

GROWTH SCENARIOS OF AREA, PRODUCTION AND YIELD OF RICE IN BANGLADESH

Hurunnahar Khushi^{1*}
Md. Moniruzzaman¹
Nazia Tabassum¹

ABSTRACT

Bangladesh is an agro-based developing country where rice is the dominant crop. And it is the staple food for this country. Over the long period, rice production in Bangladesh has been gradually increased, now the country has reached in self-sufficiency in rice production. The study attempted to estimate growth of area, production, and yield of rice in Bangladesh. The semi log model (Log-Lin) was used to estimate the compound growth rates of rice of different seasons. The study was based on secondary data covered from the period 1971/72 to 2015/16. Growth rates were estimated separately for local and high yielding variety, and also, they were estimated together. The growth rate of an area of Aus was found -3.40 percent for the entire period that means an area of Aus cultivation has been decreased on an average 3.40 percent per year and it was statistically significant. And for Aman it was 0.10 percent, but statistically insignificant. On the other hand, it was 4.40 for Boro that means an area of Boro cultivation has been increased 4.40 percent per year which was statistically significant. The growth rate of production of Aus was also significantly negative and it was 1.30 per cent and positive for Aman and Boro rice that were 1.90 and 5.70 percent per year, respectively. The growth rates of area and production of HYV rice (Aus, Aman and Boro) were found positive for every case and negative for local. Growth rates of yield of Aus, Aman and Boro were significantly positive, which were 2.10, 1.80 and 1.30 percent per year, respectively for the entire period. Growth rates were estimated for the different sub-periods dividing the entire period of decades. Examining the reasons for different growth scenarios could be the future research in this connection.

Keywords: Growth rates, rice production, area and yield, Bangladesh

I. INTRODUCTION

The agricultural and rural sector in Bangladesh has particular importance for the sustained food and livelihood security of its large, dense and ever-growing population. The agricultural activities in the country are pursuing intensively for the crop as well as allied sectors and in conditions of scarce natural resources. Agriculture remains the most important sector of the economy of Bangladesh,

¹Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh

*Corresponding address: Hurunnahar Khushi, Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh. Email: hnkhusi_abm@bau.edu.bd

contributing more than 15 percent to the national GDP and providing employment for 48 percent of the population (BBS, 2018). In Bangladesh there are 4 main crops; Rice, Jute, Wheat and Potato, where rice, wheat & potato play an important role in achieving self-sufficiency in food production (BBS, 2018). There are three seasons of rice namely Aus, Aman and Boro. As a cereal grain, rice is the most widely consumed as a staple food for a large part of the world's human population, especially in Asia. It is the agricultural commodity with the third-highest worldwide production (BBS, 2018).

Rice is the staple food of about 149 million people of Bangladesh (Ricepedia, 2019). It provides about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost 75 percent of the total cultivable land is covered with rice in Bangladesh (BBS, 2017). Rice is therefore not only a staple food, but also a way of life and a cultural heritage of the people of Bangladesh. Rice is a pivotal source of livelihood for millions of resource-poor farmers of the country. The country's population is increasing each day. On the contrary, agricultural land is decreased by about 0.75 percent every year for non-agricultural purposes. An additional 2.5 million births per year require production of additional 0.5 million tonnes of rice per year (BBS, 2016). As the increasing rate of rice production has lessened slightly over the past few years compared to the rate of population increase. To meet the additional needs, the country needs to import rice every year. Around 15 lakh tons of coarse rice was imported in the 2014-15 fiscal year through private sector (MoF, 2016). This is an ominous sign for our country.

The rice supply has steadily increased over time. Domestic production is the major reason for the steady increase in rice supply. In FY2015-16 total rice production was 347.09 lakh metric tonnes (MT), remained flat (347.10 lakh MT) of the previous fiscal year (BBS 2016). The BBS estimated for Aus production in FY2015-16 was 22.89 lakh MT and Aman 134.83 lakh MT and Boro production was 189.37 lakh MT.

For better understanding about the area ('000 acres) production and yield of different varieties of rice, the following figures will be helpful. From the Figure 1, it can be seen that the cultivated area of Aus rice was more or less constant from 1970-71 to 1984-85 then it had been declining gradually. Area cultivated of Aman rice was mostly constant all over the period if we exclude the time span from 1982-83 to 1985-86. And for the Boro rice, it has been increasing gradually since independence of the country. In case of production (Figure 2), upward trend had been observed for both Aman and Boro rice all over the period, and downward for Aus rice. Yields of rice have been increased gradually over the period (Figure 3). Boro have been found much higher yield than Aus and Aman.

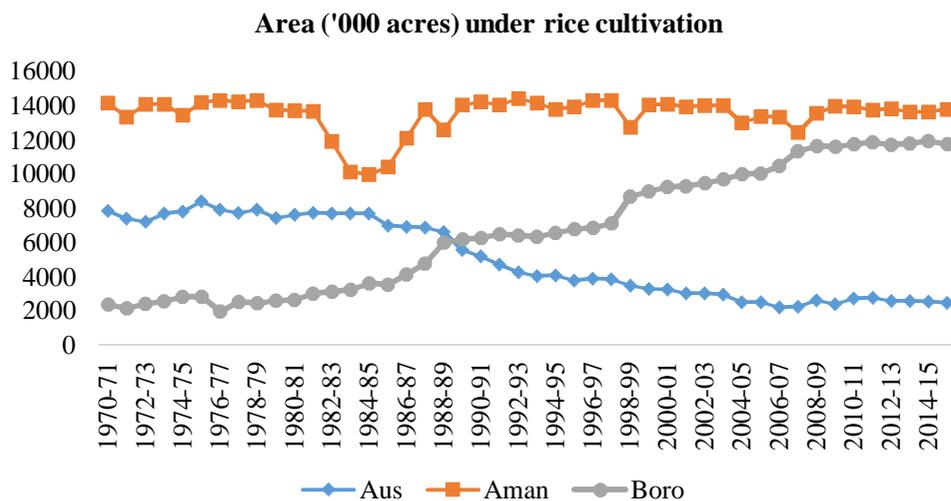


Figure 1: Year wise area ('000 acres) under rice cultivation in Bangladesh
 Source: BBS, (1979-2018)

