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GROWTH PATTERNS AND INSTABILITY OF CHICKPEA CULTIVATION IN BANGLADESH

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Abstract

Chickpea plays an important role in Bangladesh's agriculture due to its nutritional value and contribution to food security. This study examines the growth patterns and instability of chickpea cultivation in Bangladesh over four decades (1984–2023). Using secondary data, the period was divided into four sub-periods (1984–1993, 1994–2003, 2004–2013, and 2014–2023) to analyze trends. Exponential growth functions were applied to estimate growth rates, while the Cuddy–Della Valle index measured instability. The results indicate a sharp decline in the cultivated area, particularly after 1999/2000. However, yield improvements since the mid-2000s have partly offset production losses. Growth decomposition analysis shows that yield growth (96.02%) was the main driver of production, whereas area changes (3.62%) had only a minor effect. Instability indices reveal greater variability in yield compared to area and production, underscoring challenges in achieving stable productivity. Strategic measures to stabilize and expand cultivation area, alongside continuous yield improvement, are essential to ensure the sustainability of chickpea production in Bangladesh.

Keywords: Chickpea, growth rate, instability, Bangladesh.

Introduction

Pulses hold significant importance in the agricultural landscape of Bangladesh, serving as essential sources of nutrition for human consumption (Das *et al*., 2016). Their rapid growth, provision of fodder for livestock, and profitable returns for farmers underscore their multifaceted value (Miah *et al.,* 2009). In addition, pulses enhance agricultural and environmental sustainability through nitrogen fixation, carbon sequestration, and organic matter enrichment (Senanayake *et al*., 1987; Zapata *et al*., 1987; Sarker and Kumar, 2011). The favorable climatic conditions across Bangladesh support the cultivation of diverse pulse varieties, making pulses,often referred to as the "poor man's meat"- a vital component of diets, particularly for low-income populations. Among these, lentils are one of the oldest and most widely consumed legumes in Bangladesh. Their ability to grow in marginal environments, combined with their rich and balanced protein supply, has ensured their long-standing role in food security.

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Chickpea (*Cicer arietinum* L.) is another important pulse crop in Bangladesh due to its high consumer demand and widespread consumption. Traditionally grown under rainfed conditions, chickpea is mainly cultivated in Jessore, Faridpur, Rajshahi, Kushtia, Pabna, Chapainawabganj, and Dinajpur districts. In 2022–23 season, chickpea was cultivated on about 4.04 thousand hectares, producing around 4.67 thousand tonnes, with an average yield of 1.16 t/ha (BBS, 2023). However, domestic production remains insufficient, and to meet demand Bangladesh imported 354.14 thousand tonnes of dry chickpeas valued at USD 210.94 million in 2021 (FAOStat, 2021).

Instability is a common feature of agriculture, as production depends heavily on weather conditions and other external factors. Consequently, the area, production, and yield of chickpeas have experienced considerable variation over time. Despite the crop's importance, there is a scarcity of research focusing specifically on the growth and instability of chickpea cultivation in Bangladesh. While several studies (Das *et al*., 2016; Miah *et al*., 2009; Rashid *et al*., 2014) have examined pulse production, most emphasized lentils or pulses in general, with limited attention to chickpeas. Moreover, earlier studies often lacked long-term analysis and detailed decomposition of the drivers of production changes.

This study seeks to fill that gap by analyzing growth patterns and instability in chickpea cultivation over four decades (1984–2023). By applying growth decomposition techniques and instability indices, the research provides updated insights that are directly relevant for agricultural policy and planning in Bangladesh. The findings are expected to guide researchers, policymakers, and planners in formulating strategies for sustainable chickpea development.

The specific objectives of the study are:

(i) to determine the growth rates of area, production, and yield of chickpeas in Bangladesh;

(ii) to measure the changes and instability in area, production, and yield of chickpeas; and

(iii) to propose policy guidelines for the development of chickpea cultivation in Bangladesh.

Materials and Methods

Data and its Sources

The study was based on secondary data obtained from various published sources. Time series data on the area, production, and yield of chickpea for a 40-year period (1984–2023) were collected from different issues of the *Yearbook of Agricultural Statistics of Bangladesh*.

Analytical Procedures

Various statistical measures were used to analyze the data to examine the nature of change, instability, and the degree of relationship in the area, production, and yield of chickpea in Bangladesh.

***Trend analysis*:** Trend analysis aims to find out the extent and causes of instability in the area and production of chickpeas over time. This information may lead research managers as well as policymakers to prepare appropriate policy documents for the improvement of chickpeas in the country. A simple line graph and bar diagram were used to show the trends in area, production, and yield of chickpeas in Bangladesh.

