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THE ISHIKAWA CURVE AND AGRICULTURAL PRODUCTIVITY IN BANGLADESH: SOME NEW FINDINGS*

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Abstract

Based on historical experience of East Asia especially Japan and Taiwan, Ishikawa (1978) identifies a backward-bending curve depicting the relationship between land productivity and labour intensity. The predominant early view [e.g. Ruttan and Binswanger (1978); Johnston and Cownie (1969)] was that this pattern might apply to all contemporary Asia. Ishikawa himself was less optimistic about this and recent studies [Alauddin and Tisdell (1989a); Jayasuriya and Shand (1986)] support Ishikawa's caution about generalizing the East Asian experience. Both Jayasuriya-Shand and Ishikawa claim that simultaneous adoption of labour-saving technologies neutralised and in some cases more than counterbalanced the labour-using impact of the new agricultural technology.

The prime purpose of this paper is to consider for the first time whether Bangladesh data support the Ishikawa curve hypothesis for Bangladesh. The Ishikawa relationship is considered for two crop seasons (the *kharif*, wet season, and *rabi*, dry season) and annually on both a net cropped and gross cropped basis.

The result suggests that because of different geographical conditions in South Asia, East Asian historical experience cannot be extrapolated blindly to South Asia.

I. *Introduction*

In East Asia, modern technological change in agriculture initially led to greater absolute employment of labour (as well as greater labour input per cultivated hectare) in the agricultural sector, at the same time raising agricultural productivity and providing additional savings for the expansion of the urban and industrial sector as income per head in the agricultural sector rose. By the time that further technological advances in agriculture in East Asia, especially Japan, began to reduce the amount of labour absorbed in agriculture, urban and industrial expansion was well under way providing an outlet for labour displaced from the agricultural sector by further technological change primarily of the labour-saving type [Hayami and Ruttan (1985)].

On the basis of historical experience of the East Asian countries, especially Taiwan

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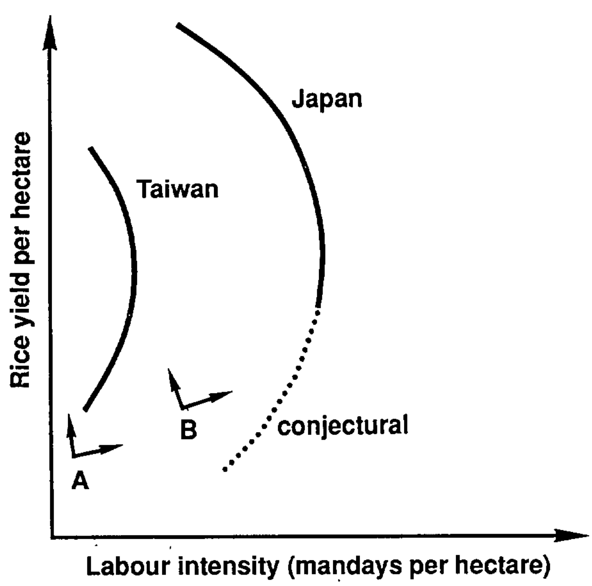
and Japan, Ishikawa (1978) identified two distinct phases in the relationship between labour-intensity (labour input per cultivated hectare) and yield per hectare: (1) A positive association between land productivity and labour intensity initially and (2) subsequently declining labour intensity associated with rising productivity [Booth and Sundrum (1985)]. This relationship is illustrated in Figure 1. A backward-bending curve depicting it is known as the *Ishikawa curve* [see Ishikawa (1978, p. 34)]. While the Taiwanese experience is based on an observed relationship, earlier Japanese experience is conjectural. The Ishikawa pattern is also believed to conform to the historical experience of the Western European economies [Booth and Sundrum (1985)] and is consistent with the pattern depicted by the Lewis two-sector model [Lewis (1954), Tisdell (1990)].

Ishikawa (1978, p. 27), however, notes that despite the apparent similarity between Japanese and Taiwanese experience, dissimilarities exist. In the initial phase, Taiwan and Japan had a similar rice yield per hectare but the amount of labour input per hectare was much higher in Japan compared to Taiwan. Differences in topography and techniques of irrigation, among other factors, according to Ishikawa, account for these international differences in labour intensities.

The spread of the 'Green Revolution' throughout Asia has generated interest in the applicability of East Asian experience to the pattern of agricultural development and labour-absorption in the whole of contemporary Asia. 'Green Revolution' technologies in many LDCs especially in South and Southeast Asia have generated new opportunities for productive employment [Hayami and Ruttan (1985, pp. 341–46)]. This has been so for example

FIGURE 1. Ishikawa curve showing relationship between land productivity (rice yield per hectare) and labour intensity (man days per hectare) for Japan and Taiwan and possible locations of contemporary Asian countries (Ishikawa, 1989, p. 34).



in Bangladesh where agrocultural production and employment has undergone considerable transformation [Khan (1985), Muqtada (1986), Alauddin and Tisdell (1991)]. Much of the literature following the 'Green Revolution' contends that agricultural labour absorption in contemporary Asian countries is likely to follow the historical pattern of East Asia especially Taiwan and Japan [see, for instance, Johnston and Cownie (1969), pp. 569–70), Ruttan and Binswanger (1978, p. 360)] even though Ishikawa himself is cautious about the possibility of generalizing this experience.