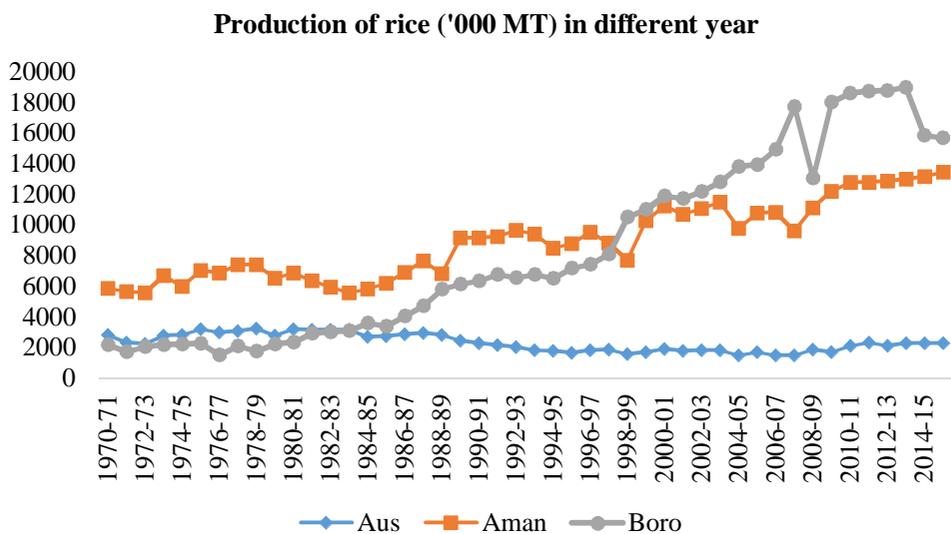


Figure 2: Year wise production ('000 MT) of different varieties of rice in Bangladesh
 Source: BBS, (1979-2018)

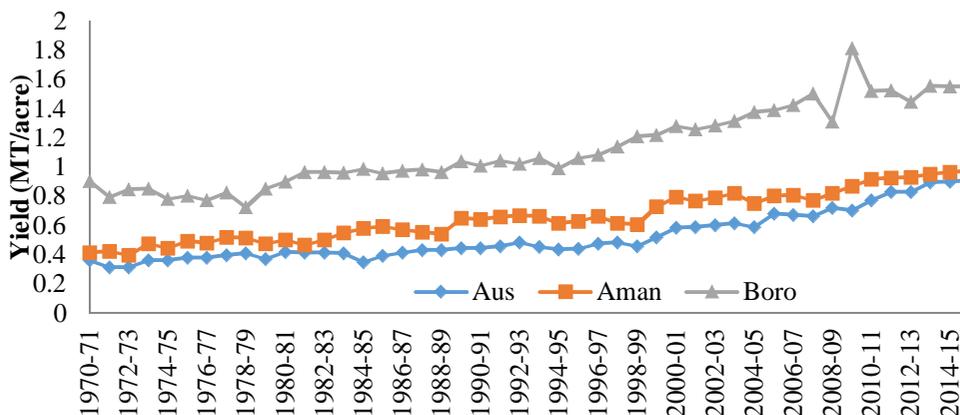


Figure 3: Year wise yield (MT/Acre) of different varieties of rice in Bangladesh

Source: BBS, (1979-2018)

It is a matter of regret that, 220 ha of agricultural land are going to the non-agricultural sector per day (Wikipedia, 2011). Though the cultivated land has diminished with the rapid growth of the population, but in spite of tripling rice production since the introduction of modern varieties in the early 70s, Bangladesh has experienced a continued annual shortage of nearly 1.5 million tonnes of food grain (Karim, 1999).

Since, about 75 percent of the cultivated land is covered by producing rice and rice is the staple food of our country (BRRI, 2017), so the rice sub-sector demands high priority for its development. The government is also more concerned to assist this sector for making it self-sufficiency in food. The country is able to feed her population (mainly rice) though some amount of rice has to import sometimes to reduce the price hike of rice. Research findings can help to take a proper policy for the development of this sector. This study can be treated as a little initiative to create a door of thinking for the concerned policy makers to formulate suitable policy in this regard. In this study, the growth scenarios of area, production and yield of rice has been estimated, so that a detail, understanding (a disaggregated data of rice and different time period) of this issue since independence to 2015-2016 can be achieved. In this study, over the period a comparative growth of rice of three seasons has to be judged in order that further area of development can be explored. Akhter *et al.* (2016) measured the growth rates of total rice, not separating the rice by seasons, only for the whole period from 1969 to 2009. Alam (1997) estimated the growth rate of area and yield of Aus and Boro for the period of 1972/73 to 1982/83. Hossain (2010) determined the growth rates of rice from the period 1980-81 to 2005-06. Khalique *et al.* (2019) estimated the growth rates of area, production and yield of rice in Bangladesh from the period 1981/82 to 2010/11 by decades and whole period and Yasmin *et al.* (2010) estimated the growth rates of rice from the period 1980/81 to 2009/10. This study estimated the

growth rates from the period 1971/72 to 2015/16 by decades and whole period, growth rates of initial decade i.e., 1971/72 to 1980/81 and growth rates of latest period i.e., 2010/11 to 2015/16 has not been estimated from the previous studies. In this aspect of initial period, latest period and the total length of time series data, this study has a new inclusion in the field of growth rates of rice in Bangladesh.

