TRADITIONAL WISDOM IN RANGE MANAGEMENT FOR RESOURCE AND ENVIRONMENT CONSERVATION IN NORTH EASTERN REGION OF INDIA

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INTRODUCTION

The North Eastern Hills Region, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura has a geographical area of 255,090 km^2. The region is endowed with rich natural resources but their indiscriminate exploitation has resulted in environmental and resource degradation due to prevalence of shifting cultivation, there has been wide scale deforestation in the region. Coupled with faulty agricultural practices, the need for fuel, forage and timber has further affected the forest cover and resulted in continuous deflation of this valuable resource. The fragile ecosystem of the region in under continuous stress from different angles and there is possibility of its being crumbled down if the corrective measures, based on traditional wisdom and the new technologies in the field, are not taken immediately. Also, care has to be taken to introduce sound technologies and offer workable solutions to stop the menace of deforestation, lest it can cause more harm than good. Gourou (1953) rightly pointed out, *"The disasters brought on by agricultural methods which have taken no account of the treasures of wisdom and experience accumulated in the old tropical system are a sufficient proof of latter's value, it can be improved only if the reasons for its processes are fully understood*". Unabated exploitation of forests in the region has caused ecological imbalance. Sharma (1993) indicated high agricultural potential of the region provided suitable, eco-friendly and socially acceptable land use systems are followed. Farmers practicing shifting cultivation, though not averse to newer technologies, do not adopt them due to socio-economic reasons. However, amidst faulty agricultural practices, there exist some indigenous land use systems, developed by the tribal farmers due to their ingenuity and skill; which are eco-friendly, do not involve deforestation and take care of resources and soil health, such farming systems need to be popularized in the region under iso-agro-climatic conditions.

SHIFTING CULTIVATION: EXTENT AND IMPACT

Large quantity of forest vegetation is burnt in the shifting cultivation (Nair and Fenandes, 1985) mentioned that the forests are in danger of disappearing if nothing was done to arrest its degradation and destruction, these would vanish in a short period. With burning of forest vegetation, there is loss of wild life, flora and fauna, wild plants of diverse gene pool and rare orchids (Watters, 1960). About 300 plant species out of the native flora of NE region of India are used for edible purposes. Of these, 25 provide tubers/ rhizomes etc., which are eaten raw or boiled, over 50 are consumed as green with their leaves and tender shoots cooked as vegetables, over 10 provide flowers/inflorescence to be used as vegetables, about 150 are used as ripe fruits or raw for pickles/vegetables etc., and about 15 have edible seeds that are eaten raw or roasted.

Shifting cultivation is practiced in about 386.9 thousand ha annually and on an average 50 to 80 tones of dry matter is burnt per ha, depending on the shifting cycle. About 1.868, 21.511 and 2.228 million tones of leaves, food and litter containing 137.35, 7.46, 95.95 and 97.50 thousand tones of N P K and calcium, respectively, are burnt every year causing enormous loss of vegetation. Besides, creating, atmospheric pollution, it causes ecological and soil degration in the region.

The shifting cultivation practice prevalent in the region causes tremendous loss of soil and nutrients (Shahlace et al, 1991) whereas, these losses can be minimized to almost negligible level by managing the watersheds (Blackburn et al, 1986, 1990; Singh and Singh 1981, Satapathi, 1996). Table 1 shows the tremendous losses of soil and nutrients due to shifting cultivation. Annual soil loss has been estimated to be 88346 thousand tones and combined loss of N, P and K 17.092 thousand tones. The area under shifting cultivation varies from 2.6% in Assam to 96.0% in the Mizoram state of the net sown area (Sharma and Prasad, 1994).

Table 1: Soil and available nutrients (N, P and K) loss due to shifting cultivation.

State	Area under shifting cultivation ('000 km^2)	% of net sown area	Loss ('000 tonnes per year)	
			Soil	N+P+K
Arunachal Pradesh	70.0	4.7	14490	3.111
Assam	69.6	2.6	12318	1.685
Manipur	90.0	64.2	20430	4.289
Meghalaya	53.0	27.0	14151	2.999

Mizoram	63.0	46.0	13041	2.738
Nagaland	19.0	34.5	7962	1.432
Tripura	22.3	8.2	5954	0.839
Total	386.9	-	88346	17.092

Forest production on acid soils that are poor in basic *Catinos* is limited by mineral deficiencies. The sustained production of forest eco-system is closely linked to their nutrient cycle particularly in the tropical regions where greater percentage of nutrients is contained in the biomass. The burning of forest residues during land clearing leads to considerable nutrient loss from the eco-system (Toky and Ramkrishna, 1981). Strained forest productivity in acid soils requires the use of techniques which reduce nutrient export, increase nutrient accumulation in the biomass, increase efficiency of nutrient absorption and utilization and conserve water in the system.

