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by

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AGRICULTURAL SUSTAINABILITY IN MARGINAL AREAS: PRINCIPLES POLICIES AND EXAMPLES

1. Introduction

Because of rising populations and advances in agricultural techniques, agriculture on marginal lands in South Asia has intensified and the margin of cultivation has been extended mostly at the expense of natural environments. While doubts have been raised about the sustainability of many modern agricultural practices, such as those associated with the green revolution, on the fertile plains of the Indian subcontinent (Alauddin and Tisdell, 1991), it is the upland areas, covering a major portion of the subcontinent, that are especially at risk due to agricultural developments. These areas also contain a high proportion of South Asia's tribal people or its minorities and much of its remaining wildlife.

The purpose of this chapter is to discuss generally the principles of sustainable agriculture and consider case material from two upland areas in South Asia, namely agriculture in the Barind Tract in the Rajshahi Division, Bangladesh and agriculture in north-eastern hills of India. Unlike the north-eastern hills, the Barind Tract is a relatively low undulating area but nearly all of it above flood. In comparison, the hills of north-eastern India rise to considerable elevations (especially in the Himalayan portion bordering China) and are often steep and heavily dissected. In the Chittagong Hill Tracts, the hilly areas of north east India extend into Bangladesh.

Let us consider the principles of sustainable agriculture in the context of South Asia, followed by case material for the Barind Tract and observations on agriculture in the north-eastern hills of India.

2. Agricultural Sustainability: Some Principles

Economic sustainability requires care to be taken of the natural environment, as does agricultural sustainability if agriculture is to remain economically viable in the long-term. If attention is not paid to the sustainability of economic production, future generations may be impoverished and even present generations may experience a decline in their incomes. For example, this result follows when land management results in a rapid rate of soil erosion and loss of valuable topsoil. As explained in Chapter 2, the productivity of economic systems and the state of the natural environment are interconnected. Economic systems (including the agricultural economic sector) may fail to sustain their productivity because (1) they produce wastes and pollutants which cannot be readily absorbed by the natural environment so reducing the quality or availability of natural resources or (2) because they irreversibly deplete or degrade natural resources.

In general, economic activity, including intensification and extension of agriculture, involves depletion or degeneration of natural resources. Extension of agriculture for example often leads to the loss of natural forests and the use of so called 'wastelands' or <u>khas</u> lands in India. These wastelands include wetlands. In the past, it was common to regard 'wastelands' as unproductive but from an environmental and biological point of view they can be extremely productive in their natural state, and often unsuitable for cultivation for very long. Furthermore, intensification of agriculture can easily result in declining long-term productivity. For example, artificial fertilizers may cause the soil to become acidic, soil structure may deteriorate due to excessive cultivation, valuable topsoil may be eroded away and soil nutrients may be mined quickly on light or poor soils such as those of the Barind Tract discussed below.

The main factor able to offset declining economic productivity due to environmental deterioration is technological progress. It usually enables greater economic production to be achieved using fewer inputs. It has enabled economic production to increase despite natural resource depletion and deterioration. While optimists take continuing technological progress for granted, in reality the likely extent of such future progress remains uncertain.

An additional factor that may offset the impacts on economic production of resource depletion is investment in man-made capital. But production of man-made capital involves the conversion of some natural resource stocks into such capital and so these stocks are further depleted. Furthermore, all man-made capital has a limited life. Consequently, unrestrained accumulation of man-made capital may not be a suitable long-term offset to or substitute for natural resource depletion (Pearce, 1993). In the early stages of depletion of natural resources such substitution is likely to be beneficial from an economic point of view, but as substitution proceeds and natural resource stocks are reduced, substitution becomes more problematic from an economic standpoint. Because many Asian countries have already depleted their natural resource stocks considerably, they might enter the problematic trade-off zone much earlier than anticipated by their political leaders.

Environmental economists differ about how much caution is needed in promoting economic changes affecting the natural environment. Nevertheless a group favouring sustainable development stress the importance of applying the precautionary principle, that is of planning which anticipates future possible environmental consequences. This is because many environmental changes which can be brought about by economic activity are irreversible (e.g. extinction of species) or can only be reversed at great cost. Furthermore, many of these changes are uncertain and some may not provide signs of adverse environmental consequences until it is too late to adopt preventative or countervailing measures.

In relation to agricultural development, adverse environmental consequences can be very costly or uneconomic to reverse e.g. desertification, salinisation of soils, or soil erosion.

3. Sustainable Agricultural Techniques and Systems of Land Management

The sustainable use of an agricultural technique of production depends not only on its biophysical sustainability in use but also on its economic viability and social acceptability.

Whether or not a technique is likely to be sustainably used appears to depend on three factors:

(1) the biophysical sustainability of its use,

(2) its economic viability, and
(3) its social acceptability.

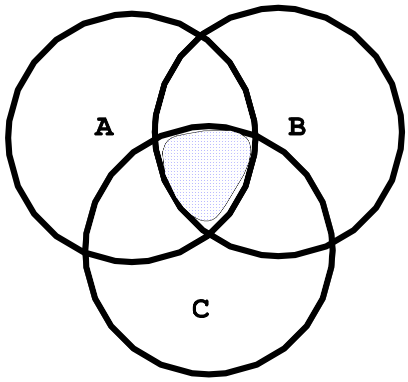
Thus a sustainable agricultural technique would be one that is economically viable, socially acceptable and biophysically sustainable. In Figure 8.1, if A represents the set of available economically viable techniques, B is the set of socially acceptable techniques and C is the set of biophysically sustainable techniques, only those techniques in the overlapping set (dotted) would be fully sustainable. In practice, we cannot be sure that such sets will overlap. However, it is possible that they *may be made to do* so as a result of extra research and development effort. Many agricultural research bodies (including international research bodies such as those belonging to CAGIAR group) have now included sustainability of agricultural techniques as an objective in their research agenda.