Jayasuriya and Shand (1986) are also sceptical about generalizing East Asian agricultural experience. After reviewing farm-level evidence from several South and Southeast Asian countires, Jayasuriya and Shand (1986, p. 415) claim that

> . . . labor-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 labor absorption indicates the need to seek solutions to unemployment in the off-farm sector.

This seems to be consistent with the earlier view expressed by Ishikawa (1978). Consider Figure 1 again. The apparent relationships for the South and Southeast Asian countries are illustrated by the locations A and B respectively. The South Asian situation is closer to Taiwan's path rather than Japan's path. In contemporary Asian countries in the period of the introduction of new technology, labour-using effects of HYV introduction have been counterbalanced more or less by the labour-saving effects of increased mechanization of various agricultural operations. Ishikawa (1978, p. 35) claims that

> . . . the resulting changes in the locations of A and B seem to have been rather toward the direction marked by B than toward the direction marked by A, at least until the present.

In contemporary Asia the initial optimism surrounding the ability of the 'Green Revolution' to provide agricultural employment has not been realised and the long-term employment potential of the new agricultural technologies remains uncertain. The 'Green Revolution' in South Asia seems to have displaced labour from agriculture [Jayasuriya and Shand (1986)] and not all of this displaced labour has found employment in the urban sector. Indeed the incidence of rural poverty appears to have increased amongst landless rural households [Alauddin and Tisdell (1989b)]. Note that the statistical data for the hypotheses of both Ishikawa (1978) and Jayasuriya and Shand (1986) are limited. Their studies are based on broken (discontinuous) time-series for labour-absorption data rather than on a continuous time-series.

The prime purpose of this paper is to consider for the first time whether Bangladeshi data support the Ishikawa-curve hypothesis for Bangladesh.[1] Variations in agricultural productivity, labour intensity and overall employment are considered and explanatory

[1] In Bangladesh about 60 per cent of (employed) labour force is engaged in agriculture. The rate of unemployment and underemployment is very high in this sector. According to an estimate of the Bangladesh Planning Commission (BPC 1985, p. V-14) the unemployment and underemployment rate is above 30 per cent. The share of total work force engaged in agriculture has fallen from 85 per cent in 1961 to 61 per cent in recent years. Despite this it still remains the largest provider of employment for the civilian labour force.

TABLE 1. TRENDS IN EMPLOYMENT, PRODUCTIVITY, LABOUR INTENSITY AND INTENSITY OF MODERN INPUT USE: BANGLADESH AGRICULTURE, 1969–70 to 1984–85

YEAR	INTN	LPPHFG	LPPHRF	LPPHKF	INYFDT	IGYFDT	IRFYLD
1969	150.90	6.81	7.84	6.50	100.00	100.00	100.00
1970	142.19	6.52	8.15	6.07	91.08	96.66	104.07
1971	138.28	6.18	7.03	5.90	84.23	91.92	91.86
1972	139.34	5.99	7.31	5.60	82.99	89.87	97.03
1973	140.27	6.85	7.29	6.61	96.14	103.42	98.45
1974	139.29	6.51	6.55	6.32	91.70	99.34	91.13
1975	141.58	7.01	6.97	8.18	100.00	106.59	95.59
1976	141.74	6.91	6.96	6.76	96.69	102.94	93.16
1977	150.74	7.54	7.75	7.65	114.42	114.54	104.26
1978	153.10	7.45	7.18	7.71	114.58	112.94	93.61
1979	153.18	7.25	8.16	6.86	111.85	110.19	101.54
1980	153.71	7.81	8.71	7.40	120.41	118.21	103.78
1981	153.86	7.49	9.05	6.87	116.51	114.27	109.54
1982	154.66	7.71	9.43	6.99	121.60	118.64	116.08
1983	153.16	7.96	9.32	7.34	124.02	122.19	115.59
1984	151.90	8.21	9.65	7.45	127.94	127.10	115.66

YEAR	KFYLD	IMDFK	IMDHFK	IMDFG	IMDHFG	IMDFR	IMDHFR
1969	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1970	93.42	94.77	100.12	97.04	100.92	110.50	100.16
1971	90.88	89.42	100.22	91.41	101.19	103.18	102.39
1972	86.51	92.11	100.48	95.37	102.06	114.65	104.11
1973	102.39	94.23	100.66	98.51	102.76	123.80	105.87
1974	97.66	92.01	100.54	98.31	103.84	135.49	109.02
1975	126.55	97.96	100.61	103.92	103.47	139.18	107.59
1976	104.51	96.2*o*	100.51	97.63	101.45	106.04	104.90
1977	118.49	98.43	100.73	104.50	103.34	140.37	105.44
1978	119.80	100.51	101.03	106.27	103.18	140.30	102.18
1979	106.76	96.76	101.26	105.02	103.44	153.84	97.58
1980	115.16	98.17	101.19	107.55	102.95	162.98	93.38
1981	107.15	98.49	101.43	109.39	103.81	173.76	94.94
1982	109.15	98.60	101.58	111.50	104.76	187.75	96.50
1983	114.23	98.09	101.13	110.93	104.52	198.76	97.24
1984	116.00	92.81	101.19	110.11	105.34	212.32	94.67