The study was undertaken to estimate the growth rates of area, production and yield of rice in Bangladesh. All the aspects of this study are not a new inclusion, but would be an improvement over them apparently because of the data available up to the year 2015-2016.

II. MATERIALS AND METHODS

Secondary data were collected from different sources and it was time series data in nature. The data were collected mainly from different yearly reports published by Bangladesh Bureau of Statistics (BBS).

Analytical Technique

Data were analyzed by using statistical software (SPSS). The following technique and statistical models were used according to the objective of this study.

Growth rates estimation

Growth rates in area, production, and yield of rice (separately and together) are estimated for examining the growth performance of the rice sector. To know the growth of area, production, and yield of rice of three seasons (*aus*, *aman*, and *boro*) in Bangladesh for the period of 1971-72 to 2015-16, the following semi-log model (Gujarati, 2003) was used, which was used by many researchers (i.e., Akhter *et al.* 2016; Khalique 2015; Hossain, 2010; Bhuiyan, 2004; Barua, 2001; Alam, 1997; Alam, 1992) for measuring the growth rate.

$$\ln Y_t = \beta_1 + \beta_2 t + U_t$$

Where,

Y_t = area/ production/ yield of selected rice of *aus*, *aman*, and *boro* seasons in year t

β_1 = intercept

β_2 = coefficient, refers the growth rate in ratio scale when multiplied by 100, it expresses percentage growth.

t = independent variable (time) and

U_t = disturbance term

III. RESULTS AND DISCUSSION

The performance of rice sector has an important role in the rate of growth in agricultural production as well as on the rate of growth of the economy. Positive growth rates of production and yield of rice indicate the development of that sector obviously. This study attempted to measure the growth of area, production, and

yield of rice in Bangladesh over 45 years but could not examine why there were different growth rates for different rice season. This could be the limitation of this study.

Growth Rates of Area, Production and Yield of Rice in Bangladesh

Analysis of growth rates in area, production, and yield can be most useful for policy making since they help to understand the magnitudes and the direction of the changes taking places. The data were divided into five sub periods for comparison growth rates among periods. Growth rates in area, production and yield of Aus, Aman and Boro were computed to have a comparative measure to see the relative growth and their relationship during four and half decades (1971/72 to 2015/16).

Growth rates in area, production and yield of all rice

Table 1 presents the growth rates in area, production and yield of rice for the entire time period (1971/72 to 2015/16) separately (local and HYV) and together also. During the entire period, area of Aus (together) was significantly decreased at the rate of 3.40 percent per annum., it was increased (3.4 percent per year) for HYV Aus and for local Aus, it was significantly decreased more (5.9 percent). Production of Aus rice (together) was decreased significantly at the rate of 1.30 percent annually. And for HYV Aus, it was increased and decreased for local Aus. But the yield of Aus rice has been increased significantly at the rate of 2.10 percent annually. The area of HYV Aman has been increased at a very high rate and that was 6.7 percent per year and for local Aman, the decrement rate was 3 percent per year during the entire period, though, the production and yield of Aman (together) have been increased significantly at the rate of 1.90 and 1.80 percent per year respectively. Production of HYV Aman has been increased much higher at the rate of 7.1 per cent. Growth of area and production of Boro rice (together) was much higher than the Aus and Aman rice and it was 4.40 and 5.70 percent per year respectively for the entire period. Positive growth rates were found in case of HYV Boro.

Table 1: Growth rates of area, production and yield of rice for the period of 1971/72 to 2015/16

Items	Aus			Aman			Boro		
	Local	HYV	Total	Local	HYV	Total	Local	HYV	Total
Area	-5.9**	3.4**	-3.4**	-3.00*	6.7**	0.1	-4.7**	5.1**	4.4**
Production	-5.0**	3.2**	-1.3**	-2.1**	7.1**	1.9**	-3.6**	6.5**	5.7**
Yield	0.8*	-0.2	2.1**	0.9**	0.4**	1.8**	1.1**	1.5**	1.3**

*indicates 5 per cent level of significance

**indicates 1 per cent level of significance

Source: Authors' own calculation by using the data from BBS, (1979-2018)

Growth rates of area of Aus rice

The area of Aus rice (together) has decreased significantly during the entire study period, except sub-periods I (1971/72 to 1981/82) and that was 0.30 percent though

it was not statistically significant (Table 2). The rates of declining were not same as other four sub-periods. Sometimes the rate was high and sometime the rate was low. Area of Aus has been showing significant negative growth in the sub-period II (1981/82 to 1990/91) which was 3.00 percent (Table 2). Yasmin *et al.* (2010) found the growth rate of area of all Aus -3.60 in the period 1980/81 to 1990/91. Khalique *et al.* (2019) found the growth rate of area of Aus -4.3, -3.6 and -2.2 in the period 1981/82 to 1990/91, 1991/92 to 2000/01, and 2001/02 to 2010/11 respectively.

However, it was observed that the growth rates of the area of Aus were significantly negative that is 4.10 percent for the sub-period III (1990/91 to 2000/01) (Table 2). After that period, it was observed that the growth rates of the Aus area were also decreased significantly, which was 3.70 percent for the sub period IV (2001/02 to 2010/11). And lastly for sub-period V (2011/12 to 2015/16) growth rate of Aus area was also significantly decreased by 2.70 percent (Table 2). The growth rate of the Aus area was significantly negative, except the period I. The growth rates of the Aus areas were high, but negative in the sub- period III and lower at the sub-period V because the farmers were influenced by the modern technology. Much higher positive growth rate (29.80 percent) was found for the HYV Aus for the sub-period I, and negative growth rate was found for the sub-period II. And other periods (III and IV), it was significantly positive. For local Aus, significant negative growth rates were found mostly. Yasmin *et al.* (2010) found the growth rate of area of local Aus and HYV Aus -3.86 and -2.58 respectively.

