

# **ECONOMICS, ECOLOGY AND THE ENVIRONMENT**

**Working Paper No. 14**

**Impact on the Poor of Changing  
Rural Environments and Technologies:  
Evidence from India and  
Bangladesh**

by

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**THE UNIVERSITY OF QUEENSLAND**

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# **IMPACT ON THE POOR OF CHANGING RURAL ENVIRONMENTS AND TECHNOLOGIES: EVIDENCE FROM INDIA AND BANGLADESH**

## **1 Introduction - Some Trends**

A number of studies have been done of rural poverty in developing Asia and that edited by Quibria (1994) is a major recent contribution. It finds that rural poverty has declined in all developing Asian countries, except Sri Lanka where it showed no change in the 1980s compared to the 1970s. Using poverty lines and a head count basis, rural poverty in Bangladesh was reported to be 41 per cent in 1985-1986 compared to 71 per cent in 1973-1974. In India, it was found to be 45 per cent in the early 1960s but to have fallen to 25 per cent in 1986-1987 (Quibria and Srinivasan, 1994, p. 6). While such poverty rates are still substantial, their downward trend is encouraging.

Although Quibria and Srinivasan (1994) identify a number of correlates of such poverty (and are careful to stress that they are just that rather than causes) they give virtually no attention to the consequences of environmental change for such poverty nor to variations in the extent of exchange and non-exchange income and their relationship to poverty. In Quibria (1994) the only exception is in relation to the contribution by Gunatilleke et al. (1994) on Sri Lanka which states (p. 530) "Policies for environmental protection often fail to take heed of the resulting deprivation of females who depend on forests for firewood, water resources, herb and food gathering (Perera, 1990). Environmental degradation, of course, has long-term effects which lead to poverty." Furthermore, while the contribution dealing with Sri Lanka (Gunatilleke et al. 1994) considers gender related aspects of poverty, those covering rural poverty in Bangladesh (Hossain et al., 1994) and in India (Dev et al., 1994) neglect this aspect even though it is an important dimension of the rural poverty problem (cf. Roy et al., 1996).

Taking into account technological and associated environmental changes, this chapter concentrates on possible variations in the relative economic position of the rural poor compared to those who are better off. It summarises some of our earlier findings and draws on the results of village surveys in West Bengal and Bangladesh.

Major environmental changes have occurred in rural India and Bangladesh in recent decades mainly due (but not exclusively) to the introduction of 'Green Revolution' technologies in agriculture and associated population increases which this Revolution has helped to make possible. 'Green Revolution' technologies involve:

- (1) the introduction of high yielding but environmentally sensitive crop varieties,
- (2) greater irrigation and water control for crops,
- (3) increased use of artificial fertiliser,
- (4) greater mechanisation of agriculture,
- (5) increased use of pesticides, and
- (6) a rise in the incidence of multiple cropping and in general, greater intensification of agriculture.

Each one of the above factors has been associated with significant environmental change. Traditional crop varieties have been lost because of their displacement by high yielding varieties (HYVs), thereby reducing biological diversity. The need for water supplies, especially in the dry season, has led to the construction of dams and barrages with adverse consequences for fishing and navigation. Underground water supplies have also been affected, e.g. 'excessive' pumping of water from underground sources has had undesirable effects on available supplies. In some areas, salinisation of soil or water has become a problem. The use of artificial fertiliser has resulted in acidification of some soils and loss of organic matter, especially when combined with multiple cropping and use of mechanical equipment (Mahtab and Karim, 1992). The use of pesticides has caused the loss of useful insects as well as pests. In some areas, e.g. Chittagong Hill Tracts, forest loss has

increased, so adding to soil erosion. One could easily add to this catalogue of adverse environmental changes in rural areas (Tisdell *et al.*, 1992).

These changes have all to some degree involved a loss of natural resources or similar resources. To a large extent, man-made resources and environments have been substituted for natural ones in an effort to increase economic productivity.