YEAR	IMDNHA	FERT	PCIMODIR	IMODRMD	ITOTKHA	ITPTRAB	ITOTMD
1969	100.00	9.91	53.78	100.00	100.00	100.00	100.00
1970	94.63	11.77	45.53	94.56	94.13	105.78	96.39
1971	91.33	10.17	38.93	82.73	86.21	97.86	88.48
1972	93.71	15.46	47.36	103.03	91.61	103.55	93.94
1973	95.47	14.89	53.79	123.01	93.41	109.46	96.53
1974	93.75	11.37	51.94	135.94	86.93	117.52	92.88
1975	94.53	17.13	51.65	124.71	90.87	119.10	96.36
1976	93.98	20.34	57.03	119.86	91.43	102.38	93.56
1977	101.53	26.94	52.29	128.29	94.60	122.73	100.03
1978	103.30	25.80	53.35	130.63	97.82	124.45	103.00
1979	103.25	28.79	54.00	147.26	93.57	129.08	100.47
1980	102.76	31.96	59.13	164.29	92.88	135.13	101.10
1981	103.57	30.17	61.99	178.37	92.42	142.53	102.16
1982	104.97	37.95	66.54	203.08	92.66	150.76	103.96
1983	103.87	41.88	71.47	227.04	92.28	149.77	103.46
1984	103.89	46.1*h*	75.06	262.22	88.16	164.08	102.92

factors are identified. These are considered on an annual basis as well as for the two crop seasons i.e. *kharif* (wet) and *rabi* (dry). As far as we are aware, this is the first in-depth investigation of these relationships for Bangladesh.

II. *The Data*

The basic data used in this empirical analysis in this paper are taken from Alauddin and Tisdell (1989a). Table 1 presents indices* of overall labour utilization and labour intensities and other relevant information. The labour absorption data relate to 50 crops from seven broad commodity groups[2] for the period 1969–70 to 1984–85. In deriving the estimates, account has been taken of the irrigated and non-irrigated cropped areas as well as techniques of irrigated and non-irrigated cropped areas as well as techniques of irrigation (BPC undated). The methods used in deriving the estimates along with their limitations have been discussed by Alauddin and Tisdell (1989a) so they will not be outlined here.

III. *Is There an Ishikawa Curve for Foodgrain Production in Bangladesh?*

Here the existence or otherwise of an Ishikawa curve for the foodgrain sector of Bangladesh is investigated. Foodgrain is emphasized for two reasons. First, Ishikawa in his study on Japan and Taiwan considered the relationship between labour intensity for rice production and its yield. It is useful to have a comparison between Bangladesh and East Asia. Secondly, foodgrain (rice and wheat) is central to the agricultural economy of Bangla-

* *Notes:* INTN is intensity of cropping. LPPHFG, LPPHRF and LPPHKF respevticely refer to kilogrammes of *all* foodgrains, *rabi* foodgrains, *kharif* foodgrains produced per man day. Columns prefixed with Is refer to indices with 1969–70=100. GYFDT, NYFDT refer to foodgrain yield per gross and net cropped hectare respectively. RFYLD and KFYLD are *rabi* and *kharif* foodgrain yields respectively. TOTKHA, TOTRAB and TOTMD are total labour required for the production of *kharif*, *rabi* and *all* crops respectively. MDFK, MDFR and MDFG respectively represent total labour requirements for the production of *kharif*, *rabi* and *all* foodgrains. MDHFK, MDHFR and MDHFG respectively refer to labour intensities per hectare of *kharif*, *rabi* and *all* foodgrains. MDNHA refers to labour intensity per net cultivated hectare. FERT is kgs of nutrients applied per gross cropped hectare. PCIMODIR is area irrigated by modern methods as a percentage of total irrigated area. MODRMD means area irrigated by modern methods per man day.

