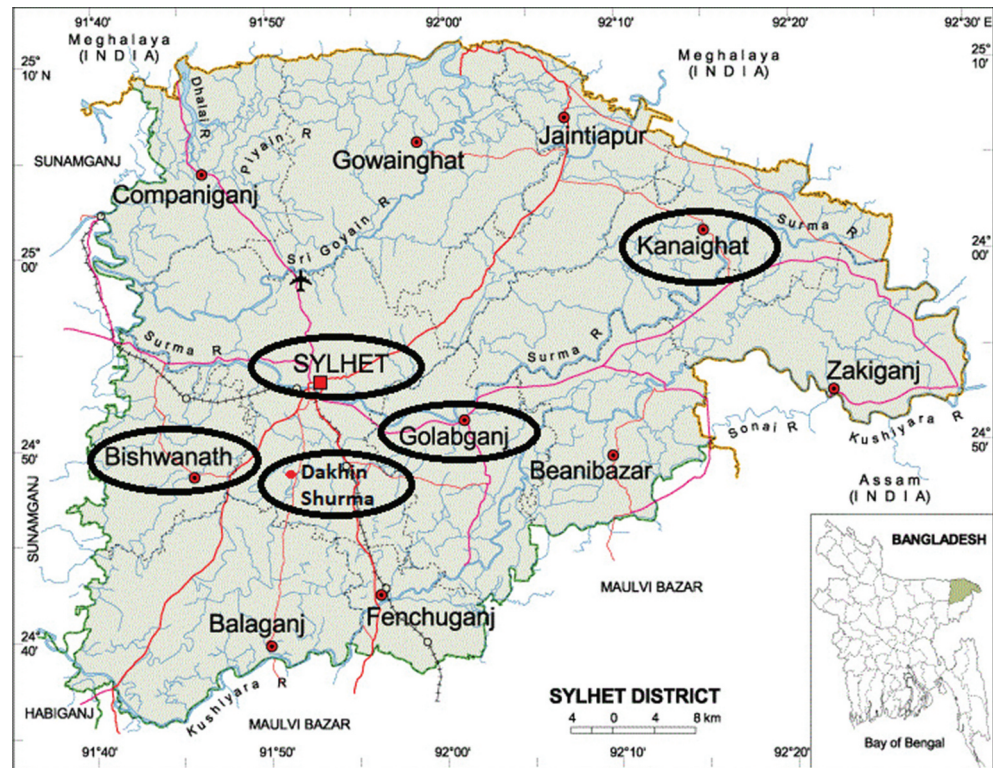
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more of an imperative activity in the agricultural sector of Bangladesh following the expansion of irrigation and the amplified significance set by the government for small-scale commercial growers. According to the Bangladesh Bureau of Statistics (BBS), around 14,616 thousand tons of vegetables were produced (including potatoes) across Bangladesh in the 2020–21 fiscal years (BBS, 2022). Although a tiny portion of cultivable lands is being used for vegetable cultivation, its production has significantly risen (38.30%) in last ten years (BBS, 2017, 2022). Almost 28 thousand acres of land in the Sylhet region (one of the major vegetable production areas in Northeast Bangladesh) were brought under winter vegetable cultivation in 2018–19 and harvested for about one hundred and fifty thousand metric tons (BBS, 2019). Although there are field management and marketing problems, vegetable farming in the Sylhet region has advanced promptly over the preceding ten years (Rahman et al., 2020). Wintertime vegetables include cabbage, tomato, cauliflower, brinjal, carrot, spinach, bottle gourd, bush bean, and radish. Okra, heat-tolerant tomatoes, eggplant, carrots, spinach, and many green vegetables are produced year-round. Winter vegetables are grown from mid-October to March. Once upon a time, vegetable farming was considered subsistence farming, but at present, it has switched to commercial agriculture. This sector involves millions of resource-poor farmers who ensure critical livelihoods, sustainable agriculture, and economic stability. Though vegetable production and marketing is a profitable business in general, the problems are associated with each node in the value chain.

According to the research findings of Katalyst, more than twelve percent of the rural inhabitants are engaged in this sector, and over a million are female laborers. Besides, many females in rural regions are involved in homestead vegetable farming (Katalyst, 2014). Branching out into vegetable crops and increasing commercialization can help maintain the agrarian sector's development in several ways (Weinberger & Genova-II, 2005). This subsector also generates cash income and creates employment opportunities. A colossal bulk of vegetables is transported daily to different parts of the country, including the capital city of Dhaka, from the North-East region. In recent years, growers have brought vast acreages under vegetable farming in new areas like Tukurbar, Lamakazi, Rakhalganj, Kamalbazar, and Lalabazar of Dakshin Surma and Sylhet Sadar Upazila (M. A. Karim,).

