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DIMENSIONS OF STRUCTURAL CHANGES IN COST AND RETURN OF HYV BORO PADDY OVER TIME IN BANGLADESH AND DETERMINANTS OF THE CHANGES

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ABSTRACT

Dimension of changes in cost and return structure of HYV Boro paddy during the last two decades and the determinants of the changes have been examined in this paper. This study is entirely based on secondary data and nominal prices of all inputs as well as output of HYV Boro overtime have been converted into real price using Consumer Price Index (CPI). The findings showed that out of total cost, the share of labour cost decreased over time while the share non-labour cost increased. Again, the share of cash cost compared to non-cash cost increased over time. The negative growth of labour cost and positive growth of non-labour cost over time indicate the expansion of capital intensive and labour saving technology in Bangladesh agriculture in recent years. Further, the positive growth of cash cost and negative growth of non-cash cost imply the transformation of traditional agriculture into a modern one in Bangladesh. Analysis of growth rates of input and output prices in real terms showed that labour wage increased slightly during the study period while fertilizer price, as well as irrigation cost decreased. Further, in real terms, the price of Boro paddy significantly declined over the years. The overall analyses of this study showed that although both total cost and gross return decreased over time the rate of decrease in gross return was higher than that of total cost during the whole period which resulted in decreased profitability of the farmers over time. The declining farmers' profitability from production of the main rice crop (HYV Boro) in recent years is likely to have had adverse effect on farmers' incentive to produce rice which has serious implication on the national policy of attaining or maintaining food grain self-sufficiency in Bangladesh.

I. INTRODUCTION

Bangladesh's population of 130.02 million grows annually at a rate of 1.5% that adds nearly 1.5 million people every year (GOB, 2000). In order to meet the demand of food grain for the increasing population and to achieve self-sufficiency in food grain, the government of Bangladesh has given much emphasis on rice production which alone meets up about 90% of total demand for food grain. For maintaining food-population balance, which is already precarious, technological progress supported by the development of irrigation infrastructure has expanded to over half of the cultivated area and modern high yielding rice varieties have spread to over 60 percent of the rice area. As a result, although rice area remained at the same level of around 10 million hectares over the last three decades, rice production has increased from about 13.18 million tonnes in 1980-81 to about 25.09 million tonnes in 2000-01 (FPMU,

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2002). Palmer-Jones (1992) observed that the growth of grain production since 1960s reflects the gradual spread of High Yielding Varieties (HYVs), ground water irrigation; and increased use of fertilizers.

Significant compositional changes occurred within rice crops (Aus, Aman and Boro) during the last few decades. While both area and production of Aus rice decreased drastically, those of Boro rice increased by several times over the past two decades. Total Boro rice production increased from 2.87 million tonnes in 1980-81 to 11.03 million tonnes in 1999-2000, while the area under Boro increased by about nearly three times in 1999-2000 compared to the area in 1980-81. This phenomenal increases in Boro production may be attributed to substitution of Aus area by Boro area, along with higher Boro yields due to increased cultivation of high yielding varieties (HYVs) of rice. While the proportions of Aus and Aman rice in total rice production decreased from 17.6 and 53.1 percent, respectively in 1985-86 to 7.64 and 44.84 percent in 2000-01, the share of Boro production increased from 22.8 to 47.52 percent (FPMU, 2002). Hence it can be noticed that Bore, rice contributes a lion's share to farmers' income as well as in the overall rice production in Bangladesh.

Although rice yield is much lower compared to many developed countries, substantial changes in rice yield were found particularly from mid 1980s. This was due to the fact that diffusion of new technologies particularly irrigation which got momentum during 1980's as privatization and deregulation polices were taken step by step during this period (Akteruzzaman and Jaim, 1999). The important policy changes occured were withdrawal of subsidy from critical production inputs like fertilizer and irrigation as well as liberalized input and output markets which have definitely changed the cost and return structure of rice production in recent years. The impact of these policy changes is likely to be more prominent for HYV Boro production as use of irrigation is indispensable for Boro production and use of fertilizer is most intensive for this crop. Further, along with irrigation and fertilizer, recent introduction of power tiller for cultivation and its multiple uses in farm sector have also impact on labour use as well as on farmers' profitability. Since production of Boro during the last few decades significantly contributed to the farmers' income as well as their livelihood, it is important to know how farmers' profitability from HYV Boro production has been changed over time which has implication on future rice policies in Bangladesh.

Various studies have shown an increase in rates of technology diffusion after the privatization and deregulation of the input markets and growth in diffusion has been seen to influence total output growth. Rosegrant and Svendsen (1992) showed that the reduction of subsidies on fertilizer and other agricultural inputs has contributed to reduced growth in Asia since the early 1980s, although rice yield growth has increased steadily in India and Bangladesh from the 1970s through the 1980s. Ahmed (1995) found that the liberalization of modern agricultural input markets in Bangladesh contributed significantly to increase in rice

production in Bangladesh. He concluded that without market reforms, Bangladesh would revert to its former cycle of regular food crisis and high rice prices.

Most of these studies focused mainly on agricultural growth performances (Rosegrant and Svendsen, 1992; Alauddin and Tisdel, 1993; Palmer-Jones, 1992; and Boyce, 1985) with little emphasis on showing what changes have been occurred with respect to cost and return structures of the most important rice crop, HYV Boro and also what happened to the farmers' profitability in recent years compared to early introduction of HYV Boro. Moreover, the data used in the studies summarized above covered the period of mid 1980s. Some of the studies showed the growth rates at two end points of time (Hossain, 1988 and Boyce, 1985), while other focused on technological periods (Boyce, 1985) and took a political point of view (Hossain, 1988) or focused on both political and technological conditions (Alauddin and Tisdel, 1993). The latest policy changes, therefore, were not reflected in those studies and their general conclusions could not be easily applied to the actual growth path of agricultural development since the policy changes were implemented. With the above background, this paper specifically investigates changes in the cost and return structures of HYV Boro paddy during the last two decades as well as trend and growth of different input and output (HYV Boro) prices during the same period. Finally impact of structural changes in cost and return of HYV Boro on farmers' profitability has also been examined.

II. METHODOLOGY

To examine the structural changes in costs and returns of rice production (HYV Boro) over time the data for different cost items (i.e. human labour, animal labour/power tiller, seed/seedling, fertilizers, irrigation and pesticides) as well as return from Boro paddy were collected for the period of 1978-79 to 1999-2000. Costs and returns data of HYV Boro were collected from different secondary sources such as Bangladesh Bureau of Statistics; Food Planning and Monitoring Unit (FPMU), Ministry of Food; Directorate of Agricultural Marketing (DAM); International Fertilizer Development Centre (IFDC), etc. For computing growth as well as trend of different cost components and return of HYV Boro over time, 20 years data from 1980-81 to 1999-2000 have been used. Again, 20 years time series data were broken down into two sub-periods (consisting of 10 years each) in order to determine how growth rates varied between two decades. The sub-periods were:

a) Period-I: 1980-81 to 1989-90
b) Period-11: 1990-91 to 1999-2000

The rationales behind this division of data series are given below:

Period – I (1980-81 to 1989-90): This period represents the onset of the policy of privatization of the business in agricultural inputs and relaxation of the dominant role of public sector institutions in the distribution and marketing of inputs.

Period II (1990-91 to 1999-2000) : This period marks continuation of those policy as part of national policy of liberalization of economy and shifting the focus on to the private sector from public sector for speeding up the pace of economic development.

