



## ORIGINAL ARTICLES

### Growth and trend analysis of onion production in Bangladesh

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#### ABSTRACT

Onion is a major spice crop that is grown and consumed extensively in Bangladesh and across the world. The present study was carried out with the goal of analyzing the growth and trend of area, production and yield of onion in Bangladesh. Annual area, production, and yield data of onion in Bangladesh were collected from FAOSTAT for 50 years from 1970 to 2019. The semi-log model and compound growth model were used to investigate the growth of onion whereas exponential trend model was employed to estimate the trend of area, production, and yield of onion in Bangladesh. According to the growth rate and trend line estimates, the area under the onion crop has been augmented over time. Specifically, the semi-log model findings show that the onion area, production and yield grew by on an average 3.87%, 5.46% and 1.58% per year, respectively. The compound annual growth rate estimate indicated significant growth of onion area, production and yield from 2015 to 2019. The exponential trend line for onion area, production and yield showed slow growth rate from 1970 to 1990 but relatively faster growth later on. These evaluations may aid the government in balancing demand and supply, as well as in regulating the price of onion in local markets Bangladesh.

#### Introduction

Bangladesh prioritizes agricultural growth and farmer well-being in order to reduce hunger and poverty. Various strategic frameworks of the country reflect this priority. The government is undertaking all sorts of efforts for the general growth of the agriculture sector in light of Vision 2021, the 8th Five Year Plan, the National Agricultural Policy

2018, the Sustainable Development Goals, the Delta Plan-2100, and other planning documents (BER, 2023). Agriculture has historically been important in Bangladesh, contributing 11.38% of GDP and employing 45.33% of the total labor force in the fiscal year 2022-23 (BBS, 2022). Cereals, pulses, oilseeds, spices and condiments, and chilli are the principal crops farmed in Bangladesh (BBS, 2022). Onion, garlic, chilli, black pepper, cinnamon, cloves,

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coriander, cumin, and mint are among the notable spices. Despite the fact that there are 109 types of spices grown worldwide, Bangladesh focuses on 27 varieties and produces 17 types. Bangladesh's onion production has steadily increased during the last five decades. In 1970, about 32,800 hectares of land were used for onion farming, yielding 181 thousand metric tons. By 2019, 187 thousand hectares of land had generated 1893 thousand metric tons (BBS, 2022). This coordinated agricultural endeavor corresponds with the government's objective of a hunger-free Bangladesh by utilizing several strategic programs and policies.

Onion is grown in practically every district of Bangladesh. Pabna, Faridpur, Rajbari, Manikganj, Kushtia, Rajshahi, Jhenaidah, Magura, Meherpur, Madaripur, Shariatpur, Gopalganj, Narayanganj, Dinajpur, and Rangpur are the primary onion-producing districts. Pabna has the greatest onion production rate of any of the 64 districts. The overall onion area in the country was 187 thousand hectares, with Pabna accounting for 42566.40 hectares and Faridpur accounting for 2617 hectares. Pabna, Faridpur, Rajbari, Rajshahi, Kushtia, and Jhenaidah produce approximately 75.79% of the country's total onion production (BBS, 2019). Onion is a widely used spice in Bangladesh so there is a huge demand for onion which is not met up by domestic production. While demand for onions was over 2.5 million metric tons (MT) in 2023, domestic production was around 3.4 million MT (Anonymous, 2023). Because onions are semi-perishable, roughly 1 million MT were lost during harvesting and storage, leaving just a part to reach the market. To make up the difference, Bangladesh purchased 600,000 to 1 million MT from other nations, especially India. This trade dynamic puts a considerable burden on the country's foreign currency reserves, highlighting the critical need for efforts to increase domestic onion production and minimize reliance on imports (Anik and Salam, 2015).

Bangladesh's onion market is now also suffering from rapid price fluctuation due to huge demand and supply gap. The price of onion in Bangladesh largely depends on India. If India implements any export

restriction on onion, then the price becomes very high in Bangladesh. Surprisingly, the price of onion increased at tsunami rate from 140 tk/kg to 250tk/kg overnight in December 2023 because of declaration of onion export ban in India (Anonymous, 2023). This came as a big blow to the lower income people who are already exhausted with high cost of living. An adequate onion pricing in all consumer markets may help to stabilize the retail sector while also encourage the farming community. This can be possible through minimizing the gap between demand and supply for which analyzing the growth and trends of onion is vital.

