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The 'Green Revolution' and Labour Absorption in Bangladesh Agriculture: The Relevance of the East Asian Experience

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The bulk of analytic/empirical literature following the 'Green Revolution' contends that agricultural labour absorption in most, if not all, contemporary Asian countries is likely to follow the historical pattern of East Asia, especially Taiwan and Japan. This paper examines the relevance of East Asian experience for increased labour intensity in agriculture in Bangladesh in the post-'Green Revolution' period. Using labour coefficient data for a wide range of crops, the analysis is carried out on an annual basis as well as for crop seasons. Observed patterns are analysed and likely determinants are identified. The findings of the paper indicate limited relevance of the East Asian experience to Bangladesh, and highlight for South Asia the importance of examining seasonal differences in labour absorption.

1. INTRODUCTION

Contemporary growth theory views unemployment, poverty, and income inequality as related phenomena [Sen (1975); Todaro (1989)]. Employment is seen both as a means of creating income and as a vehicle for income distribution. The magnitude of unemployment and under-employment in many LDCs is enormous [Todaro (1989), p. 238]. Nowhere does this problem feature more prominently than in the agricultural sector.

A realistic assessment of the structure and size of the labour force and prospects for non-agricultural employment expansion suggests that agricultural development should not only increase output but also increase labour absorption. For instance, [Ishikawa (1978), p. 3] argues that:

> "The solution to the employment and rural poverty problems in Asia has to be found in the direction of a significant increase in labour absorption in agricultural land, since, under the present day conditions, it does not seem possible for most of the economies in this region to attain sufficiently high growth rate in demand for labour for industrial employment, such that the size of the

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labour force in the rural sector could soon be expected to cease growing, much less decreasing".

References are frequently made to the historical experience of the East Asian countries, especially Taiwan and Japan, where two distinct phases in the relationship between labour intensity (labour input per cultivated hectare) and yield per hectare are identified: (1) Positive association between land productivity and labour intensity initially, and (2) declining labour intensity associated with rising land productivity subsequently [Booth and Sundrum (1985)].

The 'Green Revolution' has generated a renewed interest in the relevance of the East Asian experience to the process of agricultural development and labour absorption in much of contemporary Asia. In many LDCs, including Bangladesh, agricultural production and employment have been transformed by the 'Green Revolution' [Khan (1985); Muqtada (1986); Alauddin and Tisdell (1991) and Hayami and Ruttan (1985), pp. 341–46].

About 60 percent of Bangladesh's (employed) labour force is engaged in agriculture. However, according to an estimate of the Bangladesh Planning Commission [BPC (1985), p. V–14], the unemployment and underemployment rate exceeds 30 percent in this sector. Although the share of total work force engaged in agriculture fell from 85 percent in 1961 to 61 percent in recent years, agriculture still remains the largest provider of employment to the civilian labour force.

This paper considers the relevance of the East Asian experience to Bangladesh. Observed patterns are analysed and likely determinants are identified while paying particular attention to the following questions: (1) Have changes in irrigation technique (from the traditional to the modern methods) led to a slow-down or decline in labour intensity per hectare? (2) Have changes in the cropping pattern had any impact on intensity of labour use? (3) Is there any evidence of a potential conflict between employment and output?

In considering these matters, we provide a superior inter-temporal analysis to that in some earlier studies [Khan (1985); Muqtada (1986)].

2. THE RELEVANCE OF EAST ASIAN EXPERIENCE: A BRIEF REVIEW OF LITERATURE

Most analytic/empirical literature contends that agricultural labour absorption in contemporary Asian countries following the 'Green Revolution' is likely to follow the historical pattern of East Asia, especially Taiwan and Japan. For instance, [Johnston and Cownie (1969), pp. 569-70] claim that "the labour-using, capital-saving type of approach to agricultural development pursued in Japan and Taiwan recommends itself because of its implications for the growth of employment opportunities both in agriculture and in the farm sector...". [Ruttan and Binswanger (1978),

p. 360] argue that "the 'Green Revolution' technology... is essentially the same technology that contributed to the growth of productivity in Japan and Taiwan earlier in this century. It is also clear that the innovations in biological technology that led to the rapid diffusion of the Green Revolution... technology, in South and Southeast Asia after the mid-1960s, were induced by changes in relative resource endowments and factor prices that had occurred earlier in Japan and Taiwan".