(New para) Value chain analysis outcomes have been used to plan market-oriented associations and value chain advancement tactics that are beneficial to marginal growers in developing nations (Purcell et al., 2008). The researchers have gained some insights into the value chain and supply determinants. Hoq conducted a study on value addition in vegetables and calculated the per hectare value-adding for snake gourd, cowpea, and bitter melon by Bangladeshi farmers (Hoq et al., 2012). Akter also researched the value chain of potatoes in Bangladesh and found that value chain players like *Faria*, *Bepari*, wholesalers, retailers, and cold storage owners were tied up in the production and marketing system (Akter et al., 2016). Islam analyzed network arrangements of the value chain and found that agroforestry and timber marketing controlled several intermediaries, improving value-adding and forming high marketing margins on harvests (Islam et al., 2014). Vasishi examined the price behavior in fruit and vegetable markets, and increased volatility in the prices of fruits and vegetables in significant markets was observed (Vasishi et al., 2008). Senyolo (Senyolo et al., 2018) researched the value chain for African leafy vegetables. He found that the relationships among the value chain actors were weak. Endris identified some factors in the Ethiopian vegetable market supply (Endris et al., 2020). A couple of current research projects on value chain analysis of vegetables have been identified in India (Das & Roy, 2021), Indonesia (Wiryawan et al., 2020) and Guatemala (Amaya et al., 2020). In addition, some investigation on the vegetable export value chain (Ajwang, 2020), its future and recent developments (Fernqvist & Göransson, 2021), gender analysis in the vegetable value chain (Fischer et al., 2020), and COVID-19 impact on vegetables and fruits value chains (Hirvonen et al., 2021; Ravi Kumar & Babu, 2021) has been conducted, but to the best of our information, there is no specific study on the value chain and supply determinants of vegetables in the North-eastern part of Bangladesh. This research analyzed the vegetable value chain within the region, from input supplier to consumer. It gives an all-encompassing picture of existing challenges, openings, and section focus within the vegetable

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



value chain. Additionally, this research delivers data on marketing margin, profit share of actors, and the factors of vegetable supply to the market.

## 2. Materials and methods

Both descriptive and analytical models based on primary data were used in this research. Questionnaire and observational methods were employed to collect the data. Dakshin Surma, Kanaighat, Golapganj, and Sylhet Sadar Upazila in the North-Eastern Sylhet district of Bangladesh were carefully chosen, keeping in attention the purposes of the research (Figure 1). In 2018, Data were collected from 100 producers and 50 traders, designated by simple random and purposive sampling method by using a face-to-face interview process and examined using STATA 14. The analytical techniques that were used in this study are as follows;

### 2.1. Analytical techniques

#### 2.1.1. Value chain performance analysis

Assessments of the marketing margins are the finest tools to examine the performance of the market. Marketing margin was premeditated by differences in the middle of producers and retail prices. The producers' share is a usually engaged ratio calculated arithmetically as the ratio of producers' price to consumers' price. The mathematical expression of producers' share can be articulated as:

$$PS = \frac{P_p}{C_p} = 1 - \frac{MM}{C_p}$$

Where PS = Producer's share; P<sub>p</sub> = Producer's price; C<sub>p</sub> = Consumer price; MM = marketing margin.



Computing the aggregate marketing margin was accomplished by the following formula. This equation expresses that a greater marketing margin reduces producers' share and vice versa (Acharya & Agarwal, 1987). It likewise delivers a signal of benefit-sharing between production and marketing mediators. Calculating the Total Gross Marketing Margin (TGMM) is always linked to the ultimate price paid by the end customer and is stated as a percentage (Mendoza, 1995).

$$TGMM = \frac{\text{Consumer Price} - \text{Producers Price}}{\text{Consumer Price}} \times 100$$

Where TGMM = Total gross marketing margin.

Net Marketing Margin (NMM) is the percentage over the ultimate price received by the intermediary as his net income once his marketing costs are subtracted. The calculation expresses that a higher marketing margin reduces the producer's share and vice-versa. It also delivers a sign of welfare distribution among production and marketing agents.

$$NMM = \frac{\text{Gross Marketing Margin} - \text{Marketing Cost}}{\text{Consumer Price}} \times 100$$

An efficient marketing system is where the net margin is near reasonable profit. Higher NMM or profit of the marketing mediators imitates reduced downward and prejudicial income distribution, which reduces market involvement of smallholders. To this extent, it is likely to see the allocative efficiency of markets.

The same concept was employed with modifications to determine each actor's portion of the benefit. The marketing margins and net margins of intermediaries were estimated by using the following formulation (Acharya & Agarwal, 1987):

i) Gross marketing margin = Sale price—Purchase price

ii) Net marketing margin = Gross marketing margin—Marketing cost

iii) Return on investment =  $\frac{\text{Net margin(Tk./quantity)}}{\text{Total operating capital(Tk./quantity)}} \times 100$

### 2.1.2. Market supply model

A multiple linear regression model was used in this research to examine factors affecting farm-level vegetable market supply. This model was also carefully chosen for its ease and applicability (Greene, 2000). The econometric model arrangement of supply function in matrix notation was the following.

$$Y = \beta X' + U$$

Where Y = amount of vegetables market supply; X ' = a vector of explanatory variables = a vector of parameters to be assessed; U = error term.

*Hypothesis, variable selection, and definition.* In the progression of finding factors persuading vegetable market supply, the key task was to explore those factors which had a possible effect and in what way (the direction of the relationship) those factors were connected with the dependent variable.

*The volume of vegetable sales (VVS).* VVS was a continuous dependent variable considered in the multiple linear regression models. It embodied the market's definite supply (in kilogram) by vegetable farmstead.

*Age of household head (Age).* The household head was measured in years as a continuous independent variable. Elder households were supposed to be sensible in resource usage; instead, young household chiefs have extended investment horizons, and it was anticipated to have either positive or negative consequences on the volume of vegetable sales. Teka found that the household head's oldness negatively impacts the elasticity of the onion market supply (Teka, 2009).