This discussion can be extended by considering what would be required for economic viability, social acceptability and for biophysical sustainability. Different authors appear to have somewhat different suggestions about these requirements.

Gordon Conway (1985, 1987), for example, in considering the evaluation of agricultural systems measures (1) their economic viability by their level of returns or yields also taking account of the degree of instability of these, (2) their social acceptability by the impact of these techniques on the distribution of income, and (3) their biophysical sustainability by the ability of yields to recover to former levels after being subjected to an environmental shock.

Conway considers that traditional agricultural techniques are generally more sustainable and have a better impact on income distribution than modern agricultural techniques. On the other hand, they give lower levels of returns than modern techniques but their returns may be more stable.

Nevertheless, basically Conway defines sustainability in biophysical terms, that is the ability of yields to return to former levels after experiencing an ecological shock. For the cases illustrated in Figure 8.2, inset (a) indicates a sustainable case and (b) illustrates an unsustainable case.



A: Economically viable techniques

B: Socially acceptable techniques

C: Biophysically sustainable techniques

Figure 1 Basic requirements for the sustainability of agricultural techniques. Only techniques or projects in the overlapping sections (dotted) satisfy all the requirements for sustainability.

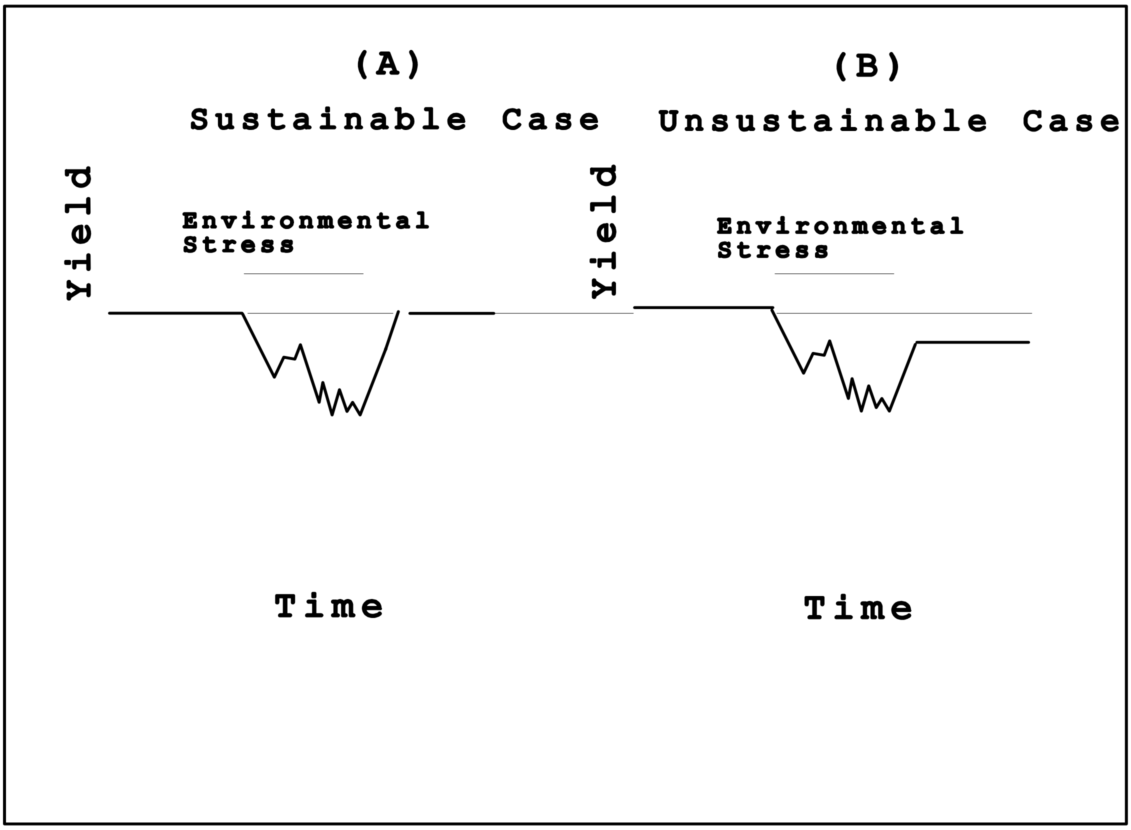


Figure 2 Illustrations of sustainable and unsustainable agricultural systems according to Conway (1985, 1987).

Somewhat different and more complex views have also been expressed about what may be required for social sustainability and for economic sustainability (Tisdell, 1993, Ch.9). Some writers (e.g. Douglass, 1984) for example, have suggested that 'community' or communal cohesion must be retained for social sustainability to be achieved.

Normative and positive attitudes to agricultural sustainability - what is versus what ought to be

It is possible to consider whether something ***is*** sustainable such as income or yields from cultivating a crop using a particular technique. This is a *positive* approach to analysing sustainability. Another approach is to consider whether it is *desirable* for some particular thing to be sustained. This is a normative approach.

Very often a clear distinction is not made between what it is *desirable* to sustain and what *can be* sustained, that is between normative and positive statements. One needs to look critically at discussions from this point of view. For example, those recommending strong conditions for sustainability (*emphasizing the importance of conserving natural resources*) may do so because (1) they have ecocentric values or (2) they believe that given current conditions, any further reduction of natural environmental stocks will threaten the economic well-being of future generations or (3) they hold both viewpoints.

It cannot be overstressed that the goal of sustainability is of little value in itself and rather meaningless unless we specify sustainability of what. Indeed, there are some situations which it is undesirable to sustain, e.g., poverty.

Economics and sustainability of agricultural production

According to neoclassical economic theory, economic activity will only be sustained by the private sector as long as it is profitable. Unfortunately, private economic decisions do not always ensure long-term sustainability of environmental resources or production.

