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CHANGE AND INSTABILITY IN AREA AND PRODUCTION OF WHEAT AND MAIZE IN BANGLADESH

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Abstract

The study measured the change and instability in area, production, and yield of two major cereal crops wheat and maize in Bangladesh based on secondary data during 1980/81-2003/04 using different statistical techniques. Area and production of wheat increased satisfactorily. But yield was not increased to meet the demand of the country. In the case of maize, significant increment happened in yield during the study period. Area and production of maize also increased to fulfill the increasing demand of population. Presently production of maize increased more rapidly than its area. The growth in area, production, and yield of wheat slightly improved in period-II, whereas the growth rate in area, production, and yield of maize improved rapidly. Though both of wheat and maize are unstable crops, maize showed very instability in its area and production because of its increasing tendency in the recent years.

Key Words: Change and instability, production, wheat, maize.

Introduction

Wheat, after rice is one the most important cereal crops in Bangladesh. It has versatile uses in making various human foods, such as bread, biscuits, cakes, sandwich, etc. But the production of wheat in the country is very insufficient to meet the increasing demand for food for the ever-increasing population. Bangladesh had to import a huge quantity of grain food, mainly wheat, to meet the deficit of cereals. In 1989/90 and 1990/91, the average supply of wheat was 2.35 million tons, of which 65% was imported (Ahmed *et al.*, 1996). In recent years, due attention has been given to wheat cultivation in Bangladesh. As a result, wheat acreage in this country has gradually been increased. Of course, there is real hope and bright possibility of' solving the crucial national food crisis by cultivating wheat.

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Maize is an important food and feed crop being recognized relatively recently in Bangladesh and has gained an increasingly important attention by the government. It accounts for 18% of the world cereal acreage and about 25% of the world cereal production (Haque, 1999). This is mainly due to the huge demand of maize particularly for poultry feed industry. Besides maize has diversified uses as food and industrial raw materials. Demand for maize is likely to progressively increase in near future. At the present increasing rate of consumption, the demand for maize and it will exceed a million tons by 2012 (Iqbal, 2001).

The rate of increase in area, production, and yield of these two important cereal crops should be stable and steady. But in reality, instability exists in area, production, and yield of wheat and maize that needs to be studied. Therefore, it is very important to know the pattern of change and relationship between area and production of cereal crops in Bangladesh. The findings of this study provide some useful guidelines for the relevant researchers, policy makers and planners of the country.

Objectives:

(i) to determine the growth rate of area, production, and yield of wheat and maize.

(ii) to measure the change and instability in area, production, and yield of wheat and maize

(iii) to derive policy implications from the above objectives.

Data and Analytical Procedures

Data and its sources

Time series data on area, production, and yields of different cereal crops for 24 years from 1980/81 to 2003/04 were collected from different issues of the Statistical Yearbook of Bangladesh. The whole period was divided into two periods viz., period-I from 1980/81 to 1991/92 and period-II from 1992/93 to 2003/04 to compare in area, production, and yield between the two periods.

Analytical procedures

In order to examine the nature of change, instability, and degree of relationship in area, production, and yields of different cereal crops in Bangladesh, various statistical measures, such as mean, correlation co-efficient and co-efficient of variation were worked out.

To identify the significant change in area, production, and yield between two periods, the following formula was used:

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}; \qquad df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}{\frac{\left(s_1^2 / n_1\right)^2}{n_1 - 1} + \frac{\left(s_2^2 / n_2\right)^2}{n_2 - 1}}$$

$\overline{x_1}$ = *mean of the data of period* I $\quad s_1^2$ - *Variance of the data of period* 1

$\overline{x_2}$ = *mean of the data of period* 2 $\quad s_2^2$ - *Variance of the data of period* 2

df= degrees of freedom

The production of wheat and maize is likely to be influenced by the area used for wheat and maize in order to estimate the parameter; simple linear regression models were fitted to examine the change of production by the change of area. The model can be expressed as:

