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Seasonal and Off-seasonal Vegetables Production in Maulvibazar District: Insight from Profitability, Price Variations and Risk Management Perspective

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ABSTRACT

The research work was conducted to assess the comparative profitability, seasonal price variations and risk management strategies in seasonal and off-seasonal vegetables production by means of tomato and bean vegetables in Maulvibazar district. Both primary and secondary data were used. The study utilized tabular, mathematical and statistical techniques for data analysis. The study found that the BCR for the seasonal and the off-seasonal tomato production were 1.59 and 2.23, respectively, whereas the BCR for the seasonal and the off-seasonal bean production were 1.32 and 2.19, respectively. The study also found that, in season (November-March), the highest seasonal price index for both tomato and bean vegetables were found in November (i.e. 149.71 and 109.24, respectively). While in off-season (April-October), the highest seasonal price index for the tomato (i.e. 177.93) and the bean (i.e. 197.80) were found in September and August, respectively. In evaluating the risk management strategies, the study found that the frequency and the relative frequency of the application of manure and the use of insecticides were 100% for both season tomato and bean vegetables. On the basis of the findings and opinions of farmers during field visit, the researchers' identified high cost of human labor, price fluctuation and deficiency of farmers' awareness in term of different risk management strategies were the major problem. The researchers' recommends that farmers should use friends' contributory labor, planning appropriate harvesting period (i.e. early period for season and late period of off-season) and increasing farmers' awareness by means of local and national level training. These findings will be helpful for farmers, researchers and policy makers to take informed production decision, formulation of future research work and policy development focusing vegetable sector of Bangladesh.

Introduction

Bangladesh achieves 3rd rank in vegetable production in the world (Hossain, 2019). But the production is insufficient to meet the per capita vegetable intake of its growing population (163 million) (DAE, 2016; World Bank, 2019). At present, the per capita/day vegetables consumption is 166.1 gram, while the requirements are 200 grams; and desirable intakes are 100 and 200 gram leafy and non-leafy vegetables, respectively (Hortex, 2013). Around 30-40% of children are suffering from vitamin deficiency in Bangladesh due to not taking vegetables (Hossain, 2019). In order to feed the growing population and to meet nutritional efficiency, the country has to increase its vegetable production three times than its current figure (in the fiscal year 2017-18, which is approximately 26200 thousand metric ton) (Hossain, 2019). While rice and other cereal crops occupying over 75% of the country's arable land and land for vegetable production is shrinking, increasing production can be very challenging (Ahmad, 2017; BARI, 2017). In this situation, off-seasonal vegetable production in line with season can be a solution.

Off-season vegetable production means the production of fresh vegetables before or after its main production season- when the supply remains low, and prices are significantly high in the market (Deshmukh et al., 2019). About 60-70% of vegetables are produced during the winter (Weinberger and Genova, 2005). As a result, supplies of vegetables increase to a large extent during the winter season. Surplus vegetable production in the winter season reduces the market price, and farmers face economic loss (Sharmin et al., 2018). On the other

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side, during summer, supplies of vegetables remain low in the market, which causes the price to increase.
Earlier, it was not possible to cultivate the *Rabi*/winter crops in *Kharif*/summer season because *Rabi* crops such as- tomato is extremely sensitive to wet growing conditions and high temperature (Rashid, 1999). As a result, it was not possible to produce tomato in summer season because the traditional cultivated varieties were not heat tolerant. Again, the availability of bean is high in winter season but inadequate during summer. Due to its photo sensitive nature this crop is mostly grown in winter season in Bangladesh (Islam, 2014). But, nowadays with the help of modern technologies (protected cultivation and improved seed varieties etc.), it is possible to cultivate *Rabi* crops in crops in *Kharif* season.

The prospect of tomato and bean production is great in Maulvibazar district due to suitable agro-climatic conditions. In the fiscal year 2017-18, the tomato and bean were produced on 240.38 hectares and 178.06 hectares area, respectively, in the Maulvibazar district. The production of the tomato and bean were 3627 metric tons and 1265 metric tons, respectively, in the following fiscal year (BBS, 2018). In spite of high production potential, sometimes farmers do not get expected price and profit by selling their vegetables. Therefore, we felt necessity to investigate the level of profitability in seasonal and off-seasonal vegetables production and also curious to make comparison. In addition to these, seasonal price variation of the tomato and the bean vegetables were examined to help farmers in taking decision about the harvesting period of their production. Again, the vegetable productions are considered as a risky farming enterprise due to its rapid perishability and the short period of supply (USDA, 1999). Biological aspects of the plant growth and the climatic conditions, poses different production risks (Goodwin and Mishra, 2000). To cope with production risk, farmers of the study area adopted some strategies: (i) correct spacing/planting distance (ii) mixed cropping/intercropping (iii) construction of drainages (iv) application of manure (organic and inorganic) (v) security against theft (vi) early planting/harvesting (vii) use of insecticides. So, it is also necessary to evaluate the practiced risk management strategies from the individual farmer's perspective.