*Distance to nearest market (DMkt).* DMkt was the remoteness of the vegetable producer households from the adjacent market. It was measured in hours of walking time as an independent variable. The nearer the marketplace, the smaller would be the marketing costs. It also ensured better access to market information and facilities. Distance to the nearest market in this study area was assumed to affect the volume of vegetable sales adversely. Tokkon studied a comparable matter on the fruit market in Gomaworeda. He acknowledged that poor market access significantly and negatively affects the amount of avocado and mango supplied (Tokkon, 2011).

*Access to training (ATr).* It was a continuous independent variable taking a value of the number of training days. It is expected that access to training widens the household's knowledge concerning the use of improved technologies and positively impacts vegetable sale volume. Therefore, this variable was hypothesized to positively influence the magnitude of vegetable sales. Tokkon found that if a fruit producer gets an extension, the number of fruits supplied to the market increases (Tokkon, 2011).

*Education of the household head (Educ).* Education was measured in years of schooling as a continuous independent variable. Education widens farmers' aptitude and allows them to accomplish farming professionally. Besides, better-educated growers tend to be more innovative and are more likely to embrace the marketing systems. Formal teaching improves the farmer's information attainment and alteration capabilities (Fakoya et al., 2007). As a result, this variable was assumed to positively influence the size of vegetable sales. Takele examined that if paddy producer becomes educated, the quantity of paddy supplied to the market rises, which proposes that schooling increases the level of sales that affects the marketable surplus (Takele, 2010).

*Vegetable farming experience (VFExp).* VFExp was the number of years a grower stays in producing vegetables. Better practiced farm household was anticipated to produce supplementary amounts of vegetables and predictable to supply additional portions of vegetables to market (Tokkon, 2011). So, it was assumed that this variable might positively influence the marketable vegetable surplus.

**Quantity of vegetables produced (QPron):** This continuous variable was projected to influence the market supply positively. It was measured in kilograms. Weldeclassie, Teke and Tokkon identified that the amount of tomato, avocado, papaya, and mango production has significantly augmented marketable supply (Teka, 2009; Tokkon, 2011). A marginal increase in vegetable production has an apparent and significant effect on moving market supply. So, this variable was imagined to impact the marketable surplus positively.

*Family size (FS).* The family size of farming households was a continuous variable. As vegetable farming is labor-intensive, it in general and market supply of vegetables in specific is a function of labor. Therefore, families with additional members tend to have more workforce, raising vegetable production and market supply. On the other hand, family size may also decrease market supply because of increased family consumption. But for this research, the family size was projected to positively influence the capacity of vegetable market supply. Ambaw conducted a value chain analysis on groundnut and found that family size positively influences the households' gross income (Ambaw, 2019).

### 3. Results

#### 3.1. Demographic characteristics of sample households

This research sampled one hundred farm respondents and fifty traders as the total sample size. On average, 80% of the total sample households were nuclear family type, and the household head's age was 42 years. Only one-fourth of the sampled growers were literate. The regular family size of the total sample of respondents was found to be six persons. On average, only 15% of sample farmers had off-farm earnings, and most had experience in vegetable cultivation (nearly 18 years of average involvement). On average, 58% of sample traders had no formal education and almost 90% had at least five years of experience in the business.

On the other hand, maximum traders were in their middle age. The proficiency of vegetable farming in the five Upazila significantly differed at a 10% significance level. The sample respondent had more than two operational persons in their family. The sample respondents of Sylhet district practiced value-adding activities and multiple crop cultivation in the winter. On average, 67% and 43% of respondents practiced considerable crop cultivation and value-adding activities, respectively. Among the five Upazila, farmers of Dakshin Surma practiced more value-adding moves (Table 1).

#### 3.2. Value chain analysis

##### 3.2.1. Actors and their role in the vegetable value chain

The value chain map (Figure 2) emphasized the participation of diverse players who contributed to the value chain. Certain players were involved in profit-making activities in the chain (producers, input suppliers, traders, consumers). Some actors delivered financial or non-financial support facilities, such as credit assistance, commercial facility providers, government, cooperatives, NGOs, researchers, and extension agents. The successive measures of different marketing intermediaries involved in the movement of vegetables from growers to the ultimate consumers are shown in Figure 3.

*Direct or primary actors.* Input suppliers, growers, traders, and consumers were the primary actors in the vegetable value chain. Every single actor enhances value to the progression of shifting the product title. More than one actor performs some functions or roles, and some actors portray more than one part. Many actors were directly or indirectly engaged in input supply at this value chain point. Private vendors, research institutes, NGOs, and DAE (Department of Agricultural Extension) are the primary sources of input supply. All such players were accountable for providing agricultural inputs like better-quality seed varieties, herbicides, fertilizers, insecticides, and farm equipment, vital inputs at the production phase. Vegetable producers were the key actors who performed the value chain tasks right from farm inputs preparation on their farms or obtaining farm inputs from other sources to post-harvest management and marketing. Vegetable growers carry key value chain roles: land preparation, fertilization, planting, irrigating, pest controlling, weeding, harvesting, and post-harvest management. The varied agro-climatic environments can make growing vegetables considerably cost-effective and competitive, making enormous prospects available in study areas. Unfortunately, growers have not achieved opportunities due to the lower price they obtained for their harvest in the markets, along with the cost of post-harvest losses. Another imperative key actor was locally called *Paiker-1/Bepari*. They were assembly-market traders who collected vegetables from producers in village markets and farmhouses to resell them to *Paiker* cum retailers and retailers. They used their funds and local understanding to bulk vegetables from the adjacent area. They performed a crucial role and did know regions of surplus well. *Paiker-1/Beparies* were the important players in the vegetable value chain. They were accountable for trading vegetables from production areas to *Arath* (where purchasing and selling roles have been executed in the active control of *Arathder*) and retail markets in the study areas. The trading activities of *Paiker-1/Beparies* include buying and assembling, repacking, sorting, transporting, and selling to *Arath* markets. *Arathder*, the important primary actor in the vegetable

