Bangladesh J. Agric. Econ. XIV, 1 (June 1991) 19-36

FACTORS INFLUENCING YIELD GROWTH AND PRODUCTION INSTABILITY OF JUTE IN BANGLADESH.

Shamsul Alam
John Lingard

ABSTRACT

Yield growth trends as well as area, yield and production instabilities and their relationships were measured. Impact of product price on yield increase was estimated. Relative product price changes had no impact on yield increase though jute area allocation was highly influenced by the relative product price changes. Both jute price and production instabilities were substantial.

I. INTRODUCTION

Bangladesh enjoys an apparent comparative advantage in jute production than any other jute producing countries. Bangladesh's share in the world supply of raw jute for the period 1975 to 1979 was on the average 64 percent compared to 49 percent during 1970 to 1974 (Rahman et. el., 1984). Jute fibre and its manufactures play an important role in the export earnings of Bangladesh. In 1985/86 about 47 per cent of the total export earnings of Bangladesh came from raw jute and jute goods. In 1986, jute production employed 214 million man-days of labour and jute production and processing provides employment and income for a large number of landless labourers and marginal farmers. [1] On a five year basis, average jute area was around 9 per cent of the net sown area during the nineteen seventies but decreased to 8 per cent in the first part of the 1980's. In terms of gross cropped area, jute was around 6 per cent in the seventies and decreased to 5 per cent in the eighties.

The first author is an Associate Professor, Dept. of Co-operation & Marketing, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh. The second author is a Senior Lecturer, Dept. of Agric. Econs. & Food Marketing, The University of Newcastle upon Tyne NE1 7RU. U.K.

This article is derived from Chapter V of the first author's Ph. D. Thesis, the University of Newcastle upon tyne, U. K. The authors are grateful to the referees of the paper who made useful suggestions in this paper. However, usual disclaimer applies.

Jute Area as a per cent of gross cropped area has been declining steadily since the independence of Bangladesh.

Analyses of yield growth pattern, effects of area fluctuations on total production and instability of output have important policy relevance in designing strategies for stable jute supply in the local and international markets. Production variability of a crop product is the result of both the yield and area variability and their interaction effect. Study of the production variability of jute is pertinent to designing procurement and stocking policies, and particularly for price stabilisation schemes. Through price policies, area allocations of a crop can be influenced to attain policy objectives. Knowledge of yield variability is helpful in investigating the technology to control the production environment and assess the effects of natural calamities on seasonal production. Stabilisation of jute prices is a major concern for designing stable agricultural product prices policies in the country. Understanding of jute area fluctuations and the sources of variability is essential to any measures to reduce instabilities of supply of jute. Apart from the analysis of yield growth pattern, one of the aims of this paper is to assess the extent of annual fluctuations and the long-run variability identifying random components compared to systematic factors of jute area, yield and production and their relationship to price variations.

Following this introduction, patterns of area growth and variations are discussed in Section II. Trends in yield growth, product price impact on yield and the factors contributing to yield growth are analysed in Section III. The yield growth and the instabilities in area, yield and production in Bangladesh is compared by including four years of the pre-Bangladesh period. Section IV deals with the relationship in variation between area and production. Jute price variations and their effects on area and output variations are discussed in the penultimate Section V. Section VI contains concluding remarks.

II. JUTE AREA FLUCTUATIONS [2]

Jute area in Bangladesh ranged from 517 thousand hectares in 1975 to 512 thousand hectares in 1987. During the first five years of Bangladesh, the coefficient of variation of jute area was 22 per cent compared to 10 per cent in 1976-80 and 18 per cent in the 1981-87 period (Table 1) [3]. Variation of area was higher during the initial years of Bangladesh, then declined during the latter half of the seventies. Variations of area increased again in the first half of

the eighties which is an increase of 81 per cent over the variation in area of the previous period. Year to year fluctuation of jute area varied from a decrease of 35 per cent to 37 per cent increase (Appendix Table 1). This, together with yield fluctuation, resulted in high variations of jute production from down 42 per cent to an increase of 55 per cent between years.

Comparative random fluctuations of jute area, yield and production are presented in Table 2. Random fluctuation is computed by following a five year moving average method. The moving average method is one procedure to separate the random component from the random element [4]. The pattern of random fluctuations of area and jute production below or above the trend element appeared to be of similar magnitudes, meaning in the long-run (of five year period in this case) yield, random fluctuations have little influence on jute production. Average jute area which peaked in the second half of the seventies was 720 thousand hectares and then fell to 686 thousand hectares in the seven years of the eighties. Jute area as a per cent

Table1. Changes in Average Area (In hectares), Yield and Production of Jute and Variations in Area, Yield and Production of Jute in Bangladesh.