Jayasuriya and Shand (1986) are skeptical about repetition of the East Asian pattern in South Asia. After reviewing farm-level evidence from a number of South and Southeast Asian countries, [Jayasuriya and Shand (1986), p. 415] claim that "labour-saving chemical and mechanical innovations originating in the developed countries are being rapidly adopted by farmers of the developing countries owing to their private cost-reducing characteristics. Recognition of this declining capacity of the agricultural sector for labour absorption indicates the need to seek solutions to unemployment in the off-farm sector".

3. THE DATA : ESTIMATES OF LABOUR DEMAND

Data on labour coefficients compiled by the Bangladesh Planning Commission BPC (n. d.) have been used in conjunction with the cropping pattern data for 50 crops to derive overall employment generation in Bangladeshi crop sector for the period 1969-70 to 1984-85. In deriving the estimates, account has been taken of irrigated and non-irrigated areas under various crops and traditional and modern techniques of irrigation. The 50 crops considered in this paper include eight cereal crops and forty-two non-cereal crops.

Estimates of seasonal employment [e.g., *rabi* (winter and early summer) and *kharif* (summer and early autumn)] have been derived on the basis of growing and harvesting periods of various crops. For crops like sugarcane, coconut and tea, mandays have been equally allocated between the *kharif* and *rabi* seasons. The estimated employment figures are set out in Table 1.

4. EMPIRICAL RESULTS: THE TRENDS IN AGGREGATE LABOUR REQUIREMENTS

The aggregate employment figures (all crops), presented in Table 1, reveal the following:

1. Total employment on an annual basis (*TOTALMD*) has increased slowly and does not seem to have increased in the early 1980s. Total employment during the *kharif* season (*MDTOTKHA*) does not show any increasing trend whatsoever. Rather it shows a slight declining tendency.
2. Employment generated in foodgrain production (rice and wheat, *MDFG*)

Table 1

Trends in Total Employment Generation in the Bangladeshi Crop Sector, 1969-70 to 1984-85: Annual and Seasonal Dimensions

Year	*MDTOTKHA*	*MDTOTRAB*	*TOTALMD*	*MDFK*	*MDFK1*	*MDFR*	*MDFG*	*ABSDIFF*	*RELDIFF*
1969-70	1857.08	448.17	2305.23	1523.83	1802.34	257.86	1781.69	1408.91	75.87
1970-71	1747.99	474.08	2222.07	1444.07	1693.56	284.94	1729.01	1273.91	72.88
1971-72	1601.07	438.56	2039.63	1362.60	1551.94	266.06	1628.66	1162.51	72.61
1972-73	1701.35	464.09	2165.44	1403.58	1653.84	295.64	1699.22	1237.26	72.72
1973-74	1734.71	490.56	2255.27	1435.85	1684.05	319.23	1755.08	1244.15	71.72
1974-75	1614.32	526.71	2141.04	1402.15	1562.27	349.37	1751.52	1087.61	67.37
1975-76	1687.52	533.78	2221.30	1492.72	1637.02	358.89	1851.61	1153.74	68.37
1976-77	1697.88	458.83	2156.70	1466.10	1647.24	273.44	1739.54	1239.05	72.98
1977-78	1756.83	550.02	2306.02	1499.83	1703.79	361.95	1861.78	1206.81	68.69
1978-79	1816.63	557.73	2374.36	1531.65	1763.41	361.78	1893.43	1258.90	69.30
1979-80	1737.62	578.48	2316.10	1474.42	1686.18	396.70	1871.12	1159.14	66.71
1980-81	1724.86	605.62	2330.62	1495.98	1673.27	420.25	1916.23	1119.24	64.89
1981-82	1716.25	628.77	2355.02	1500.86	1660.41	448.05	1948.91	1077.48	62.78
1982-83	1720.79	675.64	2396.43	1502.49	1663.52	484.12	1986.61	1045.15	60.74
1983-84	1713.72	671.22	2384.94	1494.77	1656.92	481.57	1976.34	1042.50	60.83
1984-85	1637.18	735.36	2372.55	1414.32	1582.12	547.50	1961.82	901.82	55.08

Source: Based on data from BBS (1976); (1979); (1980); (1984); (1984a); (1985a); (1985b); (1986) and (1986a).