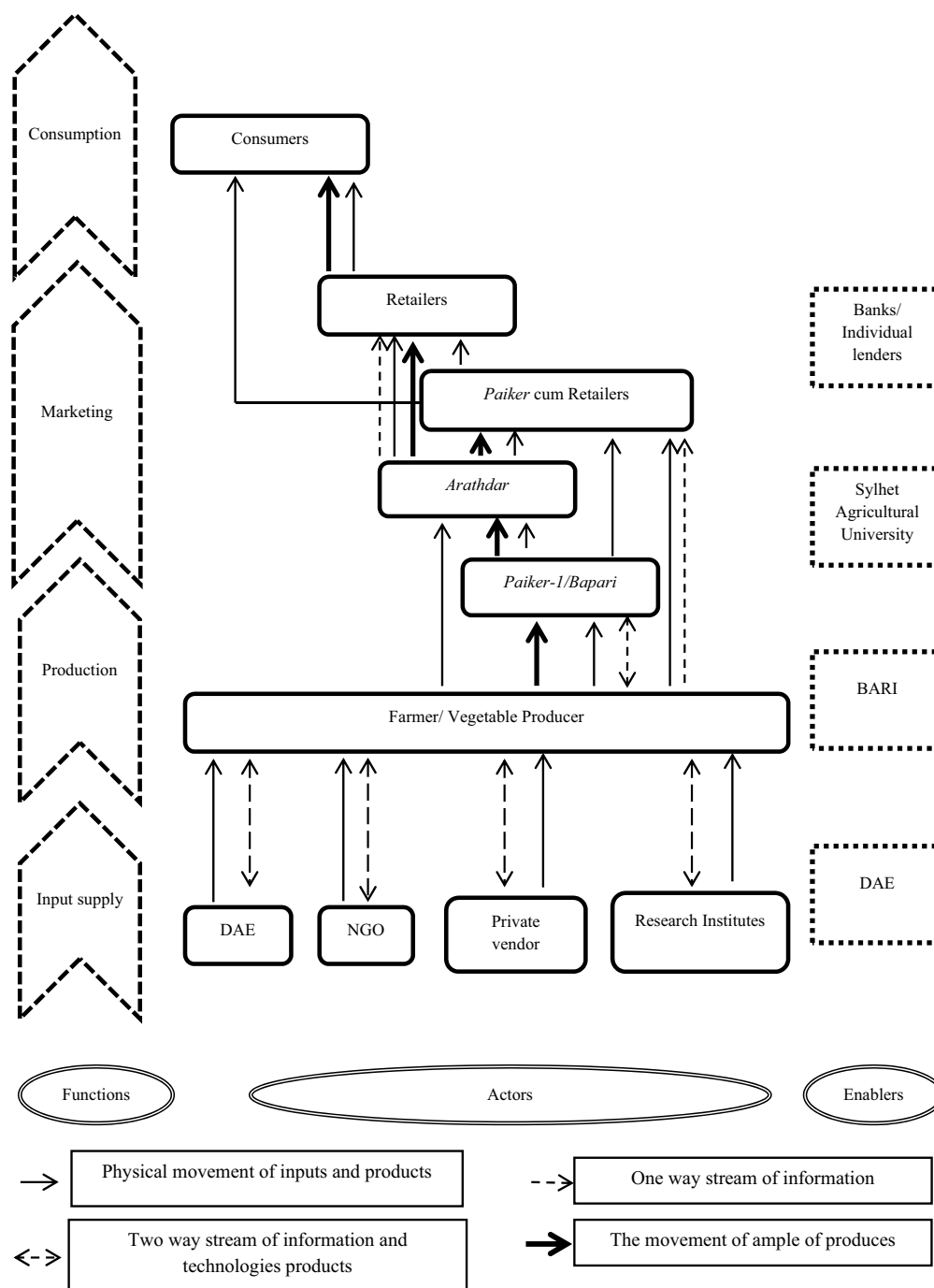


**Table 1. Number of crop cultivated and value addition by vegetables producers in Different Upazila**

Variables	Items	Biswanath	Dakshin Surma	Golapgonj	Kanaighat	Sylhet Sadar	Total	$\chi^2$ -test
Number of crop cultivated	Sole	6 (30)	7 (35)	6 (30)	6 (30)	8 (40)	33 (33)	0.72
	Multiple	14 (70)	13 (65)	14 (70)	14 (70)	12 (60)	67 (67)	
Value adding	Yes	10 (50)	11 (55)	8 (40)	6 (30)	8 (40)	43 (43)	3.10
	No	10 (50)	9 (45)	12 (60)	14 (70)	12 (60)	57 (57)	

N.B: Numeric value in the parenthesis indicates the percentage.

