Indigenous Techniques of Soil and Water Conservationin North Eastern Region of India

P. P. Dabral

Department of Agricultural Engineering
North Eastern Regional Institute of Science and Technology
Nirjuli (Itanagar)-791109, Arunachal Pradesh(India)
E-mail: ppd@nerist.ernet.in , ppd@agni.nerist.ac.in

Abstract: The north eastern region of India comprising of seven states lies between 21.5^{o} and 29.5^{o} N latitude and 89.4^{o} and 97.5^{o} E longitude. The region is unique in its diversity of climate, crops and people. Shifting cultivation is prevalent in the region for food production. Besides this, there are some potential indigenous farming system in the region developed by tribal farmers using their ingenuity and skill. These techniques and systems have sustainable agricultural base are practiced since centuries but in some isolated pockets in the north-east India. The paper is aimed to review the various indigenous techniques of soil and water conservation linked with these farming system in the north-eastern region of India.
Keywords: indigenous techniques, soil and water conservation, north-eastern region of India

1 Introduction

The north–eastern region of India comprises of seven states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura(Fig 1). The region lies between 21^{o}57′ , and 29.5 ^{o}N latitude and 89.4^{o} and 97.5^{o} E longitude. The total geographical area of the region is 2.555 lakh km^{2} which is about 8 per cent of the country's total area. The physiography of the region is divided into three divisions, namely Meghalaya Plateau, the north–eastern hills and Basin and the Brahmaputra valley. The north eastern Hills and Basin alone account for 65 per cent of the total area while the Brahamaputra valley and the Meghalaya Plateau cover 22 per cent and 13 per cent of the area respectively. Rainfall occurs in all the seasons of the year in north-eastern region of India. Annual rainfall varies from about 2,000 mm to 4,000 mm in the areas. Nearly 90 per cent of the population of the region are rural and agriculture is the most dominant vocation of the people. Among the workers of the region 60.08 per cent are cultivators, 9.28 per cent are agricultural labourers while 7.28 per cent of workers are connected with livestock, forestry, fishery and such other allied activities. Shifting cultivation is prevalent in the region on a wide scale and annual area under this practice is 386.5 thousand ha (Borthakur, 1992). Efforts are being made to wean away the farmers from shifting cultivation. It is not easy to eliminate this practice since it is linked with socio-economic condition of the people. Besides this there are some potential indigenous farming systems in the region developed by the tribal farmers using their ingenuity and skill. These techniques and systems have sustainable agriculture base and are practiced since centuries; but in some isolated pockets in the north-eastern states. These farming systems make use of locally available resources and there is need of an in-depth study to know the secrets of their success. The paper is aimed to review the various indigenous techniques in these farming systems linked with soil and water conservation in the north-eastern region of India.

2 Apatani water management system in arunachal pradesh

It is a multipurpose water management system, which integrates land, water and farming systems by protecting soil erosion, conserving water for irrigation and paddy-cum-fish culture. It has been experienced in Apatani inter-piedmont flat land of about 30 km ^{2} located at an altitude of about 1,525 m above m.s.l. in the humid tropic climate of lower Subansiri district. The area is dominated by local tribe "Apatani" which developed this system to cultivate paddy and fish together (Singh, 1999).