Private economic greed can threaten sustainability.

Desire to make large short-term profits may motivate individuals to destroy natural resources such as forests, drive species to extinction and mine the land. This could also occur because people are desperately poor, but in this case their power to transform the natural environment is rather limited because they lack capital. These changes may even happen when private rights to property are fully secured in land and natural resources. This is not to say that market economic systems do not support conservation of natural resources in some cases. They do but only if this is privately profitable.

Inappropriate property rights threaten sustainability.

In some cases, *lack of property rights* is a disaster from a conservation or sustainability point of view. This is so for *open-access* resources, that is a resource which all are free to exploit, if they are in strong demand. In the past, fishing stocks were brought to extinction or close to extinction by open-access e.g., consider the stock of whales. In Asia, access to many water resources, especially underground water has been open, and this is resulting in their excessive and inappropriate use from an economic point of view.

Private economic viability versus social economic benefit.

Private economic profitability of the use of a technique or agricultural system is necessary in most economies if the use of the technique is to be sustained. However, this does not mean that the technique is socially desirable or that its social economic return is positive. The private costs of using a technique may be less than its social cost because some of the costs are passed onto others without compensation and consequently economic externalities or spillovers occur. For example, the clearing of land for agriculture may increase water run off and increase flooding and erosion downstream imposing costs on other farmers. The flow of streams may also become more erratic and so impose additional costs on others. This is a problem arising from increased cultivation of hilly areas of much of South Asia.

Similar problems may occur in shared water bodies. Wastes may be disposed of into such bodies by economic agents and impose costs on others. The uncontrolled withdrawal of water from such bodies for irrigation can result in water shortages and a decline in agricultural production dependent on such irrigation. Examples are available from many areas in South Asia and some are given later.

Private and social returns from projects or economic activity need not coincide. This will be the case when significant environmental spillovers or externalities arise from private economic activity. Thus three possibilities exist:

(1) Projects that are economically viable privately but give a *negative* social economic return.

(2) Projects that are privately economically viable and also give a *positive* social economic return.

(3) Projects that are not privately economically viable but which give a *positive* social return. These three possibilities are represented by the Venn diagram shown in Figure 3.

Projects in Group 1 are unsatisfactory from a social point of view and are likely to threaten the sustainability of production. The government should consider measures to prevent economic entities, e.g., farmers, from engaging in these activities. Projects in group (2) are socially desirable and are likely to be adopted by farmers if known to them. Projects in group (3) are socially beneficial but will not be undertaken by private business. It may be desirable for the government to adopt policies to make these projects privately economically viable (for example, they might be subsidised by the government) or in some cases, these projects might be undertaken by the government.

Sustainability of use of agricultural techniques in a dynamic context

The world is subject to continual change. Consequently agricultural techniques of production which seem to be sustainable in a stationary setting or one of little change may not be viable in a changing world. For example, shifting or swidden agriculture may be very sustainable at low