$Y = a + bX - e$

Where, Y = *Productionin in ton*

a = *Intercept,* b = *Regression coefficient*

X = *Area in ha*

The growth rates of area, production, and yield of maize and wheat were worked out by fitting a semi-log function of the following type:

$y=e^{a+bt}$ *or* $I_n y=a+bt$

Where. y = Area (ha) or production (ton) or yield (t/ha)

t = Time period (year)

An index of instability was computed for examining the nature and degree of instability in area, production, and yield in Bangladesh. The co-efficient of variation (CV) was worked out for area, production, and yield to measure of variability. However, simple CV does not explain properly the trend component inherent in the time series data. Alternatively, the Coefficient of variation around the trend (CVt) rather than co-efficient of variation around the mean (CV) was suggested by Cuddy and Della (1978) as a better measure of variability.

A linear trend $y=a+bt+e$ was fitted to the indices of area, production and yield for the period 1 980/81-2003/04 and trend co-efficient "b" was tested for significance. Whenever the trend co-efficient was found significant, the index of instability was constructed as follows:

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

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

In words, co-efficient of variation (CV) around the mean was multiplied by the square root of the proportion of the variation, which was unexplained by the trend equation, $y=a + bi$ +e.

Results and Discussion

Change in area, production and yield of wheat and maize over the periods:

Wheat has increased its importance during the past three decades as rising levels of imports (including large quantities of food aid) have led to a rapid increase in its consumption. In the wake of 1974 famine, the planted area of wheat had sharply increased (Chowdhury, 1993). Wheat area and production increased from period-I to period-Il significantly (at 1% level of significance). The increase in yield from period-I to period-II was also significant at 10% level of significance (Table 1). So the yield of wheat is not increased from period-I to period-II satisfactorily as with the enhancement of area.

Table 1. Change in area, production and yield of wheat and maize.

Name of crops	Field of measurement	Mean Value		t-value	P(T<t) two-tail
		Period-I 980/81-1991/93	Period-II (1992/93-2003/04)		
Whet	Area (ha)	5,74,837	7,23,848***	-5.387	0.000
	Production (Ton)	10,78,557	14,97,105***	-4.736	0.000
	Yield (t/ha)	1.876	2.068*	-2.355	0.029
Maize		2,967	10,516	-1.729	0.111
		2,537	38,055	-1.680	0.121
		0.854	3.619**	-2.627	0.015

Note: '***' and '**' represent significant at 1% and 5% level

In the last two decades, the area of maize has increased by more than three times, while its production has increased by 15 times. The average area of wheat in period-I was 5,74,837 ha, whereas it was 7,23,848 ha in period-II. The change between these two periods is highly insignificant at 1% level. The mean difference between

the two maize production levels in two periods was insignificant. But the average yield of maize in period-II increased significantly at 5% level from period-I.

Correlation test

A commonly employed method for measuring the changing attitude of area and production of any crop is correlation. This procedure built on the rationale that if area influencing the production the numerical evidence of this relationship is in Table 2. The correlation coefficient (r) of area and production of wheat for whole period is 0.943, which is highly significant at 1% level implying that the increment of area strongly affect the production of wheat to increase. The wheat production in period-I was not increased significantly as the value of 'r' is 0.498. The relationship between area and production of wheat in period-Il is very much strong (r = 0.985) and significant at 1% level.

In the case of maize, the relationships between area and production in all the periods considered in this study are very strong and significant at 1% level. It implies that the production of maize has increased due to increase in its area.

Table 2. **Relationship between area and production of wheat and maize**

Name of crops	Criteria	Value of Correlation (r)		P(T<t) two-tail
Wheat	Area Vs production	Whole period	0.943***	0.000
		Period-I	0.498	0.100
		Period-II	0.985***	0.000
Maize	Area Vs production	Whole period	0.994***	0.000
		Period-I	0.922***	0.000
		Period-II	0.994***	0.000

Note: '***' and '*' represent significant at 1% and 10% level

Regression analysis

The simple linear regression functions were fitted for estimating the response of production of wheat and maize due to the change of their respective area. Production of wheat was significantly increased by 1.138 and 1.259 times during the whole study period and period 1, respectively, by unit change in area. In the case of period-I, the production of wheat was not significantly increased as the co-efficient of production on area was found to be 0.67.