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

[2] The 50 crops considered in this paper are as follows:

CEREALS:	Six crops of rice viz., *aus* local, *aus* HYV, *aman* local, *aman* HYV, *boro* local and *boro* HYV; two crops of wheat, viz. wheat local and wheat HYV (8).
CASH CROPS:	Jute, sugarcane, tobacco, tea and cotton (5).
OILSEEDS:	Rape and mustard, *kharif* sesame seeds, *rabi* sesame seeds, linseed, *kharif* groundnut, *rabi* groundnut, and coconut (7).
PULSES:	Lentil, gram, *mashkalai, moong, khesari* and pea (6).
FRUITS:	Mango, banana, pineapple, jackfruit, watermelon (5).
VEGETABLES:	Potato, sweet potato, tomato, cabbage, cauliflower, *jhinga, karala, kharif* egg plant, *rabi* egg plant, *kharif* pumpkin, *rabi* pumpkin, radish, bean, aram (14).
SPICES:	*Kharif* chilli, *rabi* chilli, onion, garlic, turmeric (5).

desh. In recent years more than 80 per cent of cultivated area in Bangladesh has been allocated to rice and wheat for which technological progress has been the fastest (Pray and Anderson, 1985).

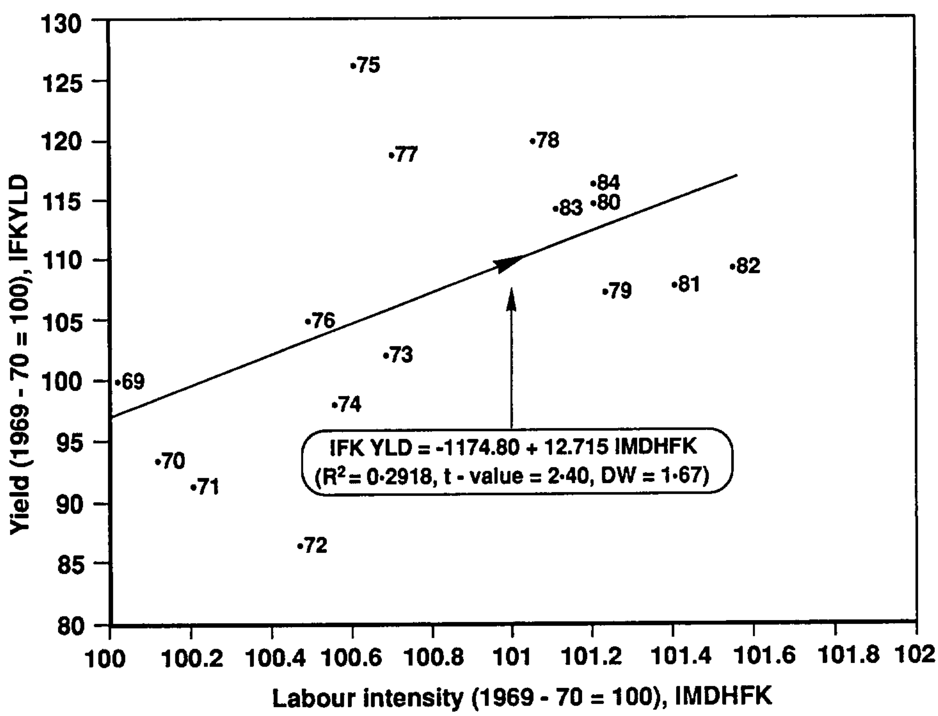
Four cases are considered. These are the relationships for (1) the *kharif* season, (2) *rabi* season (3) per gross cropped hectare annually and (4) per net cropped hectare annually.

Figure 2 plots the indices of yield (per cropped hectare) for *kharif* (wet season) foodgrains (IKFYLD) corresponding labour intensity data (IMDHFK). Overall there is a positive but very weak relationship as can be seen from the regression equation. This equation shows very poor explanatory power. Nevertheless demand for labour per cropped hectare has trended upwards in the *kharif* season as yields per hectare have risen with the introduction of the new technology.

One might be interested to know why the second part of the Ishikawa curve does not exist for *kharif* season. One possible explanation might be that technological breakthrough has not yet crossed the transitional phase whereby labour intensity per hectare might start to decline with increase in yield. One might note that only about a fifth of the area under cultivation is planted to HYV during the *kharif* season.

At this stage one might raise questions about the impact of aggregation of *aman* and *aus* rice crops into *kharif* crops. This is simply because these crops have two different