The hilly areas of North Eastern states are becoming increasingly deforested and denuded due to over-exploitation and shifting cultivation. Biotic and abiotic interferences have caused considerable degradation to natural resources such as soil, water and forest to the extent that flow of rivers becomes destructive during flooding and insufficient during dry seasons. Soil conservation measure and afforestation play a definite role in reducing runoff and control of damage caused by excessive runoff. Vegetation has a great effect on soil loss due to runoff. Due to continuous deforestation in NE region, the rainfall in the region is showing a declining trend during the last 10 years (Figure 1).

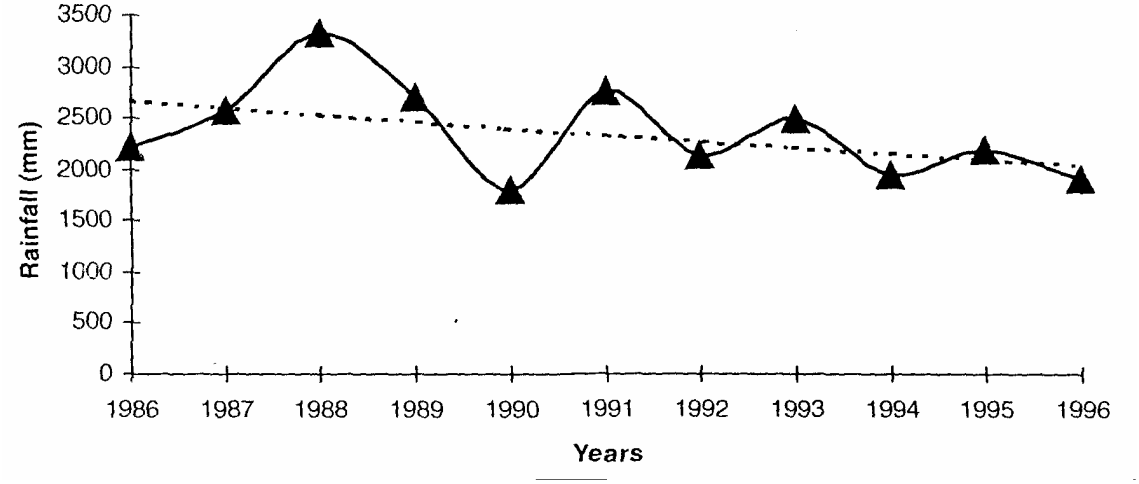

Figure 1: Declining trend in rainfall in North Eastern region

DEPLETION OF FOREST RESOURCES

Total forest area of North-Eastern Region is 167.4 thousand km^2, out of which 91.2 thousand km^2 (54.4%) area is dense forest cover and 76.2 thousand ha (45.6%) are open forests (Table 2). Arunachal Pradesh leads in forest cover with 68.6 thousand ha or 82.0% of its total geographical area. Assam has 24.0 thousand ha under forests but it is only 30.6% of its geographical area. As a whole, the region has 63.9% of its geographical area under the forest, which is well over the guidelines of the Government that in hills 60% area should be under forest.

Table 2: Forest area in different states of the region ('000 km^2).

State	Geographical area	Dense forest	Open forest	Total forest	Forest area as % of geographical area
Arunachal Pradesh	83.6	54.2 (65.2)	14.4 (21.1)	68.6	82.0
Assam	78.4	15.7 (65.2)	8.3 (34.8)	24.0	30.6
Manipur	22.3	5.3 (30.2)	12.2 (69.8)	17.5	78.6
Meghalaya	22.4	4.0 (23.0)	11.7 (74.3)	15.7	70.0
Mizoram	21.1	4.3 (23.0)	14.3 (77.0)	18.6	88.1
Nagaland	16.6	3.5 (24.4)	10.9 (75.6)	14.4	86.2
Sikim	7.1	2.4 (77.5)	0.7 (22.5)	3.1	44.0
Tripura	10.5	1.8 (32.8)	3.7 (67.2)	5.5	52.8
Total	262.0	91.2 (54.4)	76.2 (45.6)	167.4	63.9

Source: The Hindu Survey of Environment, 1997.

Table 3: Decline in forest cover between 1991 and 1995 in NE states.