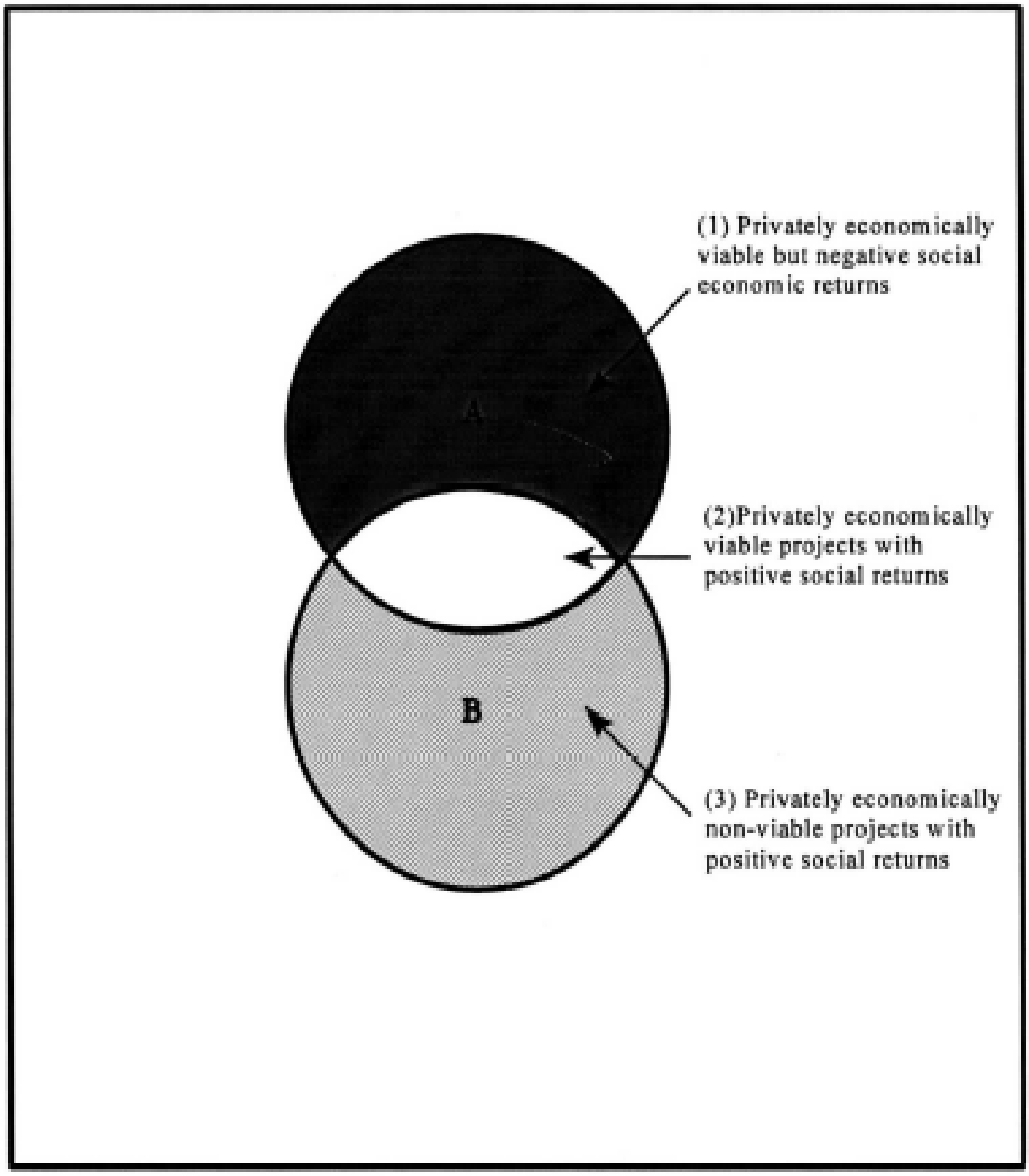


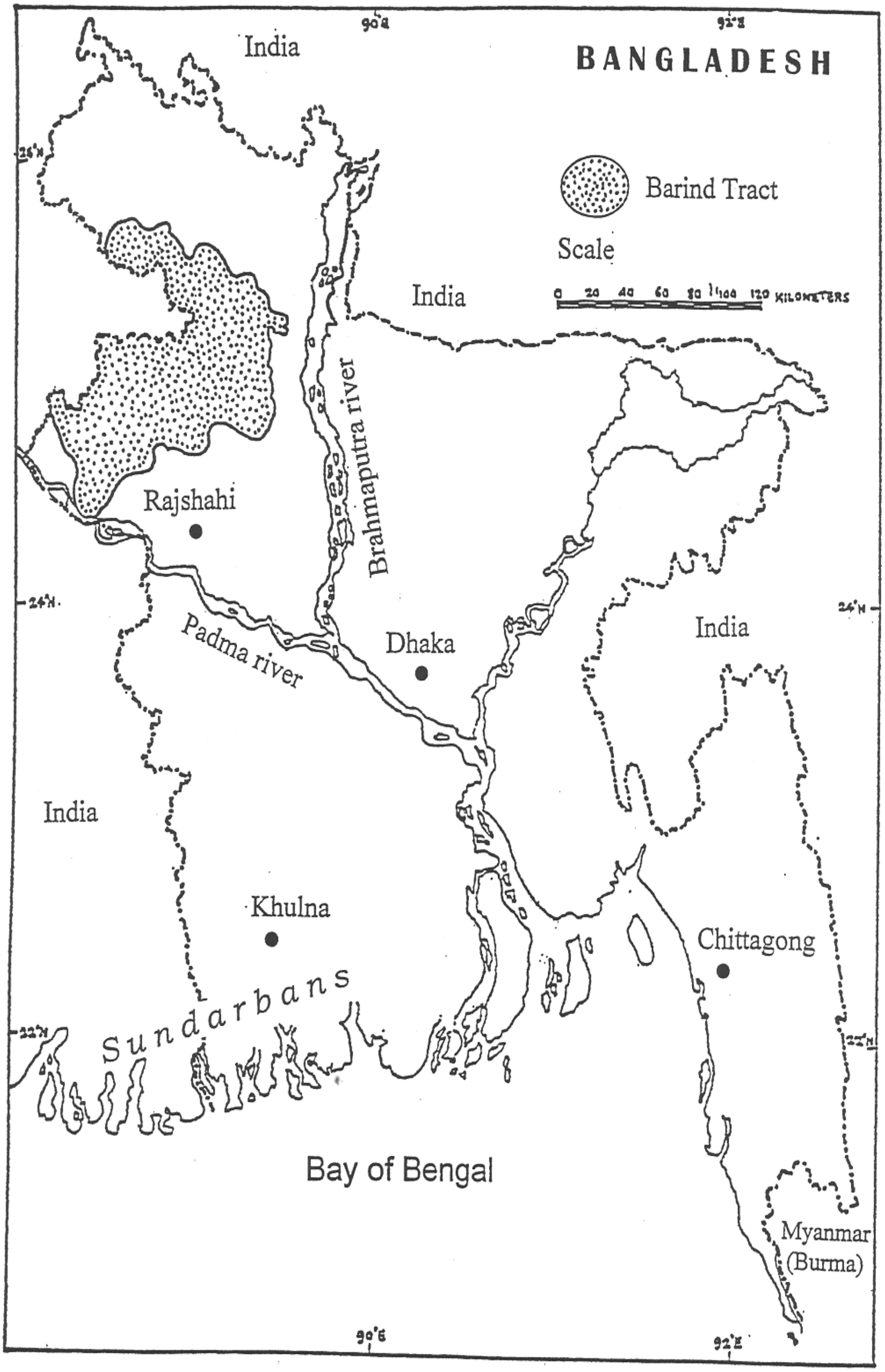
Figure 3: Due to environmental spillovers or externalities, private and social benefits from economic projects may differ. The above diagram indicates three alternative possibilities

levels of population density (Ramakrishan, 1992), but becomes unsustainable as population densities increase and the length of the cultivation cycle becomes shorter. This has happened in a number of parts of the world where shifting agriculture is practised e.g. in Northeast India. In such circumstances, it is important to search for alternative agricultural techniques which may prove to be more sustainable in the changing circumstances. This illustrates the importance from a policy point of view, of making the best adjustment to attain sustainability of production when particular trends are apparent and cannot be counteracted. This will for instance be apparent for the study below of Northeast India.

4. Agricultural Sustainability in the Barind Tract, Northwest Bangladesh

The Barind Tract covers much of the North Western region (Rajshahi Division) of Bangladesh (see Figure 4) and extends into West Bengal, India. In Bangladesh, the total area of Tract is 7,296sq km. While most of Bangladesh consists of flood-prone riverine plains and some is hilly (e.g. Chittagong Hill Tracts, and parts of Silyhet), the Barind Tract is an elevated, undulating terraced area and is flood free. Its physical features have been described in detail by Rashid (1991, pp. 13-15) and by Brammer (1996).