At the same time as the above developments have occurred, the market system has become more pervading in rural areas. Private property rights have been extended and/or are being more rigorously enforced and common or community access to natural resources has decreased and/or the natural supply of such resources e.g. fish, has declined. As some members of the Chicago School point out e.g. Demsetz (1968), it becomes more economic to enforce private property rights to a resource or set of resources when profit or returns from using this resource or set of resources rises. As a result, there may be less opportunities for the landless or near landless to use natural resources for example, to collect fodder for their animals from communal land or to obtain free water supplies. A vicious environmental cycle seems to have emerged in parts of India and in Bangladesh, especially the west of Bangladesh where natural gas supplies are not available. Demand for bricks has increased for housing and road building, placing increased strain on natural fuel supplies used in the baking of bricks. At the same time, heightened demands on remaining natural areas e.g. woodland, have made it more difficult to maintain supplies from such areas e.g. of fuel. Furthermore, inland fisheries have not only suffered from over-harvesting but also from unfavourable external effects from the development of agriculture and capital works needed for such development.

New agricultural technologies and the concomitant growth of the market system have encouraged greater specialisation in production, a reduction in the degree of subsistence farming and an increase in road-building to enable marketing to take place at reduced cost. Consequently, social relationships have come to be guided increasingly by market-oriented self-interest rather than by custom or social exchange. Thus erosion of 'community' or

traditional communal structures of social support has occurred. At the same time, there has been a reduction in social security provided by access to natural resources (the importance of which has for example been emphasised by Chambers, 1987) and local social support may have diminished.

## **2. Socio-economic Assessment of 'Green Revolution' Technological Change**

Socio-economic assessment of 'Green Revolution' technological change is not easy because the impact of such change is multi-dimensional, not single dimensional. The past practice of economists e.g. in cost-benefit analysis, has been to try to reduce evaluation to a single dimension specified in monetary units. This is not always possible but even when it is possible, it is not always satisfactory because knowledge of the way in which attributes behave may be as important as the net result for evaluation.

Alauddin and Tisdell in *The 'Green Revolution' and Economic Development*, 1991, adopt a multi-attribute approach, principally based upon Gordon Conway's (1985, 1987) suggestion that changes in agricultural technology might be best assessed by taking account of its effect on four characteristics, namely

1. the level of yields or net returns from agricultural activity,
2. the variability of the above,
3. the sustainability of the above, and
4. the consequences of the technology for income distribution.

The social desirability of a technique is positively related to the level of yields or net returns which it generates, the stability (lack of fluctuation) of these returns, their sustainability and the degree of reduction in income inequality which it brings about.

Examining these attributes in relation to the adoption of 'Green Revolution' technologies in Bangladesh, Alauddin and Tisdell (1991) found the following:

1. Crop yields (rice and wheat) were substantially increased by the adoption of these technologies. In addition, the cash income of food grain producers was estimated to

have risen by 5-6% in the period 1967-9 and 1980-2 using the model of Hayami and Herdt (Alauddin and Tisdell, 1991, p.107).

2. The relative variability of annual food grain yields declined substantially. This was partly due to the increase in the incidence of multiple cropping and partly due to a larger proportion of the crop being grown under controlled environmental conditions e.g. irrigation in the dry season. Multiple cropping increased the number of independent or at least semi-independent events in a year, thereby leading to reduced relative variability of the combined annual results. Furthermore, greater environmental control as a result of man-made investment e.g. in irrigation, and greater human effort meant that the sensitivity of the yield of HYV crops to variations in environmental conditions was not able to assert itself fully.
3. On the matter of sustainability of yields, Alauddin and Tisdell (1991) expressed concern on several grounds. These included deterioration in soil quality as a result of the use of new agricultural technologies e.g. farm soil structure, loss of organic matter, acidification and so on. Greater use of fertiliser and energy might be necessary in the future to try to compensate for soil changes. Loss of genetic diversity could also have long term adverse consequences e.g. loss of backstop local varieties of rice. Problems of controlling pests could increase because of increasing resistance of pests to pesticides and the loss of natural enemies of pests as a result of the use of modern pesticides. Adverse externalities may also become more apparent e.g. waterlogging of land or salinity as a result of irrigation, unsustainable use of water supplies, especially underground supplies.
4. The consequences of the Green Revolution for rural income distribution and wealth distribution are complicated because changes in these variables have a number of different dimensions. Alauddin and Tisdell (1991, p. 160) found evidence of "increasing concentration of use and control of agricultural land in Bangladesh, and of increasing inequality in the ownership of ancillary resources such as irrigation water,



essential for the success of the bulk of Green Revolution technologies. Increasing landlessness and near landlessness is making the Bangladeshi rural poor more dependent on wage employment for their subsistence". On the whole, wage employment provides less security than employment based on land ownership and/or access to communal resources.