Years	Average Area ('000)	% Change	Coefficient of variations	% change	Yield (bales Per	% change	Coeeficient of variationsors	% change	Average Production ('000 bales)	% change	Coefficent of variations	% change
			(Per cent)		hec)		(Per c ent)				(Per cent)	
1971-75	711.05	-	22.13	-	6.77	-	8.90	-	4823	-	24.97	-
1976-80	720.36	1.31	10.00	- 54.81	7.64	12.85	2.81	- 68.43	5506	14.16	11.34	- 54.59
1981-87	686.42	-4.71	18.12	81.20	8.43	10.35	6.12	117.76	5765	4.71	17.35	53.00
Change over												
1971-75	-	-3.46	-	-18.12	-	24.52	-	-31.24	-	19.53	-	-30.52

Note : Coefficient of variation (in per cent) is computed as follows: : (\f(Standard deviation, mean))x 100. This is neutral to variate scale and thus helps comparing variability amongst different variables having different units of measurement.

Sources : Calculated from BBS: 1979, 1983/84, 1986, 1987 and 1989 Statistical Yearbooks of Bangladesh p.173, p. 256, p. 333, p. 175 and p. 155 respectively.

of gross cropped area has been declining steadily due to growing crop intensification in the country [5]. During the eighties (1981-87), net jute area decreased almost three and a half per cent compared to the first half of the seventies. The decrease in net jute area has been the effect of higher yield variation of jute than competing rice varieties, higher jute price variations and relatively more technological advancement in rice production (Appendix Table2).

III. YIELD GROWTH AND VARIATIONS

Average jute yield per hectare has persistently been growing at a modest rate despite the short-run yearly variations. This increase of jute yields over the years is shown in Figure 1. Increase in yield of a crop is an indicator of technological progress for that crop. To see whether jute yield has grown overtime, a trend model has been estimated by fitting a log linear equation. Specification of the jute yield with a constant percentage growth

over a discrete time interval of a year is made as follows :

$Y_t = \alpha(1+g)^t u_t$ .....(1)

Where Y_t is yield of jute in time period t, g is proportionate rate of yearly growth, u_t is the error term. Linearising the above equation we obtain :

$L_nY_t=a+bt + \mu_t$.....(2).

Where L_nY_t is assumed to grow at a constant rate; $a=Ln\alpha$; $b=Ln(1+g)$; b is the rate of continuous growth, for small values which with continuous compounding would give the same result as a single increment g, $\mu_t = Ln\ u_t$ which is assumed to be normally and independently distributed. The estimated exponential trend equation (2) is :

i) 1971/72-87/88 : LnYield = -1.20+ 0.0191 T $\bar{R}^2$ =0.72

(6.29)

D.W. 2.14 (No auto correlation)

ii) 1967/68-87/88 : LnYield=-0.77 + 0.0139 T $\bar{R}^2$ =0.63

(5.66)

D.W. 2.04 (No auto correlation)

The parenthesised figures are the 't' ratios. The above simple exponential trend equation shows an annual growth rate of 1.91 per cent in the 1971-87 period. This is higher than the estimated equation for the longer period of 1967-87 implying that the yield growth has accelerated during the Bangladesh period [6]. Jute yield has grown overtime, but it is also possible that the growth rate has accelerated or declined over the period. A log quadratic equation was tried for the period 1971-87, but did not yield any useful results with non-significance of the time variables [7]. This implies that constant yield growth has not changed significantly during the Bangladesh period. The coefficient of variation of yield was the highest in the first five year period of the seventies (C.V. 9 per cent). In the second half of the seventies, the coefficient of variation in yield declined significantly (C.V. 3 per cent) over the previous period and during the seven years of the eighties, this increased again (C.V. 6 per cent; Table 1). Over the study period, yield random fluctuations have been much lower than the area fluctuations (Table 2).

The average increase in yield has been modest and persistent over the whole period of twenty years (1967-1987). In the terminal period (1982/83-87/88), yield increase was 23 per cent higher over the 1967-71 period and this has contributed to positive increase in total production while jute area declined during the Bangladesh years when compared to the latter half of the sixties.[8]

Average jute production (1981/82-87/88) has increased 25 per cent over the 1971/72-75/76 period and this has been due almost entirely to yield increases of 24.52 per cent while the area decrease was 3.46 per cent. Jute area and yield interaction effects on production have also been small (compare the last row; Table 1). Average yield variation was lower than the area variation but this has also contributed to production variation, though marginally.