Compared to the rest of Bangladesh, its Northwest has relatively unfavourable climatic conditions for agriculture. Ninety percent of its rainfall of 1200 to 1400mm occurs within the three month period, June to August. Because of the nature of the soils (discussed below) and the monsoonal downpour, much of this rainfall is lost as surface runoff and causes considerable soil erosion. During the dry period of seven to eight months, evapotranspiration exceeds precipitation. In addition, the length of the monsoon varies considerably and extremes of temperature are experienced with many summer days above 40^0C and several winter days below 5^0C.


BANGLADESH
Barind Tract
Scale
0 20 40 60 80 100 120 KILOMETERS
India
India
India
India
Rajshahi
Brahmaputra river
Padma river
Dhaka
Khulna
Sundarbans
Chittagong
Bay of Bengal
Myanmar
(Burma)
90°E
92°E
26°N
24°N
22°N

Zuberi (1992) reports the topsoil is very thin (often sandy) and beneath there is a hard clay pan. The clay pan impedes the penetration of water to underground areas and the water holding capacity of the soil is low. Furthermore Zuberi (1992) points out that the organic content of the soil is low (organic matter accounts for only 0.5 to 0.7 percent of the soil content) and that the soil is deficient in plant nutrients such as nitrogen, in zinc and sulphur and trace elements.

Considering all these aspects, Northwest Bangladesh is a marginal area for agriculture, particularly crop growing. Nevertheless, cultivation in this area has expanded and more than three-quarters of the land in Northwest Bangladesh is under cultivation, a higher percentage of land than in the more fertile Northeast (Dhaka Division) which has about 71 percent of its area under cultivation. In the Southwest area (Chittagong Division) 43 percent of land is under cultivation and in the Southwest area (Khulna Division) 63 percent.

Table 1
Land Utilization in Bangladesh (1989-90): area in _000 hectares

Item 1	North West area	% 2	North East area	% 3	South East area	% 4	South West area	% 5	Bangladesh area	% 6
1. Total land area	3457	-	3643	-	3172	-	4026	-	14289	-
2. Not available for cultivation	731	21.0	718	21.0	402	12.7	868	21.6	2782	19.5
3. Forest	14	0.4	176	4.8	1350	42.6	603	15.0	2134	15.0
4. Cultivable waste	77	2.3	83	2.3	54	1.7	21	.05	235	1.6
5. Current fallow	110	3.0	182	5.0	135	4.3	90	2.2	517	3.6
6. Net cropped area		2525	2412	66.2	1231	38.8	2444	60.7	8612	60.3
7. Net cultivable area (a)	2635	76.0	2594	71.2	1366	43.1	2534	62.9	9124	63.9
Net cultivable area (b)	2773	80.0	2778	76.2	1261	39.8	2744	68.2	9562	66.9

(a) Net cropped area + current fallow (5+6).
(b) Upzilla maximum area of crop.
Based on data from Bangaladesh Statistical Service

Table 1. specifies land use patterns in the four divisions of Bangladesh. It highlights the high degree of cultivation in the Rajshahi Division and indicates little scope for extension of cultivation in this region. The extent of the forested area in this division is the lowest in Bangladesh at approximately 0.4 of a percent of its land area. The Chittagong Division shows greatest forestation (Chittagong Hill Tracts and mangrove forests) and Khulna, the second highest degree of forestation mainly because of the presence of the Sunderbarns.

About 100 years ago, less than 50 percent of the land in the Barind Tract was under cultivation. Zuberi (1992, p.6) states that " in the past, there was a long sustained, stable land use system as indicated from the historical accounts; the comparatively flat areas were cultivated with Aman (rainfed) rice while the elevated high lands and slopes were grass lands and low jungles covered with fuel and fruit frees." Elsewhere Zuberi (1993, p.5) maintains that "North Western Bangladesh practically has no forest cover at all. But recent historical accounts show that more than 50 percent of the area was covered with natural vegetation." Hunter (1877) reported that this area was fairly well wooded. But with the expansion of agriculture and increased population, most of these natural areas have been destroyed, along with the rich biodiversity associated with these.

Loss of natural vegetation cover has reduced additions to soil organic matter, disrupted natural nutrient cycles and has exposed the soil to the elements resulting in rapid erosion of topsoil. In addition, rapid heating of the topsoil occurs thereby quickly oxidising organic matter remaining in the soil. Water retention and penetration of the soil has also been reduced by loss of natural vegetation cover, especially reduced tree cover.

Since the early 1940s cultivation of the Barind Tract has expanded at the expense of forested land, 'wasteland', grazing land, by the increased use of areas formerly used as ponds but either deliberately filled with soil or filled by silt from increased soil erosion.

The major portion of the cropland of the Barind Tract is used for rice production and most of this rice land is now sown with High Yielding Varieties (HYV) of rice. But paddy is a high user of water and encouragement of its production in a water-scarce region is risky, especially since it may quickly degrade the poor soil of this region.

Government policy has been to encourage intensification of cropping in this region including the increased cultivation of HYV rice. To this end, it established the Barind Integrated Area Development Project (BIADP) within the Ministry of Agriculture. Against advice from foreign experts, deep tube wells are being installed in this region under this project (*The Daily Star, July 13, 1996*). One problem is that the use of water from underground sources is liable to exceed the rate of recharge of the aquifers. The actual and planned water supplies from these sources are in all probability unsustainable in the long-term. Already watertables have fallen in some areas. For example, mango trees are reported to have died in some areas around Rajshahi due to falling watertables.