Note: *MDTOTKHA*, *MDTOTRAB*, and *TOTALMD* respectively refer to total labour required for the production of *kharif*, *rabi*, and all crops. *MDFK*, *MDFR*, and *MDFG* respectively represent total labour requirements for *kharif*, *rabi*, and all foodgrains. *MDFK*1 is total labour required for the production of *kharif* foodgrains and jute, taken together. *ABSDIFF* is the absolute difference between *MDTOTKHA* and *MDTOTRAB*. *RELDIFF* is the relative difference between the *kharif* and *rabi* season labour requirements and is derived as *RELDIFF* = (*ABSDIFF*/ *MDTOTKHA*) x 100. All figures, except those for *RELDIFF*, are in millions.

does show an increasing trend but seems to have remained much the same in the last 2-3 years. Total labour requirements for *kharif* foodgrain (*aus* and *aman* rice, *MDFK*) seem to have remained much the same with a slight declining tendency. However, if jute is included, then labour absorption during the *kharif* season (*MDFK*1) does show a more definite decreasing trend.

3. Labour absorption during the *rabi* season has registered a significant increase. This is true both for *rabi* crops overall (*MDTOTRAB*) and for *rabi* foodgrains (*boro* rice and wheat, *MDFR*).

The behaviour of aggregate employment comes into sharper focus when illustrated as in Figure 1, where we plot the indices (with 1969-70 = 100) of employment

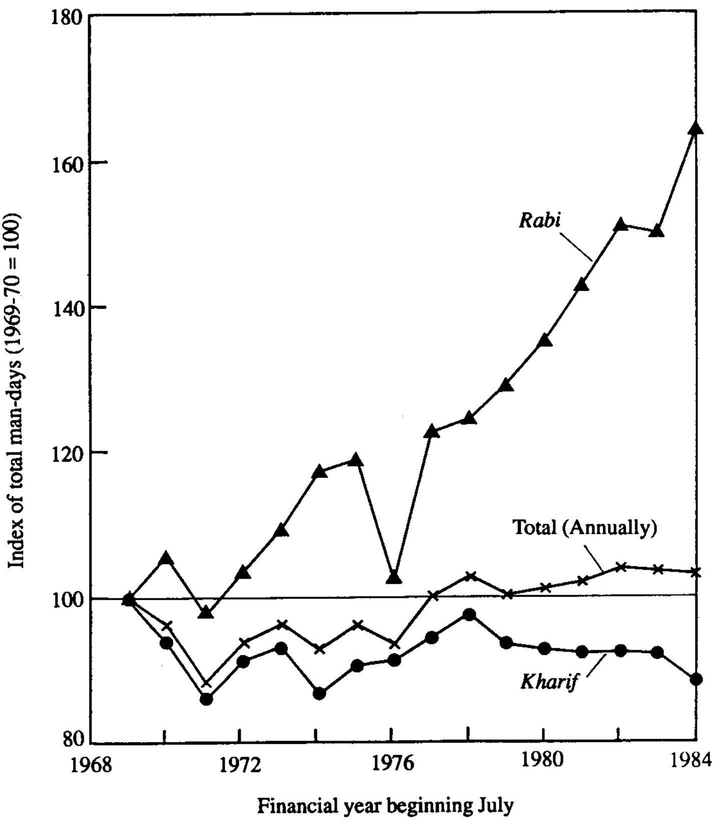

Fig. 1. Trends in Total Labour Requirements : Annual and Seasonal Dimensions.

for all crops. It shows that total employment in the *rabi* season has increased by more than 60 percent since 1969-70, but that, in the *kharif* season, it has declined by more than 10 percent. Total annual employment in crop production rose by less than 4 percent. In the same period, the population of Bangladesh rose by approximately 41 percent, and numbers in the working-age group by about 45 percent. *Consequently, increased labour absorption in the crop sector failed significantly to keep pace with rising population and potential labour supply.*

5. TRENDS IN SEASONAL LABOUR INTENSITY

Table 2 presents data on labour intensity per cultivated hectare for different seasons and crops. *MDPHAK* and *MDPHAR* respectively refer to labour intensities during *kharif* and *rabi* seasons, while *MDPHA* and *MDNHA* respectively represent labour intensities per gross and net cropped hectare [*MDNHA* = (*MPHA* x *INTN*)/100]. *INTN* refers to the intensity of cropping. *MDHFK* and *MDHFR* respectively refer to man-days per hectare of foodgrains (rice and wheat) during the *kharif* and *rabi* seasons, while *MDHFG* refers to man-days per (gross) cropped hectare under foodgrains. *MDHFK*1 represents man-days per hectare of major *kharif* crops (*aus* rice and jute).