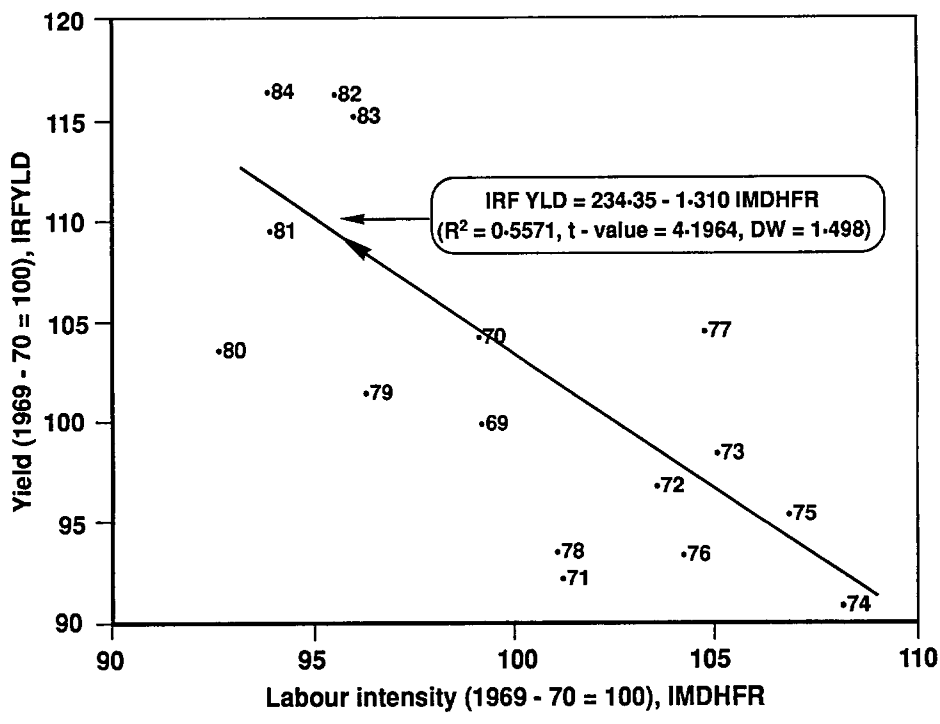
FIGURE 2. Ishikawa curve for *kharif* foodgrains showing a positive association between index of labour intensity (MDHFK) and index of yield (IKFYLD), Bangladesh, 1969–70 to 1984–85.



growing seasons. However, one could argue that there are significant overlappings in the cultivation of *aus* and *aman* rice crops. For instance *aus* rice is sown/transplanted during mid-March to mid-May and harvested during July to mid-August. On the other hand, *aman* rice is sown/transplanted during mid-March to mid-August and harvested during mid-November to mid-January [BBS (1985c, p. 5)]. Furthermore, labour coefficient data show that they have much the same labour requirements per cropped hectare. However, *aman* rice is the major *kharif* crop the cultivation of which has remained at the same level over the years whereas the area under *aus* rice has been declining or is at best stagnant. The yields of both crops have shown signs of increase even though *aman* yield has risen faster than *aus* yield. This notwithstanding, lumping the two crops together is unlikely to make any significant difference in the overall direction of relationship between productivity and labour intensity.

Figure 3 depicts the relationship for the *rabi* (dry season) foodgrains. This contrasts with the previous case: Labour intensity per hectare (IMDHFR) for this dry season is inversely related to land productivity per cultivated hectare (IRFYLD). As yields per hectare have risen, employment per hectare has fallen. Note also that the regression equation has a higher explanatory power and a higher t-value for the estimated coefficient than for the previous case.

FIGURE 3. Ishikawa curve for *rabi* foodgrains showing a positive association between index of labour intensity (IMDHFR) and index of yield (IRFYLD), Bangladesh, 1969–70 to 1984–85.



On a closer inspection of Figure 3 one can identify two clusters. This can be better understood if we consider the introduction of HYV wheat on a massive scale in the second half of the 1970s. This gained further momentum in the early 1980s. The wheat output witnessed a spectacular boost of 1200 per cent between the late 1960s and early 1980s. Wheat yield rose by a factor of 2.4 during the same period.

Note that the productivity-labour intensity curve for *rabi* lacks the first segment of the traditional Ishikawa curve. One explanation of this could be the absence of traditional agriculture in this period in Bangladesh. In Ishikawa's case this segment reports the response of traditional agriculture to new technology initially. HYV wheat and HYV *boro* rice are entirely new crops in the context of Bangladesh and in recent years account for over 70 per cent of the cropped area in the *rabi* season. We do not have a long time series data to identify the first portion of the Ishikawa curve for the *rabi* season. But it can be surmised that one is likely to find the existence of a typical Ishikawa curve in small regions where traditional type of *boro* rice used to be locally cultivated. Unfortunatley data limitations preclude any possibility of further investigation into that issue.

Figure 4 shows the relationship between labour intensity per gross hectare cropped with foodgrain (IMDHFG) and food grain yield per gross cropped hectare (IGYFDT) while Figure 5 shows the relationship on the net cropped hectare basis (IMDNHA and INYFDT). In both cases productivity is positively associated with labour intensity. How-

FIGURE 4. Ishikawa curve for *all* foodgrains showing a positive association between index of labour intensity (IMDHFG) and index of yield per gross cropped hectare (IGYFDT), Bangladesh, 1969–70 to 1985–85.

