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WATERSHED MANAGEMENT: A STRATEGIC APPROACH FOR THE DEVELOPMENT AGRICULTURE IN NEH REGION

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INTRODUCTION

The North Eastern Hill (NEH) region covers an area of 18.37 M. ha comprising hills of Sikkim, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Assam, Nagaland and Tripura. The region receives ample rainfall ranging from 1322 mm with an annual average of 2800 mm. *In situ* retention of rainfall and gradual release of water from perenial springs and streams throughout the year had been the common features of this region enabling cultivation of large number of crops and plants possible. However, with the passage of time, faulty land and water management practices and increasing biotic interference in hilly forest have caused drying up of springs and streams resulting in limited cultivation of crops and plants. Due to shifting cultivation on hill slops (which covers about 5.82% of total geographical area) forest cover is disappearing fast thereby disturbing the whole ecological balance of the region. Moreover shifting cultivation has accelerated soil erison removing soils to the tune of 18.1 M.t/year. Area under soil erosion and land degradation due to shifting cultivation is 88.60 ha which contributes about 35.20% of total geographical area. (Table 1)

Table 1. Shifting cultivation and problem area of NEH region (ha)

State	Area	Area under shifting cultivation	Area under soil erosion	Land regradation due to shifting cultivation, ravines gullies	Total area
1. Arunachal Pradesh	83.74	2.1	24.44	2.10	26.54
2. Assam	67.95	1.392	22.17	7.82	29.99
3. Manipur	22.33	3.600	3.74	3.60	7.34
4. Meghalaya	24.43	2.650	8.37	2.65	11.02
5. Mizoram	21.08	1.890	4.25	1.89	6.10
6. Nagaland	16.58	1.913	4.05	0.77	4.82
7. Tripura	10.49	1.115	1.67	1.12	2.79
Total	251.65	14.66	68.65	19.95	88.60
Percentage		5.82%	27.27%	7.92%	35.20%

Thus, development of agriculture in NEH region would greatly depend upon conservation of rainwater and top soil which can be best accomplished through watrshed management. NEH region with uniformly distributed rainfall and consisting of large numbers of springs and streams provides scopes for development of model watersheds which can be suitably managed for development of agriculture.

Need of watershed management

Since each field is an integral part of the entire watershed, the individual efforts to develop any particular field will result in limited benifits, will become costlier and may also lead to social and other problems. In watrshed management, whole area is treated with an integral efforts to develop different sectors to get the benefits of interactions. Treatment of watershed is started from the ridge and culminated at valley portion. The rainwater will be probably controlled, collected and conveyed right from the ridge portion of the watershed. At the ridge portion where mostly non arable land exist, possible water resources should be tapped and retained to raise fodder, fuel, fruit, and timber trees. The excess water will be safely lead through diversion channel to the natural *nalas* where it will be again harvested for life saving irrigation by construction of farm ponds, percolation tanks, checkdam, loose boulder dam etc. This will help in groundwater recharge in lower portion of the area. The rainwatr in arable lands will be conserved through various conservation measures like contour or graded bunds, bench terracing, contour ploughing, land levelling etc. The excess water will be let out of each field through waste-weirs to water ways. The water that has entered the waterway will be stored in a farm pond and subsequently used as protective irrigation. On the periphery of the farm pond fruit trees can be planted. On the bund section and bank of the pond, grases can be raised. The exess runoff from the farm pond will be then allowed to enter the natural *nalla*, which should be fully strengthened through vegetation and masonary structures, like gully checks, gully plugging etc. Thus it is evident how moisture conservation practices right from the ridge of the valley portion will finally ensure maintenance of higher moisture regime in the soil for better production.

Integrated land use system

Land use, namely forest and agriculture in combination with animal husbandry with well founded conservation base is to be developed in an integrated manner for water resource development, protection of environment and sustainbility of production. This system comprises of protected forest land on hill top, well planned water harvesting tank at the middle of hill slop, cattle yard and paddy fields towards foot hills. Provision of silt retention tank in runoff water courses, compaction of pond beds for checking seepage, diverting washing of cattle yard in paddy fields, use of splitted bamboo channels for water conveyance, construction of terraces with care for keeping top soil on terrace bed surface and practicing paddy cum fish culture are some special feature of this system (Sonowal *et al*, 1989).

