Ecological Constraints in Hillslope Farming

The hills and moutains together possess only 29.3 percent suitable lands for arable agriculture where 56 percent population are making their subsistence through cultivation of soils. The subsistence farmers have not only confined their agriculture to suitable lands for arable agriculture but even extended towards unsuitable areas. They had always tired to maintain harmony with nature and attempted to understand and coordinate the resources, but they did not get success to any large extent (Mc Harg, 1966, 1969; Singh and Dhillon, 1984). Various studies undertaken in Nepal have found that encroachment has already-gone beyond the limit of 'loss of land' (NPC, 1974;Rieger, 1981; Seddon, 1987; Ives and Messerli 1989). There are meagre efforts towards judicious, conscious and discriminate planning about the use and utilization of lands. This very unmatched situation necessitates an understanding of the extent of influences.

Constraint of Slope

Slope of land is directly or indirectly highly critical on terrace formation and cultivation thereon. The direct effect of slope is visualized in declining land productivity in contrast to increasing cost of production with increasing slope gradients. The differences in yield of crops per ha in BTRT Watershed indicate that per ha production of crops both in *khet* and *bari* lands decreases with increasing slope angles (Table 1). The southfacing slopes are relatively dry and give lower yields than northfacing slopes of the ridges. Lower depth of topsoils and dryness have provided less opportunity for successful growth of plants. Very steep slopes are unfavourable for cultivation of crops because they are environmentally prone to degradation. LRMP/Nepal (1984) has also noted that land utilization of crop prodution should be avoided in greater than 30 degree slopes.

The indirect effect of slope is equally important to consider. It manifests itself in pedological and climatic modification including the position of water table, development of soils, air drainage and the relative freedom from frost. As the slope increases soil depth tends to decrease. Formation of soils cannot proceed successfully because during heavy rains top layer of the soils is prone to get leached away. More labour inputs are required in land preparation and cost much. Therefore, steep slopes are considered as unfavourable areas for crop cultivation.

Table 1 :
Per Hectare Yield of Major Cereal Crops by Land Capability Subregion (in Kg/Ha)

Crop	Subtropical Subhumid			Warm Temperate Humid	
	($<5^0$) Zone-1	(5^0-30^0) Zone-2	($>30^0$) Zone-3	(5^0-30^0) Zone-4	($>30^0$) Zone-5
Wet Land Crop					
Paddy	2521	2289	1677	1948	1726
Maize	1727	1291	X	1069	1041
Wheat	1440	1094	X	680	884
Dry Land Crop					
Maize	2400	1174	740	1144	968
Millet	1120	1299	1033	1406	1394

Source : Field Survey, 1990.

Constraint of Altitude

Altitude determines the veritical zonation of land uses. The decline in temperature, spatial variation in amount of rainfall received and decrease in depth of soils with increasing altitude lower the potentiality of agriculture. The types of crop combination and land productivity are also dependent upon altitude. The deficiency of moisture in higher altitudes has prevented the production of wet crops. Irrigation can be provided to a limited extent. Only dry crops can, therefore, give profitable production in such areas. But in constrast to higher altitudes, depth of soils, level of land, temperature and availability of water facilitate successful cultivation of wet crops in lowland areas. Middle and higher altitudes are relatively dry and are largely under dry crop cultivation. In addition to moisture content in the soils, decreasing temperature in higher altitudes limits the growth of plants. For example, there is 15 days earlier sowing/planting and late harvesting period on the top of the ridges compared to the valley bottoms. The variation in the yield of crops is apparent.

Table 2 :
Per Hectare Yield of Major Cereal Crops by Altitude (in Kg/Ha)

Crop	**Subtropical** (<760m) Zone-1	**Subhumid** (760-1070m) Zone-2	**Warm Temperate Humid** (>1070m) Zone-3
Wet Land Crop			
Paddy	3281	2169	1767
Maize	1855	1160	993
Wheat	1138	961	641
Dry Land Crop			
Maize	2096	1084	1139
Millet	1664	1289	1381

Source : Field Survey, 1990.

According to the data shown in Table-2 it is clear that there is a decrease in per ha yield of crops both in *khet* and *bari* lands. In the production of paddy, maize and wheat it decreases from zone-1 to zone-3 in *khet* land. The third zone provides marginal production potential and very much prone to land degradation. In 1989/90, the average per ha yield of paddy, maize, millet and wheat in Nepal was 2366 kg, 1599 kg, 1161 kg and 1415 kg respectively, whereas the respective yields at the present study area are lower than these, excepting the first zone. Only millet has higher per ha yield in zone-2 and zone-3. This overall production differences represent that an average yield of crops per ha is lower in elevated parts even than the national average. However, the elevated areas are intensively cultivated regardless of environmental destruction.