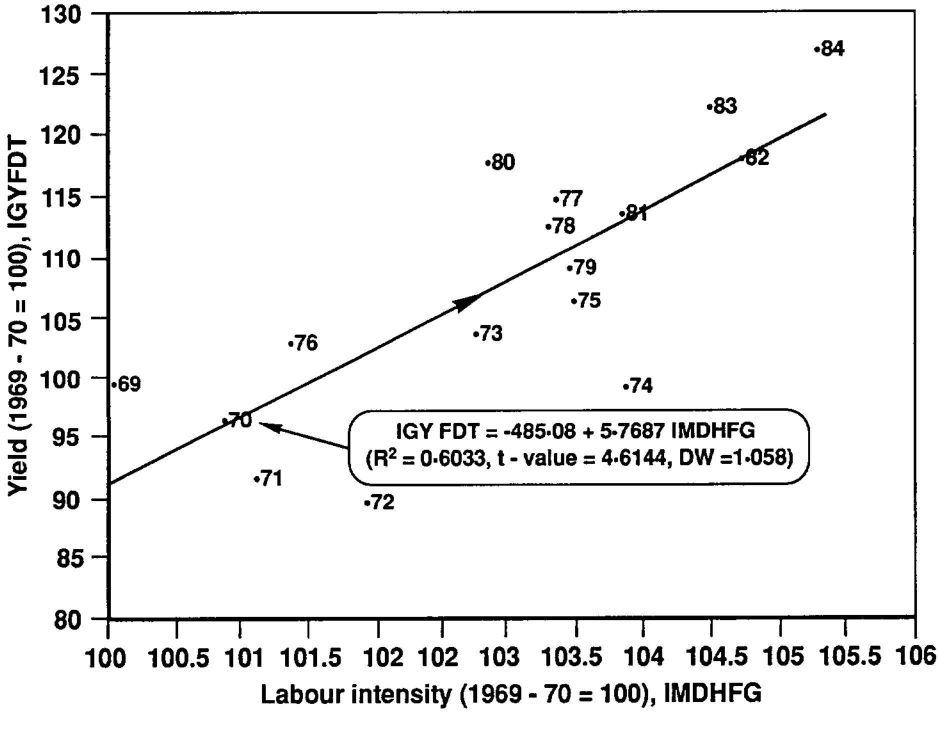
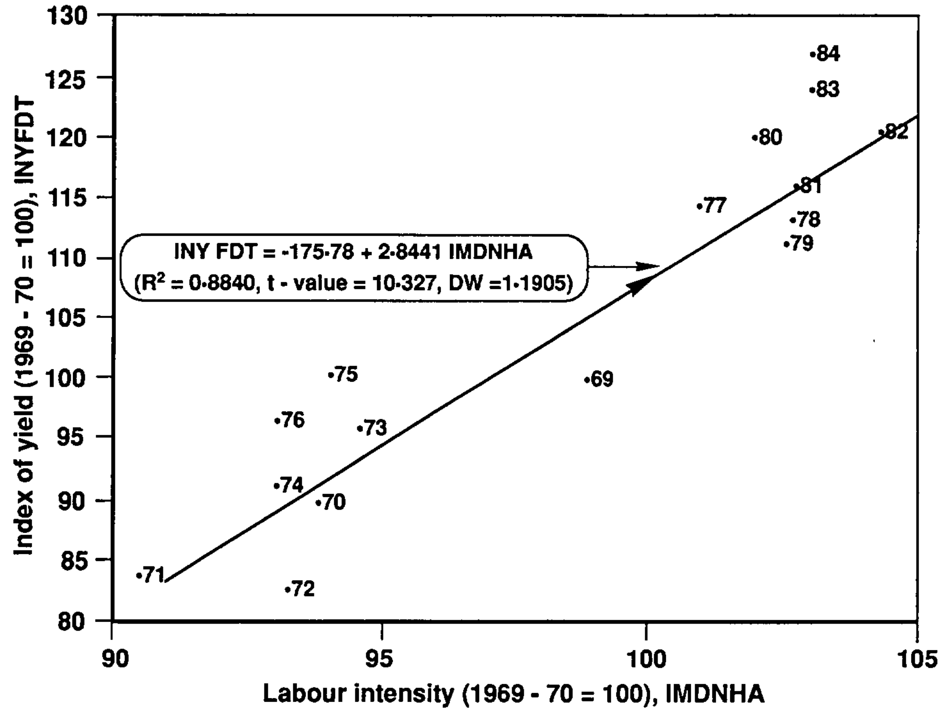


FIGURE 5. Ishikawa curve for *all* foodgrains showing a positive association between index of labour intensity per net cropped hectare (IMDNHA) and index of yield per net cropped hectare (INYFDT), Bangladesh, 1969–70 to 1984–85.



ever, the scatter of the observations differ. In Figure 4 the points are well scattered whereas in Figure 5 the observations form two clusters. The points corresponding to the earlier years are clustered to the southwest whereas those for the later years form a cluster to the northeast. In both cases labour use per hectare has risen with increased productivity.

IV. *Labour-Intensity and Land Productivity Relationships in Foodgrains: Some Further Observations*

Looking at the annual situation, Bangladesh appears to be on the bottom segment of the Ishikawa curve. But the *association* is not strong and the positive variation in employment per hectare for increased yield is small. *Important* seasonal differences exist. Results for the *kharif* season differ from those of the *rabi* season. For the *kharif* season, labour employment per hectare has risen on average with increased yields per hectare but the degree of association is weak. On the other hand, in the *rabi* season labour employment per hectare has fallen as yield per hectare has risen. This suggests that the bottom segment of the Ishikawa curve has been 'skipped' for the *rabi* (dry) season in Bangladesh and suggests the possibility that agricultural employment has suffered in this season as a result of technological progress.