In relation to wage employment in Bangladesh, there appears to have been very little increase in the number of man-days of casual agricultural employment and little or no increase in rural real wages (Tisdell and Alauddin, 1992). However, since the advent of the Green Revolution, agricultural employment has become more evenly distributed throughout the year. Agricultural employment possibilities have not fallen but they have not increased significantly. Real wages have hardly increased, if at all but steadier employment throughout the year is available. While the Green Revolution has helped to increase non-agricultural employment in Bangladesh, it has not been harnessed to industrialise Bangladesh on a major scale.

On the whole, the economic situation of the rural landless and near-landless may have deteriorated since the 'Green Revolution'. The landless and the near-landless numbers of the rural community, who tend to be its poorer members, depend upon two main sources of income: (1) exchange income, mostly from wage-employment and (2) non-exchange income such as that obtained from the gathering of fuel, fodder for animals, edible plants, fish, collection of water from generally accessible 'communal' places or from larger properties where in the past these commodities might have been provided as a free service or for a low payment. Opportunities to obtain non-exchange income are rapidly disappearing because private property rights are being more rigorously enforced and are being extended as a result of the Green Revolution and population pressure. In addition, unfavourable externalities from this Revolution are reducing the natural productivity of communal property e.g. the fisheries, and reducing supplies of natural resources due to overuse of shared resources e.g.

waterholes pumped dry during the dry season for irrigation. It appears that some impoverishment of the rural landless and near landless has occurred as a result of reduced natural resource availability and reduced opportunities for the poor to gain access to remaining natural resources. This has, for example, happened in the Barind Tract, Rajshahi Division. Communal tanks and water bodies have become silted due to changed land-use and large farmers are now using the silted beds of these for crop growing or are excluding community members from these tanks.

It might be noted that Conway's concept of sustainability (Conway, 1985,1987) is based upon the degree of resilience of an agricultural system. Other concepts exist e.g. sustainability as intergenerational equity in income distribution, ecological sustainability that is, the maintenance of biodiversity, and the sustainability of community (Tisdell, 1993, 1991). Achieving sustainability in one of these dimensions may promote its achievement in other dimensions but not always.

### **3. Village Surveys in West Bengal**

In order to gain a better insight into the economic effects of environmental and technological change in rural areas of the type mentioned above, surveys of selected villages in Bangladesh and West Bengal were undertaken in 1992. One of the main purposes of these surveys was to get an indication of the extent of natural resource loss and its consequences for income loss as a function of the economic position (situation) of households. In addition, the questionnaires were designed to elicit information about changes in social obligation, charity and social cohesiveness and the intrusion of the market system into social relationships, migration, environmental change, technological change, the economic position of income and children and the prospects for survival of the village.

In September 1992, three villages (Barakuli, Kamla and Maharajpur) near Mindapur, West Bengal were surveyed. (For further details see Tisdell et al., 1996). Direct interviews were undertaken of household heads, using a questionnaire designed by Dr. K.C. Roy and Clem Tisdell. Interviews were supervised by Dr. Roy. Most of the villagers were tribals, in

fact Santals. All told 86 households were surveyed and 98% of their household heads claimed that their income was insufficient to meet their basic needs. Very little charity was given or received. Only one rich family gave charity which took the form of an invitation to a feast. All village members believed that they were more commercial in their dealings with one another than in the past and most (over 80%) believed that there is less community spirit and sharing in their village than in the past. Apart from the 7% who did not respond to this question, the remainder said that their village is more market-oriented than in the past. Furthermore, 70% said that the giving of commodities to satisfy social obligations or needs in their village is less important than in the past.