***Index number*:** The relative changes in the area, production, and yield of chickpeas over a specified period can be quantified using an index number. For this purpose, the entire study period was divided into four sub-periods: 1984–1993, 1994–2003, 2004–2013, and 2014–2023. The division was made to analyze the changes in area, production, and yield of chickpeas within each 10-year period. The average values of area, production, and yield for the first sub-period (1984–1993) were used as the base values for comparison.

Annual growth rates: Growth rates are *the percent change of a variable over time*. It is important because it can help researchers and policymakers predict future growth. For simplicity and widely used even in the recent past (Das and Mishra, 2020; Chaudhary *et al.*, 2016), the compound growth rates of area, production, yield, and price of chickpeas were worked out by fitting an exponential function of the following type (Equation 1):

$$Y = ae^{bt} \quad \text{or} \quad LnY = Lna + bt \text{ -- (1)}$$

Where Y is the area/production/yield of chickpea, 't' is the time in a year, and 'a' is the constant, e^b -1 be the compound growth rate, which is expressed in percentage.

The component analysis model has been used to measure the relative contributions of area and yield toward the overall output change with regard to individual crops. The growth performance of the crops has been studied using this model (Equation 2) by numerous researchers in the literature (Gupta and Saraswat, 1997; Singh and Ranjan, 1998; Siju and Kombairaju, 2001; Kakali and Basu, 2006).

$$\Delta P = A\circ\Delta Y + Y\circ\Delta A + \Delta A\,\Delta Y \text{ --- (2)}$$

Change in production = Yield effect + Area effect + Interaction effect

Thus, the total change in production is attributed to area and yield that can be decomposed into three effects viz, yield, area, and interaction effects.

Instability index: Instability means the quality or state of being unstable or a lack of stability. Agricultural instability can be measured by different methods, such as the coefficient of variation (CV), dispersion, Cuddy Della Valle Index (CDI), Coppock Instability index, etc. The present study applied the Cuddy and Valle (1978) Index (Equation 3) for examining the nature and degree of instability in the area, production, and yield of chickpeas in Bangladesh. The use of CV as a measure to show the instability in any time series data has some limitations. It does not explain properly the trend component inherent in the time series data. If the time series data exhibit any trend, the variation measured by CV can be overestimated, i.e., the region that has growing production at a constant rate will score high in instability of production if the CV is applied for measuring instability. As against that, CDI first attempts to detrend the CV by using the coefficient of determination (R^2). Thus, it is a better measure to capture instability in agricultural production. A low value of this index indicates low instability in farm production and vice versa. The estimable form of the equation is as follows:

$$CV_t = (\mathrm{CV}) \times \sqrt{1 - R^2} \quad \text{--} \quad (3)$$

Where CV_t is the coefficient of variation around the trend; CV is the coefficient of variation around the mean in percent; and R^2 is the coefficient of determination from time trend regression adjusted by the number of degrees of freedom. The formulas of CV and R2 are given below.

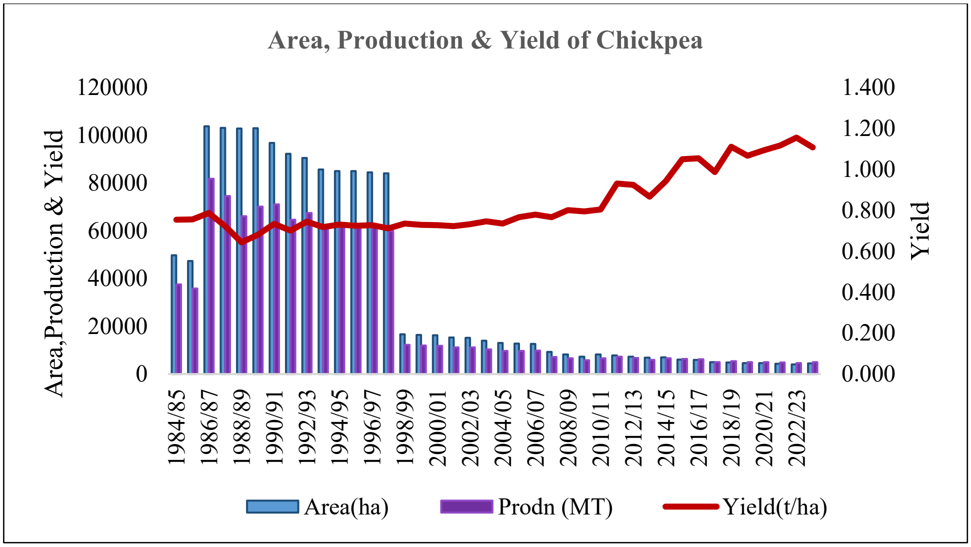
$$\mathrm{CV} = \frac{Standard\ deviation}{Mean} \times 100$$