Product Price Impact on Jute Yield.

Jute yield is postulated as being influenced by labour use (jute is a labour intensive crop). rainfall during the growing period, and the price of the crop. Fertiliser use is scant in jute production and also, data on fertiliser and pesticides uses in jute cultivation were not available. During the study period jute yield was also influenced by the availability of improved seed varieties, extension services and changing production techniques in some areas of

Bangladesh(e.g., from randomised seed sowing to line sowing). The change of technique and technological advancement if any, is expected to be captured by

Table 2. Random Fluctuations of Jute Area, Yield and Production 1971/72 -1987/88

Year	Jute area ('000 hectares)	Five Years moving average of area	Deviation of actual from moving average (Per cent)	Yield (bales per hec)	Five Years moving average of yield	Deviation of actual from moving average	Production (bales)	Five years moving average of Production	Deviations of actual from moving average (Per cent)
1971	679.89	870.90	-22	6.18	6.97	-11	4192	6109	-31
1972	897.61	785.92	14	7.26	6.75	8	6514	5370	21
1973	888.30	711.41	25	6.75	6.77	-0	6000	4823	24
1974	573.45	704.98	-19	6.05	7.02	-14	3476	5946	-30
1975	516.79	671.55	-23	7.61	7.03	8	3933	4715	-17
1976	648.73	659.89	-2	7.41	7.24	2	4806	4807	-0
1977	730.47	696.72	5	7.34	7.60	-3	5359	5304	1
1978	830.03	720.36	15	7.78	7.63	2	6461	5506	17
1979	757.59	704.90	7	7.86	7.78	1	5960	5474	9
1980	634.97	690.82	-8	7.78	8.04	-3	4942	5546	-11
1981	571.43	662.49	-14	8.13	8.16	-0	4646	5403	-14
1982	660.06	646.22	2	8.67	8.10	7	5719	5233	9
1983	688.39	704.09	-2	8.35	8.19	2	5747	5765	-0
1984	676.24	744.23	-9	7.56	8.31	-9	5111	6187	-17
1985	924.32	714.69	29	8.23	8.44	-2	7601	5998	27
1986	772.16	-	-	8.75	-	-	6755	-	-
1987	512.34	-	-	9.33	-	-	4778	-	-
Range of Deviations			(-23 to 29)			(-14 to 8)			(-31 to 27)

Source : As referred to in Table 1. The five year moving average is centred on the year for which deviation is calculated.

a 'rend variable. Within this theoretical framework of the growth of jute yield, the following equation was empirically tested to see the factors influencing the yield growth. Jute being a competitive crop to *aus*, jute price has

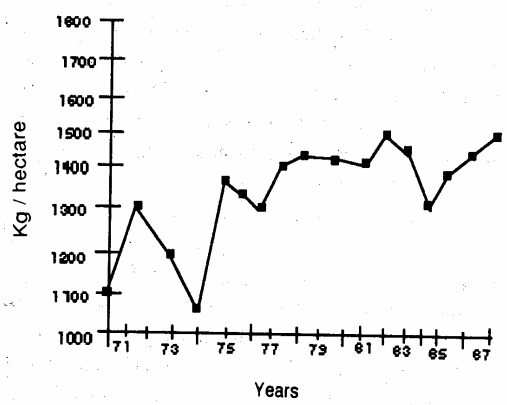

Fig 1 : Increase of jute yield over the years

been deflated by the aus harvest price (*aus* and jute harvest periods almost coincide). Labour wage has been deflated by rice price of the relevant period. To test the price elasticity of yield with other explanatory variables the following loglinear regression for the 1971-87 period was estimated using the OLS method :

$$\text{LnYield} = -0.80 - 0.015\ \text{LnPRI} - 0.061\ \text{LnRA} + 0.028\ \text{LnWA} + 0.0188\text{T}$$

$$(-0.26) \quad (-0.96) \quad (0.29) \quad (3.38)^{HS}$$

$\bar{R}^2 = 0.76$ D.W. 1.79 (No auto correlation).

