http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 5(4): 502-505, 2002

Production and Yield of HYV Boro and Aman Rice: Growth and Trend Analysis

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Abstract: The present study was undertaken to find the growth rates and trend of production and yield of HYV Boro and Aman rice. Secondary data for the period of 1974-75 to 1999-2000 were used for the study. Production and yield of HYV Boro showed significant positive growth during the study period. HYV Aman production showed significant positive growth and HYV Aman yield showed insignificant negative growth during the same period. The growth rates of yield and production of HYV Boro and HYV Aman rice were also computed for the nineties. The growth rates of nineties were computed to have a comparative measure, between the two sub-periods. During the total period of 10 years in nineties, yield and production growth rates of HYV Boro were positive and significant. The growth rates of yield and production HYV Aman were negative and positive respectively and growth rates were statistically insignificant. The growth rates of production of HYV Boro were positive and insignificant in sub-period-I (early nineties) and positively significant in sub-period-II (late nineties). The production growth rates of HYV Aman were positive both in sub-period-I and sub-period-II. But the growth rates were statistically insignificant. Yield had negative insignificant growth in sub-period-I for HYV Boro yield of HYV Aman showed negative insignificant growth in the two periods. The growth parameters of HYV Boro were significantly different in early nineties and late nineties but in case of HYV Aman growth parameters were not significantly different between the two sub-periods of nineties.

Key words: Boro and aman rice, growth, trend analysis, yield

Introduction

Bangladesh may be described as a land of rice growers and rice eaters. It is the most important food crop in terms of area, production and its contribution to the national income and national economic development. Rice grows in all the three crop season Aus, Aman and Boro and is the staple food for Bangladesh. Boro and Aman rice covered the large portion of total rice production of the country.

Bangladesh has made some progress in agriculture during the post independence period. The rate of growth has however been too low to enable the country to achieve self-sufficiency in food grains, which has been the main objective of agricultural development for a long time. To attain self-sufficiency the Government of Bangladesh given special emphasis for increasing rice production through expansion of seed fertilizer-irrigation technology. Bangladesh Rice Research Institute (BRRI) has introduced 38 types of high yielding varieties of rice during the last 29 years. The hybrid rice production was introduced was from 1998 in Bangladesh. Bangladesh has already achieved self-sufficiency in food grain production. Favorable climatic conditions and introduction of modern hybrid technologies made this tremendous development possible.

The growth rates of rice production specially HYV Boro and Aman rice varied due to changing government policies in different periods during the post independence period of Bangladesh. The study has been undertaken to find the yield and production growth of HYV Boro and Aman rice over the period 1974-75 to 1999-2000 as well as nineties. It is aimed at finding out whether the growth rates of yield and production of HYV Boro and Aman rice differ significantly during early nineties and late nineties.

Materials and Methods

Data: Secondary data were used for conducting the study. Data on production and yields of HYV Boro and HYV Aman rice for the period 1974-75 to 1999-2000 were collected from Statistical Year Book of Bangladesh, Crop Statistics of Bangladesh Bureau of Statistics (BBS., 1983, 1998, 1999, 2000). Collected data were consistent among all the sources. Production data from secondary sources that were found in acres were converted into hectares. Similarly, production in rice was converted into paddy using rice paddy by conversion ratio of 2:3.

Growth model: For computing growth rates of production and yield of HYV Boro and HYV Aman rice, two different types of growth models namely linear and exponential were fitted.
The growth models were as follows:

Linear: $Y = a + bt$ ---------- (1)
Exponential: $Y = ae^{bt}$
or, $\ln Y = \ln a + bt$ ---------- (2)

In equation (1) Y is the dependent variable (production and yield of HYV Boro and HYV Aman rice), t is the independent variable (time), "a" is intercept and b is the absolute growth rate. In equation (2), 'b' is the growth rate in ratio scale and when multiplied by 100 it expresses percentage growth, i.e., annual compound growth rate.