The information presented in Table 2 reveals the following about the behaviour of various proxies of labour intensity in the Bangladeshi crop sector:

1. Labour intensity per hectare cropped with *kharif* crops (*MDPHAK*) has remained more or less stagnant over the years while that for *rabi* crops (*MDPHAR*), despite occasional fluctuations, has increased. Overall labour intensity (*MDPHA*) has increased only marginally (see Figure 2).
2. A similar pattern emerges in the case of labour intensity per hectare cropped with *kharif* and all foodgrains (*MDHFK* and *MDPHFG*). However, labour intensity per hectare of *rabi* foodgrains (*MDHFR*) initially increases and then declines to stabilize.
3. Labour intensity per net cropped hectare (*MDNHA*), after showing an initial increase, stabilizes around 280 man-days. Labour intensity for *kharif* crops (jute and *aus* rice, *MDHFK*1) shows very little increase over the years. In fact, it has remained stagnant.

6. TOTAL LABOUR EMPLOYMENT RELATED TO LABOUR INTENSITY

The preceding discussion and Figure 1 indicate that overall labour employment in the Bangladeshi crop sector has registered a slow increase following the 'Green Revolution', and seems to have stabilized in recent years. The demand for

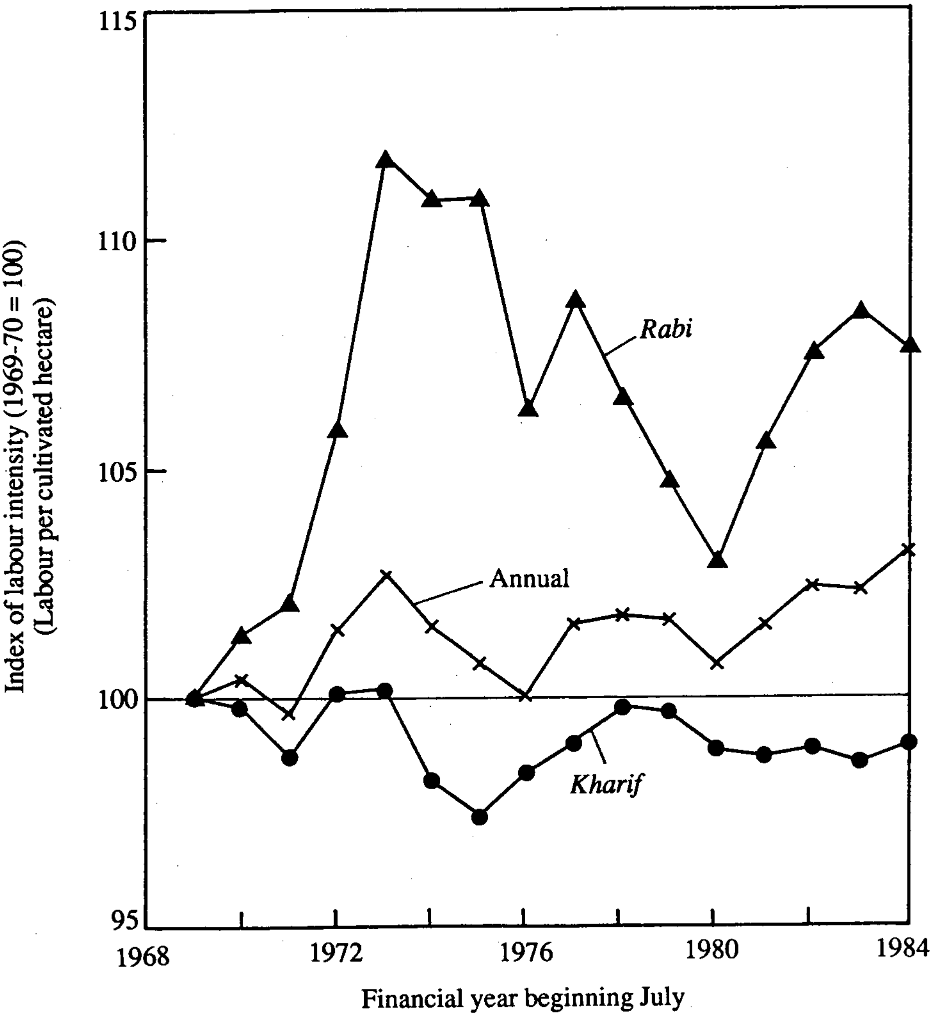

Fig. 2. Trends in Labour Intensity : Annual and Seasonal Dimensions.

labour in the *kharif* season has not increased, and may actually have fallen somewhat. This, however, has been more than compensated for by an increase in employment during the *rabi* season. Cultivated land that was once left fallow for a significant part of the year (e.g., during the dry season) is now used for crops, such as wheat or *boro* rice varieties. This is an important way in which the 'Green Revolution' technology has added significantly to agricultural employment and possibly reduced seasonal dimensions of rural poverty.