Irrigation from underground sources has enabled the area doubled cropped and triple cropped to be substantially increased. This raises the rate of depletion of soil nutrients and accelerates soil erosion. Hence "reports of HYV (rice) yields of 2.6 t/ha decreasing to around 2.0 t/ha or lower (even only 1.2 t/ha) in many areas, are common in recent years" (Zuberi, 1993, p.6). Consequently several reports and papers highlight the lack of sustainability of current agricultural practices in this region and there is significant land degradation with evidence of desertification in some areas (Ministry of Environment and Forestry and IUCN, 1991). In addition, it seems probable that current and planned supplies of underground water for irrigation are unsustainable. Thus the longer term prognosis for agricultural production in this region are bleak and the possibility of future environmental refugees from this region cannot be dismissed. This raises several questions in political economy. In particular why should the government support agricultural developments which, on the face of it, result in unsustainable increases in income?

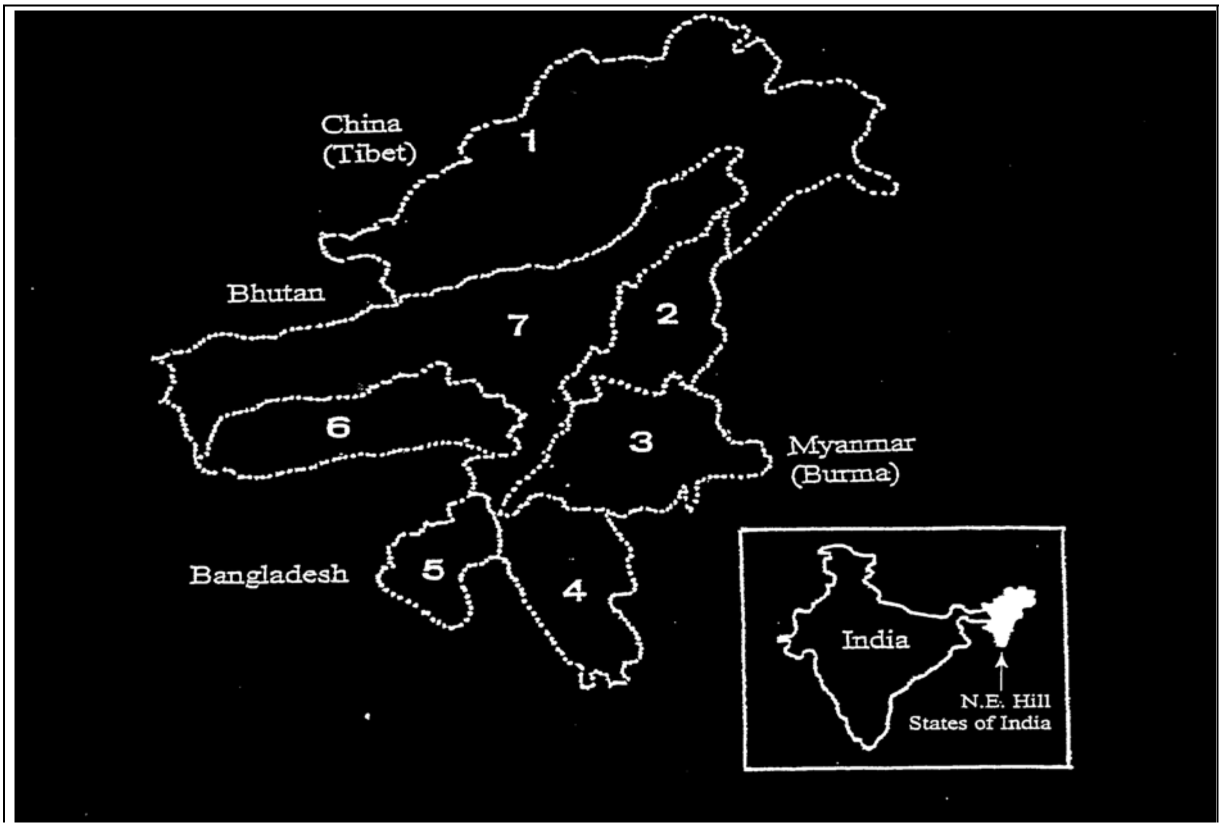
There are several possible explanations. First, governments tend to be myopic in their decision-making. Existing government is able to claim credit for increases in income in the short to medium term. In the long term, if incomes have fallen, the government has usually changed and the issue of responsibility for projects which prove to be environmentally unsustainable becomes confused, particularly if there is initial uncertainty about whether the projects involved are sustainable. Furthermore, policies to restrict use of resources such as use of underground irrigation water are liable to be politically unpopular e.g. to introduce pricing which reflects user-costs. Consequently, political mechanisms are unlikely to favour conservation and sustainability. This appears to have been the case in the Barind Tract.

It may also be that low incomes in this region result in a strong time preference for present consumption and a belief that the long-term will somehow take care of itself. Whether it does or not will depend on whether increases in man-made capital (combined with technological progress) compensate for the decline in natural resources in the Barind Tract. There is no indication that this is going to happen. This would not, however, be a problem if adequate capital accumulation were to occur in Bangladesh as a whole since there could be outward migration from the Barind Tract should its capital stock (natural resource stock plus man-made capital) and incomes decline. However these possibilities do not seem to have been considered by those determining land use in the Barind Tract. There is no guarantee that the rest of Bangladesh will be able to provide adequate income for environmental refugees from the Barind Tract.

5. The Sustainability of Agriculture and Related Land-Uses on the North Eastern Hills of the Indian Subcontinent

Much of the Northeast of India is hilly and in parts these hills extend into Bangladesh for example, the Chittagong Hills. The majority of the population of these hills consist of tribal people, and shifting agriculture and forest resources play a major role in their life. The incidence of poverty is high. The situation is not unlike that in the hilly areas of Yunnan (Zhuge and Tisdell, 1996) and in Myanmar.