Previous studies suggested that both seasonal and off-seasonal tomato production is profitable. Akter et al. (2011), and Mitra and Sharmin (2019) analyzed the on farm data and estimated that the BCR for seasonal tomato production ranges from 1.82 to 2.31. On the other hand, Islam et al. (2017) examined on station data and estimated the BCR for off-seasonal tomato production ranges from 2.18 to 2.41. However, no closely related studies were found useful in explaining comparative profitability of seasonal and off-seasonal tomato production. Again, Khandoker et al. (2016), Bithi (2014) and Chowdhuri et al. (2014) estimated that the BCR for seasonal bean production ranges from 1.42 to 2.14. In spite of having potential off-seasonal bean production in Bangladesh, we did not find any organized research work based on the profitability of off-seasonal bean production. Sabur (1990) examined the seasonal price variations for the tomato vegetable and found that wholesale price remained significantly high in December and low in March. Except this research work, we did not find any systematic research work related to seasonal price variations of tomato and bean vegetables. In evaluating the risk management strategies, we found one useful study in evaluation of practiced production risk management strategies (Osuji et al., 2018).

By addressing the research gap, the researchers of the present study aim to conduct a study focusing profitability, price variation and risk management by means of tomato and bean vegetables in a single research work in some selected areas of Maulvibazar district. Key research questions of the present study are: (i) Are off-seasonal vegetables production much profitable compared to the seasonal vegetables production? (ii) How much the seasonal price variations exist for tomato and bean vegetables? (iii) Does variations exist in terms of adopted risk management strategies for seasonal and off-seasonal tomato and bean production. However, the specific objectives of the study are: (i) To compare the profitability of seasonal tomato and bean vegetables with their off-seasonal production (ii) To examine the seasonal price variations of tomato and bean vegetables (iii) To evaluate farmers' risk management strategies in seasonal and off-seasonal tomato and bean production. We believe that the findings of the study will be helpful for farmers, researchers and policy makers to take informed production decision, future research work formulation and policy development regarding the vegetable sector of Bangladesh

Materials and Methods

Selection of the study area

The present study was conducted in some selected villages of Sreemangal and Kamalganj upazilas of Maulvibazar district. These 2 upazilas were selected due to their high potentiality of growing tomato and bean vegetables over other upzilas of Maulvibazar district (BBS, 2011). The location map of the study area is presented in Figure 1. The cultivated seasonal and off-seasonal tomato and bean varieties/genotypes in the study area are presented in Table 1.