Table2: Growth rates of area of all types of rice for different sub-periods

Sub-periods	Aus			Aman			Boro		
	Local	HYV	Total	Local	HYV	Total	Local	HYV	Total
I (1971/72 to 1980/81)	-1.3**	29.80*	0.30	0.10	7.10	0.20	-4.90*	6.50**	0.60
II (1981/82 to 1990/91)	-3.2**	-2.00	-3.00**	-2.30	14.40**	0.60	-6.20**	12.90**	9.30**
III (1991/92 to 2000/01)	-6.3**	2.40**	-4.10**	-2.90**	3.00**	-0.50	-2.50**	4.30**	3.70**
IV (2001/02 to 2010/11)	0.80	4.40**	-3.70**	-6.30**	3.40**	-0.60	-7.50**	-3.70	2.90**
V (2011/12 to 2015/16)	-7.80**	-0.10	-2.00*	-3.90**	1.20**	-0.30	-10.70**	6.40	0.10

*indicates 5 per cent level of significance

**indicates 1 per cent level of significance

Source: Authors' own calculation by using the data from BBS, (1979-2018)

Growth rates of area of Aman rice

The growth rates were not same at all the five sub-periods. Sometimes the rate was high and sometimes the rate was low and also being positive and negative. Area of Aman (together) has shown slightly positive growth rate in the period 1971/72 to 1980/81 (Table 2). However, it was observed that the growth rate of the Aman area was positive, but too low that was 0.60 percent for the next sub-period 1981/82 to 2000/01 (Table 2). After that period, the growth rates of the Aman area were decreased by 0.50 percent for the time period III 1991/92 to 2000/01. And for the

period IV (2001/02 to 2010/11) the growth rates of Aman decreased at the rate of 0.60 percent. And the Aman area was decreased at 0.30 during the sub-period V (2011/12 to 2015/16). The decreasing rate was high in the sub-period III and sub-period IV and low in the sub-period I and increasing rates were higher in sub-period II sub-period I. It was noticed from the significant value that all the growth rates were statistically insignificant. Khalique *et al.* (2019) found -0.3 and -0.2 in the period 1991/92 to 2000/01 and 2001/02 to 2010/11 respectively. Highest positive growth rate for area of HYV Aman was found in the sub-period II and it was 14.40. And for the local Aman, growth rates were found negative for different sub-periods mostly.

Growth rates of area of Boro rice

Area of Boro rice (together) has shown insignificant positive growth rate in the period 1971/72 to 1980/81 which was 0.60 percent (Table 2). It was lower than the growth rate of Boro rice area for the entire period. It was observed that the growth rate of the Boro area was significantly positive that was 9.30 percent for next sub-period 1981/82 to 2090/91 and it was higher than the entire sub-period (Table 2). After that period, it was observed that the growth rates of the Boro area was increased significantly, which was 3.70 percent for the period III (Table 2). And finally, the growth rate for the sub-period IV (2001/02 to 2010/11) was 2.90 which was significantly positive but lower than previous two periods. But during sub-period V (2011/12 to 2015/16) the growth rate of the Boro area was insignificantly positive and it was 0.10 percent. The growth rates of the sub-period I and sub-period V were lower than the growth rate of entire time period. And the growth rate of sub-period II was 9.30 which were the highest, which depict that during 1981/82 to 1990/91 the Boro rice production was highest and there was a revolution in Boro rice production. Khalique *et al.* (2019) found the growth rate of area of Boro 8.1, 4.5 and 3.0 for the period 1981/82 to 1990/91, 1991/92 to 2000/01 and 2001/02 to 2010/11 respectively. For the case of local Boro, the negative growth rates for all sub-periods were found and they were statistically significant also. For the HYV Boro, significant positive growth rates were found for the period I, II and III (Table 2).

Growth rates of rice production for all rice seasons

Production of rice for different rice seasons for the period I (1971/1972 to 1980/81), II (2081/82 to 1990/91), III (1991/92 to 2000/01), IV (2001/02 to 2010/161), V (2011/12 to 2015/16) and entire period (1971/72 to 2015/16) were measured. The results are presented in Table 1 and Table 3.

Growth rates of production of Aus rice

The production of Aus rice (together) has been shown significant negative growth rate in the sub-period II (1981/82 to 1990/91) which was 2.30 percent (Table 3). During this period the production of Aus rice was decreased at 2.30 percent per annum. Yasmin *et al.* (2010) estimated -2.94 in the period 1980/81 to 1990/91.

Khalique *et al.* (2019) significant growth rate -2.7, in the period 1981/82 to 1990/91. The growth rate of Aus rice production was significantly negative that was 3.20 percent for the sub-period III (1991/92 to 2000/01) which was higher than the previous period (Table 3). After that period, it was observed that the growth rate of the Aus production was insignificantly negative for the sub-period IV (2001/02 to 2010/11) that was 1.20 percent, but insignificantly positive for sub-period V (2011/12 to 2015/16) and it was 1.20 percent (Table 3). It is a good sign that the production of Aus rice has been increased. The policy makers should have given more emphasis to increase the production of Aus rice to acquire self-sufficiency in food as rice is our staple food. Much higher significant positive growth rate (26.20) for the production of HYV Aus was found in the beginning sub-period. For the sub-period IV and V, significant negative growth rates were found for the local Aus. Yasmin *et al.* (2010) found the growth rate of production of local Aus and HYV Aus -2.06 and -5.10 respectively in the period 1980/81 to 1990/91.