In this system, every stream rising from the hill is trapped soon after it emerges from forest, channelised at the rim of valley and diverted by network of primary, secondary and tertiary channels. The first diversion from the stream takes off at a short distance above the terraces. Central irrigation channel of 0.61 m × 0.61 m size and embankments of the same size in each of the paddy plots are constructed. The water into the plots are drawn from irrigation channel and has a check gate made of bamboo splits (huburs) at the inlet for regulation of entry and exit of water through the outlet. The farmers drain off the water from the rice fields twice, once during flowering and finally at maturity on and average 10 cm water level is maintained in the plots by adjusting the height of outlet pipes. For fish culture, a vertical pit is dug in the middle of the plot, so that the water remains in these pits even when it drains away from the surrounding fields. To prevent trashes or migration of fish, a semicircular wooden/bamboo net is installed at the inlet to reduce beating action of flowering water resulting in soil erosion; wooden strikes or planks are put at the outlet. The huburs are installed about 15 cm to 25 cm above the bed level of these fields in order to maintain proper water level. They are made of plank or pine tree trunk or bamboo stems of different diameters (Fig.2). The water from terraces is finally drained into the river, which flows the middle of valley. The tribals utilize the indigenous varieties of paddy and fish. Two categories of paddy are cultivated: (a) Mipya (early varieties and include Empu, Elang and Lalan), (b) Empo(late maturing varieties ripe at different periods and include Empu, Elang and Lalan). Mipya varieties are harvested in the early part of July, where as Emo varieties are harvested in the month of October. Paddy cultivation is started with sowing of the paddy seed in the nursery in the month of February to March. The transplanting is done in the month of April-May and lasts upto July-August depending on the monsoon. Under this cultural practice no feed and fertilizer is used other than the domestic sewage at the time of puddling the paddy fields and during the growing season. Within one month of transplantation of paddy seedlings finger lings of size 40 mm—50 mm size are stocked. The common species of the fish reared in paddy fields are: *Cyprinus carpo* (Common carp), *Cyprinus carpio var. communis* (Scale carp), *Cyprinus carpio var. specularis*(Mirror carp) and *Cyperinus carpio var. nudus* (Leather carp). The production of paddy ranges from 8.4 to10 Q • ha^{-1}. There is necessity to introduce high yielding varieties of paddy and fish to augument the income of the farmers from this system. This system and structures are highly successful and has been continued for years in the area. This is an ideal example of indigenous technology developed by the rural farmers.