The relatively faster growth in employment in the *rabi* season has reduced

Table 2

Trends in Labour Intensity in the Bangladeshi Crop Sector, 1969-70 to1984-85: Annual and Seasonal Considerations (Man-days per Hectare and Man-days per Tonne)

Year	*MDPHAK*	*MDPHAR*	*MDPHA*	*MDNHA*	*MDHFK*	*MDHFR*	*MDPHFG*	*MDHFK 1*	*PRODMDK*	*PRODMDR*	*PRODMDFG*	*INTN*
1969-70	173.20	206.45	178.80	269.81	161.59	256.93	170.76	172.84	153.73	127.53	149.30	150.90
1970-71	172.88	209.35	179.56	255.32	161.79	257.33	172.33	172.43	164.66	122.67	155.87	142.19
1971-72	170.98	210.69	178.20	246.42	161.95	263.08	172.80	170.70	169.55	142.07	164.36	138.28
1972-73	173.41	218.61	181.45	252.84	162.36	267.50	174.27	173.33	178.55	136.81	169.55	139.34
1973-74	173.59	230.93	183.64	257.59	162.65	272.01	175.48	173.31	151.13	137.07	148.36	140.27
1974-75	170.11	228.92	181.59	252.94	162.46	280.11	177.32	169.74	158.27	147.72	156.05	139.29
1975-76	168.75	229.06	180.15	255.05	162.58	276.44	176.68	168.79	145.28	143.50	144.93	141.58
1976-77	170.41	219.32	178.90	253.58	162.41	269.51	173.23	170.24	147.84	143.54	147.14	141.74
1977-78	171.51	224.47	181.73	273.94	162.77	270.90	176.46	171.32	134.80	134.28	134.70	150.74
1978-79	172.89	220.01	182.05	278.72	163.26	262.54	176.19	172.69	134.53	144.76	136.40	153.10
1979-80	172.71	216.27	181.86	278.58	163.63	250.70	176.64	172.61	145.81	122.55	140.17	153.18
1980-81	171.30	212.48	180.08	277.26	163.51	239.93	175.79	171.02	135.09	114.73	130.03	153.71
1981-82	171.01	217.99	181.62	279.45	163.90	243.93	177.27	170.67	145.53	110.52	135.65	153.86
1982-83	171.35	221.94	183.12	283.21	164.15	247.93	178.88	170.97	143.08	105.98	131.83	154.66
1983-84	170.77	223.82	182.97	280.24	163.42	249.85	178.47	170.34	136.11	107.27	127.74	153.16
1984-85	171.47	222.19	184.53	280.30	163.52	243.24	179.88	171.04	134.12	103.56	123.91	151.90

Source: Based on data from BBS (1976); (1979); (1980); (1984); (1984a); (1985); (1985a); (1985b); (1986); and (1986a).

Note: *MDPHAK* and *MDPHAR* labour requirements per hectare cropped with *kharif* and *rabi* crops respectively. *MDPHA* and *MDNHA* respectively refer to labour intensities per gross and net cropped hectare for all crops considered in this paper. *MDHFK, MDHFR,* and *MDHFG* respectively represent labour intensities for *kharif, rabi,* and all foodgrains while *MDHFK*1 refers to labour intensity for *kharif* foodgrain and jute. *PRODMDK, PRODMDR,* and *PRODMDFG* respectively refer to man-days per tonne of *kharif, rabi,* and *all foodgrains,* while *INTN* is intensity of cropping.

inter-seasonal differences in employment. This can be seen by considering the absolute difference as well as relative difference between the seasonal labour requirements over time. In Table 1, *ABSDIFF* represents the absolute difference between total labour requirements in the *kharif* and *rabi* seasons (*ABSDIFF* = *MDTOTKHA* − *MDTOTRAB*). Absolute difference in labour requirements between the two seasons has declined, on average, from around 1.3 billion man-days in the initial years to around 0.9 billion man-days in the subsequent years. In relative terms, the seasonal difference [*RELDIFF* = (*ABSDIFF*/*MDTOTKHA*) x 100] *RELDIFF* has gradually declined from an average of about 75 percent in the earlier years to less than 60 percent in the later years. The downward trends in both relative and absolute differences in seasonal employment indicate a more stable (less variable) pattern of employment throughout the year.