State	Forest cover (km^2)			Annual decrease (%)		
	1991	1993	1995	1991-93	1993-95	1991-95
Arunachal Pradesh	68750	68661	68621	0.069	0.029	0.049
Assam	24750	24508	24061	0.494	0.912	0.696
Manipur	17685	17621	17558	0.181	0.178	0.179
Meghalaya	15875	15769	15714	0.333	0.174	0.250
Mizoram	18853	18697	18576	0.413	0.323	0.367
Nagaland	14321	14348	14291	0.164	0.198	0.052
Sikkim	3127	3127	3119	-	0.128	0.064
Tripura	5535	5538	5538	+0.027	-	0.013
Total	168904	168269	167478	0.188	0.235	0.211

Data presented in Table 3, shows the decline in forest area between 1991 and 1995. While 635 km^2 of forest area was lost between 1991 and 1993, 791 ha area depleted between 1993 and 1995. The largest percent decrease in forest area was in Assam with 0.494% decrease during 1991 to 1993 and 0.921% decrease during 1993-95. Over all decrease in the region between 1991 and 1995 was 0.211 %. Recently, a news item (Sentinel, Feb., 24, 1998) indicated that the Government has shown concern over the alarming rate of decrease in forest area in the country that was 17,000 km^2 between 1995-1997. With the increase in the population and at the present Annual Compound Decrease Rate in forest area in the region, the forest cover would vanish within about next 100 years. The decline would follow exponential pattern, if care is not taken to preserve this valuable resource in the region.

FORESTRY IN INDIGENOUS FARMING SYSTEMS

Sharma and Prasad (1994) have documented some indigenous farming systems of NE Region. The important ones are being discussed in following paragraphs.

Zabo Farming System:

Zabo is an indigenous farming system practiced in **Phek** district of Nagaland state. This farming system has a combination of forest, agriculture, livestock and fisheries. *Zabo* means impounding of water. The area where this farming system is followed comes under rain shadow zone. Due to deforestation or less density of forests, the rainfall in the area has been badly affected. The tribal farmers of the area developed this system due to their ingenuity, skill and the experience gathered over long time. Forestry is an important component of the system. This farming system is followed on the hill slopes up 100% or even more.

The Zabo system has forest at the top of the hill and up to some area below the top. This serves as the catchment area for rain water harvesting. A little down below, the water is collected in ponds that are dug according to the size of the catchment and expected quantity of water available. These ponds are used as desiltation tanks and after keeping the water for 2 to 3 days in these ponds, it is transferred to a larger main tank. The desiltation ponds, are desilted every year and the material, which contains good amount of organic matter and nutrients, is put in the terraced rice fields. The tribal farmers keep their animals in bamboo enclosures a little down the main water storage tank. Generally, a few families keep their animals together in one enclosure. At the time of irrigation of the rice fields, the water from the main tank is passed through the livestock enclosures so that it can carry with it, the dung and urine of the animals. The tribal farmers do not apply fertilizers but they get 3 to 4 tones of rice yield per ha as sufficient amount of nutrients is added in the field from organic sources. The soil fertility is well maintained through this system to give optimum yield of crops.

The Zabo farming system is such that a major portion on the top hill slope is kept as forest. The grasses from this land are also used for feeding the cattle and other animals. The system has maintained the ecological balance in the area and soil erosion is very low or negligible. The tribal farmers themselves take core of the forest land and other components of the system. None is allowed to cut trees or destroy other vegetation and proper care is taken collectively for the protection of the forest land. Moreover, the tribal laws are very strict and everybody follows them dutifully.

Agriculture with Alder' System:

Alder (Alnus nepalensis) is grown in Nagaland state for enhancing soil fertility for growing crops of maize, job's tears, millet, potato, chilies, pumpkin, barley etc. The Alder grows well on lands varying in altitude from 800 to 3000m. It is a non-leguminous tree that fixes atmospheric nitrogen through nodules which develop on the roots. Alder is a multipurpose tree (MPTS) and besides improving soil fertility for growing crops, it is used as timber, furniture and fuel wood. The value of alder tree was recognized by the tribal farmers long back and more than 200 years old trees can be seen in the area. Agricultural crops, together with alder trees forms a very remunerative agro-forestry system and the ability of the tree to develop and retain soil fertility has been fully utilized by the tribal farmers of *Angami, Chakhasang, Chang, Yimchaunger and Konyak* tribes (Gokhle et

al, 1985). *Knononome* village in *Kohima* district of Nagaland is proud of its alder plantation and alder tree based agriculture.

Data given Table 4 show that per tree litter dry matter decreases with the number of plants ha^{-1}. Total litter yield depend on the number of plants and N fixed varied between 48.3 kg ha^{-1} (60 trees ha^{-1}) to 184.8 kg ha^{-1} (625 plants ha^{-1}). Besides fixing atmospheric N, the litter added to the soil provided P, K, Ca and other nutrient through the addition of biomass (Sharma and Singh, 1994).