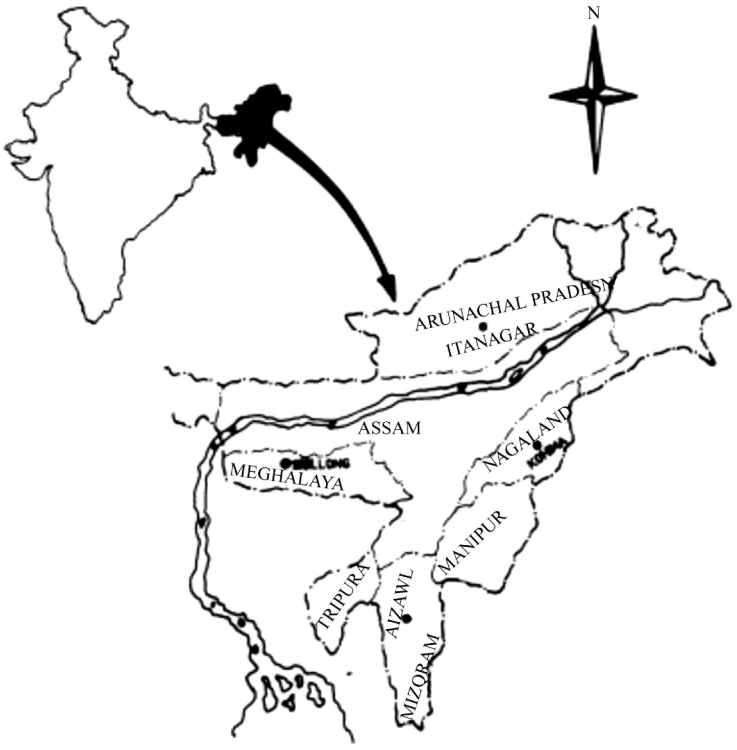

Fig.1 Map of the north eastern region of india showing the seven states

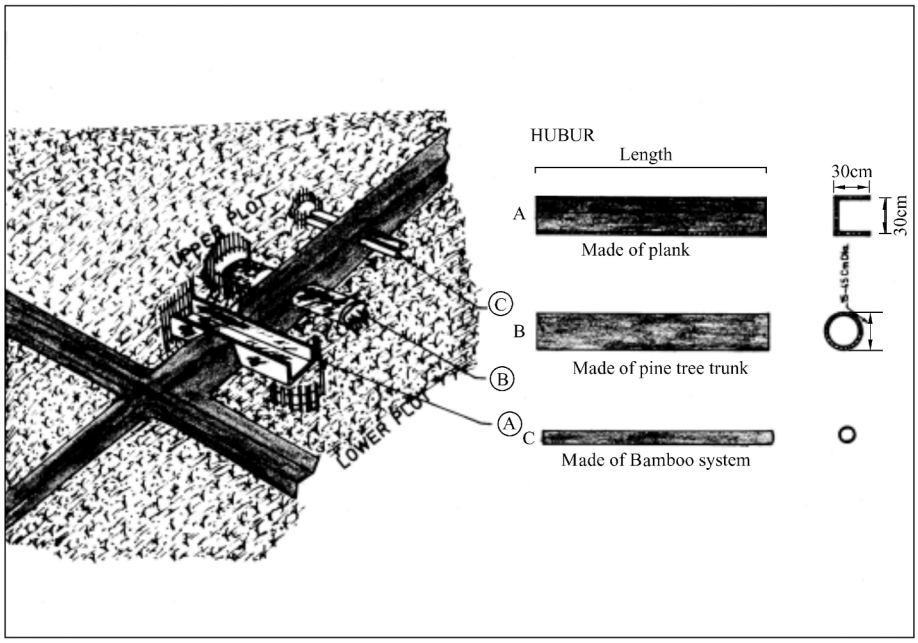

Fig.2 Apatani water management system (Source: Singh, 1999)

3 Bamboo drip irrigation system in maghalaya

Water application on hill slopes for irrigation of plantation crops poses a serious problems of soil erosion. The tribal farmers in Muktapur, Jaintia hills district of Meghalaya have developed the indigenous technique of Bamboo drip irrigation . Betel vines planted with arcanut as the supporting tree, are irrigated with this system, in which water trickles or drips drop by drop at the base of crop. In this system water from the 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 site of plantation through gravity flow (Fig.3). Discharge of water upto 25 liters/min can be easily managed by manipulating the distribution systems. Water distribution is done with the use of bamboo channels, bamboo supports; water diversion pipes and strips. The whole system enables in distribution of 15 to 25 liters of water without any leakage at point. There may be several diversion at each stage depending on the availability of water resources and number of the plants to be irrigated. The system is laid out in such a way that ground clearance of channels reduces from few meters to 10 cm to 15 cm and this is done by reducing the height of channel supports (Borthakur, 1992).

4 Roof top water harvesting in mizoram

In Mizoram most of the hills are steep having slope more than 50 per cent and are separated by deep river gorges. Despite of heavy monsoon rain, the people face acute water problems every year in the dry season. The geological formation does not permit water retention; runoff is quick and springs and small streams dry up when there is no rain. Roof top harvesting structures for drinking purpose have been developed locally and now spread in the entire Mizoram. It has proved to be quite successful. Most houses are built with sloping roofs with galvanized iron sheets to be quite successful. Most houses are built with sloping roofs with galvanized iron sheets which are conducive to rain water harvesting. A common method of storing rain water is to place horizontal rain gutters along the sides of sloping roof, which is normally made of corrugated iron sheets. Rain water pours into a pipe connected to the tank which is mostly made from GCI sheets or galvanized plain sheets. But many people have started using reinforced cement concrete tanks, located in the court yard or under the house. Now the government of Mizoram has a policy to replace thatch roof with GCI sheet roofs to improve village houses and also to provide loan for promoting roof top water harvesting (Satapathy, 2001).