Considering in *situ* retention of rainfall to water harvesting and resource management, studies were made to cover a period of nearly one and a half decade

taking into micro watershed as the base. Land use combination with local resource based conservation measures like contour bunds, half moon tarraces, bench terraces, grassed waterways and dug out cum embankment type ponds found to be ideal for water harvesting. Schematic view of surace profile of hill slope under such a land use is shown in Fig. 1 (Sigh and Verma, 1988)

Soil and watr conservation measures for watershed management in NEH region

Contour bund : Bunds of small cross section (0.05m^2) laid at 0.3 to 1.0m vertical interval on hill slopes are used as conservation measures. This practice at some places in Nagaland has resulted in conversion of slope into bench terraces. Experience reveals that it takes 4 to 8 years for contour bunded plots to get converted into benches (Prased, 1987). However maintenance of contour bunds properly is required in order to avoid escape of deposited soil.

Bench terraces : Bench terraces are most effective conservation measures which is practiced in Sikkim, parts of Nagaland, Manipur and other states. Slopes ranging from mild to steep (>100%) have been converted into benches for growing irrigated rice crops. In most of such areas excess water disposal and irrigation with application system consists of allowing the water to flow from one terrace to another by providing opening in the ridge bunds. Wherever bench terraces are without any source of irrigation water, they are needed to be maintained properly.

Half-moon terraces : Circular level benches with 0.5 to 1.0 m diameter are used for planting fruit trees in hill slopes. Area on hill slope marked in half-moon shape is cut and earth filled in half-moon shape to down hill side provides circular bed. With shoulder bund at the lower periphery of circular bench, the bed works as a good conservation measures.

Diversion of springs and streams : Use of springs and streams through diverstion is most common procedure for harvesting of perennial water. Irrigation on hill slopes and valley land can be done through this method. Tribal farmers in Jaintia hills district of Meghalaya have evolved indigenous technique of bamboo drip irrigation (Singh, 1988). In this system, water from natural streams located at higher elevation is conveyed with the use of bamboo channels supported on ground surface by wooden or bamboo supports to the side of plots through gravity flow. Natural springs in the region have been used as drinking water source during the past. But with the pace of developments they are being neglected with emphasis on bulk water supply system. Infiltration wells to trap the water from springs not only saved expenditure but also saved ground water reserve and recurring expenditure on energy for lifting the water (Singh, 1987,a)

Watershed management in NEH region

The concept and experience discussed above were tested in a humid and high rainfall area in NEH region between 1976 to 1990. Different watersheds were treated with appropriate soil and water conservation measures results of which are summarised in Table 2 and 3.

Table 2. In *situ* retention of rainfall through watershed based land use with an average annual rainfall of 1600 mm.

Particulars	Details	Remarks
Watershed area (ha)	0.09 to 0.15	Study was done on 6 watersheds
		Between 1976-1983
Mean slope (%)	40 to 45	
Soil	Sandy loam	
Land uses	Agri, Horti, mixed forest.	
Soil cons. measures	Contour bunds, bench terraces,	Depending upon the requirement of the land
	Half moon terraces and grassed	
	Water ways	
Cost (md*/ha)	135 to 750	
Run Off as % of	0.00 to 6.63	Control plot yield
Annual rainfalll	1.06 to 9.73	
Annual soil loss	0.00 to 14.28	Control plot yield
T/ha	5.1 to 83.3	

(Singh, 1987)

Table 3 : In *situ* extention of rainfall through watershed based land use with average annual rainfall

Particulars	Details	Remarks
Watershed area (ha)	0.52 to 3.89	Study was done on 8
Mean slope (%)	32.02 to 53.18	Water sheds since 1983.
Soil	Silty clay loan	
Landuses	Agril, Horti, forest, natural	
	Fallow and mixed	
Soil conservation measures	Contour bunds, bench terraces,	Depending upon the requirement
	Halfmoon terraces, grassed water	of land use.
	Ways and no measures	
Cost (md/ha)	42 to 394	
Runoff as % at	Trace to 7.21	
Annual rainfall		
Annual soil loss (t/ha)	0.00 to 7.90	