Costs, returns, and prices from year to year varied due to inflationary effect. To adjust the inflationary effects, prices of both inputs and outputs were deflated by using Consumer Price Index (CPI) considering 1980-81 as base year. Tabular analysis was used to examine the structural changes of costs and returns of HYV Boro overtime. Here total cost included only operating costs like costs of human labour, animal labour/power tiller, seed/seedling, fertilizers, irrigation and pesticides. On the other hand, non-labour cost included all operating costs except human labour.

Structural changes in cost and returns were also examined with respect to cash cost and non-cash cost. Cash cost included out of pocket expenditures for hired human and animal labour, fertilizers, pesticides and irrigation. On the other hand, non-cash cost included cost of family supplied human labour, own animal labour, seed/seedling. To examine the structural changes, three years average figures both in nominal and real prices were calculated for three different time periods (1979-81, 1989-91 and 1998-2000).

To estimate growth rates of input costs and returns, the following exponential trend function was used:

$Y = ae^{bt}$ which corresponds to the linear model:

$\ln Y = a + bt$

Where,

Y = Dependent variable (i.e., costs/returns/prices of different inputs and output in real price)

t = Independent variable (time)

a = Intercept

b = Growth rate in ratio scale and when multiplied by 100, it expresses percentage growth i.e., annual growth rate.

ln = Natural log of the variable.

III. RESULTS AND DISCUSSIONS

(A). Structural Changes in Cost and Return of HYV Boro Over Time

The expansion in the use of modern agricultural inputs and the technological progress in rice culture have been most rapid since the late 1980s, after the opening up of the agricultural input market to the private sector and removal of restrictions on imports of agricultural machinery (Hossain and Bose, 2000). This caused a structural change in cost and return of rice production. Given the changing status of the domestic rice industry, the objective of this section is to quantitatively investigate the changes in cost and return structures of rice production in Bangladesh during the period of 1978-79 to 1999-2000.

In order to analyse changes in cost and return structure overtime, the costs items have been grouped as follows:

i. Labour cost versus non-labour cost
ii. Cash cost versus non-cash cost.

Since return from HYV Boro production is just value of product and by product, the grouping of returns like cost items was not necessary. However, overall structural change in total cost and gross return of HYV Boro paddy over time has been examined in this study.

Structural Changes in Labour and Non-labour Cost Over Time

Table 1 presents changes in total cost as well as labour cost and non-labour cost over time both in nominal price and constant price. As mentioned earlier, the comparison of the structural changes in costs (also returns) have been made at three points of time: 1979-81, 1989-91 and 1998-2000. In each case, for calculation, three years average has been considered.

In the case of total cost, at nominal price it seems that compared to 1979-8 1, the total cost during 1989-91 has increased by about 2.56 times and during 1998-2000 it has increased by 3.77 times (Table 1). However, in terms of constant price (at 1980-81 constant price), just opposite trend was observed. That is, in real price total cost of HYV Boro production has gradually decreased during 1989-91 and 1998-2000 compared to 1979-81 period (Table-1). The decrease in total cost in real price was found to be 6% during 1989-91 compared to 197981. Again, compared to 1979-81, during 1998-2000 the total cost in terms of real price decreased by 8%. This implies that apparently although it seems that during 22 years period from 1979 to 2000, the cost of HYV Boro has increased substantially, in real price this in fact gradually decreased.

According to structure of total cost in terms of labour cost and non-labour cost, it can be observed from the table that there has been significant structural changes over time. The proportion of non-labour cost out of total cost has gradually increased while the proportion of labour cost has gradually decreased. During 1979-81 period, out of total cost, the shares of labour and non-labour costs were 53% and 47%, respectively. During 1998-2000 period, share of labour cost dropped from 53% to 36% while the share of non-labour cost increased from 47% to 64%. This implies that during the last two decades, compared to labour cost, non-labour cost has increased substantially. That means, cost of seed, fertilizer, irrigation, etc., have increased proportionately more compared to labour cost. It also implies that with the passage of time, HYV Boro production has become more capital intensive rather than labour intensive.

Labour cost as such has decreased over time in real price although in nominal price it seems significant increase (Table 1). Decrease in labour cost may be due to two reasons: either decrease in labour use or decrease in wage rate. In fact, use of labour in HYV Boro production in recent years has decreased due to introduction of mechanization, particularly power tiller for land preparation (as well as other farm operations). Further, in relation to decrease in labour

cost whether wage rate has decreased or not over time will be investigated in the subsequent section.

Table 1. Change in total cost, labour cost and non-labour cost over time

At Nominal Price					
Year	Total cost (Tk/ha)	Labour cost (Tk/ha)	% of Total cost	Non-labour cost (Tk/ha)	% of Total cost
1979-81	6651	3520	53	3131	47
1989-91	17050	7778	46	9272	54
1998-00	25049	9037	36	16012	64
At Constant Price (Base 1980-81 = 100)					
Year	Total cost (Tk/ha)	Labour cost (Tk/ha)	% of Total cost	Non-labour cost (Tk/ha)	% of Total cost
1979-81	7622	4053	53	3568	47
1989-91	7158	3268	46	3890	54
1998-00	7005	2527	36	4478	64

* Calculated by the method three years average

Structural Change in Cash Cost and Non-cash Cost Over Time

Table 2 presents changes in cash cost and non-cash cost over time in terms of nominal price as well as constant price. At nominal price, although it seem that both cash cost and non-cash cost have increased over time; at constant price it was found that over time cash cost has increased while non-cash cost has decreased. Further, compared to non-cash cost, proportion of cash cost out of total cost has gradually increased over time.

The share of cash cost out of total cost was 55% during 1979-81 period, which gradually increased to 63% during 1989-91 period and to 68% during 1998-2000 period. On the other hand, share of non-cash cost in total cost was 45% during 1979-81 period which gradually decreased to 37% during 1989-91 period and to 32% during 1998-2000 period (Table-2).

The above findings imply that over the years, involvement of cash cost in total cost was always proportionately higher than non-cash cost; but in recent years, the involvement of cash cost has further increased. Gradual increase of cash cost over time means that farmers now need more cash to meet operating expenses than in the past. This also implies farmers need for cash or credit (particularly for the small farmers) is increasing in recent years than in the past.

Table 2. Change in total cost, cash cost and non-cash cost over time

At Nominal Price					
Year	Total cost (Tk/ha)	Cash cost (Tk/ha)	% of Total cost	Non-cash cost (Tk/ha)	% of Total cost
1979-81	6651	3659	55	2991	45
1989-91	17050	10746	63	6304	37
1998-00	25049	17015	68	8034	32

At Constant Price (Base 1980-81 = 100)					
Year	Total cost (Tk/ha)	Cash cost (Tk/ha)	% of Total cost	Non-cash cost (Tk/ha)	% of Total cost
1979-81	7622	4155	55	3468	45
1989-91	7158	4512	63	2646	37
1998-00	7005	4764	68	2241	32

Calculated by the method three years average

Structural Changes in Total Cost and Gross Return Over Time

Table-3 presents changes in total cost and gross return over time in terms of nominal as well as constant price. In terms of nominal price although it seems that both total cost and gross return have significantly increased; the table shows that over time (1979-81 to 1998-2000), both total cost and gross return of HYV Boro have decreased in real term. Total cost has decreased mainly due to reduction in human labour cost over time (see Table 1). Again, it can be observed from Table 1 that although labour cost has decreased, the non-labour cost has increased over time, but the rate of decrease in labour cost was much higher than increase in non-labour cost which resulted in decrease in total cost as a whole over time.