Table 4: Litter yield and N added through Alder

Alder population	Litter dry matter (Kg per tree)	Litter Yield (T/ha)	N added (Kg/ha)
60	56.3	3.37	48.3
101	45.3	5.48	74.5
142	58.1	8.25	110.5
166	52.2	8.66	113.5
280	37.5	10.50	142.8
625	21.7	13.56	184.8

Pollarding of Alder

The alder tree becomes ready for pollarding after 6 to 8 years of planting when the bark is rough and develop fissures. The alder is pollarded at a height of 2.0 to 2.5 m by the farmers and the leaves and succulent twigs are incorporated in the field. The trunk then sprouts giving new shoots called C*oppices*. One alder tree sprouts approximately 100 to 200 coppices after pollarding. About 5 to 6 coppices are left on the main trunk for regeneration. It has been estimated that if a village of 100 families could set aside about 120 ha of land to grow alder trees, all families would get sufficient cereals, vegetables, firewood etc. The pollarding is done from November to January and the fresh cut is covered with stone to protect it from frost injury. Maintenance of alder trees is necessary for their long life. The whole trunk of tree should be kept free of parasitic growth.

Rice-based Farming System of Apatanis:

The ***Apatani*** tribe of Arunachal Pradesh has developed a system of cultivating rice with other crops making judicious use of available water and indigenous materials (Sharma, 1997; Mishra and Sharma, 1999). The Apatani plateau is called rice-bowl of the Apatanis, who practice wet rice cultivation. The Apatanis have a good knowledge of forest, land and water management. The Apatani plateau has a population density of 554 persons per km^2 against an average of 10 persons of the state. The plateau has about 21 villages in its vicinity. The farmers grow wet rice, integrated with fish culture in terraces and finger millet on the risers. The area is surrounded by high mountain having a height up to 2438 above. m.s.l.

To maintain and regulate water supply to the fields, the surrounding hills are fully covered with forests. These forest areas are well protected by the community. Apatani farmers are well aware and extremely cautious of their environment and ecology. Apart from conserving the soil from erosion, the farmers have taken up the plantation of *Terminalis myrinalia, Ailanthes excelsa, Michelia sp. Mangolia sp.* and bamboos. Entire surrounding hills and uplands in the area are kept conserved as forests. This helps in conserving forest resources, maintenance of ecological balance and flow of streams. It has been estimated that soil erosion, silting of rivers, drying of water sources, loss of nutrients, flora and fauna and forest resources is negligible in this area. Every stream coming from the surrounding hills is tapped soon after it emerges from the forest and the water is diverted to the fields through a net-work of channels. Use of local resources has made the system more sustainable. Nutrient and soil fertility management of the terraces is done mainly through the recycling of agricultural wastes. Paddy straw is allowed to decompose in the fields and finally incorporated in the soil. Burning/incorporation of undecomposed straw is also in practice. Pig and poultry manure is added to the fields for maintenance of soil health. Thus the farming system practiced by the Apatani tribe takes proper care of the surrounding forest and therefore, the forests and the environment have remained fully intact in this part of the state.

Bamboo Drip Irrigation System:

This system is followed in Meghalaya state in the *Jaintia* and *Khasi* hills. This system is very useful in water scarcity areas, soils have poor water holding capacity, the topography is rocky and undulating. Bamboo drip irrigation system is an excellent example of man's skill and ingenuity and glaring example in the evolution of agricultural systems (Singh, 1989). Water is carried with the help of different sizes/forms of bamboo pipes and further distributed into different bamboo water channels for application at the desired site. The special feature of the system is to convey the water to the site of actual use without leakage and loss on the way. Flow of the water from bamboo pipes can be controlled as per requirement. The tribal farmers of Jaintia hills have the necessary skill to lay-out the bamboo net-work with proficiency so that the whole unit works efficiently and

perfectly. Water trickles down from the holes in bamboo pipes at the plant sites. Plantation crops, betel-vines, black pepper etc., are irrigated by this system.

Since the water is carried through bamboo pipes, the system indirectly helps the forest areas on hills. No cutting of trees and shrubs is required to clear the land for making channels through the forest areas on hills. Another benefit to forest areas is that the farmers go for settled cultivation when bamboo drip irrigation system is followed and do not resort to shifting cultivation which involve heavy deforestation. The bamboo drip irrigation system has helped in conserving forests and natural resources.

CONCLUSIONS

For sustainable forestry, there is need to introduce it as a component of the Farming Systems. The indigenous farming systems of North Eastern Region have traditional base of forestry. However, these farming systems have either remained confined to their place of origin or are on the extinct due to the introduction of new technologies and farming systems which are more food grains production oriented and have little respect for environment. To preserve the forest wealth of the states of the region, ecology and gene pool, judicious management and care of these resources are necessary for pollution free environment and save the region from further degradation of natural resources.

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