Where LnYield is the jute yield, LnPRI is the jute *aus* rice prices ratio lagged by one year, LnRA is the total rainfall in the growing period (i.e., April, May, June), LnWA is the average daily wage rate (deflated by the *boro* paddy harvest price per kilogram) for the months of March, April, May and June (the growing and processing period) and T is the variable representing the time trend. All the variables prefixed Ln are in natural logarithms (the sources of data are referred to in Appendix, Table 2). The parenthesised figures are the 't' ratios (superscript 'HS' stands for significant at one per cent level ; a two tailed test). In the yield regression, only the time trend variables came out significant. The jute/rice price ratio came out insignificant implying that the relative jute price has little effect on

the level of yield increase. This finding conforms with the earlier studies (see, Anderson et. al, 1980; Rahman 1984) and is quite plausible for the following reasons : firstly, the yield augmentation, so far, is based on improved seeds and partly on changing cultural practices (e.g., line sowing) which does not require additional labour and the use of fertilisers, and irrigation is also scant ; secondly, the availability of improved seeds and extension services relating to the changed cultural practices is determined by the level of institutional arrangements, not dictated by the price relationship.

Because the yield augmentation is not conditioned by the increased labour use, ruling daily wage rate has little relevance. When there is a trend growth, the nominal wage rate, if used in the same equation, may be affected by a collinearity problem. To overcome this, the use of daily wage rate has been deflated and that has also not changed the significance level. Growing period rainfall (April, May and June) is not a problem for yield growth. The pre-monsoon period starts in mid April which is followed by the increasing level of precipitation. The normal rainfall during this period of the year is usually adequate for the growth level. In the absence of any significant impact of relative product prices on jute yield, the way to increase it would be to have assured provision of technological inputs e.g., improved seeds, training on line sowing, application of fertiliser and extension services. This is imperative because, 76 per cent of the annual yield variation has been due to technological effects as revealed by the significance of the time trend variable.

IV. THE RELATIONSHIP BETWEEN AREA AND PRODUCTION

The lowest production of jute was in 1974 with the production of 3.48 million bales and the peak was in 1985 with 7.60 million bales of jute fibre. The average production during the first and second half of the seventies was 4.82 and 5.51 million bales which peaked on average in seven years of the eighties at 5.77 million bales, though jute area was declining in the eighties. Increased jute production has come from higher yields. However, the average jute production in the eighties could not surpass the 1967-71 average production which was 6.09 million bales.

Annual production of jute fluctuated from –42 per cent to 55 per cent (Appendix Table 1). Most of this fluctuation can be attributed to high yearly jute area variation i.e., a major source of the production instability came from the

area fluctuations. Jute production random fluctuation was also high which has shown a change of 31 per cent decrease of production to 27 per cent increase in a year over the trend production (Table 2).

The coefficient of variation of production was higher in the first half of the seventies (C.V.25) then declined in the second half (C.V.11) of the decade, again increasing in the first half of the eighties (C.V.17; Table 2). The coefficient of variation during the 1981-87 period was 53 per cent (in terms of change) higher than the previous five year period. However, the trends of the coefficient of variation between jute area and production for the corresponding periods follow a close relationship throughout the whole period. Average production variation has exhibited close association between area variation i.e. the major source of the production instability came from the area fluctuations. The correlation between area and total output is 0.89 which also lends support to the above proposition.

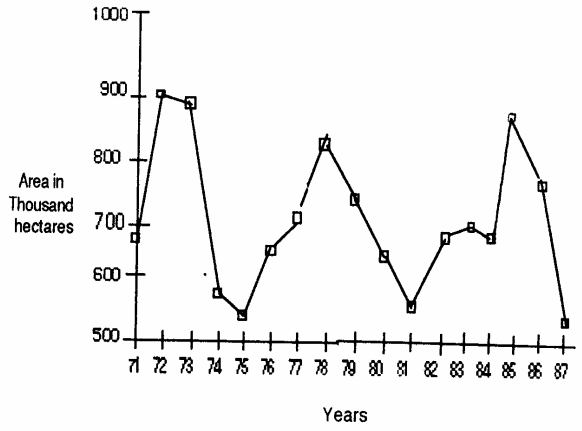

Figure 2 : Flunctuations of jute area over the years.