It can be observed from Table 3 that per hectare total cost as percentage of gross return has increased over time. The percentage of total operating cost out of gross return was 67% during 1979-81 period which has increased to 70% during 1989-91 period and to 74% during 1998-2000 period. This means that compared to early 80's farmers in recent years are less benefited investing money for HYV Boro production. It may be mentioned that decrease in benefit or return from HYV Boro production is mainly due to low output price which will be further investigated in the subsequent section.

Table 3. Change in total cost and gross return over time

At Nominal Price			
Year	Total cost (TC) (Tk/ha)	Gross return (GR) (Tk/ha)	TC as % of GR
1979-81	6651	10091	67
1989-91	17050	24221	70
1998-00	25049	34010	74
At Constant Price (Base 1980-81 = 100)			
Year	Total cost (Tk/ha)	Gross return (Tk/ha)	TC as % of GR
1979-81	7622	11342	67
1989-91	7158	10204	70
1998-00	7005	9524	74

- Calculated by the method three years average

The analysis in this section showed that there has been significant structural changes among the cost items as well as between total cost and gross return of HYV Boro which have considerable effects on farmers profitability. The cash expenditure has increased significantly which is a major constraint for farm production. The analysis in this section also shows that farmers are now gaining less compared to the past from the production of HYV Boro.

(B). Growth and Trend Analysis of Different Cost Components and Return of HYV Boro Over Time

Over the last few decades the adoption of modern seed-fertilizer-irrigation technology in rice production has clearly been the main factor behind the growth in crop agriculture, which is playing the key role in changing rural economy. Rural economy mostly depends on the farmers profitability i.e., costs occurred and return earned from rice production. In this context, using data from 1980-1981 to 1999-2000 this section deals with analysis of trend and estimation of growth rates of different cost components and gross return of HYV Boro. Exponential growth rates as well as graphical analysis have been performed to present the findings. The growth analysis has been done considering only real price as nominal price does not reflect the true picture in time series analysis where monetary transactions are involved.

As stated earlier, growth rates in cost components and return were computed for the entire period of 1980-81 to 1999-2000 as well as between the two periods of 1980-81 to 1989-90 (Period I) and 1990-91 to 1999-2000 (Period II) representing the periods of initial stage of privatization and the period after implementation of full privatization policies respectively. The cost components considered for growth estimates were labour cost, non-labour cost, cash cost, non-cash cost as well as total cost for the sub-periods 1, II and for the entire period.

Trend and Growth of Labour Cost Over Time

Trend of labour cost over time both in nominal price and real price can be seen in Figure L It shows upward trend of labour cost in nominal price over time while in real price the trend showed slightly downward sloping. Table 4 further presents growth of labour cost in terms of real price for the whole period under study as well as for the two sub-periods as mentioned earlier. It can be seen from the table that for the entire period (1980-81 to 1999-2000), labour cost for producing HYV Boro has decreased at the rate of 1.3% per annum. In sub-period II, labour cost decreased significantly at the rate of 5.2% per annum while in sub-period I, the coefficient for labour cost showed positive increase (1.2%), however, the co-efficient was found to be statistically insignificant.

Therefore, the overall analysis showed that although there had been some increase in labour cost at the initial stage of privatizaion (Period I), in full privatization period (Period II) labour cost has decreased significantly resulting in significant decrease in labour cost for the entire period under consideration in this study. Significant decrease in labour cost in Period II may be due to widespread adoption of mechanized cultivation throughout Bangladesh. It may

be mentioned here that at present power tiller/tractor for land preparation is used in more than 60% of the cultivated land of Bangladesh.

Table 4. Growth of labour cost over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Growth rate (% per annum)	t-value	$\overline{R^2}$
Total Period (1980-81 to 1999-00)	lnY = 8.201-.013t	-1.3	-1.807*	0.107
Period I (1980-81 to 1989-90)	lnY = 8.052 +.012t	1.2	1.685	0.170
Period II (1990-91 to 1999-00)	lnY = 8.293 -.052t	-5.2	-2.028*	0.257

*Significant at 10% level

Trend of Non-labour Cost Over Time

Trends of non-labour cost both in nominal and real prices can be seen from graphical presentation in Figure 2. In terms of nominal price the graph shows substantial increase in non-labour cost over time, but in terms of real price it shows slight increase in non-labour cost over time.

The growth rates of non-labour cost were found to be 0.9 percent, 1.3 percent and 0.6 per cent per annum during the total period, sub-period I and sub-period II respectively in terms of real price (Table 5). All the coefficients of non-labour cost were also found to be highly significant with positive sign which implies that non-labour cost increased significantly during the whole period under study as well as in the two sub-periods. The R^2 values were reasonably satisfactory which suggest that more than 90% of the variations in non-labour cost have been explained by the time element included in the model for total period, sub period I and sub period II. Further, in sub-period I, the growth rate of non-labour cost was found to be higher than sub-period II implying that rate of increase in non-labour cost was higher in sub-period I compared to that of sub-period II.

Table 5. Growth of non-labour cost over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Growth rate (% per annum)	t –value	$\overline{R^2}$
Total Period (1980-81 to 1999-00)	lnY = 2.112 + .009t	0.9	16.382**	0.934
Period I (1980-81 to 1989-90)	lnY = 2.09 + .013t	1.3	10.201**	0.92
Period II (1990-91 to 1999-00)	lnY = 2.21 + .006t	0.6	11.197**	0.933

** Significant at 1% level

Trend and Growth of Cash Cost Over Time

Graphical presentation of trend of cash cost both at nominal and real price over time can be seen in Figure 3. It appears from the graph that in nominal price, cash cost has increased substantially over time while in real price the graph shows slight increase of cash cost over time.

In real price growth rate of cash cost for the entire period under study and for the two sub-periods can be seen in Table 6. In terms of real price, cash cost for producing HYV Boro has increased at the rate of 0.8 per cent per annum for the entire period of 1980-81 to 1999-2000. The growth coefficient was also found to be statistically significant. Further, during the Period I, there had been significant positive increase in cash cost at the rate of 1.9 per cent per annum while during the Period II, cash cost decreased slightly (0.1% per annum) and this coefficient was not found to be statistically significant. The overall analysis showed that the involvement of cash cost over the period has slightly increased which is due to the fact that, agriculture of Bangladesh now in the process of transforming traditional agriculture into a modern one.

Table 6. Growth of cash cost over time (In terms of real price)

(Base 1980-81= 100)

Period	Fitted semi-log function	Growth rate (% per annum)	t –value	$\overline{R^2}$
Total Period (1980-81 to 1999-00)	lnY = 8.358+0.008t	0.8	2.5*	0.217
Period I (1980-81 to 1989-90)	lnY = 8.3+0.019t	1.9	2.58*	0.386
Period II (1990-91 to 1999-00)	lnY = 8.48 – 0.001t	-0.1	-0.103	-0.124

* Significant at 5% level

Trend and Growth of Non-cash Cost Over Time

Graphical presentation of trend of non-cash cost of HYV Boro both in nominal and real prices can be observed from Figure 4. The graph shows significant increase in non-cash cost over time in nominal price, but in real price it shows negative trend over time.