Most of N.E. India consists of hills or mountains deeply dissected by rivers and streams due to the uplifting of the land. This makes travel in this region slow and difficult. Of the seven hill states of N.E. India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura), shown in Figure 5, Assam is the least hilly because much of it lies in the plains of the



Brahmaputra and there are fewer tribal people in this state than in the others. In the hilly areas of N.E. India, traditional shifting agriculture is becoming unsustainable.

In general, the levels of per capita income in the north-east Indian states are lower than elsewhere in India but compare favourably with that of some other Indian states e.g. Bihar. For example, it is estimated (Ministry of Finance, 1994, Table 1.8, p.S-12) that for 1990-91 the per capita net state domestic product for Bihar was 2,650 Rupees, whereas for Manipur it was 3,893 Rupees, for Mizoram (in 1989-90) 4,135 Rupees, for Meghalaya 4,190 Rupees for Assam 3,932, for Arunachal Pradesh 5,046 and for Tripura 3,328. However, by contrast Delhi recorded a figure of 10,638 Rupees. Per capita incomes in the North-east are still considered to be low but are not dramatically below the overall level of incomes in India.

The rate of population growth in the North-east is rapid and overall is above the Indian average. It ranged in 1981-91 from an average exponential growth rate of 2.17% for Assam to 4.45% for Nagaland. Mizoram recorded a 3.34% growth rate (Ministry of Finance, 1994, Table 9, p.S-115). Population densities in the North-east are low by Indian standards and range from 10 people per square km in Arunachal Pradesh to 286 in Assam. Mizoram had a low density in 1991 of 33 people per square km (Ministry of Finance, 1994, Table 9. p.S-115). Nevertheless, with such rapid rates of population increase, population density is clearly rising rapidly and continuing to affect the region's natural environment. In addition, income aspirations are rising. Furthermore, densities are not low in relation to the quality of agricultural land available.

Agriculture and forests are important for economic welfare in North-east India where the vast majority of the people are engaged in rural pursuits. However, a number of the agricultural practices used in the North-east are becoming increasingly unsustainable and will continue to do so as population densities rise there and demands for higher incomes result in activities intensifying economic production.

As pointed out by Ramakrishnan (1992) and others, shifting agriculture (slash-and-burn agriculture, or *jhum* agriculture) which is practised by a number of tribal groups is becoming less sustainable as cultivation cycles are shortened due to population pressures. Once this cycle goes below 10-12 years it seems that it is no longer an economic form of agriculture compared to possible types of settled agriculture. In some cases the length of the cycle has fallen to 3-5 years.

This raises the question then of just how sustainable is settled agriculture in the North-east taking into account the monsoonal nature of the area, the prevalence of sloping lands and the nature of soils. Certainly *modified* forms of settled agriculture are likely to be called for in this region to improve agricultural sustainability e.g. mixed systems of cultivation as in permacultures, use of hedgerows for soil erosion control and so on. These are all matters worthy of investigation.

The above underlines the point that strategies for sustainable development must be based upon anticipation and that flexibility is needed. Given that population levels are going to increase in the North-east of India, then policies for sustainable development, including sustainable agricultural development, need to be designed *taking this into account*. A *dynamic* approach to planning for sustainability is required.

A reduction in the length of *jhum* cycles has a number of adverse environmental consequences. It reduces biodiversity and it increases the rate of soil erosion, apart from its unfavourable economic consequences for the cultivator. While the slash-and-burn technique appears to be relatively sustainable and not a major environmental danger when population densities are low, this is not the case for higher population densities.

Inroads continue to be made into forested and woody areas in north-east India as population pressures and desires for economic development increase.

Ramakrishnan (1992, p.386) reports:

> "In north-eastern India, large-scale disturbance of the rain forest ecosystem has resulted in varied levels of degraded arrested bamboo forests, with weed take-over or a totally bald landscape. During the last few decades, large-scale timber extraction for industrial purposes has cleared vast areas of land for invasion by exotic weeds..... Thus exotic weeds such as *Eupatorium* spp., and *Mikania micrantha* have taken over vast tracts of cleared land along with native weeds such as *Imperata cylindrica* and *Thysanolaena maxima*. Once this large-scale invasion has occurred, the jhum farmer is even more limited by the land area available for his jhum system of agriculture, as he prefers to avoid sites of high weed density. Because of this and increased population pressure, jhum cycle has dropped drastically in length from a more favourable 20 years or more, to an extremely short 5 years or even less. Having no other option, in the absence of an alternate agricultural technology that is viable from an ecological and social angle, the jhum farmer perforce had to resort to very short jhum cycles although the system operates below subsistence level and has caused further environmental degradation. Large-scale timber extraction and very short jhum cycles of 4-5 years have resulted in an arrested succession of weeds in north-eastern India."

In some cases, deforestation has led to desertification in north-east India. Ramakrishnan (1992, pp.386-387) suggests that desertification in Cherrapunji in Meghalaya has been rapid and sudden mainly due to past deforestation. Reforestation has been arrested. Furthermore, in other areas, reforestation has been attenuated e.g. by the growth of bamboo. Forested areas are trapped in a bamboo successional stage with "obvious adverse consequences for biological diversity in the region". Ramakrishnan, (1992, p.387) suggests that mixed plantation forests may be needed to re-establish forest succession and help in increasing biological diversity. There are clearly many other issues also that need to be investigated as far as the sustainability of forests in north-east India is concerned. Forests are especially important in north-east India because they play a substantial role in providing economic support for many tribal groups and are an important source of fuel. They also play a major role in maintaining biodiversity and in providing environmental services such as improving waterflows and reducing soil erosion.

It is often argued that sustainable development is not just a matter of achieving economic sustainability and that sustainability must be considered in relation to at least three dimensions. These dimensions are:

1. the biophysical,
2. the economic, and
3. the social.