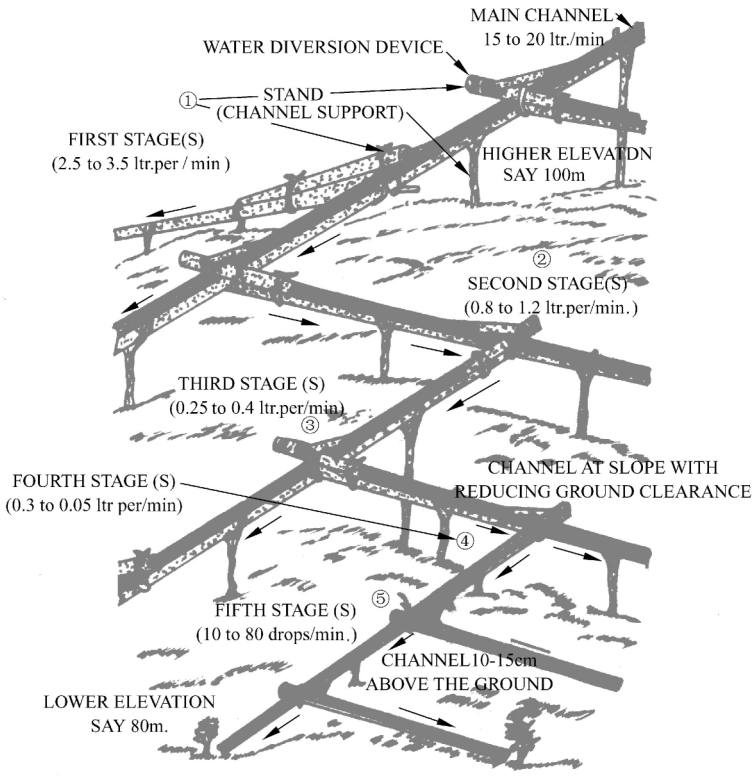

Fig.3 Sketch showing principle of water distribution in Bamboo drip irrigation (Shown in five stages) (source: Borthakur, 1992)

5 Indigenous techniques of soil and water conservation in nagaland bench terracing with continuous flow irrigation

Excellent bench terraced land cultivation system is widely practiced in some parts of the Khoima district of Nagaland. Farmers are doing cultivation in bench terraces from the time immemorial upto 100% slope and more and even rocky lands having hardly 10 cm to 15 cm depth of soil. In this system the hill streams are tapped or near the source of emergence the water is channelised to irrigate a series of terrace in such a way that water continuously flows from the upper terraces to the lower ones with out soil erosion and maintaining a desired level of water (5 cm to 8 cm) in the terrace. Terrace risers are usually maintained with stones. In the terraced field, agricultural operation starts in the month of December and January with the digging of fields with the help of spades. Puddling operation start in the month of April. After that farmers start allowing water to enter in the terrace. They are full of water by the first week of June. In the same month seedlings of paddy are transplanted (Singh, 1992). Farmers do not use any chemical to control insects and pests. Paddy is harvested during September to October.

6 Agriculture with *alnus nepalensis* (Alder) tree

In some pockets of Nagaland the farmers use *Alunus nepalensis* (Alder) tree for agriculture. In this cultivation system the *Alunus nepalensis* (Alder) seedlings are planted on the sloppy land intended for cultivation and the alder grows fast till attain six to ten years old. At this stage initially the trees are pollarded, the leaves and twigs are burnt and ash is mixed with soil to prepare it for raising crops. Subsequently also pollarding is done once every fours to six years. Under this process coppice are cut except five to six on top of the main trunk and crop schedule is followed including fellow period of two to four years. The bigger branches stripped of leaves are used for fire wood, while the root of the tree

develop nodules (colonies of Frankia) responsible for fertilizing the soil where as spreading nature of the roots helps in preventing soil erosion in slopes.

The ability of the alder trees to develop and retain fertility of the soil has been fully utilized by farmers in Angami, Chakhesang, Chang, Yimchunger and Konyak areas in Nagaland at varying altitudes (Singh, 1992).

7 The zabo system of farming

"Zabo" is an indigenous farming system of Nagaland. This system has its origin in Kikuma village of Phek district of Nagaland, located at an altitude of 1,270 m above mean sea level. The area under this practice is 957.9 ha. The word "Zabo" means impounding of water. It has a combination of forest, agriculture and animal husbandry with well-founded soil and water conservation base. Water resource development, water management and protection of environment are inherent aspects of the system (Sharma *et al*., 1994). The beauty of this system is that each and every farmer takes care of his own land with his or her ingenuity skill and natural resources.