In the case of maize, the estimated co-efficient of production on area are significant at 1% level of significance during all the periods. It implies that the production of maize increased by 1.94. 0.48 and 1.95 times during whole period, period-I and period-II due to increase in a unit area, respectively. So, an increasing tend is found in maize production with the increase in its area expansion.

Table 3. Testing dependency of production on area.

Name of crops	Period	Constant value	Regression Coefficients	t-value	P(T<=t) two tail
Wheat	Whole period	-537753.22	1.138***	13.2958	0.000
	Period-I	123961.34	0.672	1.815	0.100
	Period-II	-754086.02	1.259***	18.052	0.000
Maize	Whole period	-12069.32	1.943***	43.435	0.000
	Period-I	-982.57	0.480***	7.557	0.000
	Period-II	-12648.39	1.952***	29.192	0.000

Note: '***' and '*' represent significant at 1% and 10% level

Growth rate in area, production, and yield

The growth rates of area, production, and yield for wheat and maize during period-I, period-II, and whole period are presented in Table 4. The growth rates of area and production for wheat are positive and highly significant at 1% level during the whole period. In the case of yield of wheat, the growth rates during whole period and period-Il are positive and significant at 10% and 5% levels, respectively. In the case of maize, the growth rates of area, production, and yield are positive and highly significant at l% level during all the periods except period-I.

Table 4. Growth rates of area, production and yield of **wheat and maize.**

Name of Crops	Field of Measurement	Measurement Statistics	Growth Rate (%)	P(T<=t) two tail
Whet	Area	Whole period	1.641***	0.000
		Period-I	0.580	0.370
		Period-II	1.201	0.124
	Production	Whole period	2.182***	0.000
		Period-I	-0.970	0.374
		Period-II	2.389	0.119
	Yield	Whole period	0.541	0.078
		Period-I	-1.459	0.107
		Period-II	1.188*	0.035
Maize	Area	Whole period	7.382***	0.001
		Period-I	3.975	0.086
		Period-II	24.575***	0.086
	Production	Whole period	14.128***	0.000
		Period-I	10.234**	0.000
		Period-II	39.635***	0.001
	Yield	Whole period	6.746***	0.000
		Period-I	6.259***	0.000
		Period-II	15.059***	0.000

Note: '***'; '*' represent significant at 1%, 5% and 10% level

Instability in area, production and yield of wheat and maize

Fluctuation in area and production of wheat and maize are interrelated as wider area gives greater production if the inputs remain constant. But variation in yield may be due to weather condition, technological changes, etc. The instability of wheat and maize in area. production and yield are shown in Table 5.

Table 5. Instability in area, production and yield of wheat and maize.

Name of crops	Field of Measurement	Measurement statistics	Whole period	Period-I	Period-II
Wheat	Area	CV	15.54%	7.522	11.812
		R-square	0.569	0.067	0.126
		P(T<=t) two-tail	0.000***	0.415	0.258
		D-W	1.008	2.576	0.463
		CV around trend line	10.202	-	-
	Production	CV	23.360%	13.373	18.032
		R-square	0.465	0.074	0.199
		P(T<=t) two-tail	0.000***	0.394	0.146
		D-W	0.623	1.517	0.454
		CV around trend line	17.087	-	-
	Yield	CV	10.208%	11.538%	6.938%
		R-square	0.134	0.231	0.361
		P(T<=t) two-tail	0.078	0.114	0.039*
		D-W	0.651	1.096	0.737
		CV around trend line	9.199	-	5.544
Maize	Area	CV	165.263%	24.735	143.590
		R-square	0.305	1.98	0.552
		P(T<=t) two-tail	0.005***	0.147	0.006**
		D-W	0.326	1.522	0.421
		CV around trend line	137.774	-	96.108
	Production	CV	265.073%	37.199	192.434
		R-square	0.282	0.503	0.506
		P(T<=t) two-tail	0.008**	0.010**	0.01**
		D-W	0.257	0.945	0.365
		CV around trend line	224.6029	26.225	135.25
	Yield	CV	81.431%	22.737	73.249
		R-square	0.513	0.77	0.708
		P(T<=t) two-tail	0.000***	0.000***	0.001***
		D-W	0.2511	0.428	0.339
		CV around trend line	56.828	10.904	39.589