Table 3: Growth rates of production of all types of rice for different Sub-periods

Sub-periods	Aus			Aman			Boro		
	Local	HYV	Total	Local	HYV	Total	Local	HYV	Total
I (1971/72 to 1980/81)	-1.60	26.20**	2.40	2.80	6.00	2.70**	-7.30*	3.20	-0.30
II (1981/82 to 1990/91)	-1.40	-4.70**	-2.30**	-1.00	14.40**	3.10*	-6.00**	12.20**	9.90**
III (1991/92 to 2000/01)	5.80**	2.00**	-3.20**	-3.70**	2.80	-0.40	-1.10	6.10**	5.70**
IV (2001/02 to 2010/11)	-11.40**	5.80*	-1.30	-6.80**	3.30**	0.10	-7.20**	-0.50	4.10**
V (2011/12 to 2015/16)	-7.30**	2.70	1.20	-3.30**	2.00**	1.00**	-12.30**	0.40	-3.80

*indicates 5 per cent level of significance

**indicates 1 per cent level of significance

Source: Authors' own calculation by using the data from BBS, (1979-2018)

Growth rates of production of Aman rice

In the entire period production of Aman rice showed a positive growth rate (Table 1). The production of Aman rice has increased significantly during the entire study period, except sub-period III (1991/92 to 2000/2001) (Table 3). But the rates of increased were not same at all the sub-periods. The production of Aman rice has been shown significant positive growth rate in the sub-period I (1981/82 to 1990/91) which was 2.70 percent (Table 3). This means that during the period the production of Aman rice was increased at 2.70 percent per annum. Whereas Yasmin *et al.* (2010) found 1.28 in the period 1980/81 to 1990/91. Khalique *et al.* (2019) could not found any significant growth rate of Aman production. The growth rate of Aman rice production was significantly positive (3.10 percent) for the sub-period II (1981/82 to 1990/91). This means that during the time period the production of Aman rice was increased at 3.10 percent per annum. This was the highest growth rates for the entire periods. For sub-period V (2011/12 to 2015/16)

growth rate of Aman rice production was significantly positive and it was 1.00 percent. The growth rate of Aman rice production in the all sub-periods increased annually, except sub-period III (1991/92 to 2000/01). The growth rate was higher in the sub-period I and sub-period II compared to the sub-period IV. The study found positive production growth rates for the HYV Aman for all sub-periods as like growth rates of area of HYV Aman. Significant negative production growth rates for local Aman were found for the sub-period III, IV and V (Table 3).

Growth rates of production of Boro rice

The production of Boro rice (together) showed a significantly positive growth rate in the sub-period II (1981/82 to 1990/91) which was 9.90 percent (Table 3). This means that during the time period the production of Boro rice increased at 9.90 percent per annum. This was the highest growth rate of the Boro rice production for the entire time period. It was observed that the growth rate of Boro rice production was significantly positive that was 5.70 percent for the sub-period III (1991/92 to 2000/01). After that period, we observed that the growth rate of Boro production was significantly positive for the sub-period IV (2001/02 to 2010/11) that was 4.10 percent. From the table 3, we saw that the growth rate of Boro rice production for the all sub-periods was positive except period I and V that meant the production of Boro rice for all the sub-periods increased annually except sub-period I and V. So, the production of the Boro rice increases and the increasing rate of the Boro rice production are comparatively higher than the Aus and Aman rice production. Khalique *et al.* (2019) found significant growth rate in the three period II, III and IV and they were 8.5, 7.0 and 5.7 respectively. Most of the sub-periods, the study found significant negative production growth rates for local Boro and for the HYV Boro, significant growth rates were found for the period II and III, and those were positive also.

Growth rates of rice yield for all rice seasons

The yield of a crop is the reflection of technological advancement in production activities. Increase in crop yield acts as real indicators of progress in crop production activities.

Table 4: Growth rates of yield of all types of rice for different sub-periods

Sub-periods	Aus			Aman			Boro		
	Local	HYV	Total	Local	HYV	Total	Local	HYV	Total
I (1971/72 to 1980/81)	-0.20	-3.60**	2.10*	2.70**	-1.10	2.50**	-2.50**	-3.30**	-1.00
II (1981/82 to 1990/91)	1.80	-2.70**	0.70	1.30	0.01	2.50*	0.10	-0.70*	0.60*
III (1991/92 to 2000/01)	0.50	-0.50	0.90	-0.80	-0.20	0.10	1.40*	1.80**	2.10**
IV (2001/02 to 2010/11)	-12.20	1.5	2.40**	-0.60	-0.20	0.70	0.30	3.3	1.30
V (2011/12 to 2015/16)	0.50	2.80**	3.20**	0.60	0.90**	1.30**	-1.60	-6.00	-3.9

*indicates 5 per cent level of significance, **indicates 1 per cent level of significance

Source: Authors' own calculation by using the data from BBS, (1979-2018)

Growth rates of yield of Aus rice

The growth rate of yield of Aus rice (together) was positive and significant during the entire period (Table 1). But the rates were not same at all the five sub-periods. The yield of Aus had been shown significant positive growth rate in sub-period I (1971/72 to 1980/81) which was 2.10 percent (Table 4). This meant that during the time period the yield of Aus rice was increased at 2.10 percent per annum. It was observed from the Table 4, the growth rate of the Aus rice yield was insignificantly positive that was 0.70 percent for the sub-period II (1981/82 to 1990/91). After that period the growth rates of the yield of Aus rice were also insignificant and that was 0.90 percent for sub-period III (1991/91 to 2000/01). And the growth rates of the yield of Aus were significantly positive for the sub-period IV (2001/02 to 2010/11) that was 2.40 percent. And for the sub-period V (2011/12 to 2015/16) the growth rate of Aus yield was significantly positive and it was 3.20 percent (Table 4). This meant that during the time period the yield of Aus rice was increased at 3.20 percent per annum for the use of chemical fertilizer, pesticides, good management practices, improved variety etc. This was the highest growth rates of yield during the entire period. No significant yield growth rates in any sub-period were found for the case of local Aus but in recent sub-periods significant yield growth rates were found for the case of HYV Aus. Khalique *et al.* (2019) found significant growth rate in the three period II, III and IV and they are 1.6, 1.8 and 2.8 respectively. Yasmin *et al.* (2010) got the more or less similar results in the period 1980/81 to 1990/91.