8 Land management

The "Zabo", farming system has protected forest land towards the top of hill, water harvesting tanks in the middle and cattle yard and paddy fields at the lower side (Fig. 4). Some times it becomes difficult to get a suitable location for construction of the water storage tanks then the runoff from the catchment area is taken directly to paddy fields for storage for the crops as well as for irrigation during the crop period. Special techniques for seepage control in the paddy plots are followed. Paddy husk is used on shoulder bunds and puddling is done thoroughly.

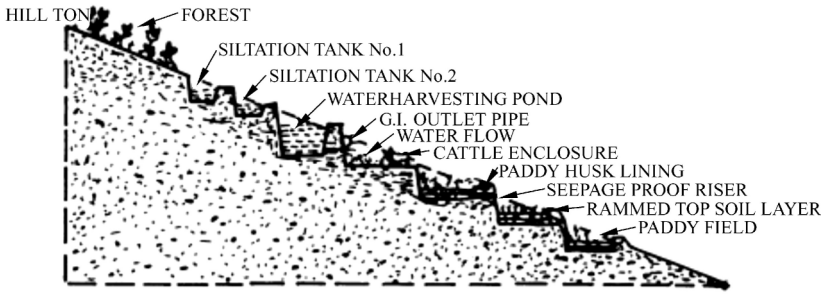

Fig.4 Concept of land management in ZABO farming system (Source: Sharma *et al*., 1994)

9 Forest land

The catchment area, which is generally 1.5 ha or more, is kept under forest cover to serve as water source for the tank (Fig. 4) . The area is not disturbed by cutting and burning of trees. The cattle pigs, poultry birds etc are some times let loose in the forest area. The slope of catchment area is upto 100 per cent or even more.

10 Water harvesting system

Near the catchment area (mid-hill), silt retention and water harvesting tanks are dugout with the formation of earthen embankments(Fig. 4). The size of pond depends on the size of the catchment area. The general observed size is 24 m $\times$ 10 m $\times$ 2 m. Silt retention tanks are constructed at two or more points before the runoff water enters the main tank. The average area devoted to water harvesting system is about 0.2 ha. The silt retention tanks are cleaned annually for proper maintenance of the water harvesting system. While constructing the water harvesting tank, the bottom surface is properly rammed and side walls are plastered with paddy husk to minimize the loss of water through seepage.

11 Cattle enclosure and maintenance of soil fertility

The open cattle enclosure is fenced with ordinary wood and branches of Bamboo (Fig 5). This is managed by group of farmers and that keep their cattle inside these enclosure on rotation basis. These cattle enclosures are constructed on a little lower side of the water harvesting pond. In Kikruma village, buffaloes and pigs are the common animals with the farmers. The water from the pond is passed through the cattle yard before taking it rice field for irrigation. The water carries with it the dung and urine of the animals to the field through split bamboo channels. This serves as good source of nutrition to crop. Apart from this farmer also add leaves and succulent twigs of *Alnus nepalensis* (Alder) etc.

Paddy fields are located at lower elevations (Fig. 4 and Fig. 5). The paddy fields are of individual farmer varies from 0.2 to 0.8 ha. The fields are thoroughly rammed at the timing of puddling through treading by human beings, cattle in -group and wooden sticks to create a hard pan in order to avoid percolation of water. Seepage losses from shoulder bund are checked with the use of paddy husk. Only one crop (rice) is grown and the common variety is "Tanyekemucah" (local). The variety matures in about 180 days. The normal seeding rate is 60 kg • ha^{-1}. Transplanting is done in June at about 12 cm × 12 cm to 18 cm × 18 cm spacing. Two supplementary irrigations are provided from the water harvesting tank. Generally about 10 cm deep water is maintained in the paddy fields. The farmers get around 3 t • $ha^{-1}$to 4 t • $ha^{-1}$of paddy.