Studies show, countries that are global leader in onion production, (i.e., India) (Choubey, 2014; Kondal, 2011) yet having an increasing area and production of onion, often goes through negative productivity growth (Mahmadajaruddin and Mamani, 2020; Mishra *et al.*, 2013; Kondal, 2011). Being perishable in nature and agricultural commodity, onion production largely depends on environmental factors (i.e., rainfall, monsoon period, humidity) and often results in production instability (Meena *et al.*, 2016; Choubey, 2014; Mishra *et al.*, 2013). Besides, producers' decision to use land for onion production alongside other crops causes production fluctuations (Sharma *et al.*, 2017; Kale *et al.*, 2016; Darekar *et al.*, 2015; Immanuelraj *et al.*, 2014). Agriculture of Bangladesh is highly incentivized, and producers of this incentivized practice usually been selling up to 86% of their onions but still the retail onion market of Bangladesh relies on importing onion from neighboring countries (i.e., India, Myanmar) (Mila *et al.*, 2023). However, forecast models present an upward trend in onion production, yield and growth for coming years (Mila *et al.*, 2019). Due to lack of timely market information, impact on onion production (Kale *et al.*, 2016) and profitability (Sabur and Mollah, 1993) is evident. Instable production leads to drastic price fluctuations and price shocks to market actors (Huda *et al.*, 2021), especially the consumers (Halder, 2023). Thus, to address the hindered supply and rapid price ups and downs, market integration assessment provided insight on different onion markets of

Bangladesh (Sabur *et al.*; 2006; Lohano *et al.*, 2005). Strong spatial market linkages exist among the market actors as well as significant seasonal influence on onion price is evident for the markets of Bangladesh (Reddy *et al.*, 2012; Sabur *et al.*, 2006; Lohano *et al.*, 2005). Despite having strong spatial connection among vegetable markets (Omar and Hoq, 2014; Hasan and Uddin, 2011; Alam and Begum, 2007) price fluctuation is prominent in the markets of Bangladesh. Beyond addressing the market trends, linkage level, some suggested on proper policy implementation, including improved variety adoption would yield greater outcome for Bangladesh's onion market (Hasan *et al.*, 2013).

However, in spite of having some rigorous studies on onion production and market integration, it is visible that more in-depth assessment of onion growth and trend is crucial. Analyzing the growth and trends of onion will show the historical performance of onion production, changing trend and growth of onion production in Bangladesh. Moreover, to achieve self-sufficiency in onion production and its demand, it is important to know the growth and trend and deficit of onion production. Bangladesh's onion market is now experiencing supply and price volatility, which is affecting farmers' market share and also hurting consumer welfare. Furthermore, the country is facing an import dependency of onion which is making foreign currency loss and market instability. Thus, this study aimed to identify and assess the growth and trend of area, production and yield of onion in Bangladesh to achieve self-sufficiency in onion production.

## Materials and Methods

### Data

The entire study was based on secondary data. To analyze the growth and trend of onion, 50 years annual data on onion's area, production, and yield in Bangladesh were collected from Food and Agricultural Organization (FAO) website from 1970 to 2019 (FAOSTAT, 2019). FAOSTAT is a worldwide accepted data source on different statistics for different countries.

### Estimation of growth rate (Semi-log model)

The semi-log model is commonly used to estimate the growth rate of area, production and productivity in several studies (Hasan *et al.*, 2013; Choubay, 2014; Rana *et al.*, 2021). It is also important to calculate both relative and absolute changes (Rana *et al.*, 2021). To measure the growth rate over a longer period of time semi-log model is suitable. In the semi-log function, a given's year output depends on the preceding year. To calculate the growth of area, production, and yield of onion in Bangladesh for the period of 1970 to 2019, the following semi-log model was used for measuring the growth rate.

$$\text{Growth rate: } Y_t = \alpha + \beta t + U_t$$

Where,  $Y_t$  = Area/ production/ yield of onion in year  $t$ ;  $\alpha$  = Intercept;  $\beta$  = coefficient of trend, refers the growth rate in ratio scale when multiplied by 100, it expresses %age growth;  $t$  = independent variable (time);  $\ln$  = natural logarithm and  $U_t$  = Disturbance term.

Here, the coefficient of trend ( $\beta$ ) measures the constant proportional or relative change in  $Y_t$  for a given absolute change in the value of the regressor  $t$ . If the relative change in  $Y_t$  is multiplied by 100, it gives the %age change, or the growth rate, in  $Y_t$  for an absolute change in  $t$ , the regressor. That is, 100 times  $\beta$  gives the growth rate in  $Y_t$ .