Growth rates of yield of Aman rice

The growth rate of yield of Aman was increasing significantly during the entire study period (Table 1). The yield of Aman showed a significant positive growth rate in the sub-period I (1971/72 to 1980/81) which was 2.50 percent (Table 4). This means that during the time period the yield of Aman rice was increased at 2.50 percent per annum. It was observed that the growth rate of the Aman rice yield was significantly positive that was 2.50 percent per annum for sub-period II (1981/82 to 1990/91), it was also higher than the growth rate of Aman for the entire period. Yasmin *et al.* (2010) found 2.19 in the period 1980/81 to 1990/91. But it was observed that the growth rate of Aman rice yield was insignificantly positive that was 0.10 percent per annum for the sub-period III (1991/92 to 2000/01). After that period the growth rate of the Aman yield was significantly positive for the sub-period IV (2001/02 to 2010/11) that was 0.70 percent per annum. And for sub-period V (2011/12 to 2015/16) the growth rate of the Aman yield was 1.30 percent per annum (Table 4). This meant that during the time period the yield of Aman rice increased at 1.30 percent per annum. The growth rate was higher in the sub-periods I and II compare to the Sub-periods III and IV. Significant yield growth rates were found only in sub-period I for the case of local Aman, and positive significant yield growth rates were found only in sub-period V for the case of HYV Aman. Khalique

et al. (2019) found significant growth rate 2.8 and 1.5 in the period II and IV respectively.

Growth rates of yield of Boro rice

The yield of Boro showed an insignificant negative growth rate in the sub-period I (1971/72 to 1980/81) which was 1.00 percent. This means during the time period the yield of Boro rice decreased at 1.00 percent per annum. However, it was observed that the growth rate was significantly positive that was 0.60 percent for the sub-period II (1981/82 to 1990/91) (Table 4). This meant that during the time period the yield of Boro rice increased by 0.60 percent per annum. Yasmin *et al.* (2010) found 0.17 for the period 1980/81 to 1990/91. After that period, it was observed that the growth rate of the Boro rice yield was significantly positive for sub-period III (1991/92 to 2000/01) that was 2.10 percent (Table 4). This meant that during the time period the yield of Boro rice was increased at 2.10 percent per annum. And this was higher than the growth rate of Boro rice yield for the entire period. It was also observed that the growth rate of Boro rice yield was insignificantly positive for the sub-periods IV (2001/02 to 2010/11) and it was 1.30 percent. But for sub period V (2011/2 to 2015/16) the growth rate of Boro rice yield was insignificantly negative and that was 3.90 percent. Khalique *et al.* (2019) found significant growth rates 0.3, 2.5 and 2.7 in the period II, III, and IV respectively. The study could not find any significant yield growth rates in recent two sub-periods IV and V for local Boro and HYV Boro.

A Comparative Analysis of Growth Rates of all Rice

The area under Aus was decreased by 3.40 percent, Aman areas were increased by 0.10 percent, and area under Boro rice increased by 4.40 percent, which showed that the change in Boro rice area was higher compared to the Aus and Aman rice during the entire period. Production of Aus rice declined in total period, whereas Aman and Boro rice production showed a significantly positive growth rate in the same period. Here Aus rice production was decreased by 1.30 percent, the production of Boro was increased by 5.70 percent and the production of Aman was increased by 1.90 percent. Production of Boro rice rapidly increased relative to Aus and Aman in sub-periods II, III, IV and entire period.

In whole period, the yield of all rice had a significantly positive growth rate 2.10 percent, 1.80 percent and 1.30 percent for Aus, Aman and Boro rice, respectively (Figure 4).

During the period I the growth rate of area for Boro rice was highest and it was 0.60 percent, growth rates of production and yield was highest for Aman rice that were 2.70 percent and 2.50 percent respectively (Figure 5).

At period II growth rate of the area was highest for Boro rice, it was 9.30 percent (Figure 6). The growth rates of production were also highest for Boro rice and it

was 9.90 percent. And growth rates of yield were highest for Aman rice and that was 2.50 percent in period II.