Constraint of Climate

The climatic factor is also important which produces local variation in land use. In fact, both the potential capacity of production and intensity of cropping depend upon the vagaries of weather condition. Among different elements of climate, temperature and

precipitation are directly related to cropping pattern. The decreasing temperature with altitude cannot provide sufficient heat for successful growth of plants. Although there is high temperature in southfacing slope of the hills, moisture deficiency prevents from plant growth. Likewise, leeward- northfacing slope of the ridges lacks precipitation as well as sunshine. Due to this there is local variation in per ha yield of crops within subtropical Subhumid and Warm Temperate Humid regions in the area of study. Upland areas are under dry crops owing to low temperature and defigency of moisture, whereas lowland areas are under wet crops mainly paddy. Here the mean monthly temperature remains above 20^0 Cfrom April to October. The range of temperature reaches maximum in April and then tends to climb down to the minimum in the month of October. About 85 percent precipitation is received in rainy season (June to September). The production of major crops is therefore confined to the rainy season when both temperature and precipitation remain higher. Even in rearing of livestock low temperature condition presents problems to the domestication of buffaloes. Only cows, oxen, goats and sheep are domesticated in elevated parts of the watershed where temperature is very low.

Development of Agriculture and its problems

Development of agriculture in the hills of Nepal has undergone several ecological constraints. The growing pressure of production on land resource has gradually led to environmental crisis and a situation of poverty. Land fragmentation has gone beyond economic size of plots and share of works has fallen below marginal productivity of labour. These have been the common features of man -environment relationships in subsistence society of the hills and mountain regions. Although, people remained always conscious about maintaining the marginal production, proverty-ridden society became unable to maintain it as suggested in the safety-first model (Singh, 1991).

The micro-leval study on BTRT Watershed reveals that the proportionate change in cultivated land from 1954 to 1990 is recorded at a net gain of +133.1 percent. In the process quite large areas which are unsuitable for agricultural use were converted into cultivation of crops. But the distribution of cultivated land according to land capability exemplifies that 40 percent lands fall in marginal areas, unsuitable for arable agriculture. In this way, the reduction of cultivated land forest ratio from 1:3.1 to 1:0.9 on the one hand and expansion of agriculture towards marginal areas on the other hand have brought in ecological imbalances. Overstress on land and destruction of forest together have resulted into soil erosion, formation of rill and gully, and landslide on the hill-slopes. This has also disturbed the lowland valley bottoms as suggested in the HED theory. The intensive cropping in slopy areas has further aggravated the situation. The stresses of agriculture on local land resource are clearly seen in the intensity of cropping in different altitude and land capability zones.

Table 3 :
Index of Intensity of Cropping by Vertical zonation and Land Capability zonation.

a) By Vertical zonation

Zone	General Index	Land Type	
		Khet	Bari
1	1.30	1.22	1.46
2	1.45	1.18	1.85
3	1.44	1.12	1.98

b) By Land Capability Zonation

Zone	General Index	Land Type	
		Khet	Bari
1	1.23	1.20	1.29
2	1.39	1.14	1.78
3	1.43	1.14	1.77
4	1.53	1.18	2.07
5	1.33	1.20	1.66

Source : Field Survery, 1990.

According to altitude the intensity of cropping is the highest in zone-2 because of high concentration of settlements.It is followed by zone-3 and zone-1 respectively.By land type, the intensity of cropping is decreased with increasing altitude in *khet* land, whereas it is increased in *bari* land. In the case of land capability, zone-3 and zone-4 fall on densely settled areas and are intensively used. Steep slopes are unfavourable for wet crop cultivation. Therefore, the intensity of cropping has decreased from zone-1 to zone-3 in subtropical subhumid areas and from zone-4 to zone-5 in warm Temperate Humid Areas (Table 3b). In dry land, except the flat portion of the valley other areas do not show much difference. The intense use of land in upland areas has led to soil erosion and destruction of land. This has also violated the condition of lowland areas as mentioned above.