However, labour demand per hectare has not increased all that much. Annually, for all crops, it has increased since 1969 by nearly 3 percent. There are signs that, after registering initial increases, it has stabilized and in some cases may have started to decline. For instance, labour intensity for *rabi* foodgrains (*MDHFR*) has decreased from around 260 man-days in the earlier years to under 250 man-days in the recent years. This downward trend is unlikely to be reversed.

In the light of the preceding discussion, an important question emerges: How is labour intensity related to the overall demand for labour?

The relationship involving labour intensity and the overall demand for labour is illustrated in terms of Equations (1) – (3). Equations (1) – (3) illustrate the relationship for *kharif, rabi,* and annual situations, respectively. *Overall,* there is a positive association between the two variables for the seasonal and the annual scenarios. However, the fitted regression lines clearly show that labour intensity is a poor predictor of total employment. This is especially true for *rabi* crops, for which the statistical quality of the fit is very poor (Equation 2).

$$MDTOTKHA = -3004.97 + 27.5076\, MDPHAK \quad (R^2 = 0.3231,\ t = 2.585) \quad \ldots \quad (1)$$

$$MDTOTRAB = -243.63 + 3.6287\, MDPHAR \quad (R^2 = 0.0822,\ t = 1.120) \quad \ldots \quad (2)$$

$$TOTALMD = -3825.76 + 33.6264\, MDPHA \quad (R^2 = 0.3448,\ t = 2.715) \quad \ldots \quad (3)$$

Let us now concentrate on the pattern of the employment relationships for foodgrains. For *kharif* foodgrains, there is a *very weak* positive relationship (Equation 4). One observes an inverse relationship between total labour intensity and total labour requirement for *rabi* foodgrains (Equation 5). The estimated equation does not have a high explanatory power but the coefficient is highly significant. *Overall,* there is a *reasonable* positive relationship between labour intensity and total employment. The overall fit is reasonably good (Equation 6) both in terms of explanatory power and statistical significance of the coefficient.

$$MDFK = -2414.33 + 23.8203\,MDHFK \quad (R^2 = 0.1396,\ t = 1.507) \quad \ldots \quad (4)$$

$$MDFR = 1513.91 - 4.4113\,MDHFR \quad (R^2 = 0.4043,\ t = 3.083) \quad \ldots \quad (5)$$

$$MDFG = -4407.34 + 33.8033\,MDHFG \quad (R^2 = 0.5986,\ t = 4.569) \quad \ldots \quad (6)$$

7. THE OBSERVED PATTERN OF LABOUR DEMAND: SOME EXPLANATIONS

In the light of the preceding discussion, this section examines the observed patterns in the demand for labour (overall and per hectare), paying particular attention to various components of the new agricultural technology.

Overall Labour Demand

Consider first the overall labour demand. Why has employment in the *kharif* season failed to increase, or even declined? Furthermore, why, despite a significant increase in the percentage area cropped with HYVs (nearly a fifth), have the labour requirements for *kharif* foodgrains not increased? There are two reasons for this phenomenon:

1. *Kharif* HYVs of rice are primarily rainfed, and have basically similar labour requirements per hectare to those for the traditional varieties. Therefore, the replacement of the traditional varieties by rainfed HYVs has had very little impact in overall labour demand during the *kharif* season. Hence, total labour requirements for *kharif* foodgrains have remained much the same.
2. There has been a significant shift in area from jute to different varieties of rice. Jute being a much more labour-intensive crop than rainfed HYVs of rice, this change in the cropping pattern has had a depressing effect on the overall demand for labour during the *kharif* season [Alauddin and Mujeri (1985), p. 63; Alamgir (1980), p. 346].