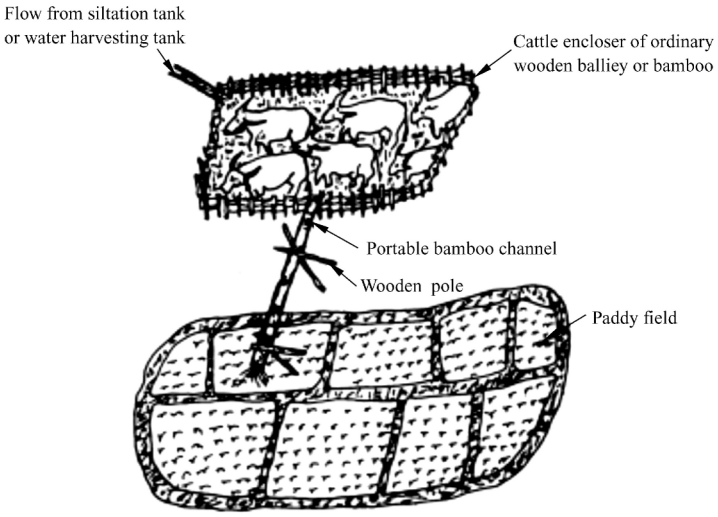

Fig.5 Method of manuring paddy crops(Source: Sharma *et al*., 1994)

12 Paddy- cum-fish culture

Majority of the farmers practice paddy-cum-fish culture. A small pit is dug in the middle of rice field. The fish fingerlings are put in the fields. When the water is drained out from the fields before harvesting of paddy crop, the fish remain in the water of pit in the fields. Through this technique farmers generally harvest about 50 kg to 60 kg of fish per hectare as an additional output.

13 Soil fertility status

Sharma *et al.* (1994) reported that the soils under "Zabo" system of cultivation are fairly rich in organic matter (organic carbon 1.79%—2.87%) and available nutrients (N: P_2O_5 ∶ K_2 O=209 kg • ha^{-1}—370 kg • ha $^{-1}$ ∶ 6.7 kg • ha $^{-1}$—18.8 kg ha^{-1} ∶ 60 kg • ha^{-1}—160 kg • ha^{-1}). This makes a good yield of rice even in the absence of inorganic fertilizers. In the "Zabo" system of farming improvement can be made by using inorganic sources of fertilizer and improving the paddy-cum-fish culture technique.

14 Conclusion

Although north-eastern region of India is characterized by heavy rainfall, yet the concentration of precipitation is primarily limited to few months from May to September. Due to hilly topography most of the rain water is wasted as runoff and lot of soil erosion also occurs. Shifting cultivation is practiced in most of the region. The irrigation system in the entire region has not been developed in most of the area. The application of chemical fertilizer application and use of HYV etc. are still not practiced by the tribal farmers. The various indigenous techniques of soil and water conservation developed in the region (in some pockets) by the local people are based on local conditions and resources. They are exiting in the region from the time immorial and they are socially accepted and suited to local condition too. They have got sustainable base. Still there is a scope for improving efficiency/productivity of these system using modern scientific methods. Before developing or recommending any new farming practice/technique in the region, researchers and planner should consider these indigenous techniques of soil and water conservation into account for better implementation at field condition in the region.

References

Borthakur, D. N. (1992). Agriculture of the north- eastern region. Bee Cee Prakashan, Guwahati(Assam), India.

Satapathy, K. K.(2001). Water harvesting and recycling in hills. Lecture notes on “Integrated Watershed Development and Management”(Eds.S. K. Srivastava and A.K. Sahu), Winter School held at Department of Agricultural Engg., N.E.I.R.I.S.T.,Nirjuli-791109, Arunachal Pradesh (India) from December 17-28, 2001.

Sharma, U.C., Prasad, R. N. and Sonowal (1994). An indigenous technique of soil and water conservation in north -eastern region- The Zabo system of farming. Soil and Water Conservation Challenges and Opportunities (Proceeding of 8th, ISCO conference. Ed. L. S. Bhushan, I. P. Abrol and M. S. Rama Mohan Rao). Oxford and IBH, publication Co. Pvt. Ltd., New Delhi (India). p. 969-975.

Singh, N. P. (1992). Natural farming in Nagaland-an outline. Proceeding of national seminar on “Natural Farming” (Eds. L. L. Somani, K. L. Totawat and B. L. Baser). Department of Agricultural Chemistry and Soil Science, R AC, Udaipur. p.161-168.

Singh, S. (1999). Atlas of Arunachal Pradesh. Publication of Govt. of Arunachal Pradesh.