To check the overall significance of the estimated regression, F-test was also done. To test the null hypothesis Ho: b = 0, according to Gujarati (1995) we computed -

$$F = \frac{R^2/d.f}{(1-R^2)/d.f} = \frac{\sum \hat{y}i^2/K-1}{\sum ei^2/n-k}$$

$R^2 = \sum \hat{y}_i^2$ = Explained sum squares
$1-R^2 = \sum e^2_i$ = Unexplained sum squares

d.f = degree of freedom
n = sample size
k = number of parameters

Testing the stability of growth parameters between two periods: Attempts were made to test the stability of growth parameters between the two periods using the following formula as

developed by Chow and stated by Koutsoyiannis (1977)

$$F = \frac{[e_p^2 - (e_1^2 + e_2^2)]/k}{(e_1^2 + e_2^2)/(x_1 + x_2 - 2k)} \quad \text{with d.f. } (x_1 + x_2 - 2k)$$

where,

F = statistics
e_p^2 = Residual sum of squares for pooled sample
e_1^2 = Residual sum of squares for Period-I
e_2^2 = Residual sum of squares for Period-II
x_1 = Sample size of Period-I
x_2 = Sample size of Period-II
k = No. of parameters.

Fertilizer crisis and unfavorable climatic conditions specially cyclones in 1991 very much affected the rice production during the period of 1990-91 to 1994-95, whereas integrated agricultural policy, efficient management of fertilizer distribution, favourable climatic condition and introduction of hybrid technology of rice production favors the rice production during the period of 1995-96 to 1999-2000. Thus the period 1990-91 to 1999-2000 was divided into two periods as early nineties and late nineties for testing the stability of growth parameters of rice production.

Results and Discussion

Growth rates of production and yield of HYV boro and aman rice for the period 1974-75 to 1999-2000: The growth rates of yield and production of HYV Boro and HYV Aman rice were calculated on the basis of growth model. The results of the estimated model are presented in Tables 1 and 2. The growth rates of yield and production of HYV Boro and HYV Aman rice are also presented in these tables.

During the total period (1974-75 to 1999-2000) under study the HYV Boro and HYV Aman production registered significant positive growth. The production of Boro and HYV Aman increases by 1260250 and 787898 metric tons per year respectively (Table 1).

Considering the non-linear trend equation HYV Boro production grew 8.37 per cent per annum over the 26 years total time period while HYV Aman production grew @ 8.14 per cent per annum. The growth rates of the production of both HYV Boro and HYV Aman were significant. The R^2 of HYV Boro production and HYV Aman production were 0.95 and 0.88 respectively. The R^2 values were satisfactory because these explained 95 per cent and 88 per cent of the total variation of production by the time element included in model.

Yield of HYV Boro for the study period showed significant positive growth. The yield increased by 0.0253 metric ton per year under

Table 1: Linear trend function fitted to the actual production and yield of HYV Boro and HYV Aman rice from the period 1974-75 to 1999-2000

Types of rice	Items	Fitted trend functions	R^2	F-value
HYV Boro	Production	Y= -80792 + 1260250x	0.926	299.84**
	Yield	Y= 3.6696 + 0.0253x	0.510	24.97**
HYV Aman	Production	Y= 737580 + 787898x	0.920	277.73**
	Yield	Y= 3.1562 -0.0011x	0.001	0.04

** Significant at 1 per cent level.

Table 2: Exponential trend function fitted to the actual production and yield of HYV Boro and HYV Aman rice from the period 1974-75 to 1999-2000

Types of rice	Items	Fitted semi-log function	Annual growth (% per annum)	R^2	F-value
HYV Boro	Production	LnY= 4519.07 + 0.0837x	8.37	0.951	468.17**
	Yield	LnY = 3.6799 + 0.0062x	0.62	0.512	25.14**
HYV Aman	Production	LnY= 3152.400+ 0.0814x	8.14	0.875	168.66**
	Yield	Ln Y= 3.1425 + 0.0002x	0.02	0.033	0.01

** Significant at 1 per cent level.

Table 3: Linear trend function fitted to the actual production of HYV Boro and HYV Aman rice

Types of rice	Period	Fitted trend functions	R^2	F-value
HYV Boro	Total period	Y= 17506600+ 1785050x	0.744	23.25**
	Sub-period-I	Y= 22485600+ 204516x	0.228	0.89
	Sub-period-II	Y= 19672100+ 3959160x	0.906	28.96**
HYV Aman	Total period	Y = 15853700+ 462721x	0.452	6.61
	Sub-period-I	Y = 16502100+ 285285x	0.127	0.44
	Sub-period-II	Y = 16648400+ 930324x	0.397	1.97

** Significant at 1 per cent level.

Table 4: Exponential trend function fitted to the actual production of HYV Boro and HYV Aman rice