In fact, the development of agriculture is dwindling into two contemporary issues: agriculture cannot support and keep up the growing population and that there is little scope for acheiving a meaningful level of progress; and it is related to large scale outmigration caused by the entrenched poverty situation. The indepth study made in BTRT Watershed area reveals that agricultural development in the hills is hindered by high man-land ratio inadequacy of land and small holding, decline in agricultural productivity, susceptibility of land for improvement, underemployment, high cost of maintenance, lack of marketing facilities and traditional technology itself. The per capita landholding size is reduced to 0.12 ha, wheras it is estimated that at least one needs 0.20 ha to fulfil basic livelihood in the hills of Nepal (Rieger, 1981). Because of low per capita landholding, even steep slopes and higher altitudes are brought in crop farming. However, the decreasing per ha yield of crops has lowered the output and has become uneconomic. Owing to increasing population pressure landseekers have extended their agricultural land even towards marginal areas and destroyed forest coverage. This destruction of forest has already surpasssed the minimum forest area requirement of at least 60 percent for successful cultivation of crops.

Underemployment has also been a crucial factor in reducing per capita income as well as increasing number of outmigrants in absence of off-farm employment opportunities in the villages. In the rural areas, one can actively occupy oneself or engage labour in field crop cultivation only for 40 days per annum. The lack of non-farm job opportunities and limited farm works have rather compelled to move outside in search of gainful employment. This is also limited to the selected male youths of 20-24 years of age. It cannot solve the problem of underemployment. The additional number of labour force has led to intensify cropping and exploit forest resources upto a level of violation. Over and above the traditional technology and subsistence production have caused to get entrenched on poverty.

In the process of development, livestock rearing, a part of hill agriculture, is also not free from the problems. It constitutes about 20 percent of the total farm incomes. However,

in a growing shortage of feedstuffs and grazing lands the ever increasing number of livestock pupulation has been a great burden on the local environment. Overgrazing of animals has increased the process of soil erosion, formation of rill and gully in weaker structure of the landscape. An average livestock herd size of 5.62 units, mainly ruminant pupulation of livestock has not only stressed grazing land but also caused to degrade forest quality. The biomass production capacity of existing forest is limited. Whereas the rate of extraction has already surpassed the potential rate of yield per annum. This very situation has further aggravated the crop-livestock based agro-environment of the hills.

Conclusion

Despite the marginal production potential of steep slopes, high altitudes and deficiency of moisture and temperature in several places, crop farming is widely extended in the hillslope as a result of population pressure. The pressure of production on fragile resource base is, in fact, leading to pressure of people on people - a situation of hue and cry. There are still some prospects of development under proper land management. The intense cropping in lowland areas can give economic production than the existing cropping pattern and land use as well. In addition to these, use of local traditional artisans in their professional business is equally important to release the excess pressure of population on land. If endowed land and human resources are properly used with harmony to nature there will be a lesser danger of physical and socio-economic degradation. Therefore, to sustain ecological order financial support to the needy farmers, provision of marketing facilities, concrete policies and programs of the government and technical supports should be given in the process of agricultural development of the fragile hills of the country.

References

Blaikie,P. and Brookfield, H. (1987). Land Degradation and Society., London: Methuen.

Bruijnzeel, L.A. and Bremmer, C.N. (1989), Highland-Lowland Interactions in the Ganges-Brahmaputra River B asin: A Review of Published Literature (ICIMOD Occasional paper No.11), Kathmandu : ICIMOD.

Eckholm, E.P. (1976), Losing Ground: Environmental Stress and World Food Prospects. New York : W.W. Norton.

Ives, J.D. and Messerli, B. (1989), The Himalayan Dilemma : Reconciling Development and Conservation, New York : The United Nations University, Routledge.

Jodha, N.S. (1990), Sustainable Agriculture in Fragile Resource Zones: Technological Implications, (MFS Series No.3), Kathmandu : ICIMOD.

Mc Harg, I.L. (1969), Design with Nature, New York : Natural History Press.

National Planning Commission (NPC) (1974), Draft Proposals of Task Force on Land Use and Erosion Control, Kathmandu : HMG/Nepal.

Rieger, H.C. (1981), "Man Versus Mountain : The Destruction of the Himalayan Ecosystem", in Lall, J.S. and Moodie, A.D. (eds), The Himalaya : Aspects of Change. Delhi: Oxford University Press.

Seddon, D. (1983), "Nepal : A State of Poverty", Report to ILO, Geneva.

Sigh, J. and Dhillon, S.S. (1984), Agricultural Geography, New Delhi : Tata Mc Graw Hill Publishing Company.