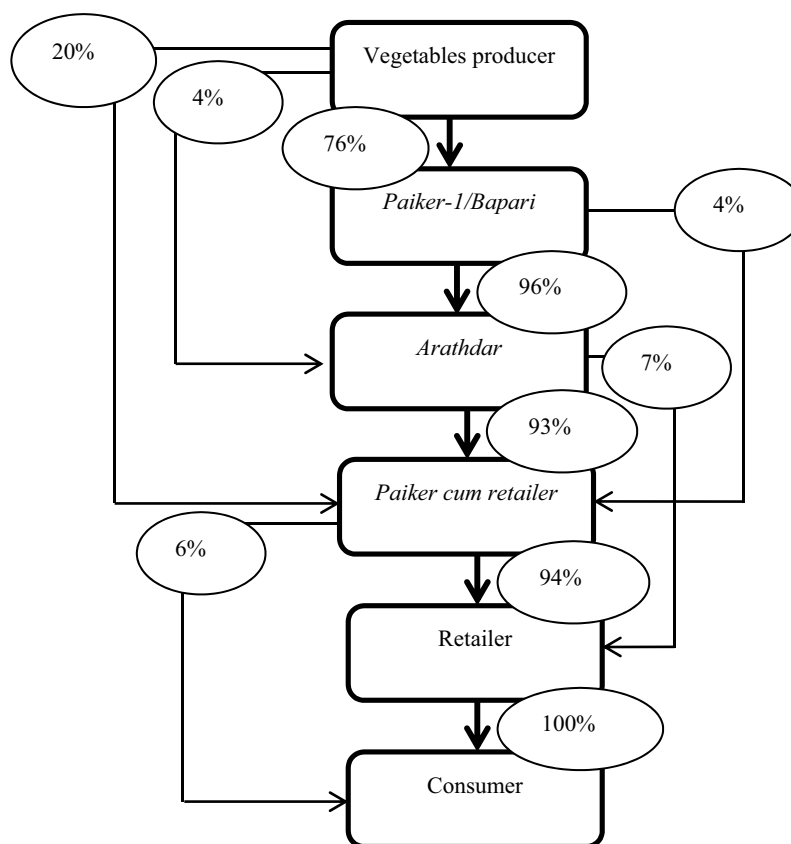
**Figure 2. Vegetables value chain map in North-Eastern part of Bangladesh.**



value chain, were big licensed traders. They played an essential role in vegetable marketing. All the *Arathdar* were full-time traders, and they had a fixed establishment. They have permanent staff, and actually, they served as a commission agent.

On the other hand, *Paiker* cum retailers are mainly involved in buying vegetables from *Beparis* in *Arath* market and producers and supplying them to retailers and consumers. Lastly, retailer participation in the chain consists of purchasing vegetables, carrying to retail shops, grading, putting them on the show, and selling them to consumers. They were the last link among

**Figure 3. Vegetables marketing channels in North-Eastern part of Bangladesh.**



producers and consumers in the value chain. Retailers generally purchased from *Paiker* and sold to city consumers. Occasionally they could directly purchase from the farmers. Concerning the requirement and purchasing power, consumers typically buy the produces from retailers as they offer. In general, three categories of vegetable consumers were identified. They were households, restaurants, and institutions which provide services such as higher education institutions, hospitals, etc. The private consumers were employees and urban and rural dwellers who bought and consumed vegetables. Institutes like hospitals purchased their product from *Paiker cum retailer* who could supply centered on contractual settlements.

*Indirect actors.* Department of Agricultural Extension (DAE), Sylhet Agricultural University (SAU), Bangladesh Agricultural Research Institute (BARI), and other NGOs were the primary sources of training and extension in the study area. The survey outcome showed that 48%, 14%, 7%, and 3% of sample respondents took part in vegetable production training, fertilizer application training, post-harvest handling, and vegetable marketing training offered in the preceding three years, respectively. The survey result displayed that maximum institutional training was given on vegetable production techniques, and the other activity was not given in a minimum range. Moreover, 98% of the sample farmers have taken extension services. In the study area, government banks, NGOs, and moneylenders have been recognized as prospective sources of finance.

### 3.2.2. Value chain governance

The leading value chain players performed facilitation roles. They regulate the level of prices and the movement of supplies. They direct the value chain, and most other chain actors pledge to the directions fixed in the marketing practice. The study outcomes indicated that the *Paiker-1/Bepari*

**Table 2. Market performance of vegetables in terms of marketing cost with respect to the share of actors**

Cost items	Tk. per 100 kg			
	<i>Paiker-1/Bepari</i>	<i>Arathdars</i>	<i>Paiker cum retailer</i>	<i>Retailer</i>
Transportation	43.30 (19.48)	-	32.45 (25.61)	38.50 (21.11)
Commission ( <i>Arathdar</i> )	115.00 (51.75)	-	-	-
Storage	1.06 (0.48)	4.90 (15.27)	10.05 (7.93)	5.05 (2.77)
Wastage	20.40 (9.18)	2.30 (7.17)	25.50 (20.13)	30.50 (16.73)
Wages and salaries	16.43 (7.39)	5.67 (17.67)	16.85 (13.30)	8.50 (4.66)
Market toll	3.00 (1.35)	1.50 (4.68)	8.05 (6.35)	16.85 (9.24)
Rent and electricity	7.50 (3.37)	2.90 (9.04)	4.02 (3.17)	25.45 (13.96)
Loading and unloading	5.45 (2.45)	5.00 (15.59)	6.93 (5.47)	10.50 (5.76)
Grading	1.02 (0.46)	1.00 (3.12)	4.84 (3.82)	7.50 (4.11)
Mobile phone cost	3.05 (1.37)	2.25 (7.01)	3.50 (2.76)	17.00 (9.32)
Security cost	2.50 (1.12)	3.00 (9.35)	1.50 (1.18)	7.80 (4.28)
Personal expenses	2.50 (1.12)	2.06 (6.42)	8.50 (6.71)	11.05 (6.06)
Others	1.02 (0.46)	1.50 (4.68)	4.50 (3.55)	3.65 (2.00)
Total	222.23	32.08	126.69	182.35