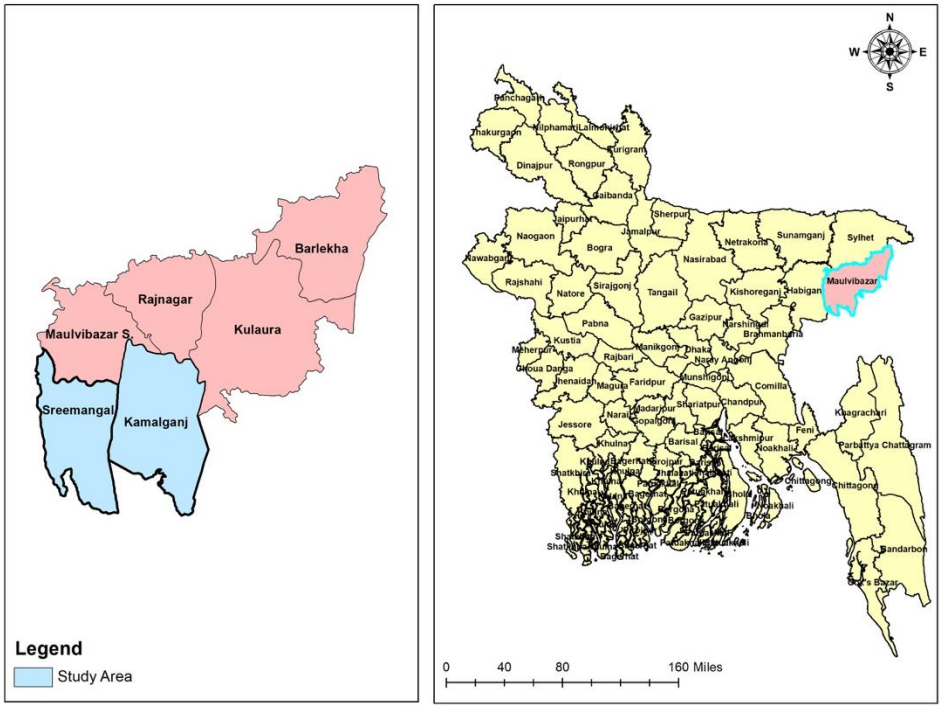

Figure 1. Location of the study site

Table 1. The cultivated seasonal (winter) and off-seasonal (summer) tomato and bean vegetables varieties/genotypes in the study area

Vegetables	Varieties/Genotypes
Seasonal (winter) tomato	Jessica, Raja, Mintoo, Mintoo Super, Epok
Off-seasonal (summer) tomato	BARI Hybrid Tomato-4, BARI Tomato-8, BARI Tomato-11
Seasonal (winter) bean	Goalgadda, Ayna (local variety)
Off-seasonal (summer) bean	SB-002, BARI Sheem-7

Source: Field Survey, 2019

Table 2. Sample distribution for seasonal (winter) and off-seasonal (summer) tomato and bean farmers

Target Groups	Study Area			Sample size	
	District	Upazila			
Seasonal tomato farmers	Maulvibazar	Kamalganj	Sreemangal	15	15
Off-seasonal tomato farmers				15	15
Seasonal bean farmers	Maulvibazar	Kamalganj	Sreemangal	15	15
Off-seasonal bean farmers				15	15
			Total	120	

Source: Field Survey, 2019

Sampling design

For the presented study, four categories of farmers were selected. The target groups included seasonal tomato farmers, off-seasonal tomato farmers, seasonal bean farmers and off-seasonal bean farmers. Farmers were selected using convenience sampling technique. The total sample size was 120. The sample distribution is presented in Table 2.

Method of data collection and analysis

The study utilized both primary and secondary data. For collecting primary data, a pretested structure interview schedule was used. The data were collected during September to October in 2019. The present study also utilized some secondary data, which were collected from FAOSTAT (5-yearly monthly producer price data of tomato and bean vegetables), different journals, reports, websites, books and handouts. In the price dataset, some data were found missing. This missing data were handled using linear interpolation technique. The data were analyzed using descriptive, mathematical and statistical technique. For data analysis, Microsoft Office Excel 2010, IBM SPSS (Version 25.0) and Stata (Version 15.0) were used.

Analytical techniques

The objective based analytical technique is discussed below:

Objective-i: Comparative profitability

The profitability of seasonal and off-seasonal tomato and bean production were measured in terms of gross return (GR), gross margin (GM), net return (NR) and benefit-cost ratio (BCR). The algebraic formulae are expressed below:

- $GR=X_{mp}P_{mp} + X_{bp}P_{bp}$;
- $GM = GR - \sum C_v$;
- $NR= GR - \sum C_v - \sum C_f$;
- BCR (undiscounted) = GR ÷ GC

Where, X_{mp} = Yield of main product; P_{mp} = Price of main product; X_{bp} = Yield of by-product; P_{bp} = Price of by-product; $\sum C_v$ = Total Variable Cost; $\sum C_f$ = Total Fixed Cost; GC = Gross Cost (i.e. $\sum C_v + \sum C_f$). In the algebraic form of GR, the yield of by-product for tomato and bean vegetables were considered as zero (0) because there existed no saleable by-product quantity for both tomato and bean production. For comparison, GR, GM, NR and BCR (undiscounted) were compared. By using opportunity cost concept, interest on operating capital was determined. In the present study, interest rate and production period (land preparation to harvesting time) were 10% and 3 months, respectively. The formula which was used for calculating interest on operating capital is given below (Bithi, 2014; Alam, 2016):

Interest on operating capital= (operating capital× rate of interest× time considered)/2

Objective-ii: Seasonal price variations

Seasonal price variation can be examined by means of four techniques, i.e., simple average method, ratio to trend method, ratio to moving average method and link relative method (Roy et al., 2012). In examining seasonal price variations, 12-months ratio to moving average technique was utilized, which is impartially a decent estimate of the trend and cyclical components combined (Lutfa et al., 2018).