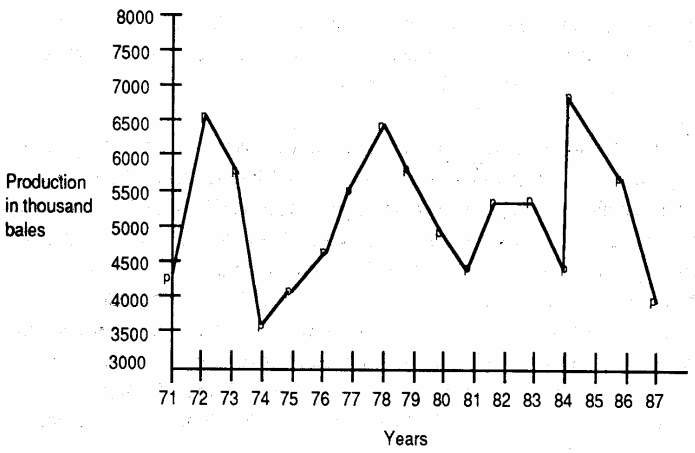

Figure 3 : Jute production over the years.

The fluctuation of jute area is shown in Figure 2 and that of jute production is presented in Figure 3 which shows a close correspondence between area and production fluctuations. The production fluctuation is almost entirely dependent on area fluctuation. In terms of area, yield and production variations, the percentage variations of area, yield and production were highest, in each case, in the early seventies. The relationship between jute area variation and a one period lagged jute rice relative price has been established by other studies (Stern 1962, Hussain 1964, Rabbani 1966, Huq 1968/69, Anderson, et. al. 1980, Ahmed 1981 and Alam 1991). These studies revealed that jute-rice relative price exerts significant influence on jute area allocation decisions by the farmers. The other reasons for yearly jute area variations are sowing period rainfall, availability of technological inputs during sowing season, and price and yield risks as perceived by the farmers (Alam 1991). However, the jute area and one period lagged jute/aus price ratio (because the expected price to be realised is not known when area is allocated) is significantly positively correlated. The correlation coefficient between the lagged relative product price and area for the period 1971-1987 is 0.74 (significant at one per cent level).

V. PRICE CHANGES.

Farmgate price of jute fibre per tonne was Taka 1071 in 1971 which increased to Taka 7100 in 1987. This represents a 663 per cent increase in

nominal terms. The real changes in prices and their coefficients of variation over a five year period are presented in Table 3.

The jute price on an average in the eighties (until 1987) has increased by 242 per cent over that in the first half of the seventies while the *aus* rice price increase during the same period was 146 per cent. Though average real *aus* price was higher than the jute price in the early seventies, average real prices of jute during the second half of the seventies and the eighties remained higher than the *aus* harvest prices.

Table 3. Changes in Harvest Prices of Jute and Aus Rice in Bangladesh (1979 Price =100)

Year	Average Real Price				Coefficient of Variations of Prices (Per cent)			
	Jute	% change (previous period)	Aus rice	% change (previous period)	Jute	% change (previous period)	Aus rice	% change (previous period)
1971-75	64.86	-	77.74	-	29.56	-	51.00	-
1976-80	123.17	90	95.57	23	17.80	-40	15.79	-69
1981-87	221.62	80	191.09	100	44.23	148	19.70	25
% change over 1971-75		241.69		145.81		49.63		-61.37

Sources : Calculated from Ahmed, (1984) p.21 for both jute and rice prices for 1971.For jute and rice prices for other years ; BBS: 1979,1987, 1989 Statistical Yearbooks of Bangladesh, p. 368, p.449 p. 433 and Yearbook of Agricultural Statistics of Bangladesh 1987-88 p. 241 respectively.

The coefficient of variation of *aus* rice price was 73 per cent higher than that of jute price during the initial years of Bangladesh. During 1976-80 period, jute price variation was 13 per cent higher, and in 1981-87 it was 125 per cent higher than the *aus* harvest prices. Over the 1971-75 period, the coefficient of variation of jute prices increased by fifty per cent during the eighties while the coefficients of variation of rice prices decreased by sixty-one per cent implying that the rice prices were more stable. The real price of jute increased more than that of rice, but this increase in prices has been also associated with high variations in jute prices. Still, the average jute/aus harvest price ratio has moved more unfavorable for jute in the eighties than in the preceding five year period. The jute *aus* harvest price ratios, on average in the 1976-80 and 1981-87 periods, have been 1.29 and 1.16 respectively (worked out from Table 3).

The coefficient of variation of jute and *aus* prices for the whole period have been worked out at 63 and 48 per cent respectively i.e., jute price variations have been 31 per cent higher than the aus price variations. Higher coefficients of variation for the whole period for jute price implies higher instabilities of jute prices than *aus* rice prices. Price variations for both the jute and *aus* prices have increased more in the eighties than in the preceding five year period, but the increase in jute price variations have been higher(148 per cent for jute and 25 per cent increase for rice). Government rice price stabilisation measures are partly responsible for jute price volatility.

