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CHANGE AND INSTABILITY IN PRODUCTION AND YIELD OF RICE IN BANGLADESH

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ABSTRACT

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Rice is considered as one of the monumental sources of human energy in Bangladesh. It can be stated that a vital element by which agronomic sector has been earned most of the quantity of profits for national development in this country is rice. This study covers the data of rice including the time from 1972 to 2016 has been collected from secondary sources of Bangladesh Bureau of Statistics. Different statistical tools have been used to complete the analysis. The analysis reveals that area, production and yield of rice has increased significant during the study period. The growth rate of production is significantly higher than the growth rate of area and yield. Despite the production has been increased, It is not enough to full fill the demand of the country. It is observed that area, production and yield are not stable. Therefore, researchers, government, non-government organization and policy makers should come forward to improve this sector. By this way new ideas and findings could be generated in order to improve the growth of rice.

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INTRODUCTION

The population of Bangladesh is increasing rapidly. Rapid population growth, along with unplanned urbanization, causes the cultivable land area to be used for non-agricultural purpose. As a result, the cultivable area is reduced significantly (Akther et al., 2016). Rice is the main food for most of the people in Asia, almost half of world's population live on rice (Bhuiyan, 1992). At most 2.4 billion people depend on rice and provides more than 20% of their daily calorie intake (Lampe, 1995). The annual growth rate for rice consumption in the Asia-Pacific Region over a period of 45 years (1950 to 1995) has kept pace with the demand, more through yield increase rather than area expansion (Papademetriou, 2000). Within 2030 our world population will increase 8.27 billion and we can ensure enough rice for the increasing population (Kubo and Purevdorj, 2004). With an increasing population leading to an increase in demand, the main drivers which determine rice production need to be identified (Milovanovic and Smutka, 2017). Rice production has increased because of the use of modern technology and the price of rice is increasing due to rising agriculture wage rates and decline availability of cultivable land (Ahmed, 2004). In recent years the production of rice has increased in South Asian Countries but in other countries of the region yields have stagnated (Mutert and Fairhurst, 2002). Bangladesh has huge population as compared to many other countries and it occupies 8th position over the world because of over population. With the increase of population our cultivated land is decreasing day by day. About 75% of the country's population is engaged in the agricultural sector (BSGDMA, 2007). Rice is one of the dominant crops of the agrarian economy of Bangladesh and it is reflected in the high per capita rice consumption in this country (Shelley et al., 2016). In Bangladesh rice production most rain fed rice is faced problem because of drought and diurnal temperature range (Rahman et al., 2017). Average yields per hectare and total rice production increased significantly, leading to a substantial increase in the supply of rice in the domestic market which resulted in significant reductions in rice prices and the average production cost of rice per acre in terms of input use varied across the three rice crops as well as across the various stages of rice cultivation (Talukder and Chile, 2014). Despite pressure from overpopulation, the country has reached self-sufficiency in rice production (Shelley et al., 2016). Production of rice has increased because of the development of high-yielding varieties and use of high level of fertilizer in last four decades (Prasad et al., 2016).

The production of rice is increasing over time despite the land area is decreasing, but population is also increasing. But the production of rice still does not meet the current demand of the country. To achieve better economy and fulfill the demand of increased population, it is needed to increase the production of rice. Rice production and area should be increased and yield rate should be stable. A good number of researches are done in this sector. However, these research works are not sufficient to improve the sector. Therefore, this study is investigated to know the change and instability of rice production in Bangladesh.

MATERIALS AND METHODS

Secondary sample data on area, production and yield of rice for the last 45 years from 1972 to 2016 have been collected from different issues of Statistical Yearbook of Bangladesh Bureau of Statistics (BBS). To observe the change and growth of rice production, the whole study period has been divided into two periods. Period I starts from 1972 to 1993 and Period II from 1993 to 2016. To examine the nature of change, instability and degree of relationship in area, production and yields of rice in Bangladesh, various descriptive statistical tools, such as mean, correlation coefficient and coefficient of variation have been used. The t-test, simple linear regression technique and semi log growth model have been used to analyze the data. The data analyses have been performed by using SPSS software.

Regression Analysis

To estimate the parameters, simple linear regression models have been fitted to examine the change of production by the change of area. The model can be expressed as:

$$y = \alpha + \beta x + e$$

Where, $e \sim N(0, \sigma^2)$, y is the production (in ton), x is the area (in acre), α is the intercept and β is the regression coefficient of the model.

Measure of Growth Rate

The growth rates of area, production and yield of rice were worked out by fitting a semi-log function of the type: $\log y = \alpha + \beta t$, where, y is the area (in acre) or production (in ton) or yield (ton/acre) and t is the time period (in year).

Measurement of Instability

An index of instability in area instability was computed for examining the nature and degree of instability in area, production and yield of total rice in Bangladesh. The co-efficient of Variation (CV) of rice was worked out for area, production and yield to measure of variability. However, simple CV does not explain variation properly the trend component inherent in the time series data. To overcome the mentioned problem, Cuddy and Della (1978) suggested a better measure of variability. They used the coefficient of variation around the trend line (CV_t) rather than co-efficient of variation around the mean (cv).

A linear trend model $y = \alpha + \beta t + e$ was fitted to the indices of area, production and yield for the study period and trend co-efficient ' β ' was tested for significance. Whenever the trend co-efficient was found significant, the index of instability was constructed as follows:

$$cv_t = cv \times \sqrt{(1 - R^2)}$$

Where, $cv = \frac{s}{\bar{x}} \times 100$, where \bar{x} and s are the mean and standard deviation of the sample period.