Table 7. Growth of non-cash cost over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Growth rate (% per annum)	t –value	$\overline{R^2}$
Total Period (1980-81 to 1999-00)	lnY = 8.036 – .018t	-1.8	-3.863**	0.423
Period I (1980-81 to 1989-90)	lnY = 7.92 + .006t	0.6	0.618	-0.074
Period II (1990-91 to 1999-00)	lnY = 7.87 – .023t	-2.3	-1.574	0.141

** Significant at 1% level

The coefficient of non-cash cost showed negative sign for the total period and period II in terms of real price. This implies that the non-cash cost decreased considering the whole period as well as in period II. Slight increase in non-cash cost was found in period I. However, except the coefficient for entire period, the coefficients for the two sub-periods were not found to be statistically significant. The analysis showed that, for the entire period, non-cash cost decreased significantly at the rate of 1.8 per cent per annum. This is quite consistent with the reality as technology advances, cash cost replaces non-cash cost.

Trend and Growth of Total Cost Over Time

Figure 5 presents trend of total cost of HYV Boro over time both in nominal and real prices. The trend analysis showed substantial increase in total cost in nominal price over the period, but in real price it showed slight decrease.

The estimates of growth rates in real price can also be seen in Table 8 for the whole period as well as for the two sub-periods considered in this study. In terms of real price, the total cost showed negative trend for the entire period of 1980-81 to 1999-2000 and period II. The rates of decrease were 0.1 percent and 0.8 percent, respectively for the whole period and period II; however, these coefficients were found to be statistically insignificant. On the contrary, the analysis showed that total cost has increased at the rate of 1.4 percent per annum during the period I and the coefficient was found to be statistically significant. The overall analysis indicated that total cost of HYV Boro over the period slightly decreased in real price.

Table 8. Growth of total cost over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Growth rate (% per annum)	t –value	$\overline{R^2}$
Total Period (1980-81 to 1999-00)	lnY = 8.898 – .001t	-0.1	- 0.455	-0.044
Period I (1980-81 to 1989-90)	lnY = 8.822 + .014t	1.4	1.962*	.240
Period II (1990-91 to 1999-00)	lnY = 8.915 – .008t	-0.8	-0.939	-0.013

*Significant at 10% level.

Trend and Growth of Gross Return Over Time

Figure 6 presents trend of gross return of HYV Boro over time both in nominal and real prices. In terms of nominal price, trend in gross return showed substantial increase over time while in real price it showed slight decrease.

The estimates of growth rates of gross return overtime as well as during the two sub-periods can also be seen in Table 9. In terms of real price the gross return showed negative coefficient for total period and Period II. However, only the coefficient for whole period was found to be significant. It showed that gross return of HYV Boro during the period from 1980-

81 to 1999-2000 decreased at the rate of 0.9 per cent per annum, which implies that farmers gross return from HYV Boro production has decreased over time.

Table 9. Growth of gross return over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Growth rate (% per annum)	t-value	$\bar{R}^2$
Total Period (1980-81 to 1999-00)	lnY = 9.316 – 0.009t	-0.9	-3.062**	0.306
Period I (1980-81 to 1989-90)	lnY = 9.257+0.004t	0.4	0.406	-0.102
Period II (1990-91 to 1999-00)	lnY = 9.199 – 0.007t	-0.7	-0.894	-0.023

** Significant at 1% level

The overall analysis in this section showed that the cost of producing HYV Boro in real price has slightly decreased over time, but at the same time gross return from production has also decreased significantly, particularly due to low output price which resulted in low profitability from production of HYV Boro. The relationship between of total cost and gross return in real price can be seen in Figure 7. Growth analysis showed that for the entire period (1980-81 to 1999-00), the rate of decrease of gross return was 0.9% while the decrease in total cost was 0.1% which resulted in gradual reduction in net return or profit for the farmers in recent years compared to early eighties. This has serious implication on farmers incentive for the production of main rice crop, HYV Boro.

(C). Trend of Input and Output Prices of HYV Boro Over Time

Among the inputs for production of HYV Boro, costs of human labour, fertilizer and irrigation are the most important inputs which determine extent of farmers' profitability. For that matter over time trends of wage of human labour and price of fertilizer and irrigation cost have been examined in this section. On the other hand, HYV Boro paddy price trend over time has also been examined.

Growth of Labour Wage

In nominal price although it seems that wage of human labour over time has substantially increased (Figure 8), in fact in real price a different picture emerged. Table - 10 shows the growth of human labour wage over time in terms of real price.

Table 10. Growth of labour wage over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Annual Growth (% per annum)	t-value	$\overline{R^2}$
Total Period (1980-81 to 1999-00)	lnY =2.760 + .002t	0.2	2.071**	0.147
Period I (1980-81 to 1989-90)	lnY = 2.747 + .005t	0.5	1.582	0.143
Period II (1990-91 to 1999-00)	lnY = 2.779 + .002t	0.2	0.753	-0.051

**Significant at 10 % level.

It can be seen from the table that labour wage during the period form 1980-81 to 1999-2000 increased only at the rate of 0.2 per cent per annum in real price. The growth rates of labour wage during the Period I and Period II were also low and the coefficients were found to be statistically insignificant. Therefore, it may be said that over the last two decades, the labour wage has increased at a very slow rate.

Growth of Fertilizer Price

Urea meets up 92 percent demand of total fertilizer. So the price of urea mostly represents the price of fertilizer. Fertilizer price showed significant upward trend in terms of nominal price but in terms of real price, it showed downward trend over the years (Figure 9).

The fertilizer price decreased by 4.1 % per year during the whole period from 1980-81 to 1999-2000. Decrease in fertilizer price in Period I (4.3%) was found to be higher than that of Period II (2.3%). The growth rates were statistically significant and all the equations fitted well (Table 11). The overall analysis showed that even after withdrawal of subsidy from fertilizer, in real terms price of fertilizer decreased significantly although from nominal price trend it seems that fertilizer price has increased overtime.

Table 11. Growth of Urea price over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Annual Growth (% per annum)	t-value	$\overline{R^2}$
Total (1980-81 to 1999-00)	lnY = 1.170 - .041t	-4.1	-15.795**	0.929
I (1980-81 to 1989-90)	lnY = 1.196 - .043t	-4.3	-6.320**	0.812
II (1990-91 to 1999-00)	lnY = 0.652 - .023t	-2.3	-4.239**	0.653

**Significant at 1% level

Growth of Irrigation Cost

As diesel cost occupies about 65-70% of irrigation cost, it has been considered as proxy for cost of irrigation. Graphical presentation of diesel price over time at nominal price showed upward trend but it showed downward trend in real price (Figure 10).

In terms of real price, the coefficient showed negative sign for the total period and Period I, and the coefficients were found to be statistically significant. This means that diesel price declined over the years as well as in Period I. The declining rates were 2.1 percent and 4.1 percent respectively for the whole period and Period I. But in Period II, it showed positive sign which implies that the diesel price grew at a rate of 1.0 percent per year in this period, but the coefficient for growth rate in this case was found to be statistically insignificant (Table 12). The reason for increasing diesel price in Period II was increase of fuel price after Gulf war. Analysis in this section confirmed that over the last two decades the diesel price or in other words irrigation cost in real terms has significantly decreased.