Domestic jute price fluctuations may be attributed mainly to annual supply variations and export price variations. The relationship between world price and harvest price of jute shows that the harvest price fluctuated in the same manner as the world price did. The relationship is shown as follows:

$$P_h = -583.42 + 0.7204\ Pw \qquad \bar{R}^2 = 0.85$$

(-1.05) (9.11) D.W. = 2.10 (No auto correlation).

The parenthesised figure is t ratio.

Where P_h=harvest price of jute and Pw= world price of jute. It is seen from the above regression that if the export price of jute changes by 1 unit, harvest price would change by 0.72 units. Eighty five per cent of the total harvest price variation is explained by world price variations. It is also interesting to note that export prices affect domestic prices and thus production. Bangladesh's jute production has little influence on world prices, even though it is a major exporting country. This is mainly due to availability and continuous development of cheap synthetic substitutes (polymer and polythene products) for jute products in the major importing countries (the U.S.A. and E.E.C.). The correlations between domestic production and current export price (production and export prices in the same year), and also the export price in the following year are 0.25 and 0.18 respectively. This reveals Bangladesh's weak position in influencing world jute prices on the one hand and on the other supply instabilities are not directly transmitted to world prices. Private and public sector stocks play a role in smoothing out the domestic supply shocks to export prices. This is also obvious with a high price elasticity of demand for Bangladesh's raw jute and jute goods in the world market. IBRD (1978) estimated export

demand for raw jute which ranged from -0.71 to -1.10. Rahman (1984) estimated export price elasticities of demand which ranged from -0.75 to -0.88.

VI. CONCLUSIONS

High random area fluctuations contribute largely to high jute production variations. Jute yield has been increasing modestly in Bangladesh though annual and random jute area and production variations have been substantial signifying high jute supply instabilities in the local and international markets (Bangladesh being a major jute exporting country). Instabilities in supply result in costs both to producers and consumers. Resources would continue to be sub-optimally allocated in the production activities so long farmers face prices and production risks. As production instabilities mostly originate from yearly area variations, by reducing area variations total jute supply variations can be reduced. To mitigate area variability, price policies for both jute and rice have to be developed so as not to distort the domestic relative price structure. To influence farmers' jute area allocation decisions, price policy instruments like shifting the relative jute/rice price and price stabilisation would be effective.

Reduction of the large swings in jute prices can arrest high area fluctuations and thus jute production. Yield growth has accelerated during the Bangladesh years. Strengthening of extension services plus adequate and timely provision of improved jute seeds will result in increased supply of jute fibres to help decrease yield variations. Jute yield increasing efforts would lead to releasing lands for alternative uses. Scope for increasing yield of jute is enormous because the bulk of the jute areas is yet under traditional production method. One of the ways of encountering world jute prices fluctuations would be to reduce per unit cost of production through yield augmentation which should give an edge over easily available and lower cost substitutes like polymer and polypropylene products.

Notes

1. Jute requires 112 man-days of labour per acre for local varieties, 111 man-days for HYV (Ahmed 1984). In 1982-83 total employment in crop production was 2058 million man-days (Rahman 1987). It is computed (BBS : 1986) that in that year jute production activities required 183 million man-days which was 3.62 per cent of total employment in the crop sector.

2. The study period is 1971/72 to 1987/88. Statistical Yearbooks and Agricultural Yearbooks published by the Bangladesh Bureau of Statistics (BBS) were used extensively as the data sources. Interpretations of results should be taken with caution relating to the first half of the seventies. Because, a great deal of dislocations in data collection occured following the war of liberation during the early seventies.

3. To some extent, yearly fluctuations of area or for that matter total production are inevitable due to the operation of the factors like rotational changes and yearly relative changes in product and input prices. Unpredictable random changes i.e., above or below trend, incur costs to producers and consumers. Random fluctuations truly reflect instabilities. In this study, a moving average technique is used to measure instabilities for the whole period and the coefficient of variation (in per cent) is used for comparison between periods.

4. The other procedure for separating the trend element from the random component is regression analysis. Both simple linear and log linear regressions for jute area and production shows very poor fits with trend variables and therefore, for detrending jute area, yield (for comparability sake though the trend variable is significant with yield) and production the moving average technique has been followed.