Objective-iii: Risk management strategies

For evaluation of risk management strategies, simple statistical techniques- frequency and relative frequency were utilized. In order to count relative frequency, the researchers divided the frequency by the total number of data values.

Results and Discussion

Cost of production for seasonal (winter) and off-seasonal (summer) tomato production

Table 3 indicates that, when all variable and fixed costs are taken into account hectare^{-1} gross cost for seasonal tomato production amounted to be Tk 481988.81 while hectare^{-1} cost of production for off-seasonal tomato production amounted to be Tk 1176542.84. It is observed that in case of seasonal tomato production, human labor stood the highest cost parameter constituting 41.25% of the gross cost followed by bamboo (*barak*), miscellaneous, cow dung, insecticide, seed/seedling, urea, power tiller, TSP (Triple Super Phosphate), irrigation and MoP (Muriate of Potash) having the respective shares of 20.91%, 12.05%, 4.78%, 2.61%, 2.43%, 2.06%, 1.86%, 1.84%, 1.69% and 1.40%. Similarly in case of off-seasonal tomato production, human labor stood the highest cost parameter constituting 26.95% of the gross cost followed by polyethylene, bamboo (*makhal*), bamboo (*barak*), nylon (rope), miscellaneous, *sutoli*, cow dung, insecticide, seed/seedling, TSP, urea, power tiller, irrigation and MoP having respective shares of 15.89%, 15.82%, 13.23%, 5.45%, 5.36%, 3.09%, 2.39%, 2.07%, 1.38%, 1.10%, 0.98%, 0.95%, 0.92% and 0.71% (Table 3).

It is noticeable from Table 3 that, the gross cost of production for off-seasonal tomato is much higher than seasonal tomato production. This is because during off-season, farmers cultivate tomato vegetable by means of poly-shed construction. As a result, farmers have to endure the cost of poly-shed construction materials such as: bamboo (*makhal*), polyethylene, nylon (rope), *sutoli* which are not prevailing for seasonal tomato production.

Cost of production for seasonal (winter) and off-seasonal (summer) bean production

Table 4 indicates that, after taken all fixed and variable costs into consideration on an average hectare^{-1} gross cost for seasonal and off-seasonal bean amounted to be Tk 402229.14 and Tk 520042.42, respectively. It is observed that, human labor stood the highest cost parameter for seasonal bean production constituting 48.03% of the gross cost followed by miscellaneous, fence and mancha, cow dung, insecticide, seed/seedling, urea, TSP, irrigation, power tiller and MoP having respective shares of 12.59%, 9.01%, 5.73%, 3.55%, 2.89%, 2.76%, 2.49%, 1.97%, 1.84% and 1.25%. Similarly in case of off-seasonal bean production, human labor stood the highest cost parameter constituting 49.33% of gross cost followed by miscellaneous, fence and mancha, insecticide, cow-dung, seed/seedling, irrigation, power tiller, urea, TSP and MoP having respective shares of 13.38%, 6.72%, 5.54%, 4.66%, 2.87%, 2.80%, 2.50%, 2.25%, 1.93% and 1.03% (Table 4). It is noticeable from Table 4 that, the gross cost of production for off-seasonal bean is higher than seasonal bean production. This is because for off-seasonal bean production, intensive maintenances such as: additional field operation, insecticides, irrigation etc. are required which are not proportionally persistent in case of seasonal bean production. As a result, gross cost of off-seasonal bean differs from seasonal bean production.

Table 3. Comparison of hectare^{-1} cost of production for seasonal (winter) and off-seasonal (summer) tomato production