Consider the overall labour demand in the *rabi* season. The *rabi* season HYVs (e.g., *boro* rice) require much more labour per hectare. This is also true of the local varieties of *boro* rice. With irrigation, their cultivation requires even higher amounts of labour. This can be seen more clearly if one estimates simple linear equations with the overall labour requirement for *rabi* foodgrains (*MDFR*) as the dependent variable, and percentage area under irrigation (*PCIRRI*) and percentage area under *rabi* HYVs (*HYVPCR*) as the independent variables. We have estimated two separate equations because of the high degree of collinearity between the two explanatory variables (0.921). These are presented as Equations (7) and (8), which suggest the significant positive impact of both these variables on *rabi* season labour absorption. Clearly irrigation has the greatest impact.

$$MDFR = 118.62 + 4.2249\,HYVPCR \qquad (R^2 = 0.8231,\ t = 8.07) \quad \ldots \quad (7)$$

$$MDFR = -108.58 + 40.6821\,PCIRRI \qquad (R^2 = 0.9576,\ t = 17.78) \quad \ldots \quad (8)$$

Traditional irrigation techniques are more labour-intensive than the modern methods [BPC (n. d.)]. How, then, does increased use of modern techniques influence the total labour requirement? Let us consider this by examining the impact of the percentage area irrigated with modern methods (*PCMODIR*) on the total labour demand for *rabi* season foodgrains (*MDFR*). This is presented as Equation (9).

$$MDFR = -8.1364 + 5.9913\,PCMODIR \qquad (R^2 = 0.8205,\ t = 8.00) \quad \ldots \quad (9)$$

Equation (9) suggests that, regardless of the techniques of irrigation, the use of irrigation has a positive and substantial impact on the overall labour demand.

Labour Intensity

Let us now examine the factors that explain the behaviour of labour intensity. Consider the impact of the percentage area under jute (*PCJUT*) on labour intensity as is done in Equation (10). The percentage area cropped with jute (*PCJUT*) has a significant positive impact on labour intensity in the *kharif* season.

$$MDHFK1 = 166.00 + 0.9443\,PCJUT \qquad (R^2 = 0.7400,\ t = 6.31) \quad \ldots \quad (10)$$

The behaviour of overall labour intensity during the *kharif* (*MDPHAK*) seems to be significantly influenced by the percentage of gross cropped area under jute (*PCJUT*) and the *kharif* HYVs of rice (*HYVPCK*). This is clear from Equation (11). However, *PCJUT* is by far the more dominant of the two influences.

$$MDPHAK = 161.71 + \underset{(12.81)}{1.4477\,PCJUT} + \underset{(6.41)}{0.1599\,HYVPCK} \qquad (R^2 = 0.8202) \quad \ldots \quad (11)$$

(Figures in parentheses are t-values.)

How can one explain the observed behaviour of labour intensity for *rabi* crops as a whole (*MDPHAR*), or that for *rabi* foodgrains (*MDHFR*)? What impact does HYVs or irrigation have on these measures of labour intensity? This impact is quantified in terms of Equations (12) – (15).

$$MDPHAR = 202.23 + 1.4718\,PCIRRI \quad (R^2 = 0.1844,\ t = 1.78) \quad \ldots \quad (12)$$

$$MDPHAR = 209.75 + 0.1646\,HYVPCR \quad (R^2 = 0.1839,\ t = 1.78) \quad \ldots \quad (13)$$

$$MDHFR = 296.72 - 3.1663\,PCIRRI \quad (R^2 = 0.2790,\ t = 2.33) \quad \ldots \quad (14)$$

$$MDHFR = 202.23 - 0.3454\,HYVPCR \quad (R^2 = 0.2647,\ t = 2.24) \quad \ldots \quad (15)$$

Both irrigation and HYVs have a positive impact on the overall labour intensity during the *rabi* season [Equations (12) - (13)], but a negative impact on the labour intensity for *rabi* foodgrains [Equations (14) - (15)]. However, the low statistical significance of the coefficients and their poor explanatory power preclude any firm conclusion. Nevertheless, the results are indicative of an emerging trend.

But why the perverse relationship depicted by Equations (14) and (15)? The relationship depicted by Equations (14) and (15) may not be a causal one. Rather it may have occurred because of the changes in irrigation technique; from the more labour-intensive traditional to the less labour-intensive modern. Let us explore this possibility by asking the question: How does an increased use of modern irrigation technique influence labour intensities for all *rabi* crops (*MDPHAR*) and *rabi* foodgrains (*MDHFR*)? We use the percentage area irrigated by modern methods (*PCMODIR*) as the explanatory variable. The estimated equations are:

$$MDPHAR = 204.37 - 0.2405\,PCMODIR \quad (R^2 = 0.1945,\ t = 1.84) \quad \ldots \quad (16)$$

$$MDHFR = 289.08 - 0.4835\,PCMODIR \quad (R^2 = 0.2570,\ t = 2.20) \quad \ldots \quad (17)$$