$$R^2 = 1 - \frac{Unexplained\ variation}{Total\ variation}$$

Results and Discussion

Trends of Area and Production of Chickpea in Bangladesh

Fig. 1 shows that the area and production of chickpeas for the period from 1984/85 to 1985/86 were very low compared to the succeeding years. After that chickpea cultivation is gaining popularity among farmers. Therefore, both area and production of chickpeas were very high for the period of 1986/87-1997/98 due to the higher adoption of improved varieties (BARI Chola-2, -3, -4, -5 & -6) and technologies of chickpeas at the farm level (Kabir et al., 2009). Again, the overall area and production of chickpeas in the country were found to decrease for the period from 1998/99 to 2023/24. The reason for decreasing trend was to put high emphasis on increasing the area and production of cereals like rice, wheat, maize, and other short-duration oilseed crops throughout the country (Rashid *et al*., 2014).



Source: Using data from various issues of the BBS in different years

Fig. 1. Trend of area, production, and yield of chickpea, 1984/85-2023/24.

The overall indices show that the area and production of chickpea show a decreasing trend from its base period during 2014-2023. On the other hand, the productivity indices revealed an increasing trend during the period from 1984-1993 to 2014-2023 (Table 1). Despite the decrease in area, the yield of chickpeas has gone up in those periods, which was mainly due to the adoption of improved varieties along with management technologies of chickpeas.

Table 1: Index of area, production, and yield of chickpea

Period	Area (%)	Production (%)	Yield (%)
1984-1993	100 (87506)	100 (63048.5)	100 (0.724)
1994-2003	49.4	49.7	100.7
2004-2013	10.7	11.9	112.8
2014-2023	5.8	8.6	147.5

Note: Figures within parentheses indicate a 10-year average value in the base year of the indices. Source: Various issues of BBS

Annual Growth of Chickpea Production

The overall annual growth rates scenario reveals that the area and production of chickpea registered highly significant negative growth rates during 40-year period (1984-2023). The growth rates registered in area and production from 1984 to 1993 were found positive and significant (Table 2). Both area and production growth rates were found significantly negative during 1994-2023 due to putting a high emphasis on increasing the area and production of cereals like rice, wheat, maize, and other short-duration oilseed crops (Rashid *et al*., 2014). However, the growth rates of yield were positive and highly significant for all periods except the period 1984-1993 and 1994-2003 (-0.619 and 0.18). The highly significant growth rates of yield were mainly due to the adoption of improved chickpea variety and technology. This indicates that more adoption of the modern varieties of chickpea is needed for the expansion of this crop throughout the country.

Table 2: Annual growth rates of area, production, and yield of chickpea, 1984-2023

Period	Area	Production	Yield
1984-1993	5.24***	4.62***	-0.619
1994-2003	-25.33***	-25.15***	0.18
2004-2013	-7.59***	-5.27***	2.31***
2014-2023	-5.36***	-3.74***	1.62***
1984-2023	-9.6***	-8.34***	1.25***

Note: '***' '**' & '*' represent 1%, 5% and 10% level of significant

Sources of Growth of Chickpea Production

The decomposition of chickpea production growth reveals that both area and yield contributed differently across the periods (Table 3). During 1984–1993, the major contribution came from yield improvement (123.20%), while the effect of area was negative (–15.81%). Similarly, in 1994–2003, yield contributed 103.06% to production growth, whereas the area effect was almost negligible (–0.02%).

In 2004–2013, yield improvement (126.63%) remained the dominant factor, though the area effect (–26.51%) negatively influenced production. The most striking result was observed in 2014–2023, where yield accounted for as high as 250.23% of the change in production, while the area effect again showed a strong negative contribution (–141.28%).

When the entire period (1984–2023) is considered, yield effect (96.02%) overwhelmingly dominated chickpea production growth, while the area effect (3.62%) played a relatively minor role. The interaction and residual effects were very small and inconsistent across the periods.

Overall, this analysis clearly shows that the improvement in yield was the principal driver of chickpea production growth in Bangladesh, while area under cultivation generally declined and negatively contributed to production growth.