Apart from the 7%, who did not respond to this question, all of the household heads said that the state of their local environment and the availability of natural resources had deteriorated. Ninety percent said that this had had an unfavourable effect on their economic welfare, 8% said that the changed effect was favourable, and 2% did not respond to this question. Only a few of the very poor or the poor said that environmental change had been favourable for them economically. Seventy-two percent of the households said that if the availability of natural resources and the natural environment was the same as 5-10 years ago, the economic position of their household would be better, whereas 27% said it would be worse and 1% did not respond. Most households claimed to be worse off as a result of environmental change and most households (87%) said that this change had made it more difficult for some members of their households to contribute to the livelihood of their family. On average, the lower the income of the family the more frequently was increased difficulty said to be experienced on the employment side because of environmental change.

In these villages, forest cover has declined and considerable replacement of indigenous forest by introduced eucalyptus has occurred. This has several unfavourable environmental consequences. It now takes householders a longer time to collect a smaller amount of forest product and less opportunities are available to graze animals and collect

fodder. More time is spent on water gathering, leaves from eucalyptus trees do not provide income and are unsuitable for fodder.

Several modern technologies have been introduced into the villages in the last 10 years. Seventy-one percent of householders thought that these had a bad impact, 25% considered their impact to be good, 1% said the impact was neutral and 3% did not respond. Ninety-four percent of households said their employment was affected. Eighty-one percent considered the employment effect to be favourable, 17% believed this effect to be unfavourable and 2% gave no response. Those who classified themselves as being in an average economic situation in the village less frequently said that the employment effect had been positive. Eighty-nine percent of respondents considered that it was now easier to obtain paid work as a result of technological change. In most cases it was easier for women to obtain work if allowed by their caste. However, 80% of respondents indicated that it was not easier for children to obtain work.

So we have mixed results: natural resource loss has led to a reduction in real income (or welfare) but technological change has increased the availability of paid work opportunities, according to the villagers surveyed. As mentioned above, more than 90% of respondents believed that their economic welfare had been adversely affected by environmental change in their village.

In order to specify and quantify the significance of environmental and natural resource changes at village level on the economic situation of households, household heads were asked the following:

'Suppose that the availability of natural resources and the natural environment was as it was 5-10 years ago. Would the economic situation of your household be better, worse or the same? If better or worse, 'percentagewise' by how much would it be better or worse?'

Nearly all household heads responded that they would be in a better economic position and indicated the extent to which their economic situation would be improved

'percentagewise'. Answers ranged from a 2.5% improvement to a 97.5% improvement, except for respondents indicating no change. On average, respondents in the three Bengali villages believed that their economic situation would be improved by almost 50% (48.9%) by restoration of their pre-existing stock of natural resources and their previous environmental state. Thus clearly householders at the village level consider that the loss of natural and environmental resources is leading to a substantial loss in their opportunities for enhancing their economic welfare. It is uncertain whether the benefits from agricultural development are sufficient to compensate for these lost opportunities.

In addition, it is revealing to consider how the responses to the above query varied with the current economic status of householders within their village. In order to determine the relative economic status of each household in its village, each household head was asked to indicate the percentage of households in their village in a better economic situation and the percentage of those in a worse economic position. The mid-point in the range between these two figures was used as a percentile economic ranking of the household. It is a proxy for the relative economic status or income level of the household. It makes use of the self-ranking method (Sathiendrakumar and Tisdell, 1986; Firdausy and Tisdell, 1992) which appears in practice to be surprisingly accurate. Similarly, household heads were asked whether they considered their household to be very poor, poor, average, rich or very rich.

Considerable variation exists among households for the percentage improvement in their economic situation to be expected from restoration of their natural environment. The scatter of these percentages are plotted on Figure 1 in relation to the percentile ranking of households of their economic position in the village.

A regression line can be fitted to this set of data. The line estimated by least squares is:

$$y = 56.51 - 0.288x \quad (1)$$

where  $y$  is the percentage improvement in the economic situation of the household expected by the household head and  $x$  is the percentile ranking of the economic position of the

household. This line indicates that the poor can be expected to benefit proportionately most by restoration of the natural environment. However, the coefficient of determination for this relationship is low because  $R^2 = 0.13$ .