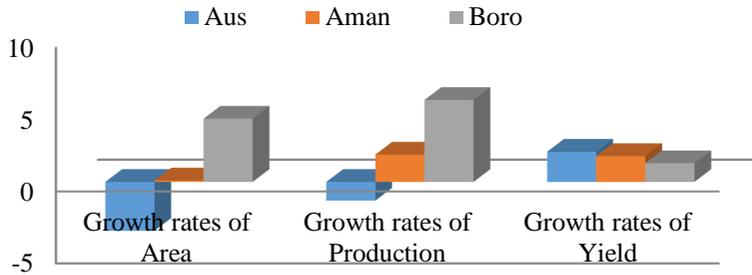


Figure 4: Comparative growth rates for all rice types for entire period

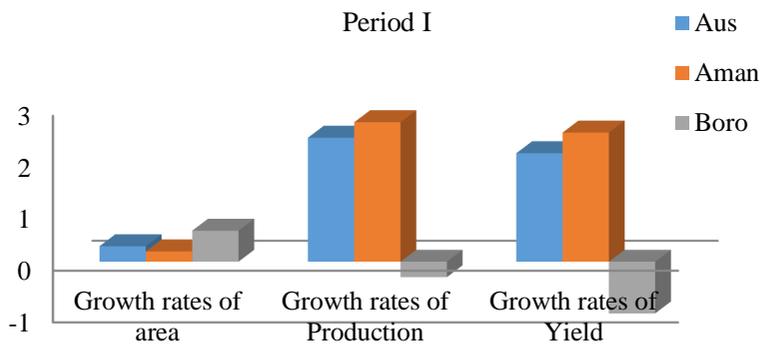


Figure 5: Comparative growth rates for all rice types for period I

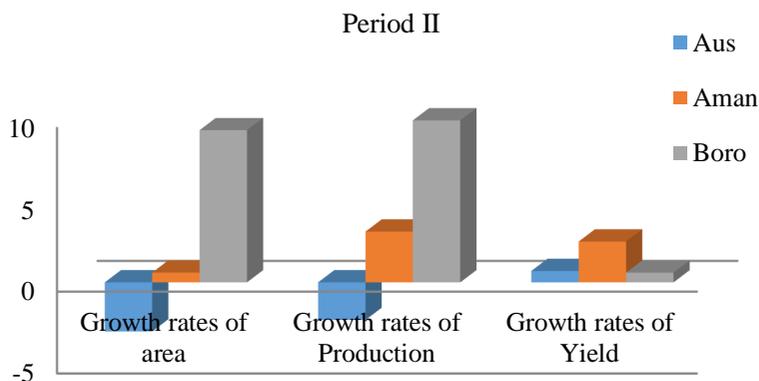


Figure 6: Comparative growth rates for all rice types for period II

During the period III growth rates of area, production and yield all were highest for Boro rice and that were 3.70 percent, 5.70 percent and 2.10 percent, respectively (Figure 7).

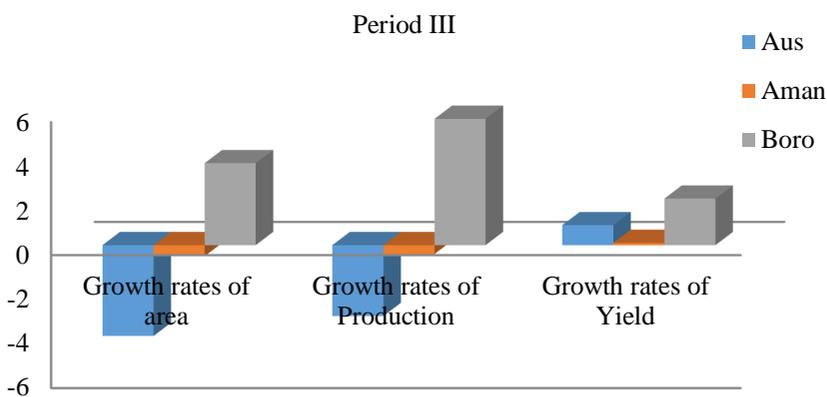


Figure 7: Comparative growth rates for all rice types for period III

During period IV growth rates of area and production were highest for Boro rice that was 2.90 percent and 4.10 percent. The growth rate of yield was highest for Aus rice and it was 2.40 percent (Figure 8).

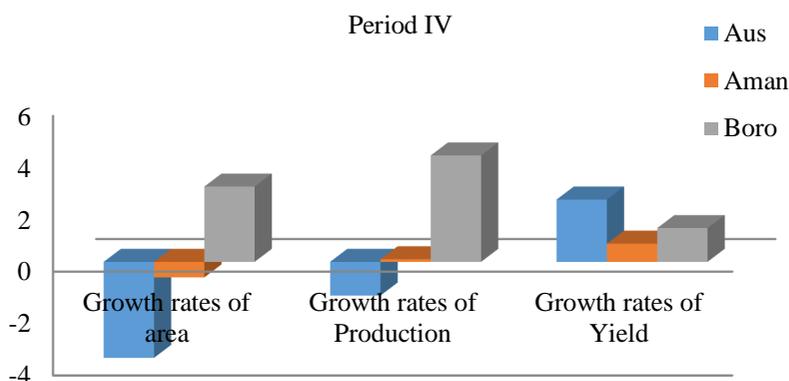


Figure 8: Comparative growth rates for all rice types for period IV

In period V growth rate of the area was highest for Boro rice and it was 0.10 percent. The growth rate of production was highest for Aman rice and it was 1.00 percent. The growth rate of yield for Aus was highest and it was 3.20 percent (Figure 9).

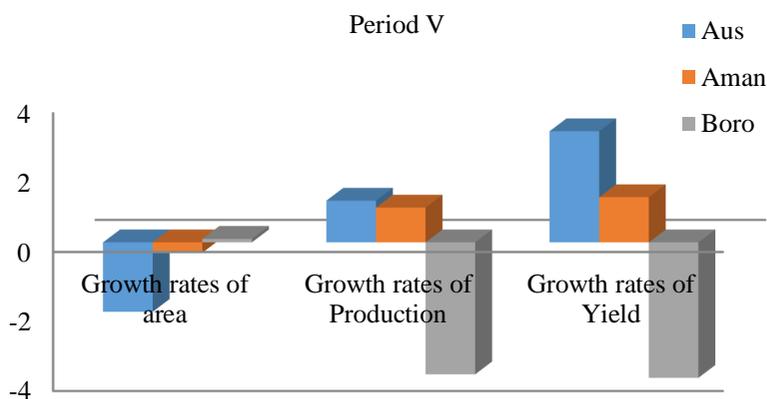


Figure 9: Comparative growth rates for all rice types for period V

IV. CONCLUSION

In this study time series data of area and production of rice (*aus*, *aman* and *boro*) for the period 1971/72 to 2015/16 for the country as a whole were employed. Rice is the principal cereal crop. It is the largest with an average 71 percent share of the gross output value of crops and the total rice crop covers 75 percent of the total cropped area (BBS 2017). Rice production has been increased by 2.87 times since independence without further increase in rice area. This is a single study that one can find the growth rate of area, production, and yield of rice (separately-local, HYV, and together) in Bangladesh over the period from 1971/72 to 2015/16 by

decades and also by whole period. In this perspective this study has the significance in the field of growth of rice in Bangladesh.