Types of rice	Period	Fitted semi-log function	Annual growth (% per annum)	R^2	F-value
HYV Boro	Total period	LnY = 19147.9 + 0.0609x	6.09	0.785	29.21**
	Sub-period-I	LnY = 22473.0+ 0.0090x	0.90	0.233	0.19
	Sub-period-II	LnY = 21362.71+ 0.1243x	12.43	0.918	33.75
HYV Aman	Total period	LnY = 16017.2+ 0.0242x	2.42	0.458	6.76
	Sub-period-I	LnY = 16458.4+ 0.0170x	1.70	0.135	0..47
	Sub-period-II	LnY = 16870.0+ 0.0454x	4.54	0.382	1.85

* Significant at 5 per cent level. ** Significant at 1 per cent level.

Table 5: Linear trend function fitted to the actual yield of HYV Boro and HYV Aman rice

Types of rice	Period	Fitted trend Functions	R^2	F-value
HYV Boro	Total period	Y = 3.7659+ 0.0781x	0.708	19.35**
	Sub-period-I	Y = 4.0341-0.0124x	0.033	0.10
	Sub-period-II	Y = 3.9129+ 0.1603x	0.953	60.93**
HYV Aman	Total period	Y = 3.2853-0.0169x	0.118	1.07
	Sub-period-I	Y = 3.3202-0.0240x	0.298	1.27
	Sub-period-II	Y = 3.0654+ 0.0238x	0.038	0.12

** Significant at 1 per cent level.

Table 6: Exponential trend function fitted to the actual yield of HYV Boro and HYV Aman rice

Types of rice	Period	Fitted semi-log function	Annual growth (% per annum)	R^2	F-value
HYV Boro	Total period	LnY = 3.7878+ 0.0182x	1.82	0.705	19.11**
	Sub-period-I	LnY = 4.0346-0.0032x	-0.32	0.035	0.11
	Sub-period-II	LnY = 3.9321+ 0.0365x	3.65	0.954	62.80**
HYV Aman	Total period	LnY = 3.2887-0.0056x	-0.56	0.127	1.16
	Sub-period-I	LnY = 3.3216-0.0075x	-0.75	0.301	1.29
	Sub-period-II	LnY = 3.0696+ 0.0067x	0.67	0.030	0.09

** Significant at 1 per cent level.

Table 7: Stability of growth parameters of HYV Boro and HYV Aman rice production and yield between two periods (1990-91 to 1994-95 and 1995-96 to 1999-2000)

Types of Rice	Production /Yield	Calculated F-value	Tabulated F-value with d.f. 2,23 at 5% level of significance	Decision at 5% level of significance	Tabulated F-value with d.f. 2, 23 at 1% level of significance	Decision at 1% level of significance
HYV Boro	Production	12.29	5.14	Null hypothesis rejected	10.92	Null hypothesis rejected
	Yield	14.65	5.14	Null hypothesis rejected	10.92	Null hypothesis rejected
HYV Aman	Production	0.31	5.14	Null hypothesis accepted	10.92	Null hypothesis accepted
	Yield	0.32	5.14	Null hypothesis accepted	10.92	Null hypothesis accepted

HYV Boro production (Table 1). Yield of HYV Aman indicated negative growth, but the growth rate was statistically insignificant. It means that yield of HYV Aman rice did not depend on time significantly.

In Table 2, it may be seen that yield of HYV Boro grew positively, which was 0.62 percent per annum. Yield coefficient of HYV Aman showed negative value but it was not statistically significant during the total period. In case of HYV Boro yield, the overall fit of the equation was quite satisfactory as evidenced by acceptable values of R^2 and F-values. But in case of HYV Aman the overall fit of the equation was not satisfactory.

Growth Rates of the Production of HYV Boro and HYV Aman Rice in the Nineties: HYV Boro production showed gradual increase in total period and sub period-II which were 17,85,050 metric tons and 39,59,160 metric tons per year. The growth was highly significant. In sub-period-I HYV Boro production showed insignificant increasing trend. HYV Aman production showed increasing trend in total period (4,62,721 metric ton per year) and sub-period-I (2,85,285 metric ton per year). In sub-period-II it also showed increasing trend (9,30,324 metric ton per year). The trends were not statistically significant (Table 3).