Despite the low  $R^2$  value, the general relationship is clear. On average, it seems that relative to their economic situation, the economic cost (or opportunities forgone) by the poorer members of society are greater than for those forgone by the richer ones. Loss of the natural environment seems to have an income regressive effect.

A further observation should be made in relation to Figure 1: The scatter of observations for  $y$  (the variance of  $y$ ) is much greater for households in lower income groups than for those in their income groups. This means that *some* poor households do not believe restoration of the previous natural environment of the village would do much for their

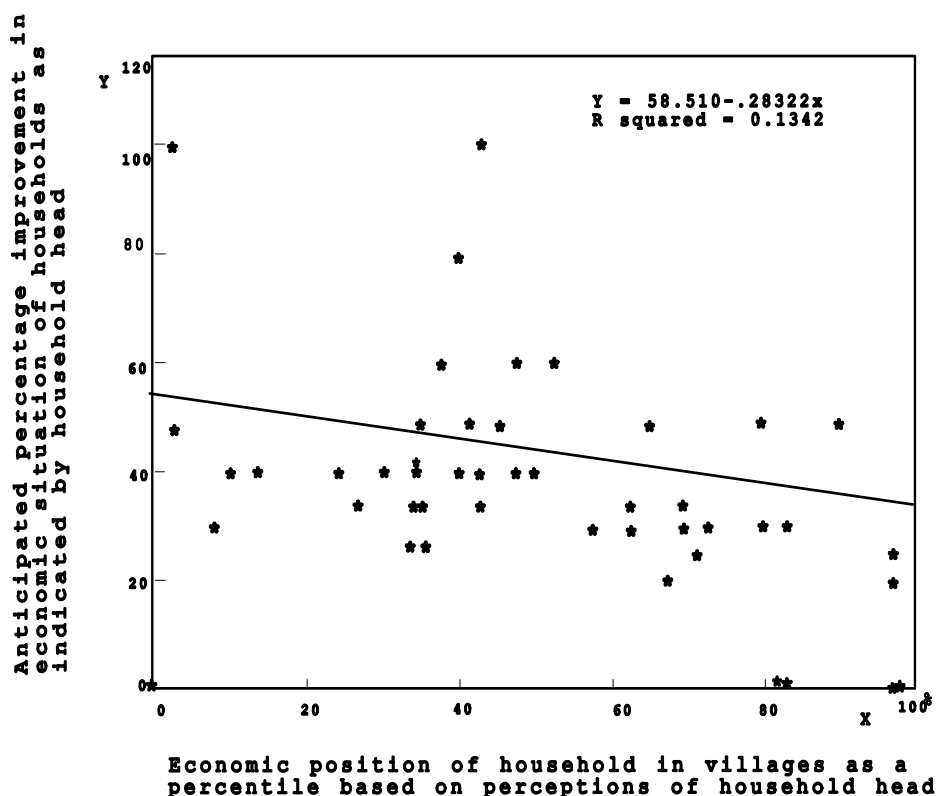


Figure 1 Anticipated improvement in the economic position of households for restoration of natural environment/resources of 5-10 years ago as a function of their relative economic position in the villages of Barakuli, Kamla and Maharajpur, India, September, 1992.

economic situation but other poor villagers believe that the effect would be substantial for them. The latter is not the case for the richer village members. The poor stand to benefit most it seems in relative terms by environmental or natural resource restoration.

It might be noted that economic development tends to lead to the increased privatisation of natural resources. There is evidence of scheduled classes and tribes being dispossessed of their customary access to land resources by enclosures or variations in property rights, a process which began with British occupation but which has continued in recent times. Because of their relative lack of education and positions of social influence, tribal people have been unable to defend their customary or *de facto* rights to the use of forests and other natural resources. Such a process of systematic dispossession by legal means has not, however, been confined to India. It is a sad indictment of human behaviour that dispossession of tribal people has occurred in many countries both capitalist and non-capitalist in the last few centuries and is still continuing. Nath (1992) has observed, in relation to Orissa:

'The landless peasants and agricultural labourers should have been the principal beneficiaries from the land reform measures, but paradoxically it rendered them landless.. Changes in the legal structure in respect of common property resources like land, forest, water, mineral, rivers, stream introduced during the British period and which are continuing today in amended form further alienated them from their traditional source of employment and living. These changes further led to privatisation of common property in favour of some by excluding the vast majority. This is the basic factor in peasant differentiation' (Nath, 1993, pp. 284-285).