During the overall study period for the country as a whole growth rates of the area which was negative for Aus (together), that was 3.40 percent on an average per year and the growth rate of Aman (together) and Boro (together) were positive, but for Aman it was too low 0.10 percent and for Boro it increased significantly at the rate of 4.40 percent per year during the period. The growth rate of production of Aus was decreased at the rate of 1.30 percent.

And for Aman and Boro the growth rate was increased significantly at the rate of 1.90 and 5.70 percent respectively during the period. Production growth rate of Boro has been increased much more than others. The growth rates of yield of Aus, Aman and Boro were increased significantly at the rate of 2.10, 1.80 and 1.30 percent respectively during the entire time period. The contribution of yield to increase production can be considered to be the technological improvement and adoption of technologies by the farmers. For the case of HYV (Aus, Aman and Boro), growth rates of area, production and yield has been increased significantly (except yield of Aus). The importance of Aus rice had been decreased as farmers slowly started shifting to the cultivation of irrigated Boro rice encouraged by its higher yield. It was found that the reasons behind the falling of Aus rice production was non-availability of land as its seed sowing or transplanting period falls during the March and April months when Boro rice still remains in the field. Farmers are not getting enough time and land to grow Aus rice. The government can take incentive programs for farmers with an attempt to rejuvenate Aus cultivation. There is an important role of the agricultural sector in the developing countries which can accelerate the growth of the economy. Most of the national policies and planning of the developing countries are reflected by the agriculture sector. Both developed and developing countries pursued a different policy to protect agriculture, to obtain self-sufficiency in food for domestic consumption, price support and protect the producer from the global competition etc.

ACKNOWLEDGEMENT

The authors would like to thank Ministry of Science and Technology, Government of the People's Republic of Bangladesh for funding through NST (National Science and Technology) fellowship to complete this research work smoothly within time frame.

REFERENCES

- Akhter, S., Sarker, J.R. and Das, K.R. (2016). Growth and Trend in Area, Production and Yield of Major Crops of Bangladesh. *International Journal of Economics, Finance and Management Sciences*, 4(1): 20-25.
- Alam, M.J. (1997). An Analysis on Price Behaviour of Rice in Bangladesh-A Time series Analysis. Unpublished MS Thesis, Department of Cooperation and Marketing, Bangladesh Agricultural University, Mymensingh, Bangladesh.

- Alam, S. (1992). Rice Yield Growth Scenario and the Factors Contributing to Output Changes of Different Rice Varieties and Types in Bangladesh." *The Bangladesh Journal of Agricultural Economics*, 15(2):19-33.
- Barua, P. (2001). Inter-temporal Price Behavior and Price-supply Relationship of selected Crops in Bangladesh. Unpublished MS thesis, Department of Cooperation and Marketing, Bangladesh Agricultural University, Mymensingh.
- BBS (Bangladesh Bureau of Statistics) (1979-2018). Yearbook of Agricultural Statistics. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. Dhaka, Bangladesh.
- BBS (Bangladesh Bureau of Statistics) (1982-2016). Statistical Yearbook of Bangladesh. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. Dhaka, Bangladesh.
- Bhuiyan, I.N. (2004). Inter-Temporal and Spatial Price Variation of Leading Vegetables in Bangladesh. Unpublished MS Thesis, Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh, Bangladesh.
- Bangladesh Rice Research Institute (2017). Rice in Bangladesh. Bangladesh Rice Knowledge Bank, Training Division. www.knowledgebank-brrri.org/rice in ban viewed on November 20, 2017.
- Gujarati, D.N. (2003). *Basic Econometrics*, 4thed. New York: McGraw Hill Inc.
- Hossain, D.M.I. (2010). Change in Area and Production of Rice, Wheat, Maize, Potato, Tomato and Jute in Bangladesh. Bangladesh Rice Research Institute. Agricultural Statistics Division.
- Karim, Z. (1999). Accelerating the growth of agriculture in Bangladesh. Pages 53-64 in Bhuiyan, S.I. and A.N.M.R. Karim (ed). *Increasing Rice Production in Bangladesh: Challenges and Strategies*. Dhaka (Bangladesh): Bangladesh Rice Research Institute and Manila (Philippines): International Rice Research Institute.
- Khalique, M.F.B. (2015). Acreage Response and Price Fluctuation of Rice in Bangladesh. Unpublished MS Thesis, Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh, Bangladesh.
- Khalique, M.F.B., Touhiduzzaman, S.M., Islam, M.S., Murmu, H. and Rasel, M. (2019). Economic Analysis of Rice Production in Bangladesh, *United International Journal of Research & Technology*, 01(02): 8-17.
- MoF (Ministry of Finance) (2016). Bangladesh Economic Review, Finance Division, Government of the People's Republic of Bangladesh, Dhaka.
- Ricepedia(2019).Research program on rice- A project of CGIAR. Available at: <http://ricepedia.org/bangladesh>[Accessed: 17 November 2019].
- Yasmin, S., Alam, S. and Moniruzzaman, M. (2010). Growth Estimation of Selected Major Crops in Bangladesh, *Bangladesh Journal of Agricultural Economics*, XXXIII (1&2): 133-147.
- WIKIPEDIA (2011). The world fact book, Central Intelligence Agency: <https://www.wikipedia.org> [Accessed:20November, 2017].