HYV Boro production increased by 6.09 per cent per annum in total period. In sub-period-I HYV Boro production increased by 0.90 per cent per annum. In sub-period-II HYV Boro production increased by 12.43 per cent per annum. HYV Boro production growth in sub-period-I and sub-period-II were not significant but in total period of nineties it was significant. The exponential growth functions of HYV Aman production indicated insignificant positive annual compound growth in total period and sub-period-I. The annual compound growth rates were 2.42 and 1.70 per cent for total period and sub-period-I respectively. In sub period-II it was 4.54 and statistically insignificant (Table 4).

Growth rates of the yield of HYV Boro and HYV Aman rice in the nineties: Yield of HYV Boro exhibited positive growth with respect to time in total period and sub-period-II. The growth of yield of HYV Boro was estimated at 0.0781 metric tons and 0.1603 metric tons per year for total period and sub-period-II respectively. In total period and sub-period-I yield of HYV Aman showed negative insignificant growth. The growth rates were 0.169 and 0.0240 metric tons per year in total period and sub-period-I (Table 5). In sub-period-II it was positive (0.0238) and statistically insignificant. Table 6 delineates the result obtained from exponential trend function fitted to the actual yield of HYV Boro and HYV Aman rice. The log-linear trend model revealed a significant positive trend in total period and sub-period-II in terms of yield of HYV Boro. These annual compound growth rates were 1.82 and 3.65 per cent. The yield of HYV Boro rice in sub-period-I showed insignificant negative growth, which was 0.32 per cent per annum.

Yield of HYV Aman rice decreased insignificantly in total period and sub-period-I. It decreased by 0.56 per cent and 0.75 per cent per annum. In sub-period-II yield of HYV Aman, however increased by 0.67 per cent per annum. But the growth rate was statistically insignificant. The R^2 values and F-values were econometrically and statistically accepted for total period and sub-period-II of HYV Boro. The values of R^2 were reasonably satisfactory which suggest that more than 70 per cent and 95 per cent of the variations were explained by the time element included in model of total period and sub-period-II for HYV Boro respectively.

Testing the stability of the growth parameters: To find out whether there was structural difference in the regression parameters of HYV Boro and HYV Aman rice between the sub-periods 1990-91 to 1994-95 and 1995-96 to 1999-2000, the whole period of study i.e., 1990-91 to 1999-2000 was divided into two periods namely, early nineties (i.e. from 1990-91 to 1994-95) and late nineties (i.e. from 1995-96 to 1999-2000). So, the whole period was treated as the pooled sample, early nineties as sub-period-I and late nineties as sub-period-II. Related F-statistics are presented in Table 7.

HYV Boro production and yield growth rates differed significantly at both 5 per cent and 1 per cent level. The growth rates of production and yield of HYV Aman did not differ significantly at both 5 per cent and 1 per cent level.

In case of production and yield, F-values of HYV Boro were found to be statistically significant. It implies that the regression parameters of production and yield of HYV Boro were different between the two periods. So the division of period done in this study was justified in respect of production and yield of HYV Boro rice.

F-values of production and yield of HYV Aman were not statistically significant implying that the two regression parameters of HYV Aman rice were same between the two periods. Thus it was not justified to divide the total period into two sub-periods in respect of production and yield data of HYV Aman rice.

HYV Boro and Aman production has increased 8.37 per cent and 8.14 per cent per annum, respectively during the period 1974-75 to 1998-99. Yield of HYV Boro for the period 1974-75 to 1998-99 increased 0.62 percent per annum whereas yield of HYV Aman for the same period decreased 0.02 per cent per annum. Production of HYV Boro and Aman during the post independence period of Bangladesh increased mainly due to the expansion of HYV areas. Since the natural calamities such as rainfall, flood etc. existed in HYV Aman growing season the yield level of HYV Aman

decreased. In nineties the production and yield of HYV Boro and Aman showed the same picture as the post independence period. HYV Boro and Aman production in early and late nineties exhibited positive growth, but the yield of HYV Boro and Aman showed negative growth in early nineties and positive growth in late nineties. Unfavorable climatic conditions such as cyclones in 1991 and fertilizer crisis in the last two years of early nineties can be identified for decreasing yield levels of HYV Boro and Aman rice. On the other hand, favorable climatic conditions, favorable agricultural policy and efficient management in the distribution of agricultural inputs were the main reasons for increasing yield levels in late nineties.

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