Table 12. Growth of diesel price over time (In terms of real price)

(Base 1980-81 = 100)

Period	Fitted semi-log function	Annual Growth (% per annum)	t-value	$\overline{R^2}$
Total (1980-81 to 1999-00)	lnY = 1.612 – 0.021t	-2.1	-4.544**	0.508
I (1980-81 to 1989-90)	lnY = 1.734 – 0.041t	-4.1	-4.033**	0.629
II (1990-91 to 1999-00)	lnY = 1.227 + 0.010t	1.0	0.952	-0.010

**Significant at 1% level

Growth of HYV Boro Price

In terms of nominal price it seems that price of Boro paddy (Harvest price) has increased significantly over time but in terms of real price this has actually decreased as can be seen in Figure 11. On the other hand, in terms of real price, the coefficient of Boro price showed significant decrease at the rate of 3.4% per annum over the entire period of 1980-81 to 1999-00 (Table 13). Significant decreases in Boro paddy prices were also found in Period I and period II. However, the declining rate is higher in Period II (3.4%) compared to Period I (2.9%) which implies that after full privatization period farmers are getting less price of paddy compared to partial privatization period.

Table 13. Growth of Boro price over time (In terms of real price)

(Base 1980-81=100)

Period	Fitted semi-log function	Annual Growth (% per annum)	t-value	$\overline{R^2}$
Total (1980-81 to 1999-00)	lnY =1.162 - .034 t	-3.4	-8.276**	0.780
I (1980-81 to 1989-90)	lnY = 1.135 - .029t	-2.9	-1.978*	0.244
II (1990-91 to 1999-00)	lnY = 0.811 – .034t	-3.4	-3.452**	0.548

**Significant at 1% level

*Significant at 10% level

Analysis in this section showed that in real price, labour wage over the years has slightly increased while the fertilizer and diesel prices have decreased significantly. On the other hand, price of Boro paddy price also significantly decreased over time.

IV. CONCLUSIONS

On the basis of the findings of this study it may be concluded that there has been significant structural changes in total cost and return of HYV Boro over time. Compared to non-cash cost, cash cost has gradually increased over time which means that the farmers now need more cash to meet operating expenses. Further, compared to cost of human labour, non-human labour cost (i.e. seed, fertilizer, irrigation, etc.) has increased over time indicating that rice production has become more capital intensive rather than labour intensive. This also implies that farmers' need for credit is increasing in recent years than the past. Therefore, credit facilities to the farmers particularly for the poor farmers should be expanded on easy terms and conditions, so that they can adopt new technologies.

The overall analyses of this study showed that in real terms over the period both production cost and return from HYV Boro have decreased, but the rate of decrease in return was more than the cost. Again, among the cost items, labour wage over the last two decades has slightly increased in real price while fertilizer price despite of withdrawal of subsidy has decreased. Further, diesel (for irrigation) price has also significantly decreased during the same period. However, significant decrease in real price of paddy compared to overall decrease in production cost has reduced farmers' profit margin from HYV Boro production in recent years. This may discourage farmers to enhance rice production in future. Therefore, farmers need either input subsidy or output price support for HYV Boro for maintaining sustainable rice production in Bangladesh.

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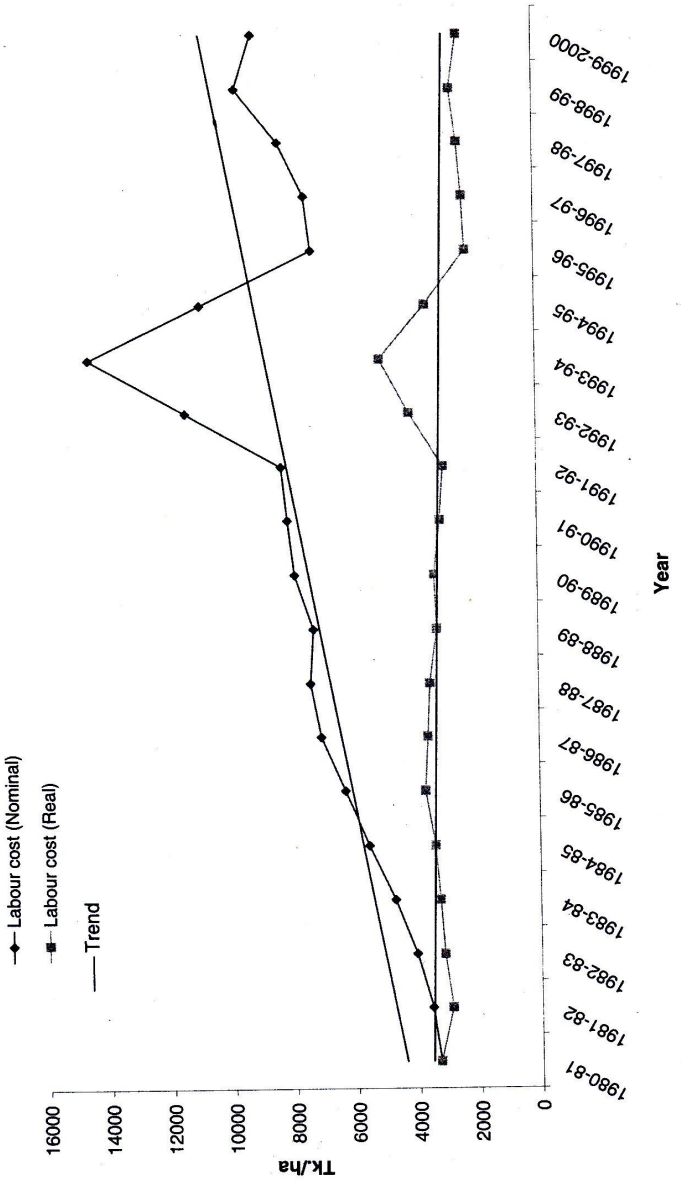

