

ASSESSMENT OF TREND AND INSTABILITY OF AREA AND PRODUCTION OF MUNG BEAN IN BANGLADESH

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ABSTRACT

Instability is an inherent aspect of agriculture due to its reliance on weather conditions, resulting in substantial fluctuations in crop area, production and yield. Mung bean (*Vigna radiata*) is one of Bangladesh's most important pulses. It is highly valued for its nutritional composition and also helps improve soil health. This study focused on analyzing the changes in the cultivation area, production and yield of mung bean in Bangladesh through growth rate and instability analysis based on secondary data over a 40-year period (1981-2020). The entire timeframe was divided into four sub-periods: 1981-1990, 1991-2000, 2001-2010 and 2011-2020 allowing for analysis using various statistical tools. Growth rates were calculated by fitting an exponential growth function, while instability was assessed using the Cuddy-Della Valle index. The analysis revealed that the area and production of mung beans had increased. The change in area and yield contributed respectively 51.3% and 46.8% to changes in the mean production of mung bean at the national level. Though the mung bean yields increased significantly, the rate of growth is slow, and it is insufficient to meet our country's demand. The analysis also revealed that the area, production, and yield of mung bean were not stable during the study period.

Keywords: Cuddy-Della Valle index; growth decomposition; growth rate; trend analysis.

INTRODUCTION

Pulses play a crucial role in Bangladesh as important food crops. They offer significant nutritional value to the human diet (Das et al., 2016), with rapid growth, providing animal feed, and generating profitable returns for farmers (Miah et al., 2009). Moreover, pulses contribute to agricultural and environmental sustainability by enriching the soil with nitrogen, carbon, and organic matter (Sarker and Kumar, 2011). A favorable climatic condition exists in Bangladesh for growing different types of pulses all over the country. Due to their high protein content and

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affordability, pulses are often referred to as the "poor man's meat," making them an ideal staple food for low-income populations. The per capita consumption of pulse in our country is only 15.7 g/day (HIES, 2016) which is much lower than the desirable intake of 50 g/day (DDP, 2013).

Mung bean (*Vigna radiata* L.) popularly known as green gram is an ancient and well-known pulse crop that belongs to the *Papilionoideae* family and originated from South East Asia. It is widely cultivated throughout Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia, South China, and the Republic of Formosa (Mogotsi, 2006). It is a source of high-quality protein which can be consumed as whole grains, dhal, or sprouted form and is an excellent complement to rice concerning balanced human nutrition. Dry beans are sometimes used for animal food, mainly poultry, and their biomass is used as fodder (Winch, 2006). Thus, it has great value as food and fodder. Mung bean supplies a substantial amount of nitrogen to the succeeding non-legume crops (i.e. rice) grown in rotation (Sharma and Prasad, 1999). Mung bean is grown around the year (three times) in Bangladesh. At present, this crop is being cultivated after harvesting *Rabi* crops (i.e. wheat, mustard, lentil, etc.). As a short-duration crop, it can be fitted in as a cash crop between major cropping seasons. The present area under mung bean cultivation is 44.25 thousand ha with a total production of 41.19 thousand tons and an average yield of 93.08 t/ha (BBS, 2021). In recent years, due attention has been given to mung bean cultivation in Bangladesh. As a result, mung bean acreage in this country has gradually increased. Of course, there is real hope and a bright possibility of solving the crucial national food crisis by cultivating mung beans.

Instability is an inherent aspect of agriculture due to its reliance on weather conditions, resulting in substantial fluctuations in crop area, production and yield. This instability also extends to mung bean crops. However, there is a lack of comprehensive studies addressing the growth and instability of mung beans in Bangladesh. Therefore, this current study aims to analyze the growth and instability in the area, production, and yield of mung bean, while also identifying the contributing factors that affect mung bean production. The outcomes of this study will offer valuable insights and guidelines for researchers, policymakers, and planners in the country, enabling them to make informed decisions regarding mung bean cultivation and management to determine the growth rates of area, production, and yield of mung bean in Bangladesh and to measure the change and instability in area, production, and yield of mung bean.

MATERIALS AND METHODS

Sources of Data

The study was based on secondary data collected from various published sources. Times series data on the area, production, and yield of mung bean for 40 years from 1981 to 2020 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 degree of relationship in area, production, and yield of mung bean crops in Bangladesh.

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

Index number: We can measure the relative changes in area, production and yield of mung bean that are changed or produced within a stipulated period by using an index number. At first, the entire study period is divided into four sub-periods: 1981 to 1990, 1991-2000, 2001-2010, and 2011-2020. The reason for the division was to know the changes that occurred in the area, production, and yield of mung bean after a 10-year period. The 10 years (e.g. 1981-1990) average value of area, production, and yield was considered the base year.