### Compound annual growth rate

The method of calculating the annual growth rate is the compound annual growth rate, which is widely used. The compound annual growth rate is defined as the year-over-year growth rate over a specified period of time. The compound annual growth rates were computed using the following equation –

$$\text{CAGR} = \left[ \frac{E_v}{B_v} \right]^{(1/n)-1}$$

Where,  $E_v$  = Ending value;  $B_v$  = Beginning value;  $n$  = Year

### Analyzing trend of onion area, production and yield

A trend line is most reliable when its R-squared value is at or near 1. When we fit a trend line to

data, graph automatically calculates its R-squared value. Data of area, yield, and production of onion from the year 1970 to 2019 were used to analyze the exponential trend line because its R-square value which was a relatively good fit of the line to the data. The trend was calculated with the help of following formula:

$$\text{Exponential Trend Line, } Y = ae^{bX}$$

Here is Y= Forecast; X=Year; e = mathematical constant; a= Intercept (Base level); b= Slope (Trend)

The results revealed that the increase in area, production, and yield of onion was positive. On the positive side of the growth rate, the area, production and yield of the onion increased by 3.87%, 5.46% and 1.58% per year respectively. Over the past few decades, the adoption of modern varieties in onion cultivation has become one of the main reasons behind the growth of onion, which is laying a major role in the transformation of the rural economy (Rana *et al.*, 2021). Besides, year-round demand,

**Table 1. Growth rate of area, yield and production of onion using semi-log model (1970-2019)**

Particulars	Area	Production	Yield
Trend Coefficient	0.03869***	0.05456***	0.01579***
P value	0.000	0.000	0.000
F- Statistics	119.09	87.45	44.73
Growth Rate (%)	3.87%	5.46%	1.58%

Note: (\*\*\*) Significant at 1 % level of significance

## Results and Discussion

### *Overall growth rate*

The growth analysis was done through a semi-log model to find out the area, production, and yield growth of onion crops from 1970 to 2019. The results are presented in Table 1. The results of P-values indicate that the models were highly significant at 1% level of significance for onion crop area, production, and yield growth in Bangladesh.

high price and increase profitability of onion production motivated the farmers to cultivate the crop at increasing rate.

### *Compound annual growth rate (CAGR)*

By calculating the compound annual growth rate of the onion, it is possible to estimate how much area, production, and yield increases every year and every five years based on the base year.

**Table 2. Compound annual growth rate of onion area in Bangladesh**

Year	Area (ha)	Growth from base year (%)	Growth from five years before (%)	CAGR from base year (%)	CAGR from five years before (%)
1970	32800	-	-	-	-
1975	31145	-5.046	-5.046	-1.03	-1.03
1980	32051	-2.284	2.909	-0.23	0.58
1985	34058	3.835	6.262	0.25	1.22
1990	35235	7.424	3.456	0.36	0.68
1995	34165	4.162	-3.037	0.16	-0.61
2000	33994	3.640	-0.501	0.12	-0.1
2005	86429	163.503	154.248	2.81	20.52
2010	117560	258.415	36.019	3.24	6.35
2015	169609	417.101	44.274	3.72	7.61
2019	172456	425.780	1.679	3.45	0.42

From the Table 2 we can see that the compound annual growth rate of the area of the onion crop in Bangladesh. In 1975, the compound annual growth rate of onion was -1.03%. It had increased to 3.45% in 2019. Compare to base year in 1970, the area

maximum of 5.1% and minimum of -4.36% in 1975. Compound annual growth rate from five years' interval had increased to 1.41% in 2019. In 2005, the production under onion cultivation recorded the maximum of 34.48% and minimum of -4.36% in

**Table 3. Compound annual growth rate of onion production in Bangladesh**

Year	Production (MT)	Growth from base year (%)	Growth from five years before (%)	CAGR from base year (%)	CAGR from five years before (%)
1970	181900				
1975	145578	-19.968	-19.968	-4.36	-4.36
1980	141652	-22.126	-2.697	-2.47	-0.55
1985	140695	-22.653	-0.676	-1.7	-0.14
1990	147845	-18.722	5.082	-1.03	1
1995	144000	-20.836	-2.601	-0.93	-0.53
2000	134000	-26.333	-6.944	-1.01	-1.43
2005	589410	224.030	339.858	3.42	34.48
2010	872081	379.429	47.958	4	8.15
2015	1704402	836.999	95.441	5.1	14.34
2019	1802868	891.131	5.777	4.79	1.41

under onion cultivation recorded the maximum of 3.72% in 2015 and the minimum of -1.03% in 1975. In five years' interval, the highest area under onion cultivation recorded 20.52% in 2005 and the lowest was -1.03% in 1975. minimum of -4.36% in 1975.