(Singh, 1990)

As seen from Table 2 and 3, over 90% of rainfall was retained/intercepted within the watershed and this approach facilitilated in maintaining desirable hydrological process of sub-surace flow and ground water recharge.Rainfall retained in the hill slopes through good land use methods moves as a subsurface flow. Often path of flow is very near to the ground surface at foot hills. Dug out cum embankment type of water storage structures can help in blocking the path of base flow., which results in the accumulation of water in the pond. In a case study, it was found that a watershed of area 11.1 ha, which was treated with conservation measures like bunds, bench terraces, half moon terraces, stilling basin etc, a pond received on an average of 3.7 ha.m water yield through runoff (3.2%), base flow (80.0%) and direct rain (16.8%) as shown in Table 4.

Table 4. Water yield to a dugout-cum embankment type of pond located in a hilly watershed of 11.1 ha area

Particulars	1984	1985	1986	1987	1988	Mean
Rainfall (mm)*	2194.6	2234.3	2230.1	2705.8	3323.8	2537.7
Water yield (ham)	1.2	1.2	2.6	5.2	8.6	3.7
- as runoff (%)	2.3	3.8	1.9	0.6	7.5	3.2
- as base flow (%)	75.3	77.4	82.8	85.0	78.5	80.0
- as directed rain (%)	24.4	18.8	14.3	14.4	14.0	16.8
Thresh hold rainfall (mm)	1613.4	1560.1	1136.8	773.1	511.3	118.9
Life of stored	121	181	69	155	225	
Overflow	0.0	0.0	1.1	3.1	5.9	2.0

(Singh, 1990)

(*Cumulative rainfall during the year, beyond which the phenomenon of water storage in the seasonal pond initials)

Based on the traditional and subsequent developments works, it can be concluded that watershed management programmes integrating all relevant activities like soil conservation measures, land development, agriculture, animal husbandary, fisheries and plantation crops according to scientific land use should be consiodered as most important and vital for sustaining the productivity of the region.

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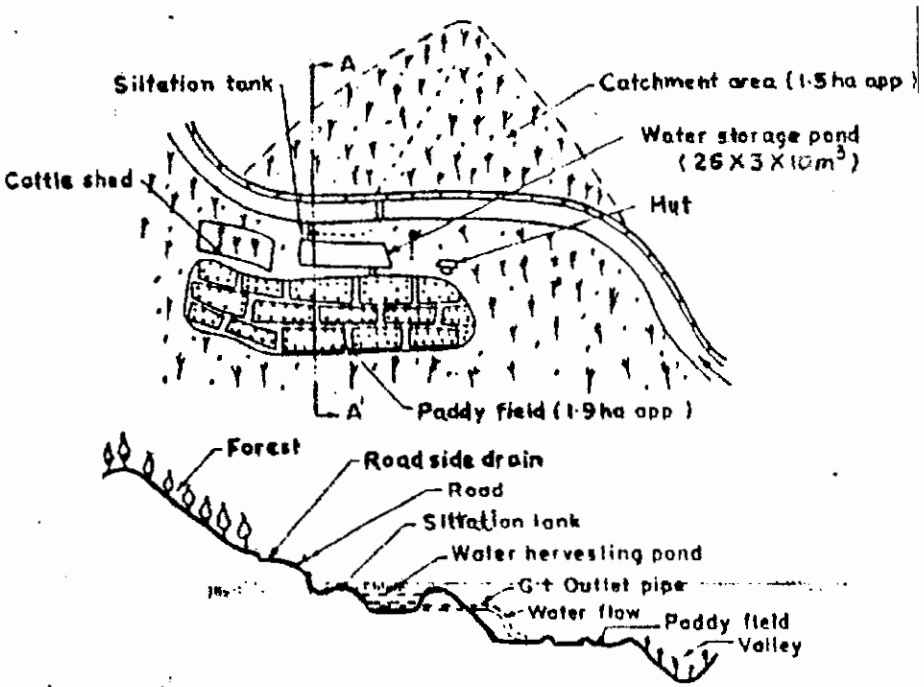

Fig. 1. Sketch showing land use system under zabo farming on a hill slope