Cost parameters	Unit	Quantity	Price/ unit	Cost in season (Tk)	%	Quantity	Price/ unit	Cost in off-season (Tk)	%
Variable Cost									
Human Labor	Man-days	568.00	350	198800.00	41.25	906.00	350	317100.00	26.95
Power Tiller	Tk	-	-	8978.14	1.86	-	-	11119.73	0.95
Seed/Seedling	Gram	167.16	70	11701.20	2.43	203.29	80	16263.20	1.38
Cow dung	Kg	11531.56	2	23063.12	4.78	14084.99	2	28169.98	2.39
Urea	Kg	551.87	18	9933.66	2.06	642.47	18	11564.46	0.98
TSP	Kg	317.12	28	8879.36	1.84	461.26	28	12915.28	1.10
MoP	Kg	374.78	18	6746.04	1.40	461.26	18	8302.68	0.71
Irrigation Cost	Tk	-	-	8154.47	1.69	-	-	10872.62	0.92
Insecticide Cost	Tk	-	-	12602.36	2.61	-	-	24381.02	2.07
Bamboo (*barak*)	No.	840.00	120	100800.00	20.91	1557.00	100	155700.00	13.23
Bamboo (*makhal*)	No.	-	-	-	-	3723.00	50	186150.00	15.82
Polyethylene	Kg	-	-	-	-	1869.76	100	186976.00	15.89
Nylon (rope)	Kg	-	-	-	-	712.49	90	64124.10	5.45
Sutoli	Kg	-	-	-	-	1210.81	30	36324.30	3.09
Miscellaneous Cost (wastage, transportation, security etc.)	Tk	-	-	58069.68	12.05	-	-	63011.78	5.36
A. Total Variable Cost (TVC)	Tk	-	-	**447728.03**	**92.89**	-	-	**1132975.15**	**96.30**
Fixed Cost									
Land Rent	Tk	-	-	28664.18	5.95	-	-	29405.50	2.50
Interest on Operating Capital	Tk	-	-	5596.60	1.16	-	-	14162.19	1.20
B. Total Fixed Cost (TFC)	Tk	-	-	**34260.78**	**7.11**	-	-	**43567.69**	**3.70**
C. Gross Cost (A+B)	Tk	-	-	**481988.81**	**100.00**	-	-	**1176542.84**	**100.0**

Source: Field Survey, 2019

Table 4. Comparison of hectare^{-1} cost of production for seasonal (winter) and off-seasonal (summer) bean production

Cost parameters	Unit	Quantity	Price/ unit	Cost in season (Tk)	%	Quantity	Price/ unit	Cost in off-season (Tk)	%
Variable Cost									
Human Labor	Man-days	552.00	350	193200.00	48.03	733.00	350	256550.00	49.33
Power Tiller	Tk	-	-	7413.15	1.84	-	-	13014.20	2.50
Seed/Seedling	Gram	5806.97	2	11613.94	2.89	5971.70	2.5	14929.25	2.87
Cow dung	Kg	11531.57	2	23063.14	5.73	12108.15	2	24216.30	4.66
Urea	Kg	617.76	18	11119.68	2.76	650.71	18	11712.78	2.25
TSP	Kg	358.30	28	10032.40	2.49	358.30	28	10032.40	1.93
MoP	Kg	280.05	18	5040.90	1.25	296.53	18	5337.54	1.03
Irrigation Cost	Tk	-	-	7907.36	1.97	-	-	14538.01	2.80
Insecticide Cost	Tk	-	-	14290.91	3.55	-	-	28828.92	5.54
Fence and Mancha	Tk	-	-	36242.07	9.01	-	-	34924.17	6.72
Miscellaneous Cost (Wastage, transportation, security etc.)	Tk	-	-	50656.53	12.59	-	-	69601.24	13.38
A. Total Variable Cost (TVC)	**Tk**	-	-	**370580.08**	**92.13**	-	-	**483684.81**	**93.01**
Fixed Costs									
Land Rent	Tk	-	-	27016.81	6.72	-	-	30311.55	5.83
Interest on Operating Capital	Tk	-	-	4632.25	1.15	-	-	6046.06	1.16
B. Total Fixed Cost (TFC)	**Tk**	-	-	**31649.06**	**7.87**	-	-	**36357.61**	**6.99**
C. Gross Cost (A+B)	**Tk**	-	-	**402229.14**	**100.00**	-	-	**520042.42**	**100.0**

Source: Field Survey, 2019

Comparative profitability of seasonal (winter) and off-seasonal (summer) tomato and bean production