N.B.: Numeric value in the parenthesis indicates the percentage.

and Paiker cum Retailer backed by the Arathder are vital value chain authorities. Because of improper market information and negligible bargaining influence, farmers were enforced to sell their produce at a value offered by traders. The vertical linkage was absent among value chain actors, but the horizontal link was identified. In general, the domination of the vegetable value chain was buyer-driven. Traders' top complaints were the farmers low quality produces, while farmers pointed the finger at the traders for offering low prices and unfair means in weighting. The marginal farmers were not organized and were not leading the value chain. Therefore, they were price takers and barely negotiated the price because of post-harvest loss, lack of storage facilities, market risk, and the absence of processing techniques.

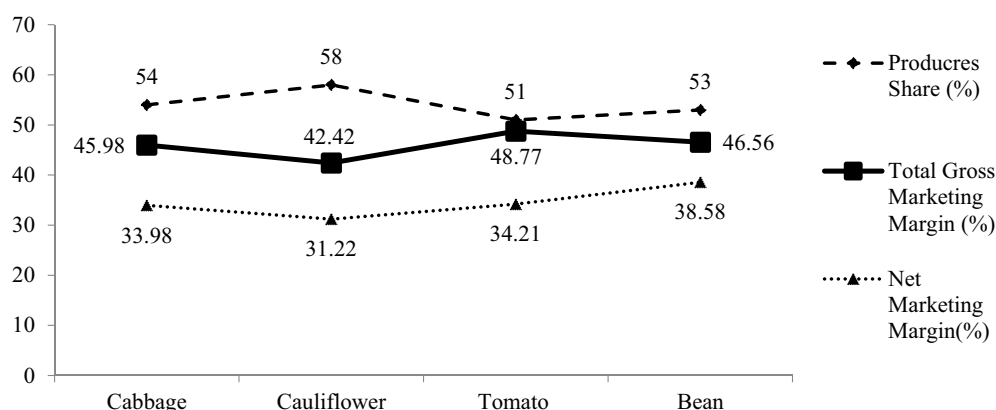
### 3.2.3. Marketing cost and margin of vegetables in Sylhet district

Among all traders of vegetables, *Paiker-1/Bepari* incurred the highest marketing cost (Tk.222.23). Commission to *Arathder* comprised more than half of the total marketing cost of *Paiker-1/Bepari* (Table 2). On the other hand, transportation and wastage are the high cost of vegetable marketing for *Paiker cum retailer* and *retailer*. The net marketing margins of *Paikers-1/Beparis*, *Arathdars*, *Paiker cum retailers*, and *retailers* were estimated at Tk.106.34, Tk.147.22, Tk.198.52, and Tk. 635.3 per hundred kg of cabbage trading, respectively. *Arathdar's* return on investment was the highest (459%). But, the *retailer* received the highest marketing margin (Table 3). For cauliflower, the net marketing margins of *Paikers-1/Beparis*, *Arathdars*, *Paiker cum retailers*, and *retailers* were estimated at Tk. 111.10, Tk. 161.77, Tk. 152.48, and Tk. 605.15 per hundred kg trading, respectively. *Arathdar's* return on investment was the highest (504%), and the *retailer* received the highest marketing margin (Table 3). The net marketing margins of *Paikers-1/Beparis*, *Arathdars*, *Paiker cum retailers*, and *retailers* were estimated at Tk. 43.37, Tk. 120.8, Tk. 112.46 and Tk. 687.17 per hundred kg of tomato trading, respectively. *Arathdar's* return on investment was the highest

**Table 3. Market performance of vegetables in terms of marketing margin with respect to the share of actors**

Traders	Tk. per 100 kg					
	Purchase price	Sale price	Gross marketing margin	Marketing cost	Net marketing margin	ROI (%)
Cabbage	Paiker-1/Bepari	2057.14	328.57	222.23	106.34	6
	Arathdar	-	179.3	32.08	147.22	459
	Paiker cum retailer	2382.35	325.21	126.69	198.52	9
Cauliflower	Retailer	3200	817.65	182.35	635.3	25
	Paiker-1/Bepari	2233.33	333.33	222.23	111.10	5
	Arathdar	-	193.85	32.08	161.77	504
Tomato	Paiker cum retailer	2512.5	279.17	126.69	152.48	7
	Retailer	3300	787.5	182.35	605.15	22
	Paiker-1/Bepari	1700	257.14	213.77	43.37	3
Bean	Arathdar	-	151.84	31.04	120.8	389
	Paiker cum retailer	1944	244	131.54	112.46	6
	Retailer	2816.67	872.67	185.5	687.17	32
N.B: ROI indicates Return on investment	Paiker-1/Bepari	2228	300	213.77	86.23	4
	Arathdar	-	274	31.04	242.96	783
	Paiker cum retailer	2228	605	131.54	473.46	20
	Retailer	2833	775	185.5	589.5	19