For this reason, it is usually recommended that strategies for sustainable development be studied on a holistic basis employing an interdisciplinary approach. Sustainable development strategies should ideally satisfy sustainability conditions for all of the above *three* dimensions.

Views differ about what constitutes social sustainability but it involves the maintenance of a sense of community and of cohesion in society. It also requires the continuing ability of the society to avoid disintegration and to respond affectively to changes which call for a communal response. Irrespective of the exact definition adopted, it is clear that the social dimension cannot be ignored in planning and implementing development strategies.

Ramakrishnan (1992, Ch.3) has described social patterns in north-east India as being ones involving economic mutualism between different tribal and ethnic groups, using somewhat different techniques of obtaining a livelihood and utilising different sets of resources so that competition between them is reduced and they are able to more easily retain their separate identities and communities. While some exchange occurs between groups, subsistence activities play a dominant role in the North-east.

Ramakrishnan (1992, p.88) points out that although it is difficult to generalise about village organisation and formation in this region, "diverse communities often coexisting in the same area have evolved ways in which that are able to do so, sharing resources in a highly complementary manner".

However, the equilibrium of communities can easily be shattered by resource-depletion and increasing resource scarcity which can render some ways of life and some communities unsustainable. For example, with diminishing forest resources in the North-east, those communities heavily specialised in using these resources could find their communities endangered. Gathering from forests still plays a significant role in the subsistence of some tribal groups. One group, the Sulungs of Arunachal Pradesh, obtains almost half of its food requirements from hunting and gathering (Ramakrishnan, 1992, p.117). Hill tribes such as the Garos and the Khasis in Meghalaya and the Nithis, the Karbis, the Kacharis and the Chackmas all show significant dependence on forest resources for food and fuel, a dependence that rises during poor seasons. These societies are liable to be disrupted by loss of forest resources.

It was suggested above that in hilly areas where shifting agriculture is becoming economically and ecologically unsustainable, there may be a case for promoting relatively sustainable forms of settled agriculture. Some such relatively sustainable forms include alley cropping with hedgerows (Jha, 1995), agroforestry, and perennial crops, such as fruit trees. Research to develop sustainable agriculture systems appropriate to this region is required.

However, it is one thing to develop ecologically sustainable agricultural techniques. It is another to have them adopted. They may fail to be adopted for economic reasons or because of social constraints.
A number of forms of conservation agriculture e.g. alley cropping with hedgerows, require an investment. Many poor farmers are not in a position to undertake such investment (Tisdell, 1996) because of their lack of capital or of access to credit, or because at the time the conservation measures can be implemented, their labour is required for cropping activities and the opportunity cost of withdrawing it for implementation of conservation measures is too high.

The main constraint to the introduction of settled conservation-type agriculture in the region is a social one. Tribal social systems have evolved around shifting agriculture and in many cases, tenure of individuals or households in land does not exist. The Mizos of Mizoram for example allocate land to households as the village shifts its cultivation from one area to another in its territory by ballot. Consequently, a family may be allocated a different portion of land when the village returns to the same area after cultivation completes one cycle. This discourages a household from undertaking any long term investment in the land which it temporarily occupies. In these circumstances, there is no incentive to plant perennials such as trees and there is no scope to introduce hedgerows and alley cropping. Furthermore, possibilities for credit are limited because of lack of collateral. Note, however, that forms of shifting agriculture differ in N.E. India and property rights also show some variation. In Arunachal Pradesh for example amongst some tribes individual households are assigned fixed or definite parcels of land throughout the territory of their villages for use for shifting agriculture. This provides greater scope for development of settled agriculture since it increases private property rights.

Changing property rights in this region is not easy because of vested interests in the existing systems. Furthermore, social systems and economic systems are interrelated. Changing to settled agriculture involves substantial alterations in the social system, and if serious social disruption is to be avoided, new systems need to evolve.

Nevertheless, in several areas near sizeable urban populations eg. near Aizawl in Mizoram, *de facto* private property rights and relatively settled forms of agriculture are emerging because of the availability of nearby urban markets for production. Commercialisation and market-related agriculture are evolving and are encouraging the establishment of private property.

The Government of Mizoram under its New Land Use Plan (Leanzela, 1995, Ch.9) has assigned a limited number of small parcels of land to some individuals (as private property) and has provided them with an initial subsidy to engage in settled forms of agriculture eg. the growing of fruit trees such as bananas and mangoes. This is a transitional type of policy and because it is on a small scale unlikely to be socially disruptive.

Apart from the lack of sustainability of shifting agriculture in N.E. India, it results in a magnification of adverse environmental externalities. Apart from causing biodiversity loss, loss of natural vegetation cover from changes in shifting cultivation is resulting in increased soil erosion and greater fluctuations in streamflows so that both flooding in wet seasons and lack of availability of water in streams in dry seasons become more pronounced.

Note, however, that this situation would not necessarily be rectified merely by the provision of private property rights in land and the adoption of methods of settled agriculture. The latter methods need to be economic and environmentally appropriate. For example, a number of Bengalis have migrated to the foothills of the Chittagong Hill Tracts and are employing the same agricultural techniques as they used on the plains. These techniques are resulting in severe soil erosion (Alauddin et al., 1995).

6. Concluding Comments

Issues involved in agricultural sustainability are very wide ones, and they have been placed in a general context in this chapter and related to case studies for two marginal agricultural regions, mainly the Barind Tract situated mainly in Northwest Bangladesh and the Northeast hills of India. The case study for the Barind Tract illustrates how modern agricultural technologies promoted by government can threaten agricultural sustainability. By contrast, the case material for Northeast India illustrates a traditional agricultural system that is becoming unsustainable with population growth and rising income aspirations. It highlights the point also that changing agricultural techniques in this situation is not easy because of existing social systems and the inertia of current institutional and cultural arrangements. In each of these cases, socio-economic challenges as well as scientific and technological ones are involved in devising strategies for sustainable development.

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