Table 5 indicates that, hectare^{-1} gross return for seasonal and off-seasonal tomato production estimated Tk 766025.50 and Tk 2629197.20, respectively; where the gross return increases 243.23% from seasonal tomato production. In case of seasonal and off-seasonal bean vegetables it is evident that, hectare^{-1} gross return was Tk 529578.90 and Tk 1139154.00, respectively; where the gross return increases 115.11% from seasonal bean production. It is also witnessed from the net return parameter estimates that, for seasonal and off-seasonal tomato production hectare^{-1} net return were estimated Tk 284036.69 and Tk 1452654.36, respectively; while for seasonal and off-seasonal bean production hectare^{-1} net return were estimated Tk 127349.76 and Tk 619111.58, respectively. Again, in case of off-seasonal tomato and bean production it is observed that, hectare^{-1} net return increased by 411.43% and 386.15%, respectively. Moreover, the parameter estimates regarding BCR indicates that, hectare^{-1} BCR for seasonal and off-seasonal tomato production were 1.59 and 2.23, respectively; while the BCR for seasonal and off-seasonal bean production were 1.32 and 2.19, respectively. Likewise net return; it is apparent that the BCR for off-seasonal tomato and bean production were increased by 40.25% and 65.91%, respectively (Table 5). The gross return, net return and BCR parameter estimates clearly indicates that, for both tomato and bean vegetable, off-season production is more money-spinning than its regular production season. During off-season, the vegetable supply remains low in the market. As a result, the off-seasonal vegetables farmers maximized their return by means of high selling price.

Seasonal price variations of tomato and bean vegetables

The seasonal price index for the tomato vegetable is presented in Table 6. It is observed that, in season (November-March), the highest seasonal index for tomato vegetable was 149.71 found in November, i.e., producer price was 49.71% higher than average producer price in this month, while the lowest was 32.71 found in March, i.e., producer price was 67.29% lower than the average producer price in this month. There was a big difference between the highest and the lowest seasonal price indices (i.e. 149.71-32.71=117.00). However, in off-season (April-October), the highest seasonal index for tomato vegetable was 177.93, found in September, and the lowest index was 44.96, found in April. In this case, there also existed a big difference between the highest and lowest seasonal price indices (i.e. 177.93-44.96=132.97).

The seasonal price index for the bean vegetable is presented in Table 7. It is observed that, in season (November-March), the highest seasonal index for bean vegetable was 109.24 found in November, i.e., the producer price was 9.24% higher than average producer price in this month, while the lowest was 47.24 found in February, i.e., the producer price index was 52.76% lower in this month. There was a big difference between the highest and the lowest seasonal price indices (i.e. 109.24-47.24=62.00). Conversely, in off-season (April-October), the highest seasonal index was 197.80 found in August, while the lowest seasonal index was 62.98 found in April. In this case, there also existed a big difference between the highest and lowest seasonal price indices (i.e. 197.80-62.98=134.82).

For both vegetables, price remains significantly high with in early period of season. This is because with the starting of the season, vegetables supplies remain low in the market. Over time, the increased market supplies of vegetables cause price to decline. Again, with the starting of off-season, price remains low in the market. This may be due to the late harvesting of seasonal vegetable producers. But over time, with the decrease of seasonal market supplies price of off-seasonal vegetables again increase. This relationship is presented in Figure 2.

Table 5. Comparative economic performance for hectare^{-1} seasonal (winter) and off-seasonal (summer) tomato and bean production

Parameters	Unit	Seasonal tomato	Off-seasonal tomato	% change	Seasonal bean	Off-seasonal bean	% change
Yield	Kg	30641.02	34594.70	12.90	15575.85	15188.72	-2.48
Average Selling Price	Tk Kg^{-1}	25	76	204.00	34	75	120.59
Gross Return	Tk	766025.50	2629197.20	243.23	529578.90	1139154.00	115.11
Gross Cost	Tk	481988.81	1176542.84	144.10	402229.14	520042.42	29.29
Gross Margin	Tk	318297.47	1496222.05	370.07	158998.82	655469.19	312.25
Net Return	Tk	284036.69	1452654.36	411.43	127349.76	619111.58	386.15
BCR	-	1.59	2.23	40.25	1.32	2.19	65.91

Table 6. Seasonal price index for tomato vegetable in Bangladesh

Period	Month	Seasonal Index	Highest Value	Lowest Value	Difference
Season	November	149.71	149.71	32.71	117.00
	December	93.47			
	January	54.63			
	February	38.70			
	March	32.71			
Off-season	April	44.96	177.93	44.96	132.97
	May	63.79			
	June	76.90			
	July	121.23			
	August	172.57			
	September	177.93			
	October	173.37			