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 mung bean were worked out by fitting an exponential function of the following type (equation 1):

$$Y=ae^{bt} \text{ or } \text{Ln}Y = \text{Ln}a + bt \text{ ----- (1)}$$

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

The component analysis model has been utilized to assess the respective influences of area and yield on overall output changes for individual crops. This model has been extensively employed by researchers in the literature to investigate the growth performance of various crops (Siju and Kombairaju, 2001; Kakali and Basu, 2006).

The model can be represented as follows:

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

Where:

ΔP represents the change in production.

A signifies the area effect.

Y denotes the yield effect.

ΔA represents the change in area.

ΔY represents the change in yield.

This equation suggests that the total change in production is attributed to the effects of area and yield, which can be further decomposed into three distinct effects: yield effect, area effect, and interaction effect.

Instability index: Instability means the quality or state of being unstable or 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 for examining the nature and degree of instability in the area, production, and yield of mung bean 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 which has growing production at a constant rate will score high in instability of production if the CV is applied for measuring instability (Bisht & Kumar, 2018). As against that, CDI first attempts to de-trend 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 equation (3) is as follows:

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

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.

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

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

RESULTS AND DISCUSSION

Trends of Area and Production of Mung Bean

Figure 1 shows that the area and production of mung bean for the period from 1981/82 to 1985/86 were very low compared to the succeeding years. Besides various positive sides, most of the mung bean areas in the aforesaid period were replaced by cereals (Abedin and Anwarul, 1991). After that mung bean cultivation is gaining

popularity among farmers day by day. The reasons for its higher adoption were: i) short duration crop; ii) many HYVs were available to the farmers; iii) highly responsive to irrigation and fertilizer use; iv) possible to cultivate three seasons due to its photo-insensitive nature; and v) profitable replacement of *Aus* rice and upland jute by mung bean (Miah et al. 2004). It revealed that the Pulse Research Centre of BARI developed four improved mung bean varieties namely BARI Mung-2, BARI Mung-3, BARI Mung-4, and BARI Mung-5 during 1987-1997 (Razzaque et al., 2000). Besides, several HYV of mung bean varieties were also developed by BINA and Bangladesh Sheikh Muzibur Rahman Agricultural University (BSMRAU). Therefore, both area and production of mung bean were very high for the period of 1987/88-1999/00 due to the higher adoption of improved varieties and technologies of mung bean at the farm level. In the period 2001/02 to 2009/10, the overall area and production of mung beans in the country decreased due to insect infestation, insecticides not working properly, a lack of training about improved mung bean cultivation, and the high price of insecticides (Islam et al., 2013). After that period, it again shows an increasing trend.

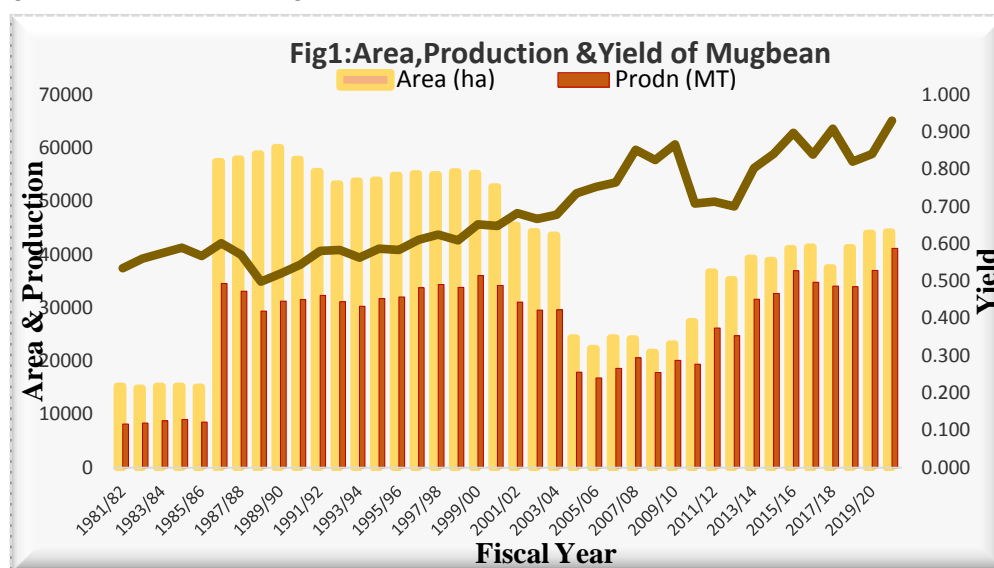


Figure 1. Trend of area, production and yield of mung bean in Bangladesh, 1981/82-1999/20

Source: Researchers estimated using data from various issues of BBS in different years.