But we should be wary about drawing the latter conclusion because it will not hold if the area cultivated rises sufficiently as the input of labour per unit of land area declines. In Japan, the area of land cultivated during agricultural modernisation may not have altered greatly so aggregate employment of agricultural labour tended to follow the patterns suggested by the Ishikawa curve, that is to move in accordance with labour-use per unit of cropped land. But as discussed below, in Bangladesh the area under foodgrains increased during the *rabi* season with modernisation more than counteracting the decline in labour employed per unit of area during this season.

In the *rabi* (dry) season in Bangladesh labour employed per hectare cropped with foodgrain has declined as a result of changed irrigation technology, that is, a transition from traditional (relatively more labour-intensive) to modern methods (relatively labour-saving).[3] For instance, share of area irrigated by modern methods in total area irrigated has increased from just over 50 per cent in 1969–70 to over 75 per cent in 1984–85.

However, the amount of labour employed in foodgrain production in this season has increased substantially. This is because 'Green Revolution' technologies using irrigation have made it worthwhile to extend greatly the area of land cropped with foodgrains in this season. For instance, the incidence of multiple cropping increased with the introduction of new technologies. For example, the area triple cropped (annually) expanded from around 480 to 649 hectares between 1965–66 to 1969–70 and 1980–81 to 1984–85 [BBS (1978, 1985b, 1986b)]. Thus increased employment in foodgrain production during the *rabi* (dry) season resulted from increased intensity of cropping despite a negative impact of the changes in irrigation technology.

By contrast in the *kharif* (wet) season, labour used per hectare cropped with foodgrain marginally increased *but* total employment in foodgrain production has declined by a small amount, despite some switching of jute land to rice production and the slightly increased labour-intensity of HYV foodgrain production compared to that for traditional varieties. This can only be explained by the reduction in the area under foodgrain crops during this season. This may have come about because:

(1) there has been a loss in agricultural land due to incrrased allocation of land for human habitation, urbanization and associated uses[4] (Hossain, 1980);
(2) loss of land due to agricultural damage e.g. land degradation, decline in soil fertility (Jones, 1984; Alauddin and Tisdell, 1991).

Also it is possible that marginal foodgrain land from the *kharif* season has been withdrawn from production because of interseasonal price competition of grains from the *rabi* season. It should be noted that the real prices of grains in Bangladesh have fallen (Alauddin and Tisdell, 1991).

In the case of Bangladesh, and possibly most South Asian countries, it is necessary to go beyond the Ishikawa curve and consider changes in cropped area, for with the modernisation of agriculture, the size of the gross cropped area has altered annually. This

[3] Traditional irrigation methods include *doon*, swing baskets dugwell etc. while modern methods include large-scale canal irrigation, shallow and deep tubewells and low lift pumps.

[4] In Bangladesh, the area actually cultivated annually fell from around 8.8 million hectares in the late 1980s to around 8.6 million hectares in the early 1980s (BBS 1978; 1985b; 1986b).

has been principally due to expansion of the size of the cropped area in the dry season. Unlike most of South Asia, Japan, Korea and Taiwan do not have a well developed dry season.

4.1 Climatic or Geographical Factors

Countries of East Asia i.e. Japan, Taiwan and Korea differ significantly in climatic conditions from those of South Asia e.g. India and Bangladesh [Russell and Coupe (1984, pp. 68–69)]. The former group of countries belong to two broad climatic zones in terms of precipitation:

(1) Humid sub-tropical climate: Precipitation in all seasons with maximum rainfall in the summer.

(2) Humid mid-latitude climate: Precipitation in all season.

Japan has both types of climate while Taiwan belongs to the first type and Korea belongs to the second.

This contrasts markedly with the climatic pattern of Bangladesh and India. Both these countries belong to the *wet and dry climatic zone with well developed dry and wet seasons.* In case of India in particular, marked regional differences exist in terms of the amount of annual rainfall. However, for both countries most precipitation takes place during the months of May to October. The other months are acutely dry and receive very little rainfall. Most of Southeast Asia belongs to the rainy tropical climatic zone having *at most one or two dry months.* Thus the overall pattern of rainfall in East Asia and to a significant extent Southeast Asia is similar only to the South Asian wet season.

One should exercise caution in generalizing the East Asian experience to South Asia as climatic patterns critically influence labour utilization in agriculture. It is also possible that estimates of the Ishikawa curve for the wet season in South Asia would most closely parallel those for East Asia. Little variation in cropped area in Bangladesh has occurred during the wet season and presumably little variation in net cropped area in Japan occurred during its introduction of new technologies.