Source: Author's estimation, 2019

Table 7. Seasonal price index for bean vegetable in Bangladesh

Period	Month	Seasonal Index	Highest Value	Lowest Value	Difference
Season	November	109.24	109.24	47.24	62.00
	December	66.92			
	January	56.09			
	February	47.24			
	March	49.21			
Off-season	April	62.98	197.80	62.98	134.82
	May	64.95			
	June	77.74			
	July	97.43			
	August	197.80			
	September	186.98			
	October	184.03			

Source: Author's estimation, 2019

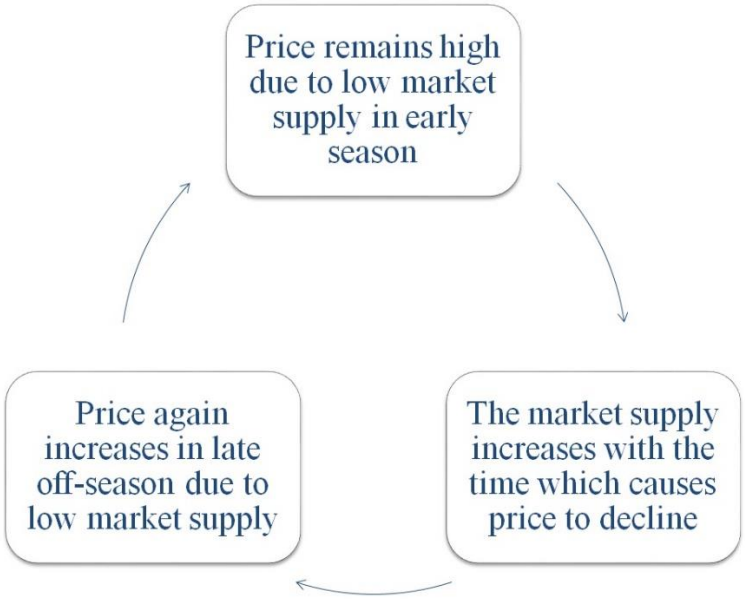

Figure 2. Seasonal market supplies and off-seasonal vegetables price cycle

Farmers' risk management strategies on seasonal (winter) and off-seasonal (summer) tomato production

Table 8 indicates that, for both seasonal and off-seasonal tomato production, majority of the farmers' adopted the application of manure (100.0%) and the use of insecticides (100.0%) as a risk management strategy. Again, the planting distance for tomato plant depends upon the cultivated variety. In general, the ideal distance for tomato plant is between 24 to 36 inches where anything less than 24 inches will reduce air circulation which may lead to various plant diseases (Grant, 2018). It is evident that, a quite good number of farmers' adopted correct spacing/planting distance (66.7%), construction of drainages (70.0%) and early planting/harvesting (60%) as a risk management strategy in case of seasonal tomato production. Similar situation had been observed in case of off-seasonal tomato production, where a good significant proportion of farmers' adopted correct spacing/planting distance (86.7%), construction of drainages (70.0%) and early planting/harvesting (63.3%) as a risk management strategy.

It is also witnessed that, in case of seasonal tomato production security against theft (20.0%) as a risk management strategy adopted by a few number of farmers' only. On the contrary, for off-seasonal tomato production, greater proportion of farmers' adopted security against theft (33.3%) as a risk management strategy (Table 8). For both seasonal and off-seasonal tomato farmers, the adopted risk management strategies were not up to the mark and there remains some scope of improvement. Special concern is required in terms of security against theft and early planting/harvesting strategy for both seasonal and off-seasonal tomato farmers because during harvesting period security against theft strategy reduce the possibility of unwanted loss of farmers produce and early planting/harvesting provides shelter from natural hazards in one hand and somewhat reduce the price risk on other hand.

Farmers' risk management strategies on seasonal (winter) and off-seasonal (summer) bean production