So, the index of instability (cv_t) is the multiplication coefficient of variation to the square root of unexplained variation by the trend equation $y = \alpha + \beta t + e$.

RESULT AND DISCUSSION

Change in Area, Production and Yield of Rice

As the number of people increased agricultural area of rice has been increased. As a result the production of rice has been increased. The cultivable area, production and yield of rice have increased 1.06, 1.78 and 1.89 times respectively during the last 45 years. The average production of rice is 26561.10 metric tons in period II, while it was 14034 metric tons in period I. The change between these two periods is highly significant ($P < 0.01$). Though, the production has increased significantly but it cannot meet the current demand of the country. From the analysis it is evident that there is a significant changed in area, production and yield of rice in Bangladesh (Table 1).

Table 1. Change in area (in acre), production (in ton) and yield of rice in Bangladesh

Field of measurement	Mean Value		t-value	p-value
	Period-I	Period-II		
Area (in acre)	25170.84	26598.23	-4.261	0.00
Production (in ton)	14034.45	26561.10	-8.786	0.00
Yield	0.55560	0.9902	-9.84	0.00

Correlation Analysis

One of the common procedures for measuring the fluctuating of area and production is correlation. Our study show that for whole period the correlation ($r=0.884$) is highly positive and significant. For period I and period II our study also find significant positive correlation. So this investigation reflects that augmentation of area has strong effect on the outturn of rice (Table 2).

Table 2. Relationship between area and production of Rice in Bangladesh

Criteria	Value of Correlation co-efficient (r)		p-value
Area verses Production	Whole-Period	0.884	0.01
	Period-I	0.673	0.01
	Period-II	0.953	0.01

Regression Analysis

The simple linear regression models were fitted for estimating the response of production of rice due to the change of their respective area. For the production on area during whole period, period I, period II our investigation find that the estimated coefficients are significant. This inquiry indicates that during whole period, period I, period II the production of rice has increased by 5.28, 2.15 and 4.33 respectively. So this exploration indicate that there is an upward trend in rice production with the increase in its area (Table 3)

Table 3. Testing dependency of production on area of rice

Measurement Period	Constant value	Regression coefficient	t-value	p-value
whole period	-116244.49	5.28	12.43	0.00
Period I	-40068.837	2.15	4.07	0.01
Period II	-88671.335	4.33	14.37	0.00

Growth rate of area, production and yield of Rice

Growth rate can be defined as a satisfactory method for measuring the change in past and also indicates the change in future. Growth rate is measure by using the exponential model. With the increase of cultivation area the production of rice is also increased. The result of our investigation reveals that there is positive and significant growth rate of area, production and yield during whole period, period I, period II. This study reflect that the production of rice is increased 2.7%, 3.5% and 2.6% during the period I, period II and Whole period, respectively.

The growth rate of production is higher in period II than any other period. Similarly growth rate of yield is higher in period II than the whole period. So, a remarkable growth rate of area, production and yield of rice have been observed during the study period (Table 4).

Instability in area, production and yield of Rice

Fluctuation in area and production are correlated as larger area gives higher production if all other inputs remain constant. But instability of yield may be due to weather condition, natural calamities like floods, droughts, cyclone etc. and technical changes. So variation of agricultural production always exists in Bangladesh. Our analysis supports this claim. The area, production and yield of rice showed 3%, 9.8% and 6.8% variation during the study period (whole period). It is clear that the production and yield of rice showed more instability during whole period. The yield showed less instability than production. The area of rice also showed remarkable variation during the whole period. The area, production and yield of rice showed the significant fluctuation during study period (Table 5).

Table 4. Growth rate of area, production and yield of rice

Field of Measurement	Measurement period	Growth Rate (%)	p-value
Area (in acre)	Whole period	0.3	0.00
	Period I	0.3	0.001
	Period II	0.7	0.00
Production (in ton)	Whole period	2.9	0.00
	Period I	2.7	0.00
	Period II	3.5	0.00
Yield	Whole period	2.6	0.00
	Period I	2.4	0.00
	Period II	2.8	0.00

Table 5. Instability in area, production and yield of rice in Bangladesh

Field of Measurements	Measurement Statistics	Whole period	Period I	Period II
Area (in acre)	CV	5.1%	3.2%	5.1%
	R-Square	0.649	0.436	0.814
	p-value	0.00	0.00	0.00
	D-W	0.57	1.031	0.993
Production (in ton)	CV around trend line	3%	2.4%	2.2%
	CV	38.7%	18.1%	23.4%
	R-Square	0.936	0.953	0.968
	p-value	0.00	0.00	0.00
	D-W	0.218	1.95	0.898
	CV around trend line	9.8%	3.9%	4.1%
Yield	CV	33.9%	16.4%	18.9%
	R-Square	0.96	0.937	0.975
	p-value	0.00	0.00	0.00
	D-W	0.25	1.156	0.886
	CV around trend line	6.8%	4.1%	2.9%

CONCLUSION

Rice is the most important food in Bangladesh. The findings reveal that overall production of rice in Bangladesh is satisfactory as the average area, production and yield have increased. It is observed that the production and yield has increased for period I and period II. The growth rate of area and production are also increased. Therefore, it is concluded that cultivable area is important factor to increase the production of rice. If we fail to increase cultivate land, the production will suffer most. But area is limited. So, it is better to consider other factors which affect the production. The production may be depends on quality of seeds, new technology, quality of fertilizer etc. So this research may be helpful for the stakeholders and policy makers to overcome food problems in Bangladesh.

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