Table 3: Growth decomposition in the production of chickpea during 1984-2023

Period	Effect (%)				
	Area (A)	Yield (Y)	Interaction	Residual	Total
	ΔA*Y	A*ΔY	ΔA*ΔY	ΔCOV(A,Y)	ΔQ
1984-1993	-15.81	123.20	7.39	-14.78	100
1994-2003	-0.02	103.06	3.04	-6.09	100
2004-2013	-26.51	126.63	0.12	-0.23	100
2014-2023	-141.28	250.23	8.95	-17.89	100
1984-2023	3.62	96.02	-0.36	0.72	100

Source: Author's calculation using BBS data of different years

Instability of Chickpea Cultivation

The estimates of instability in area, production, and yield of chickpeas are presented in Table 4. The instabilities of the chickpea area (4.35%) and production (4.65%) at the national level were not so high, but the instability of production was a little bit higher than the area instability. On the other side, the instability related to productivity was about -43.08% during 1984-2023, meaning that chickpea productivity was almost stable over the stipulated period.

Table 4: Instability indices for area, production, and yield of chickpea, 1984-2023

Period	Instability (%)		
	Area (ha)	Production (t)	Yield (t/ha)
1984-1993	2.24	2.21	-16.90
1994-2003	4.06	4.16	-3.32
2004-2013	1.14	1.41	-19.41
2014-2023	0.81	0.76	56.96
1984-2023	4.35	4.65	-43.08

The results clearly show that yield growth (96.02%) was the principal driver of chickpea production, compensating for the continuous decline in cultivation area. This finding is consistent with Kabir *et al.* (2009), who emphasized the role of BARI-developed chickpea varieties. The strong negative contribution of area reflects a national policy shift toward rice, wheat, and maize (Rashid *et al.*, 2014), which discouraged chickpea expansion. Instability patterns indicate that while productivity remained stable in earlier decades, the last decade (2014–2023) experienced high variability in yield (56.96%). This rise can be attributed to climatic fluctuations, including erratic rainfall and drought events, as well as limited adoption of climate-resilient practices—challenges that have also been observed in pulse production across South Asia (Sarker and Kumar, 2011). Thus, while yield improvements are promising, their sustainability remains vulnerable to environmental risks and management inefficiencies.

Conclusions

The analysis of chickpea cultivation in Bangladesh over 1984–2023 highlights significant structural changes in area, production, and yield. Since the late 1990s, the cultivated area has declined sharply, largely due to the expansion of cereals such as rice, wheat, and maize, along with short-duration oilseed crops. Despite this contraction, production losses were partly offset by substantial yield improvements, driven by the adoption of improved varieties and modern cultivation technologies.

Growth decomposition analysis shows that yield effect (96.02%) was the principal contributor to production gains, whereas area effect (3.62%) was marginal and often negative in sub-periods. This indicates that productivity improvements have compensated for land reduction, but declining area remains a critical constraint to sustaining output growth.

Instability analysis further reveals that production instability (4.65%) has been slightly higher than area instability (4.35%), while yield instability fluctuated considerably—remaining stable in earlier decades but increasing sharply in recent years (56.96% during 2014–2023). These findings suggest that although yield growth has been the main driver of production, it is also increasingly vulnerable to environmental variability and management challenges.

In conclusion, yield improvements have been the key determinant of chickpea production growth in Bangladesh; however, the persistent decline in cultivation area and rising yield instability pose serious challenges for long-term sustainability. Strategic interventions are required to stabilize cultivation area, promote wider adoption of improved varieties, and strengthen crop management practices. Without such measures, dependence on chickpea imports will continue to grow, threatening national pulse security.

Recommendations

Based on the study findings, the following recommendations are proposed to promote sustainable growth in chickpea production in Bangladesh:

1. **Strengthen varietal improvement and seed dissemination:** Since yield contributed 96.02% to production growth, future strategies should prioritize the development and dissemination of climate-resilient, high-yielding chickpea varieties. Ensuring timely access to quality seed for farmers is essential.

2. **Reintroduce chickpea on marginal and fallow lands:** The sharp decline in cultivated area highlights the need for policy incentives—such as input support, minimum price guarantees, or intercropping schemes—to encourage farmers to allocate land for chickpea cultivation.
3. **Reduce yield instability through risk management:** The high variability in yield during 2014–2023 underscores the importance of adaptive measures, including crop insurance schemes, supplemental irrigation, improved soil management, and integrated pest and disease management practices.
4. **Strengthen extension and value chain linkages:** Collaboration among BARI, extension services, NGOs, and private seed companies should be enhanced to scale up technology adoption. Developing efficient marketing and value chain systems can also reduce import dependence and stabilize domestic chickpea prices.

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