It might also be noted that the Japanese experience is complicated by economic protection for domestic rice production. Increasing economic support for rice production can for example offset or retard any tendency for labour-use per unit of land area to fall. Thus the nature of the Ishikawa curve can be influenced, apart from geographical factors, by the nature of the general economic policies adopted by a country. Nevertheless, even in this case, one would expect fundamental patterns such as those highlighted by Ishikawa to emerge.

V. *Concluding Comments*

The nature of the Ishikawa curve for Bangladesh agriculture is uncertain. However, the relationship between foodgrain-yield and labour-intensity both annually and for the *kharif* season seems to indicate the initial phase of the curve for these periods. For *rabi* foodgrains the yield-labour intensity relationship is indicative of the existence of the top segment of the curve.

This paper highlights the importance of interseasonal differences as far as Ishikawa-type factors are concerned. Overall employment in foodgrain production has risen in terms of man-days. This is so because total employment-enhancing effects of the 'Green

Revolution' in the *rabi* season have outweighed the reductions in total employment experience in the *kharif* season. This means less interseasonal fluctuations in employment *but* it does not imply necessarily an increase in *persons* employed in foodgrain production.

Note that scope for further extension of area under foodgrain production in Bangladesh in the *rabi* season is limited by the availability of irrigation water which is a crucial input [Boyce (1986)]. Irrigated water supplies are not readily available for extending cultivation in this season. Only a third of the cultivable area is utilized during the *rabi* season. This is despite optimistic predictions of vast potential for extending cultivated area through water resource development [see for example MPO (1986)]. In some cases underground water supplies are being unsustainably utilized and this is a further limiting factor (Ahmed, 1986; Sinha, 1984). This combined with the risks for yields of further intensification of agriculture make it unlikely that the foodgrain sector of Bangladesh will add substantially to agricultural employment. Declining employment in this sector in the future seems most probable. Thus for the *rabi* season agricultural sector is rapidly rising to the backward portion of the Ishikawa curve.

The present paper indicates a marginal increase in labour intensity for *kharif* foodgrains as well as annually. However, the transition from traditional to modern irrigation techniques and the consequent substitution of capital for labour has led to declining labour intensity. Labour employment has increased in foodgrain during the *rabi* season due primarily to increased area under cultivation during that season. Overall labour employment in foodgrains (IMDFG) and in production of all crops (ITOTMD) have increased marginally. The real contribution of the 'Green Revolution' in Bangladesh as far as agricultural employment is concerned appears to be in creating extra employment during the *rabi* season thereby reducing seasonal differences in labour employment.

'Green Revolution' technologies have not led to a significant increase in agricultural employment in Bangladesh. But by the same token they have not been associated with decreased employment or significantly decreased employment [Khan and Hossain (1989)]. There is little evidence that the 'Green Revolution' changes which are and have been occurring in Bangladesh are going to generate enhanced industrial expansion or the pattern of urbanisation reminiscent of East Asia where the labour displaced from agriculture was absorbed in more productive non-agricultural employment.[5]

The Ishikawa curve is important in a macroscopic economic perspective because, on the basis of it, one would expect disguised unemployment in agriculture (and the size of the surplus agricultural labour force) to first diminish with technological progress in agriculture before increasing again if sufficient agricultural labour has not been transferred to the industrial sector. When the traditional Ishikawa curve applies there is a breathing space for expansion of industry to absorb agricultural labour. This expansion is facilitated by rising productivity in agriculture which increases the amount of food available to support industrial workers and extends the market for industrial goods. But when the upward-sloping phase of the Ishikawa curve is absent, there is no breathing space for industrial ex-

[5] For instance value added per labourer in agriculture (It 1972–73 prices) increased from Taka 1716 to Taka 2242 between 1973–74 and 1983–84. On the other hand it declined from Taka 6428 to Tala 2060 for trade; from Taka 8820 to Taka 4855 for transport and from Taka 47583 to Taka 7357 for construction over the same period (Khan and Hossain 1989, p. 16).

pansion to absorb surplus agricultural laboiur and the agricultural surplus tends to rise almost immediately. Therefore, industrialisation or non-agricultural employment opportunities need to expand at an even faster rate in order to absorb the otherwise *growing* surplus agricultural workforce. As before, however, increased agricultural productivity does make available an 'agricultural food surplus' (wage goods) which can be used to support industrial workers and provides a market for their products.

In conclusion it seems most likely that the East Asian experience cannot be extrapolated to contemporary Asia (especially South Asia). Widespread labour-saving bias in the modern industrial sector [Morawetz (1974); Todaro (1989)], relatively rapid rate of capital substitution for labour in agriculture and the prevalence of urban surplus labour seems in South Asia to limit the relevance of the East Asian experience. Furthermore, geo-physical characteristics, amount of annual rainfall and its distribution, differ significantly between countries of South Asia and East Asia. Thus marked differences in climatic conditions and patterns of industrialization and urbanization in South Asia may make generalization of the historical pattern of East Asia inappropriate. Overall the findings of this paper for Bangladesh seem to support the caution of Ishikawa (1971) and of Jayasuriya-Shand (1986).

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