Table 9 indicates that, for both seasonal and off-seasonal bean production, majority of the farmers' adopted the application of manure (100.0%) and the use of insecticides (100.0%) as a risk management strategy. Correct spacing ensures the optimum production by means of land utilization and somewhat safeguard the farmers' produce from different diseases. The appropriate planting distance in case of pole bean (a climbing bean), either row or hills is, with the seeds 6-10 inches (15-25 cm) apart in rows which are approximately 3-4 feet (Grant, 2018). It is evident that, in case of seasonal bean production, a good number of farmers' adopted correct spacing/planting distance (63.3%), construction of drainages (53.3%) and early planting/harvesting (43.3%) as a risk management strategy. Similar situation had been observed in case of off-seasonal bean production, where a good number of farmers' adopted correct spacing/planting distance (80.0%), construction of drainages (53.3%) and early planting/harvesting (73.3%) as a risk management strategy. In case of bean vegetable, mixed cropping/intercropping strategy provides advantage to the cultivating farmers by means of enterprise diversification. It is also observed that in case of seasonal bean production, only a few numbers of farmers' adopted mixed cropping/intercropping (20.0%) and security against theft (13.3%) as a risk management strategy. Although, a good number of off-seasonal bean farmers' adopted mixed cropping/intercropping (56.7%) as risk management strategy; only a few off-seasonal bean farmers' adopted security against theft (13.3%) as a risk management strategy (Table 9). The frequency and relative frequency for correct spacing/planting distance, mixed cropping/ intercropping, construction of drainages, security against theft and early planting/harvesting are lower from application of manure and use of insecticides; and there requires some extent of improvement regarding the mentioned strategy for both seasonal and off-seasonal bean farmers in order to maintain farmers produce.

Table 8. Risk management strategies of the seasonal (winter) and off-seasonal (summer) tomato farmers

Sl no.	Risk Management Strategies	Seasonal Tomato		Off-seasonal Tomato	
		Frequency	Relative Freq. (%)	Frequency	Relative Freq. (%)
1	Correct spacing/ Planting distance	20	66.7	26	86.7
2	Construction of drainages	21	70.0	21	70.0
3	Application of manure (Organic and Inorganic)	30	100.0	30	100.0
4	Security against theft	06	20.0	10	33.3
5	Early planting/ harvesting	18	60.0	19	63.3
6	Use of insecticides	30	100.0	30	100.0

Source: Field Survey, 2019

Table 9. Risk management strategies of the seasonal (winter) and off-seasonal (summer) bean farmers

Sl no.	Risk Management Strategies	Seasonal Bean		Off-seasonal Bean	
		Frequency	Relative Freq. (%)	Frequency	Relative Freq. (%)
1	Correct spacing/ Planting distance	19	63.3	24	80.0
2	Mixed cropping/ Intercropping	6	20.0	17	56.7
3	Construction of drainages	16	53.3	16	53.3
4	Application of manure (Organic and Inorganic)	30	100.0	30	100.0
5	Security against theft	4	13.3	4	13.3
6	Early planting/ harvesting	13	43.3	22	73.3
7	Use of insecticides	30	100.0	30	100

Source: Field Survey, 2019

Conclusion and Policy Recommendations

This paper assesses the comparative profitability, seasonal price variations and farmers' risk management strategies in seasonal and off-seasonal vegetables production. The researchers' did not find any previous organized research work based on comparative profitability, seasonal price variations and evaluation of farmers' risk management strategies considering tomato and bean vegetables. The research work reveals that both the seasonal and off-seasonal tomato and bean production were profitable. The study estimated that BCR for seasonal tomato and bean production were 1.59 and 1.32, respectively whereas the BCR for off-seasonal tomato and bean production were 2.23 and 2.19, respectively. In examining the seasonal price variations, the study found that for both tomato and bean vegetables producer prices' remain high in early period of season and the late period of off-season. However, in case of evaluation of farmers' risk management strategies, the study identified that the application of manure (organic and inorganic) and the use of insecticides were adopted by majority of the seasonal and off-seasonal tomato and bean farmers. On the basis of findings and field experience of researchers', the following recommendation may be followed to develop the better practice of seasonal and off-seasonal vegetables production in Maulvibazar district:

i. According to the farmers' opinion high cost of human labor for both seasonal and off-seasonal tomato production was the major problem. So, it is necessary for farmers to use other sources of human labor such as- friends' contributory labor.
ii. The research found that the seasonal price indices for both tomato and bean vegetables remained high for early period of season and low for late period of season. So, the seasonal tomato and bean farmers should plan to harvest in the early period of season. Again, the seasonal price indices for both tomato and bean vegetables remained high for late period of off-season and low for early period of off-season. Therefore, off-seasonal tomato and bean farmers should plan to harvest in the late period of off-season.
iii. The research identified that different practiced risk management strategies to minimize production risk such as- correct spacing/planting distance, mixed cropping/intercropping, construction of drainages, security against theft, early planting/harvesting and use of insecticides were not fully adopted by all the farmers. So, it is necessary to increase the farmers' awareness concerning the mentioned risk management strategies. In this regard, Department of Agricultural Extension (DAE) could arrange different local and national level training.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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