1975. The compound annual growth rate of the yield of the onion crop in Bangladesh was represented in Table 4. Compare to the base year in 1970, the compound annual growth rate of onion yield was -3.36% in 1975. It had increased to 1.3% in 2019. The yield under onion cultivation recorded the maximum of 1.33% in 2015 and minimum of -3.36% in 1975. In five years' interval, the yield under onion cultivation recorded the highest was 11.59% in 2005 and the lowest was -3.36% in 1975.

From the Table 3 we can understand that the compound annual growth rate of the production of the onion crop in Bangladesh. Compare to base year in 1970, the lowest compound annual growth rate of

**Table 4. Compound annual growth rate of onion yield in Bangladesh (1970-2019)**

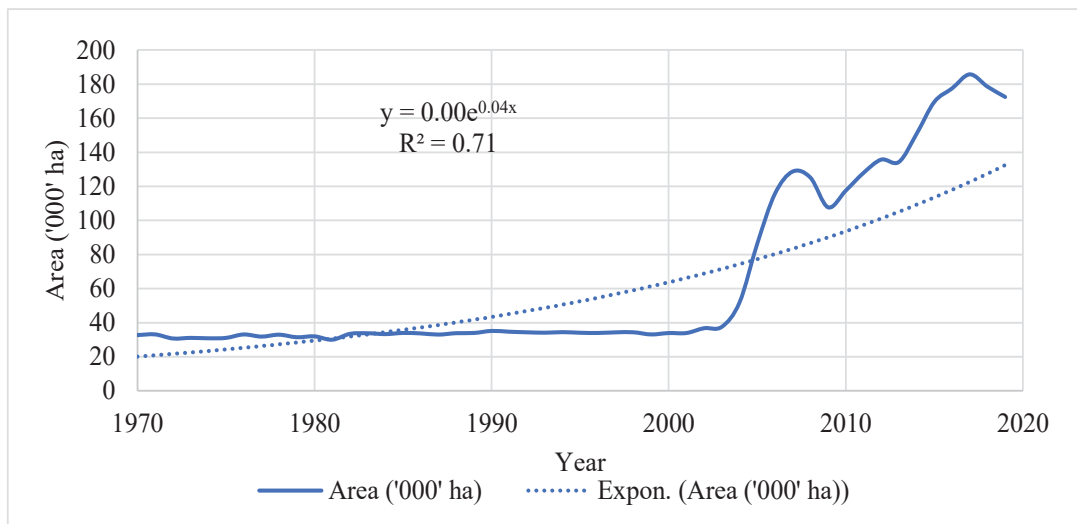
Year	Yield (hg/ha)	Growth from base year (%)	Growth from five years before (%)	CAGR from base year (%)	CAGR from five years before (%)
1970	55457	-	-	-	-
1975	46742	-15.715	-15.715	-3.36	-3.36
1980	44196	-20.306	-5.447	-2.24	-1.11
1985	41310	-25.510	-6.530	-1.94	-1.34
1990	41960	-32.166	1.573	-1.38	0.31
1995	42148	-23.999	0.448	-1.09	0.09
2000	39419	-28.920	-6.475	-1.13	-1.33
2005	68196	22.971	73.003	0.59	11.59
2010	74182	33.765	8.778	0.73	1.7
2015	100490	81.203	35.464	1.33	6.26
2019	104541	88.508	4.031	1.3	0.99

the production of the onion crop in Bangladesh. Compare to base year in 1970, the lowest compound annual growth rate of onion production was -4.36% in 1975. It had increased to 4.79% in 2019. In 2015, the production under onion cultivation recorded the

#### ***Onion area, production and yield trend in Bangladesh***

The overall trend of onion has been increased from 1970 to 2019 in case of area, yield and production.