Even though one should be wary of the poor statistical fits, the coefficients are significantly negative. Thus, an increased use of modern irrigation techniques seems to have a negative impact on the intensity of labour use during the *rabi* season. How do changes in the cropping pattern, area under HYVs, and irrigation influence the overall labour intensity (*MDPHA*)? We have used *PCJUT*, the percentage of gross cropped area under irrigation, and HYVs (*PCIRRI* and *PCHYV*) as proxies for changes in the cropping pattern, irrigation, and HYVs. The results are presented as Equations (18) and (19). These indicate that these proxies, especially irrigation, have a significant positive influence on the overall labour intensity.

$$MDPHA = 161.65 + \underset{(4.12)}{1.0875}\, PCJUT + \underset{(7.45)}{1.1438}\, PCIRRI \quad (R^2 = 0.8232) \quad \ldots \quad (18)$$

$$MDPHA = 172.11 + \underset{(2.69)}{0.8618}\, PCJUT + \underset{(5.42)}{0.2421}\, HYVPC \quad (R^2 = 0.7143) \quad \ldots \quad (19)$$

(Figures in parentheses are t-values.)

8. CONCLUDING COMMENTS

The 'Green Revolution' in Bangladesh has led to some increased labour demand annually due, primarily, to a significant increase in labour use during the *rabi* season. However, the use of labour in the *kharif* season has not increased and appears to have fallen. The intensity of labour use increased initially but subsequently fell marginally, and then seems to have stabilized. Results for the *kharif* season seem to be consistent with the findings of Jayasuriya and Shand (1986) for South and Southeast Asia.

The decline in seasonal differences in labour demand has several consequences. *First,* there may be greater use of permanent labour in preference to seasonal (casual) labour. *Secondly,* there may be less need for inter-seasonal grain storage at the household level. *Thirdly,* it is possible that for some farms, especially those using family labour, the need for off-farm employment is reduced during *rabi* season. *Fourthly,* it seems likely that throughout the year fewer people are actively employed, but those employed work longer hours annually. This may imply relatively greater use of family labour, and less use of hired labour, from those belonging to the ranks of the landless or near-landless. Thus, the 'Green Revolution' may have reduced under-employment rather than unemployment *per se* [Alauddin and Tisdell (1986)].

Labour use in the Bangladeshi crop sector appears to be significantly influenced by changes in the cropping pattern and various elements of the agricultural technology, viz., irrigation and HYVs. While irrigation has a significant positive impact on the overall labour demand, an increased use of modern irrigation techniques seems to have a negative impact on labour intensity during the *rabi* season. Significant output gains have not been accompanied by considerable employment growth as suggested by low employment elasticities. One of the key contributors to the increased overall labour demand is the increased incidence of multiple cropping. As discussed elsewhere [Alauddin and Tisdell (1987)], the problems are associated with further intensification of cultivation. This raises doubts about the prospects for continued increases in labour absorption within the Bangladeshi agricultural sector.

Furthermore, production processes in Bangladeshi agriculture may have become relatively more capital-intensive following the 'Green Revolution' [Alauddin and Tisdell (1991a)].

The substitution of capital for labour in Bangladeshi agriculture does not seem to be linked to industrialization in the country. The East Asian historical pattern involved a process of high rates of capital accumulation as well as growth of the modern sector, whereby surplus labour was transferred from the traditional to the modern sector without the occurrence of urban unemployment. This is broadly in conformity with the historical experience of economic growth in the West and consistent with the pattern depicted by the Lewis two-sector model [Lewis (1954)]. The widespread labour-saving bias of the modern sector [Todaro (1989), Chapter 8] and the growing prevalence of the urban surplus labour in contemporary Asian countries including Bangladesh seem to limit the relevance of the East Asian development experience.

The agricultural sector in Bangladesh alone cannot absorb all the rural labour force [Islam (1985), p. 154]. A partial alleviation of the labour surplus problem probably lies in the expansion of the employment base within the broader context of the rural sector [BPC (1985), p. V-2; Shand (1985)]. With a broad-based rural development, the growth of off-farm employment is likely to ameliorate poverty and unemployment. [Khuda (1985), p. 203], citing evidence from two Bangladeshi villages, suggests that off-farm employment contributes to a more equitable distribution of rural income. This is especially relevant, given the exclusion of the Bangladeshi rural poor from land and other natural resources [Alauddin and Tisdell (1989)].

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