**Figure 4. Vegetables Producers Share, Total Gross, and Net Marketing Margin**



(389%), and the retailer received the highest marketing margin for tomatoes (Table 3). Finally, the net marketing margins of *Paikers-1/Beparis*, *Arathdars*, *Paiker cum retailers*, and *retailers* were estimated at Tk. 86.23, Tk. 242.96, Tk. 473.46, and Tk. 589.5 per hundred kg bean trading, respectively. *Arathdar's* return on investment was the highest (783%), and the retailer received the highest marketing margin (Table 3). From Figure. 4, it seems clear that producers got the highest share of consumer payment from cauliflower than cabbage, bean, and tomato. Compared to other vegetables, tomato traders got the highest gross marketing margin, but bean traders earned the highest net marketing margin (Figure. 4).

### 3.3. Determinants of vegetable market supply

Studying the factors distressing farm-level marketable vegetable supply is essential to detect those factors. All surveyed households were suitable market suppliers of the vegetables. The analysis was completed distinctly. The numbers of tomato, cabbage, cauliflower, and bean growing farmers were 72, 31, 32, and 30, respectively. The multiple linear regression models were used to determine the factors. Assumptions of the Classical Linear Regression (CLR) model should hold to estimate the parameters efficiently and consistently. Therefore, multicollinearity and heteroscedasticity detection test was done using proper test statistics. The command robust (in STATA) was used to spot heteroscedasticity. Since VIF output was less than 10, there was no multicollinearity problem. Seven independent variables were assumed to determine the household level marketable vegetable supply. These are quantity production, age of the household head, education, family size, vegetable farming experience, access to training, and distance to market (Table 4). Among those determinants, quantity produced significantly affects the quantity supply of tomato, cabbage, cauliflower, and bean. Distance to the market substantially negatively affects the tomato, cabbage, and cauliflower marketable surplus. On the other hand, the experience of vegetable farming and access to training significantly and positively affected bean market supply (Table 4).

## 4. Discussion

The maximum amount of vegetable flow went through the producer channel 1 to *Paiker-1/Bepari*, *Paiker-1/Bepari* to *Arathder*, *Arathder* to *Paiker cum retailer*, *Paiker cum retailer* to *retailer*, and finally *retailer* to *consumer*. The value chain map mainly identified the two actors (Primary and Indirect) who facilitate the vegetable production by procuring different inputs, extension advice from the other stakeholders, and supplying the harvesting vegetables to the end-user. As revealed in the map (Figure 1), the vegetable value chain acts as a combination of value chain functions, actors or operators, and four enablers. Apart from the value chain functions and actors, in Nepal, Bhutan, and the Oromia region of Ethiopia, there are more than four value chain supporters or enablers (ANSAB, 2011; Joshi & Gurung, 2009; Woldesenbet, 2013). In the northeast region of Bangladesh, most of the vegetables supply to the market through the four-level marketing start



**Table 4. Determinants of vegetables quantity supplied to the market**

Variables	Tomato			Cabbage			Cauliflower			Bean		
	Coef.	Robust Std. Err.	Sig	Coef.	Robust Std. Err.	Sig	Coef.	Robust Std. Err.	Sig	Coef.	Robust Std. Err.	Sig
QPron	0.99***	0.01	0.00	1.0***	0.01	0.00	0.96***	0.02	0.00	1.00***	0.00	0.00
Age	-1.17	22.44	0.96	0.59	3.06	0.85	3.84	7.78	0.62	-7.6	2.48	0.76
Edu	147.16	132.09	0.27	7.19	27.15	0.79	-13.61	16.89	0.42	-1.70	4.27	0.69
FS	129.15	120.37	0.29	8.16	16.20	0.61	-15.59	28.85	0.59	6.33	5.43	0.25
VFExp	-62.36	40.22	0.13	-0.04	8.88	0.99	-12.53	8.55	0.15	8.24***	2.18	0.00
DMkt	-102.85*	57.15	0.07	-115.77*	66.84	0.09	-322.58***	84.47	0.01	-5.94	22.01	0.79
ATr	-373.09	230.50	0.11	-49.38	73.66	0.50	-35.93	42.91	0.41	16.99***	5.64	0.01
constant	1000.08	1434.37	0.49	-105.56	305.59	0.73	804.01	478.62	0.10	-273.35	95.95	0.01
N	72			31			32			30		
F Statistic	2187.19***			1512.63***			386.34***			99.999***		
R-squared	0.97			0.98			.99			0.99		

Dependent variables are amount of tomato, cabbage, cauliflower and bean sold in Kg.

\*\*\*And \* are statistically significant at 1%, and 10%, respectively. Std.Err is robust.

from the production point to the consumption point. Our results also agree with Singha and Salam. They found that the distribution channel of potato and fresh-cut vegetables in Bangladesh is more extended, contributing to more value addition and leading to an inefficient marketing system (Salam et al., 2020; Singha & Maezawa, 2019). In Bhutan, potato marketing channels can be categorized into the informal and unorganized channels; and semi-organized and organized marketing channels (Joshi & Gurung, 2009). In Andhra Pradesh of India (Reddy et al., 2010), most of the vegetable marketing followed the traditional value chain where the channel is longer than the modern value chain, which is similar to our study.