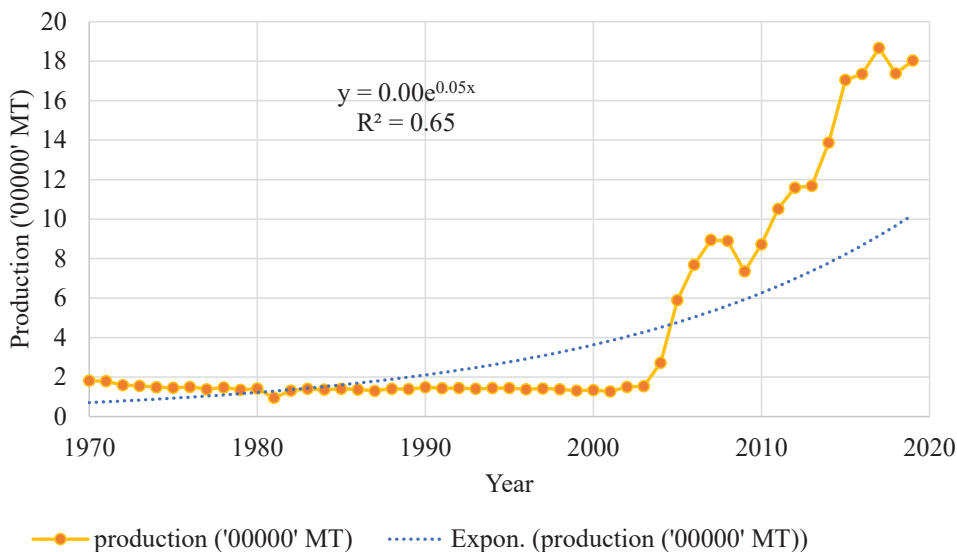




**Fig. 1. Trend line of onion area (ha) in Bangladesh from 1970 to 2019**

The Fig. 1 clearly illustrates that the onion field had grown significantly over the last 50 years (1970-2019), but this graph consisted of fluctuations rather than a smooth growing line. The area of the exponential trend line had been steadily increasing since 2004. And the R-square value of 0.84 indicated a fairly good fit of the approximate trend line values with the actual data. The growth estimate was found to be 4%. So, the question arises as to why there

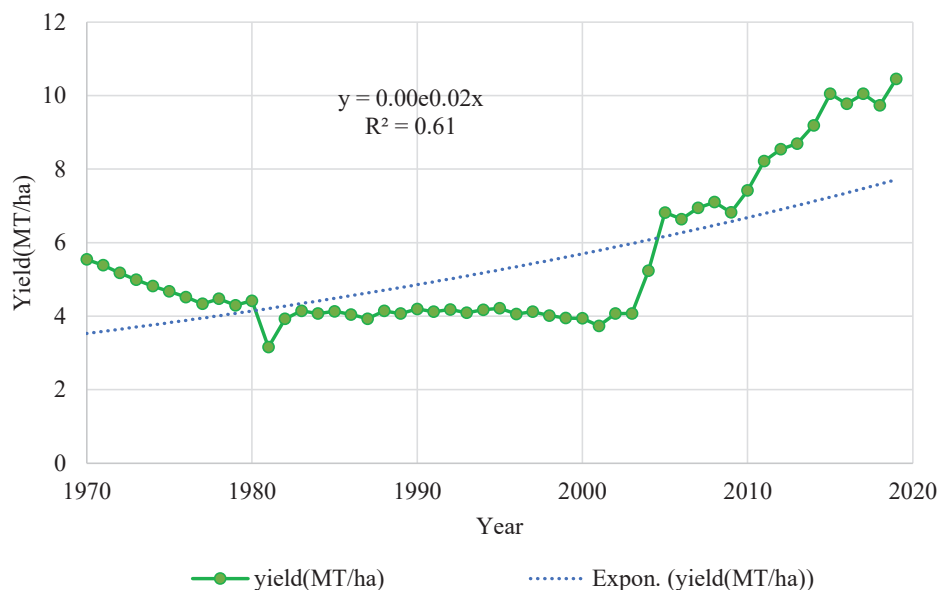
were such fluctuations in cultivation area. Onion cultivation might be increased or decreased due to the fact that it largely depends on the price and when production increased the price decreases, resulting in loss to the farmers. Under these circumstances farmers decided to produce less of the crop in the next year which again leads to a deficit of supply, leading to a rise in price. These induced farmers to produce more the next year.