5. Intensity of cropping has increased from 142 per cent in 1971/72 to 159 per cent in 1986/87 (BBS : 1982b; 1989a).

6. To test whether the two trend functions are different for the two periods the pooled trend function was estimated using two dummy variables for the intercept and slope coefficients :

$$LnYield = a_0+a_1D_{1i}+a_2T+a_3(D_{2i}.T)+Ui$$

$$= a_0+a_1D_{1i}+(a_2+a_3 D_{2i})T+U_i$$

where, a_1 is the differential intercept and a_3 is the differential slope coefficient indicating how much the intercept and the slope coefficients of 1971-87 differ from the intercept and the slope coefficents of 1967-87 period respectively. D_{1i}=1 if the year is 1971 or onwards, otherwise 0.This is also the same for the D2i where,D2i=1 if the year is 1971 or onwards, otherwise 0. T represents each year from 1967 to 1987. The estimated equation is :

$$\text{LnYield} = 0.23 - 1.43\ D_1 + 0.0191\ D_2 .T \qquad \bar{R}^2 = 0.72 ; (D.W.\ 2.28)$$

(-5.97) (6.37)

(The parenthesised figure is the t ratio).

The coefficients of both the dummy variables turned out statistically highly significant implying that the intercept and the slope coefficients differ in the two periods.

7. Inclusion of the time squared on the right hand side of equation (i) resulted in non-significance of both the 'time variables' (t,t^2) though with high coefficient of determination (0.70) and high standard errors of the coefficients estimated signify that the 'time variables' suffer from a collinearity problem. Based on Reddy and others 1978 (quoted in Boyce 1987), Boyce used the normalisation of time in mean deviation form, i.e. by setting t equal to zero at the mid-point of the time series to avoid the problem of multi-collinearity between 'time variables' (Boyce 1987). The same procedure was also applied, but neither time variable turned out to be significant.

8. Jute yield increase also has been reported by other studies. Alauddin and Mujeri (1986) estimated 12 per cent increase on average in value product per hectare in the period 1978-80 over the base period of 1967-69. Rahman et. al. (1984) reported that under the intensive jute cultivation scheme (which was launched in 1974) one million acres was covered in 1978-79, where the jute yield increased to 4.5 bales per acre compared to 3.0 bales in the non-scheme area. Contrary to this, Boyce(1987) reported low jute yield growth over the period 1965-80 measured through a kinked exponential trend estimates which is 0.30 per cent. He used revised jute data set before 1970's for his estimation.

REFERENCES

Ahmed, C. S. (1981) : "Supply Analysis of Jute with Consideration of Risk". *The Bangladesh Journal of Agricultural Economics*, IV, 2 (December).

Ahmed, R. (1977) : *Foodgrain Production in Bangladesh: An Analysis of Growth : Its Sources and Related Policies*. Agricultural Economics and Rural Social Science Papers No. 2, Bangladesh Agricultural Research Council, Dhaka.

Ahmed, R. (1984) : *Agricultural Price Policies under Complex Socio-Economic and Natural Constraints : The Case of Bangladesh*. BARC/ADC Social Science Reprint Series No. 5, Bangladesh Agricultural Research Council, Dhaka.

Alam, S. (1991) : The Effects of Price and Non-price Factors on the Production of Major Crops in Bangladesh. Ph. D. Thesis, University of Newcastle upon Tyne.

Alauddin, M. and Mujeri, M. K. (1986) : "Growth and Change in the Crop Sector of Bangladesh : A Disaggregated Analysis". *Journal of Contemporary Asia*, 16,1.

Anderson, J. R. et. al., (1980) : A Dynamic Simulation Model of the World Jute Economy. World Bank Staff Working Paper No. 391 (Revised), World Bank, Washington D. C.

Bangladesh Bureau of Statistics (1979) : *1979 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the people's Republic of Bangladesh.

_____(1981) : *1980 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1982a) : *1981 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1982b) : *1982 Agricultural Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1984) : *1983/84 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1985) : *1984/85 Yearbook of Agricultural Statistics of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1986) : *1986 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1987) : *Yearbook of Agricultural Statistics of Bangladesh 1985/86.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1988) : *1987 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1989a) : *1989 Statistical Yearbook of Bangladesh.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

_____(1989b) : *Yearbook of Agricultural Statistics of Bangladesh 1987-88.* Ministry of Planning, Govt. of the People's Republic of Bangladesh.

Boyce, J. K. (1987) : *Agrarian Impasse in Bengal ; Institutional Constraints to Technological Change.* Oxford University Press, Oxford.