Figure 1 Trends of labour cost over time

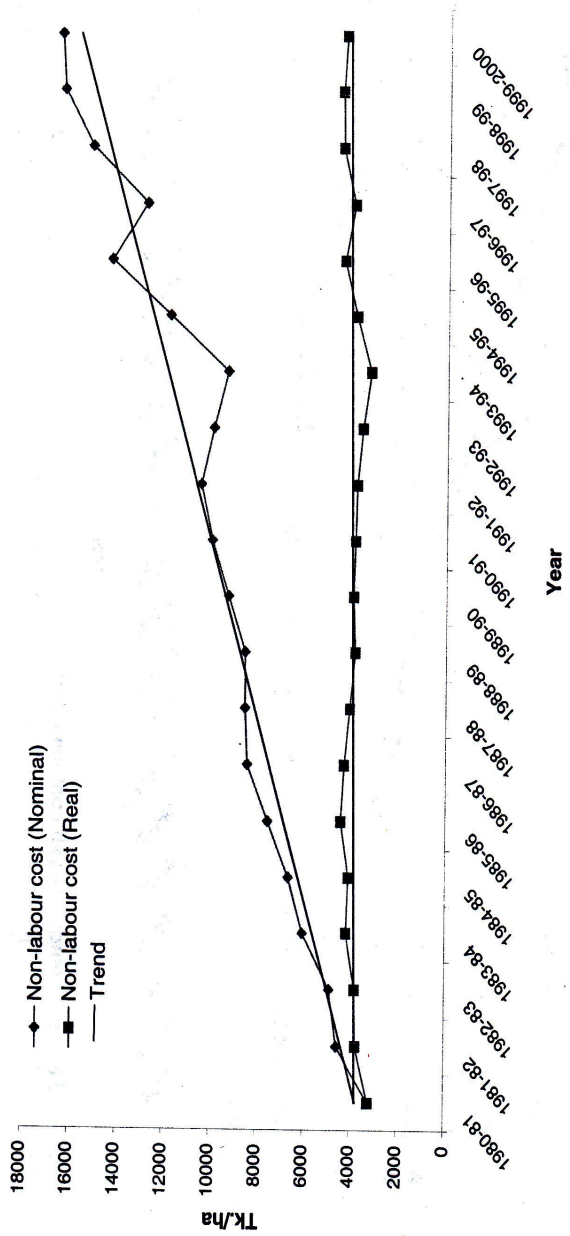

Figure 2 Trends of non-labour cost over time

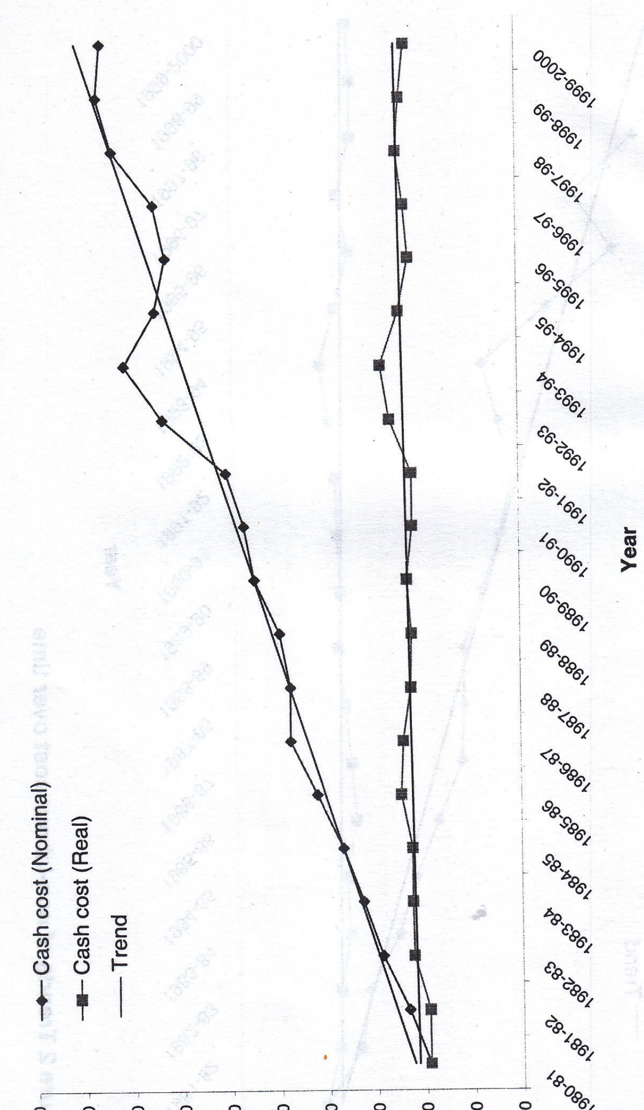

Figure 3 Trends of cash cost over time

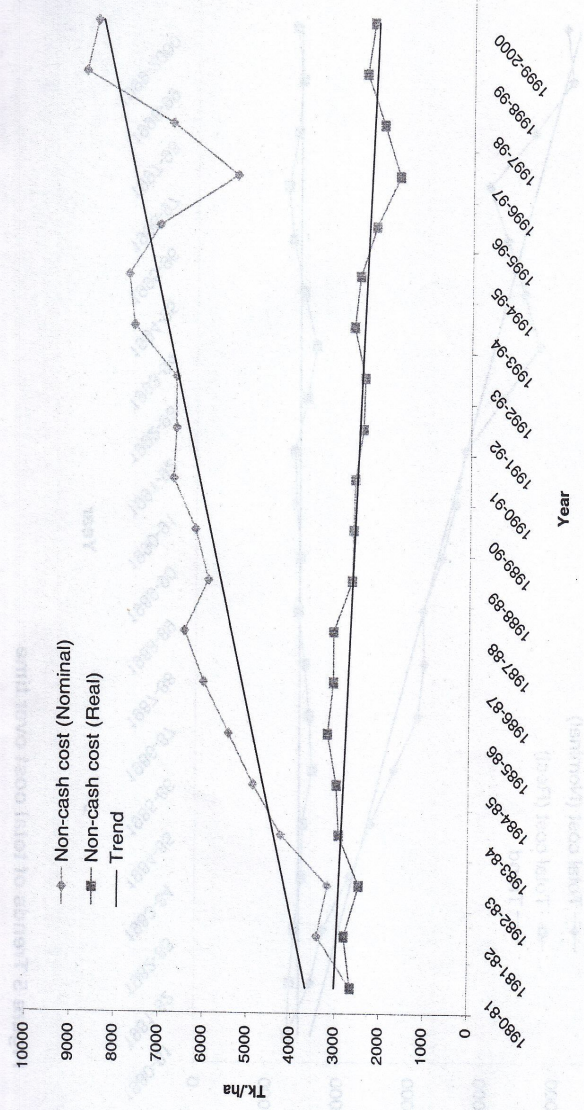

Figure 4 Trends of non-cash cost over time