Note: '***' and '*' represent significant at 1% and 10% level

The area and production of wheat during the whole period experienced the highest degree of instability, which is significant at 1% level. Yield of wheat during whole period is significantly fluctuated at 10% level.

Area of maize during the whole period shows highest degree of instability. Production during whole period and period-II reflect higher degree of instability at the same time yield also shows remarkable degree of instability during these two periods.

Conclusion and Recommendation

Overall condition of wheat production in Bangladesh is not satisfactory during the study period. Since remarkable increment in average area and production of wheat witnessed during period-II, but in case of yield, there happened a little increment to meet the increasing demand of the country. Trend line for area and production of wheat also give evidence in favour of the above statement. During period-II, area is strongly influenced its production, but in period-I, the relationship is weak. In period-II, wheat production shows a slight upward tendency. Therefore, scientists should give more attention to develop sustainable variety in unfavourable weather to meet the increasing demand. If we fail to provide farmers, weather suitable and high yielding variety, the rate of import of wheat must be increased.

The overall trend of maize production in Bangladesh is quite satisfactory. The average yield of maize is double in period-Il compared to period-I. Examination of correlation and regression analysis also shows that production of maize increase nearly 2 times with unit increase in area. The trend line for maize also gives the evidence on behalf of increasing tendency of area and production of maize. Growth rate in production and yield of maize is greater than growth rate in area. Thus maize production in Bangladesh has bright future to meet the increasing demand.

Through the production trend of maize in Bangladesh is satisfactory, a huge amount of maize has to be imported from foreign countries every year. Therefore, researchers, policy makers, and farmers should give more attention to increase maize production.

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Appendix Table

Year	Wheat			Maize		
	Area (acre)	Production (ton)	Yield (t/acre)	Area (acre)	Production (ton)	Yield (t/acre)
1980-81	1460910	1075255	0.73602	5000	1000	0.20000
1981-82	1319735	952110	0.72144	5000	1000	0.20000
1982-83	1283445	1078070	0.83998	4000	1000	0.25000
1983-84	1299755	1211501	0.93210	10139	3118	0.30752
1984-85	1670765	1463630	0.87602	9321	3270	0.35082
1985-86	1335140	1041825	0.78031	7803	2920	0.37421
1986-87	1445000	1090990	0.75501	7666	2934	0.38272
1987-88	1476290	1048015	0.70989	7579	2855	0.37669
1988-89	1384030	1021950	0.73839	8324	3229	0.38791
1989-90	1463060	890000	0.60831	8265	3350	0.40532
1990-91	1480050	1004290	0.67855	7680	3040	0.39583
1991-92	1419990	1065050	0.75004	7225	2725	0.37716
1992-93	1573930	1175630	0.74694	7200	2725	0.37847
1993-94	1520120	1131050	0.74405	6710	2785	0.41505
1994-95	1580030	1244990	0.78795	6700	2680	0.40012
1995-96	1732430	1369130	0.79029	6550	2675	0.40839
1996-97	1749080	1454100	0.83135	6570	2695	0.41019
1997-98	1988420	1802815	0.90665	6295	2650	0.42096
1998-99	2179640	1908435	0.87557	6955	2970	0.42703
1999-00	2056950	1839980	0.89451	7810	4075	0.52176
2000-01	1909290	1673280	0.87638	12130	10350	0.85325
2001-02	1833110	1605760	0.87597	49350	64335	L30364
2002-03	1745750	1506710	0.86307	71805	117255	1.63296
2003-04	1586110	1253380	0.79022	123625	241460	195316