The vegetable value chain analysis helped examine the producer share, gross, and net marketing margin in different levels or intermediaries of marketing. In the case of tomatoes, gross marketing margin or value chain performance was highest at the retail level. On the contrary, in the South-eastern region of Bangladesh, the vegetables market margin was more elevated in the local market (Karim & Biswas, 2016). Still, now, the small and marginal vegetable grower has no power to set up the product price in the market most of the time; the different intermediaries in the market intensely manipulate them. Often producers confronted predetermined prices of their products set by the *Beparies* and other intermediaries. So, vegetable producers were treated as the less influential actors in every marketing stage. These findings matched the marketing of different agroforestry products (pineapples or gingers) in Bangladesh (Islam et al., 2014). The value chain study results revealed value addition in vegetable marketing through transportation, storage, cleaning and maintenance (wages and salaries), loading and unloading, and grading, where transportation cost was highest, followed by wages and salaries for labor and grading at different levels of marketing. In Ethiopia, cleaning and sorting were the most value-adding activities adopted in the fruit sector value chain (Mossie et al., 2020).

Table 4. shows the results of the classical linear regression model, out of seven exploratory variables, four significantly contributed to the marketable supply. The quantity produced (QPron) significantly affects the supply of tomatoes, cabbage, cauliflower, and bean. The result implies that a one-kilogram escalation in the amount of tomato, cabbage, cauliflower, and bean production has triggered an increase of 0.99, 1.0, 0.96, and 1.0 Kg of marketable supply, respectively. The results support Woldesenbet, Teka, Tokkon, and Mussema, who exemplified a rise in potato, cabbage, tomato, mango, avocado, and red pepper production has significantly increased the marketable supply of the produces (Mussema, 2006; Teka, 2009; Tokkon, 2011; Woldesenbet, 2013). Distance from the nearest market (DMkt) had significant adverse effects on tomato (10%), cabbage (10%), and cauliflower (1%) marketable surplus. The outcome displays that as the remoteness from the adjacent market increased by one kilometer, the amount of tomato, cabbage, and cauliflower delivered to the market reduced by 102.85, 115.77, and 322.58 Kg, respectively. The possible reasons might be the increasing remoteness to the market center raises the shipping cost. This result is conformity with Tokkon and Woldesenbet (Tokkon, 2011; Woldesenbet, 2013). They showed that distance to the market triggered a market surplus of cabbage and avocado to decline at Gomma Woreda in Ethiopia. However, Ngenoh, Narrod, and Trebbin illustrated that the distance market is positively affected the access to competitiveness and access to producer groups to gain the economics of scale, particularly input procurement and supply the farm product to market (Narrod et al., 2009; Ngenoh et al., 2016; Trebbin, 2014).

In addition, vegetable farming experiences (VFExp) positively affect bean market supply. The outcome proposes that as farmers have more bean production experience, the volume of beans brought to the market increases. Thus,

the result denotes that, as farmers' experience increased by a year, beans supplied to market increased by 8.24 Kgs. The results are in line with Woldesenbet, Ouma, and Mossie; who proved that increasing farmers' experience caused an increasing amount of potato, tomato and Banana market supply (Mossie et al., 2020; Ouma et al., 2010; Woldesenbet, 2013). Moreover, training accessibility (ATr) significantly and positively allied with bean sale volume at less than a 1%

significant level. The result indicates that if the bean producer gets extension training, the quantity of beans delivered to the market is amplified by 16.99 kg. This result complies with Mateows, Mussema, and Abrha; who illustrated that contact with extension facilities improved the quantity of mango market supply in Ethiopia (Abrha et al., 2020; Mateows, 2015; Mussema, 2006).

## 5. Conclusion

Inclusive governance of the vegetable value chain in the North-Eastern part of Bangladesh was buyer-driven. The maximum amount of vegetable flow went through only one channel that included the producer, different local traders, and consumers. The Paiker-1/Bepari acquired the total marketing cost, but the retailer secured the maximum margin. The primary cost-bearing item was transportation and wastage for the traders. In vegetable marketing, Arathders worked as a commission agent, and their return on investment was very high. On the other hand, the vegetable supply was highly determined by vegetable production. In some contexts, market distance, farming experience, and access to training facilities significantly affected the supply of vegetables. Reducing the expenses of shipping that stem from improvements in road infrastructure and extension facilities would facilitate the motivation of market participation. It supports the vegetable growers to gain the paybacks allied with vegetable marketing. Besides, physical linkages between farming areas to markets are a course of action that could expand native and regional trade. Locational characteristics, promotion of commercial horticultural farming, institutional arrangements (contractual farming, hedging) set up, local government and NGO supports, frequent market monitoring, and post-harvest management technology are also crucial for value chain management enhancing the marketable and marketed surplus.

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## Authors' contributions

Md. Mostafizur Rahman, Swarup Barua, and Shaikh Farid conducted this research in Bangladesh. They have collected the data and analyzed it carefully. Md. Mostafizur Rahman and Swarup Barua wrote the main text. Dr. Zhou Deyi and Teng Li contributed to this research paper's methodological and analytical part. Professor Dr. Zhou Deyi edited the English writing. However, all authors tried their best to make this research paper more scientific and accurate.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Data availability statement

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