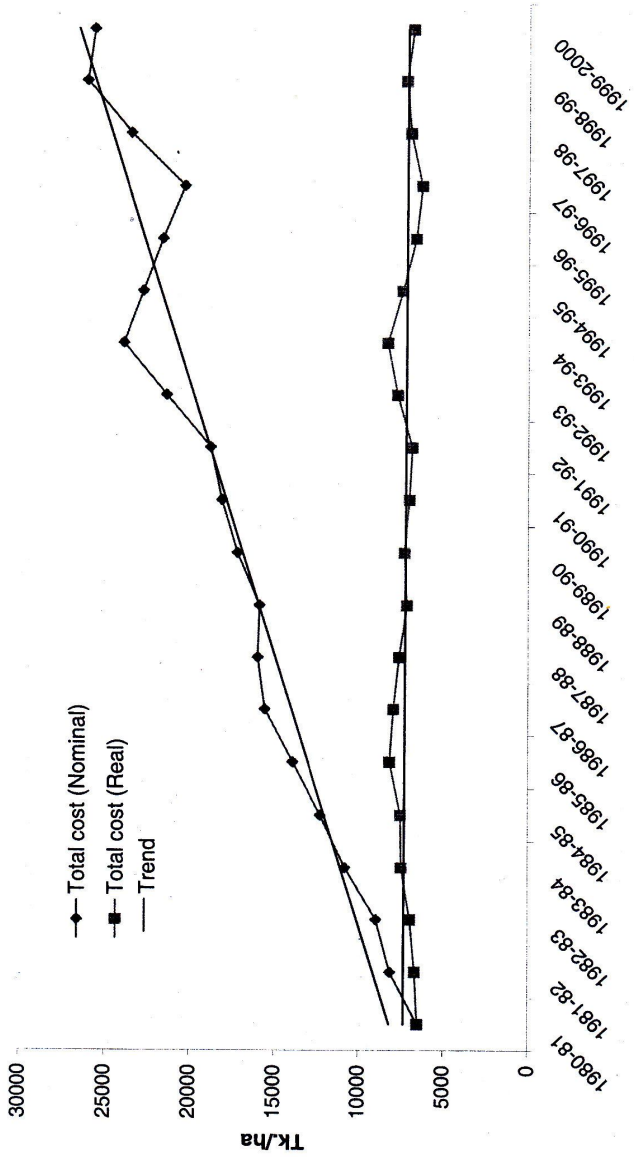

Figure 5 Trends of total cost over time

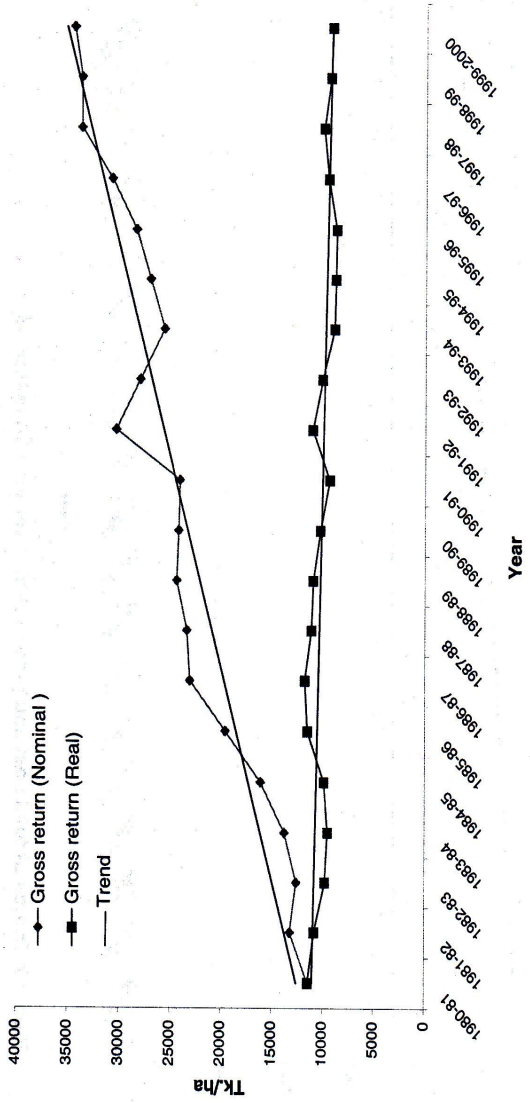

Figure 6 Trends of gross return over time

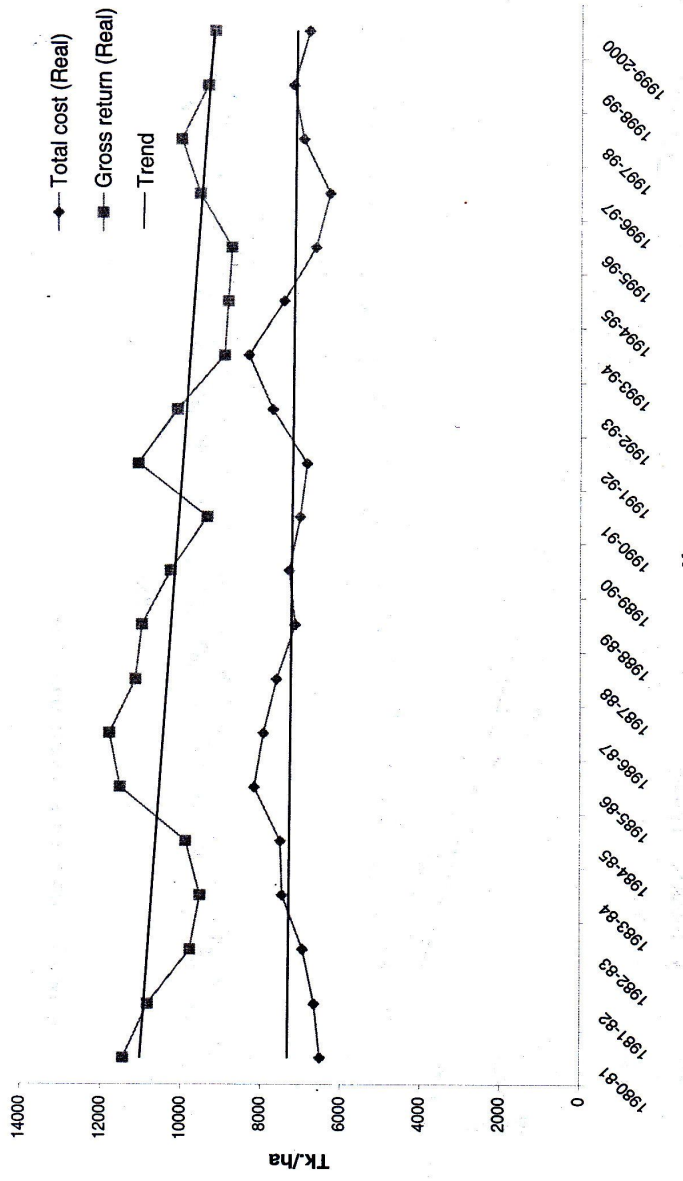

Figure 7 Trends of total cost and gross return over time (in real price)