The overall indices indicated a moderate increase in the cultivated area during other decades compared to the base period of 1981-1990, except for the period of 2001-2010 (refer to Table 1). Conversely, the productivity indices revealed a consistent upward trend during other decades compared to the base period, albeit with some minor fluctuations (see Table 1). Moreover, the yield of mung bean experienced

growth during these periods, primarily attributed to the adoption of improved varieties and the implementation of advanced management technologies specific to mung beans (Table 1).

Table 1. Index of area, production and yield of mung bean

Time period	Area (%)	Production (%)	Yield (%)
1981-1990	100 (36846)	100 (20297)	100 (0.556)
1991-2000	148	163	109
2001-2010	82	109	135
2011-2020	109	164	149

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 Mung Bean Production

The overall annual growth rates scenario reveals that the area, production, and yield of mug beans registered positive growth rates during 40 years' period (1981-2020) although the area growth rate was not significant at all (Table 2). The growth rates of different periods show that some growth rates registered in the area were found positive and significant from 1981 to 1990 and 2011-2020. Similarly, highly significant positive growth rates of production were observed from 1981 to 1990, 1991-2000, and 2011-2020. Both area and production growth rates (-7.58 & -5.41) were found significantly negative during 2001-2010 due to insect infestation, insecticides not working properly, a lack of training about improved mung bean cultivation, and the high price of insecticides (Islam et al., 2013). However, the growth rates of yield were positive and highly significant for all periods except the period 1981-1990 (-0.67). The highly significant growth rates of yield were mainly due to the adoption of improved mung bean variety and technology. This indicates that more adoption of the modern varieties of mung bean is needed in the farmers' fields.

Table 2. Annual growth rates of area, production and yield of mung bean, 1981-2020

Time period	Area	Production	Yield
1981- 1990	20.47***	19.80***	-0.67
1991- 2000	-0.002	1.44***	1.45***
2001- 2010	-7.58**	-5.41**	2.18**
2011- 2020	2.04***	4.42***	2.38***
1981- 2020	0.45	1.85***	1.40***

Note: '***' & '**' represent significant at 1% and 5% levels of significance, simultaneously

Sources of Growth of Mung Bean Production

Change in the mean area appeared to be the largest source of change in the mean production of mung bean in all the periods except 1991-2000. At the national level, changes in the mean area and yield were the main two sources of changes in mung bean production in Bangladesh. The change in area and yield contributed 51.3% and 46.8% to the changes in mean production of mung bean at the national level. This means that the positive change in production has been attributed to the positive change in area (Table 3).

Table 3. Growth decomposition in the production of mung bean during 1981-2020

Time period	Effect (%)				Total
	Area (A)	Yield (Y)	Interaction	Residual	
	$\Delta A * Y$	$A * \Delta Y$	$\Delta A * \Delta Y$	$\Delta COV(A, Y)$	
1981-1990	109.4	-3.7	5.7	-11.4	100
1991-2000	-119.3	215.4	-3.8	7.7	100
2001-2010	123.6	-10.7	12.8	-25.7	100
2011-2020	58.9	41.2	0.2	-0.3	100
1981-2020	51.3	46.8	-1.9	3.8	100

Source: Author's calculation using BBS data from 1981 to 2020.

Instability of Mung Bean Cultivation

The estimates of instability in area, production, and yield of mung bean are presented in Table 4. The instabilities of the mung bean area (4.3%) and production (4.08%) at the national level were not so high, but the instability of the area was a little bit higher than the production instability. On the other side, the instability related to productivity was about -17.75% during 1981-2020 meaning that mung bean productivity was almost stable over the stipulated period.

Table 4. Instability indices for area, production and yield of mung bean, 1981-2020

Time period	Instability (%)		
	Area (ha)	Production (t)	Yield (t/ha)
1981-1990	3.36	3.58	-9.22
1991-2000	0.17	0.29	-4.43
2001-2010	1.98	1.71	-24.31
2011-2020	0.4	0.75	-32.05
1981-2020	4.3	4.08	-17.75

Source: Author's calculation using BBS data from 1981 to 2020.

CONCLUSION

High growth rates and little production instability are necessary for sustainable agricultural performance, which has significant policy consequences. This study focuses on the analysis of mung bean production growth in Bangladesh, revealing positive and statistically significant growth rates in yield and overall production. However, it is important to note that the observed growth is relatively modest. Agricultural production in Bangladesh is susceptible to natural disasters, resulting in inherent production instability. The findings further corroborate this assertion. But the instability in the area, production, and yield of mung bean is low at the national level. Based on this study's findings, several recommendations can be made to promote sustainable growth in mung bean production in Bangladesh.

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