#### **4. Results from a Village Survey in Bangladesh**

Data from the village of Durgapur in western Bangladesh collected in 1992 is consistent with the results obtained from India. A similar questionnaire was used and Dr. M.

Alauddin arranged for the interviews. Observations were obtained from 127 household heads and on average they indicated that they would expect a 32.36 percent improvement in their economic situation with a return to the natural resource base/natural environment of five to ten years ago. While considerable variation exists in improvement expected, the coefficient of variation of 42.5% was somewhat lower than for the Indian villages for which it was just under 50%. The range of anticipated percentage improvement in economic situation (its variance) of households in Durgapur tended to vary inversely with the economic position of the household, as in the Indian case.

Respondent household heads in Durgapur were asked to locate the economic position of their household in the categories (1) very poor, (2) poor, (3) average (4) rich, (5) very rich. Table 1 shows the average expected improvement in the economic situation of each of these groups for restoration of natural resource loss in the last five to ten years. While the proportionate amount of expected improvement falls with rises in the economic position of families, it does not do so as quickly as in the case of the Indian villages surveyed.

Percentile rankings of the economic position of households were also considered. As in the Indian case the variance of observations tended to be higher for those on lower incomes than for higher incomes. The line of best fit to the data using least squares is

$$y = 33.35 - 0.025x \quad (2)$$

A very weak negative correlation,  $R = -0.39$ , exists between  $y$  and  $x$  and only a slight fall occurs in percentage expected improvement with increases in the economic position of the household. However, we can conclude that on average the relative benefit expected by the poor from natural resource restoration is at least as great as for the rich. Hence, given the diminishing marginal utility hypothesis, the relative gain in utility by the poor as a result of natural resource restoration would on average, be greater than for the rich.



**Table 1** Percentage Improvement in Economic Situation Expected by Household Heads in Durgapur, Bangladesh, 1992 from Restoration of Natural Resources to their levels of 5-10 Years prior to 1992.

<b>Economic Group*</b>	<b>No. of Households</b>	<b>Income compensation. % needed on average</b>
Very poor	18	34.7
Poor	71	32.8
Average	33	30.7
Rich	5	28.0

\* No household considered itself to be very rich.

## **5. Concluding Comments**

From the results above of surveys of rural villages in West Bengal and Bangladesh, the opportunity cost to villagers of natural resource loss and environmental deterioration in the last decade has been substantial. Such costs are often ignored, as is mainly so in Quibria (1994). Both in the Mindapur District and in Durgapur, nearly all villagers indicated that their economic position would be much improved by natural resource restoration. The average percentage improvement for Durgapur was lower than for the three villages in the Mindapur District. The lower figure for Durgapur might be explained by the smaller initial stock of natural resources in Durgapur and the greater dependence of the Santals in the Mindapur District (and elsewhere) on the utilisation of natural resources, compared to Bengalis in Durgapur. However, all the income groups in all the villages claimed on average to have suffered a substantial loss in income opportunity due to natural resource loss and environmental deterioration. Of course, it might be argued that the restoration of the previous environmental situation for the villages is a pipe-dream. This, however, is not the point. The point is to bring out the fact that environmental loss involves economic cost. The percentage loss in income opportunities on average suffered by the poorer members of the villages was greater on average than the claimed loss by the richer members. Thus on average, losses in income opportunities resulting from natural resource/environmental deterioration have been regressive in rural areas judging from the results of the surveys reported here. While it is too early to generalise these results, they should not be ignored.

Note that these results do not indicate that the incomes of villagers have been reduced on average as a result of environmental change, but rather that villagers perceive considerable lost economic opportunities as a result of environmental changes. They are very aware of the opportunity cost of 'development' which depletes natural resources and degrades the environment. In their own informal way, they are sensitive to the need for natural resource accounting (Cf. Adger and Whitby, 1992; Bartelemus, 1991; Pearce et al., 1990).

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