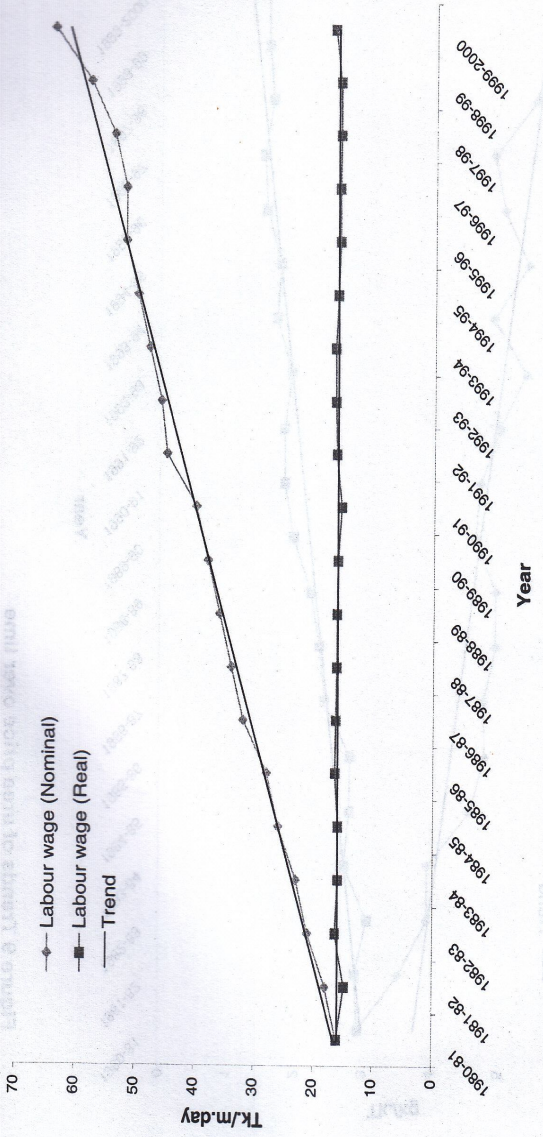

Figure 8 Trends of labour wage over time

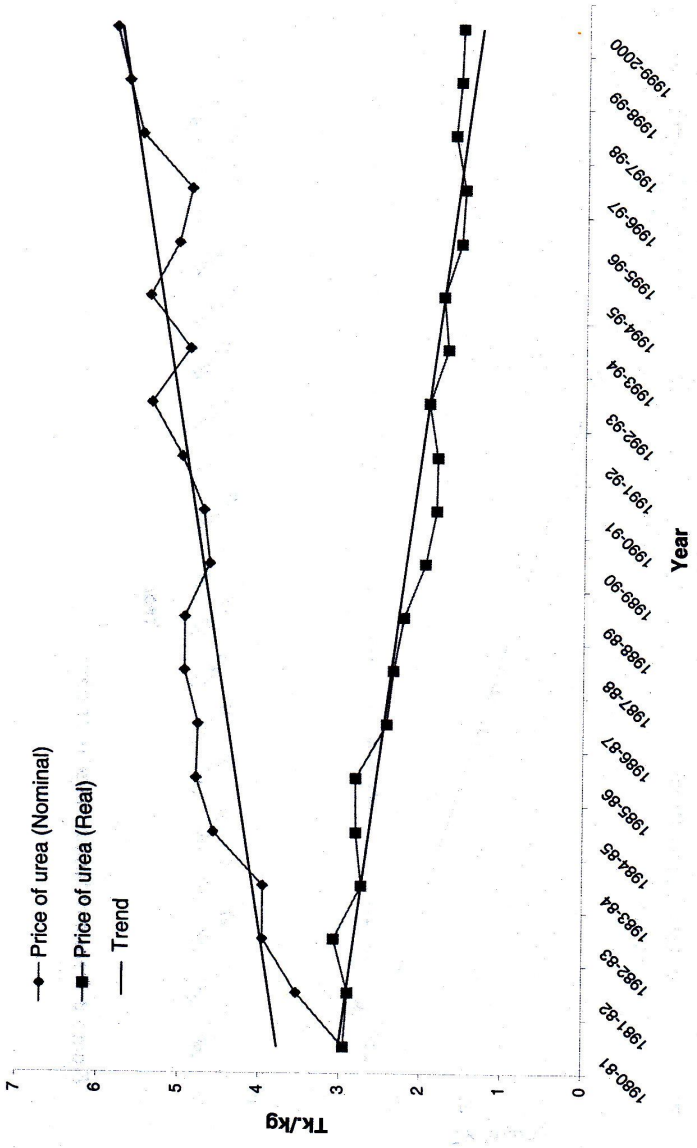

Figure 9 Trends of urea price over time

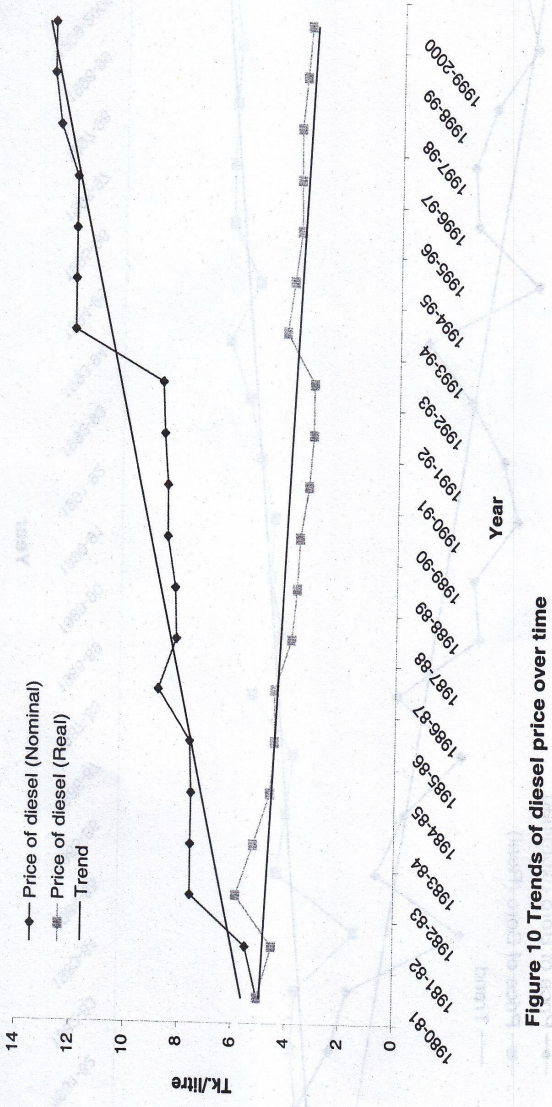

Figure 10 Trends of diesel price over time

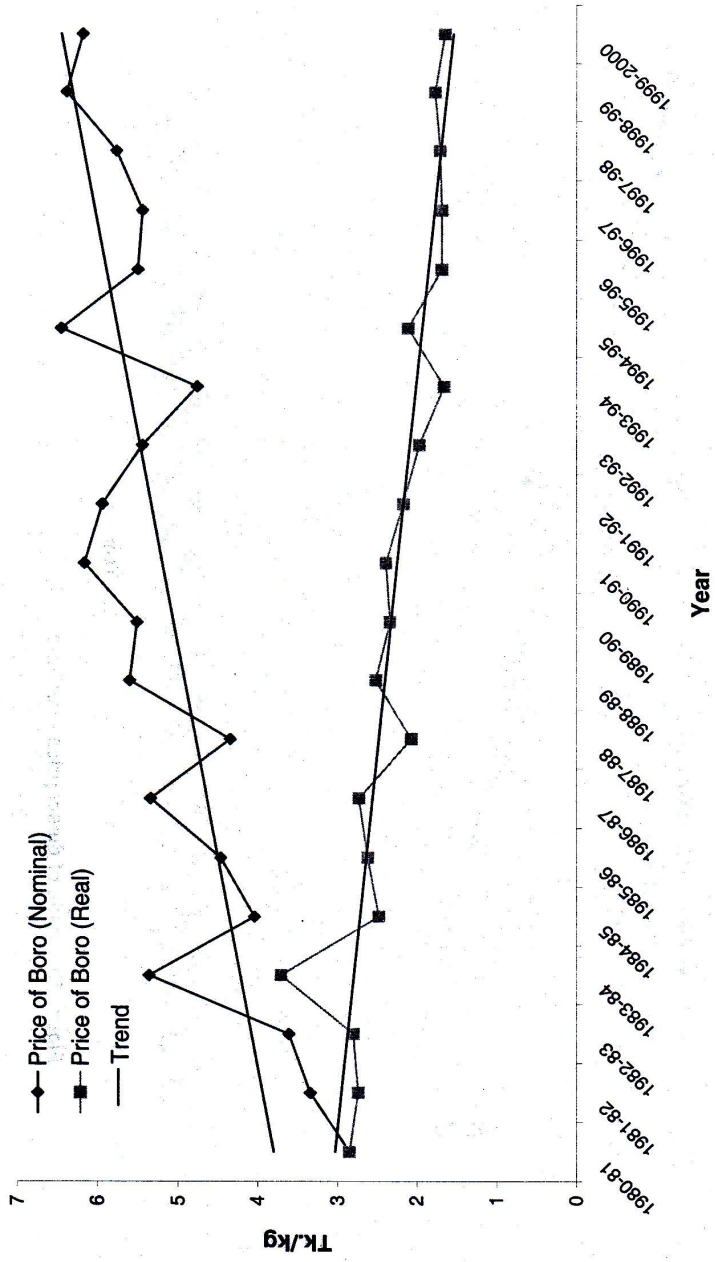

Figure 11 Trends of Boro price over time