**Fig. 2. Trend line of onion production (MT) in Bangladesh from 1970 to 2019**

From Fig. 2 it is clearly understandable that the production of onion has significantly increased over the past 50 years (1970- 2019). It can also be seen that the graph was not a smooth line which had lots of fluctuations especially from 2005 onwards indicating that production of onion was not steady year after year. Nevertheless, onion production sometimes increased and decreased. The exponential or the

ha) followed by Pakistan (13.0 MT/ha) (Srikanth *et al.*, 2020). Thus, Bangladesh has great opportunity to increase the production of onion through increasing the yield following the neighboring countries. Adequate research should be conducted to find yield difference between Bangladesh and other countries. From the value of the exponential, we can see that the R-square was 0.61 and growth



**Fig. 3. Trend line of onion yield in Bangladesh from 1970 to 2019**

fitted trend line was found to be sloping upwards and the R-square value of 0.87 indicated a pretty good fit of the approximate trend line values with the actual data. The growth estimate was found to be 5%. Production had been steadily increasing due to improved varieties of seeds, advanced technology and the use of proper fertilizers (Anik and Salam, 2015).

The above diagram shows that the yield of onions had slightly increased over the past 50 years. The yield was the highest during the year 2019 (10.45 MT/ha) and the lowest in the year 1981 (3.15 MT/ha). Thus, the difference between the highest and the lowest yield is 7.3 MT/ha. The yield of onion is the highest in USA (54.6 MT/ha) followed by Netherlands (49.7 MT/ha) and Egypt (33.7 MT/ha). In South Asia, India has the highest yield (16.1 MT/

estimate rate of the yield over the past 50 years was 2%. Also evident from the chart was that there had not been a substantial increase of yield over the past 50 years. Thus, we can infer that there is still scope for improvement in the yield through the use of better variety seeds, better technologies and proper fertilizers. It should ensure that farmers are trained on proper application of fertilizers and pesticides.

Onion is a widely used spice in Bangladesh so there is a huge demand for onion which is not met up by domestic production. Every year, demand outstrips local output, necessitating considerable imports which cause significant loss of valuable foreign currency. Bangladesh is the highest onion importing country in the world. According to the National Board of Revenue (NBR), Bangladesh imported 727,000 MT of onions in 2022, the largest amount

of import in the world for that year (Milad, 2023). Moreover, Bangladesh is badly suffering due to decreasing trend of foreign reserve in recent year. Thus, it is really essential to save foreign currency by increasing the production of onion. If Bangladesh wants to be self-sufficient in onion production, it is important to know the growth and trend and deficit of onion production.

Furthermore, the price of onion is not stable in Bangladesh which affects both the welfare of producers and consumers. Though price remains low during the time of harvesting, it becomes very high in non-harvesting period due to lower supply in the market. To ensure the fair price of onion the balance between demand and supply should be maintained throughout the year. At present, Bangladesh has sufficient onion production to meet up the local demand but a significant amount of onion spoil due to lack of storage facilities which causes deficit of production (Anonymous, 2023). So, adequate storage facilities should be developed to ensure adequate supply of onion throughout the year.

### Conclusion

Over the last five decades, Bangladesh has seen substantial growth in onion cultivation, with an overall growth rate of 3.87% in area, 5.46% in production and 1.58% in yield. Although this growth is notable, it falls short of meeting the increasing domestic demand driven by population growth. Efforts are needed to enhance yield through modern technologies, high quality seeds and improved agricultural practices. In a forecast, it was observed that while onion supply has increased, demand is expected to surge significantly, creating a projected deficit of 1 million metric tons in 2030. To eliminate this gap, initiatives should be focus on expanding cultivation areas and adopting innovative production models. Investment in research and development, coupled with technology adoption can booster onion production. Every year, demand outstrips local output, necessitating considerable imports. Improving local production through competent management is critical to reducing this reliance.

Balancing winter and summer onion production can meet domestic need while also allowing for exports. Modern harvesting technology and adequate storage facilities should be developed to reduce harvesting loss and perishability of onion. Balance between demand and supply must be maintained by regular market monitor, projecting demand and supply gap and improving market infrastructures to ensure fair price for both producers and consumers. An adequate onion pricing in all consumer markets may help to stabilize the retail sector while also encouraging farming. Overall, the findings highlight the need for concerted efforts to enhance onion production, ensure market efficiency and meet the rising demand in Bangladesh.

### Disclosure of potential conflicts of interest

All authors agreed that they do not share any potential conflicts of interest.

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