Huq, S. (1968/69) : "Jute Price Stabilization and Resource Allocation Between Jute and Rice in East Pakistan". *Pakistan Economic Journal.* 19,2.

Hussain, S. M. (1964) : "A Note on Farmer Response to Price in East Pakistan". *The Pakistan Development Review.* 4, (spring).

I B R D (1978) : Bangladesh : Current Trends and Development Issues. Report No. 2245-BD, Washington D. C.

Rabbani, A. K. M. G. (1965) : "Economic Determinants of Jute Production in India and Pakistan". *The Pakistan Development Review*, 5, (summer).

Rahman, A. et. al. (1984) : Production Procurement and Agricultural Price Policy in Bangladesh. Institute of Business Administration, University of Dhaka.

Rahman, A. (1987) : "Resource Use in Bangladesh Agriculture - An Empirical Analysis". *The Bangladesh Development Studies*, 15, 2 (June).

Rahman, Sultan H. (1984) : Evaluation of Jute Policies and a Jute Policy Model for Bangladesh. Research Monograph No. 3, The Bangladesh Institute of Development Studies, Dhaka.

Stern, M. R. (1962) : "The Price Responsiveness of Primary Producers". *The Review of Economics and Statistics.* 44, (May).

Appendix Table 1: Annual Fluctuations of Jute Area (in hectares), Yield and Production 1971/72-1987/88.

Year	Jute Area ('000)	Change from previous year (Per cent)	Yield (bales per hec)	Change from previous year (Per cent)	Production ('000 bales)	Change from Previous year (Per cent)
1971	679.89	-	6.18	-	4192	-
1972	897.61	32	7.26	18	6514	55
1973	888.3	-1	6.75	-7	6000	-8
1974	573.45	-35	6.05	-10	3476	-42
1975	516.79	-10	7.61	26	3933	13
1976	648.73	26	7.41	-3	4806	22
1977	730.47	13	7.34	-1	5359	12
1978	830.03	14	7.78	6	6461	21
1979	757.59	-9	7.86	1	5960	-8
1980	634.97	-17	7.78	-1	4942	-17
1981	571.43	-10	8.13	4	4646	-6
1982	660.06	16	8.67	7	5719	23
1983	688.39	4	8.35	-4	5747	0
1984	676.24	-2	7.56	-9	5111	-11
1985	924.32	37	8.23	9	7601	49
1986	772.16	-16	8.75	6	6755	-11
1987	512.34	-34	9.33	7	4778	-29
Range of fluctuation		(-35 to 37)		(-10 to 26)		(-42 to 55)

Source : As referred to in Table 2.

Appendix: Table 2. Jute, Aus Harvest Prices (Taka per Tonne), Rainfall (in millimetre) and Average Daily Labour Wage(March to June) Information

Year	Jute Price (per tonne)	Aus Price (per tonne)	Rainfall(April, May and June)	Labour Wage(Tk.)
1971	1071	945	619	3.06
1972	1529	944	429	3.69
1973	1417	1242	842	4.42
1974	2389	3170	788	8.02
1975	2292	2064	533	9.60
1976	2735	1547	876	8.72
1977	4281	2061	1181	9.05
1978	3552	2191	1065	9.94
1979	2682	2187	526	10.79
1980	3267	2598	775	12.61
1981	3555	2752	948	14.71
1982	4273	3592	850	15.56
1983	5443	3665	888	17.69
1984	11616	4904	1080	20.63
1985	5646	4131	715	27.71
1986	3074	4888	612	31.38
1987	7100	5010	706	33.50

Sources: 1971 jute harvest price, Ahammed 1981, p.33 and Aus price Ahmed 1984, p.21; 1972-1977 prices, 1982 Agril Yearbook, pp.735-41; 1978-1986, from 1989 Yearbook, p.433; 1987 price, 1987-88 Agril. Yearbook, p.242. Rainfall data, 1971-73 from Ahmed 1977, p.150; 1974-80, from 1982 Agril. Yearbook, pp.550-62; 1981-84, from 1984-85 Agril. Yearbook, pp.313-16; 1985-87, from 1987-88 Agril Yearbook, pp.169-71. Jute labour wage data from 1982 Agril. Yearbook, pp.673-81, 1984-85 Agril. Yearbook, pp.382-86, 1985-86 Agril. Yearbook, p.357 and 1987-88 Agril. Yearbook, pp.192-93.