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# Sustainable agricultural practices and the methods of traditional water harvesting in North East Region of India

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**ABSTRACT**

*North East India is unique in its diversity of physiographic features, climate and people. It is home to a large no of ethnic groups. Different types of indigenous systems of farming are found among these people those are in vogue for a long time. They are very skilled to utilise the natural resources perfectly at a low cost using the locally available material and overcome the problem of irrigation. This paper is a review that deals with the existing indigenous systems of farming of the North East India and its importance and sustainability.*

**Keywords**: North East India, Indigenous system, water harvesting.

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## INTRODUCTION

The North Eastern Region is one of the most ethnically diverse regions in India. Each of the seven states has its own tradition and culture. This region is now constituted of eight administrative units known as seven sisters and one brother (Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim). The region lies between $21^0$ N and $29^0 30'$ N latitude and $89^0 4'$ E to $97^0 30'$ E longitudes. The North Eastern states together represent 7.9 % (2, 62,179 sq. km) of the total land area of India. North-East India belongs to the Eastern Himalayan Region. The entire NE Region falls within the sub tropical belt of warm summer monsoon climate. "Water harvesting" is the general name used for all the different techniques to collect runoff or flood water for storage in the soil profile or in tanks so that it can be used for the production of crops, trees or fodder. "Water harvesting" also can be the collection of runoff water for human or livestock consumption. The benefit of water harvesting is not only to secure and increase crop production, but also to stop soil erosion and to recharge aquifers tapped for irrigation. An underestimated benefit of water harvesting is also the improvement of soil fertility. Silt, manure and other organic matter is "harvested" or kept in place together with the water. The soil profile stays moist for a longer time, which stimulates soil life so that the formation of stable humus, the nutrient availability and the water holding capacity are improved. [1].

### Traditional farming and water harvesting techniques

In traditional farming, farmers use locally available materials for cultivation. They do not use chemical fertilizers, pesticides and herbicides. They harvest water in their traditional way for irrigation. The NE region of India is a home of several traditional water harvesting systems. Some of these are still prevalent like ‘Dongs’ in Assam, ‘Bamboo drip irrigation’ system of Meghalaya, ‘Wet rice cum fish cultivation’ system of Ziro valley of Arunachal Pradesh, ‘Zabo’ system of Kikruma village of Phek district of Nagaland and ‘Roof top rain water harvesting’ system of Mizoram and Meghalaya .

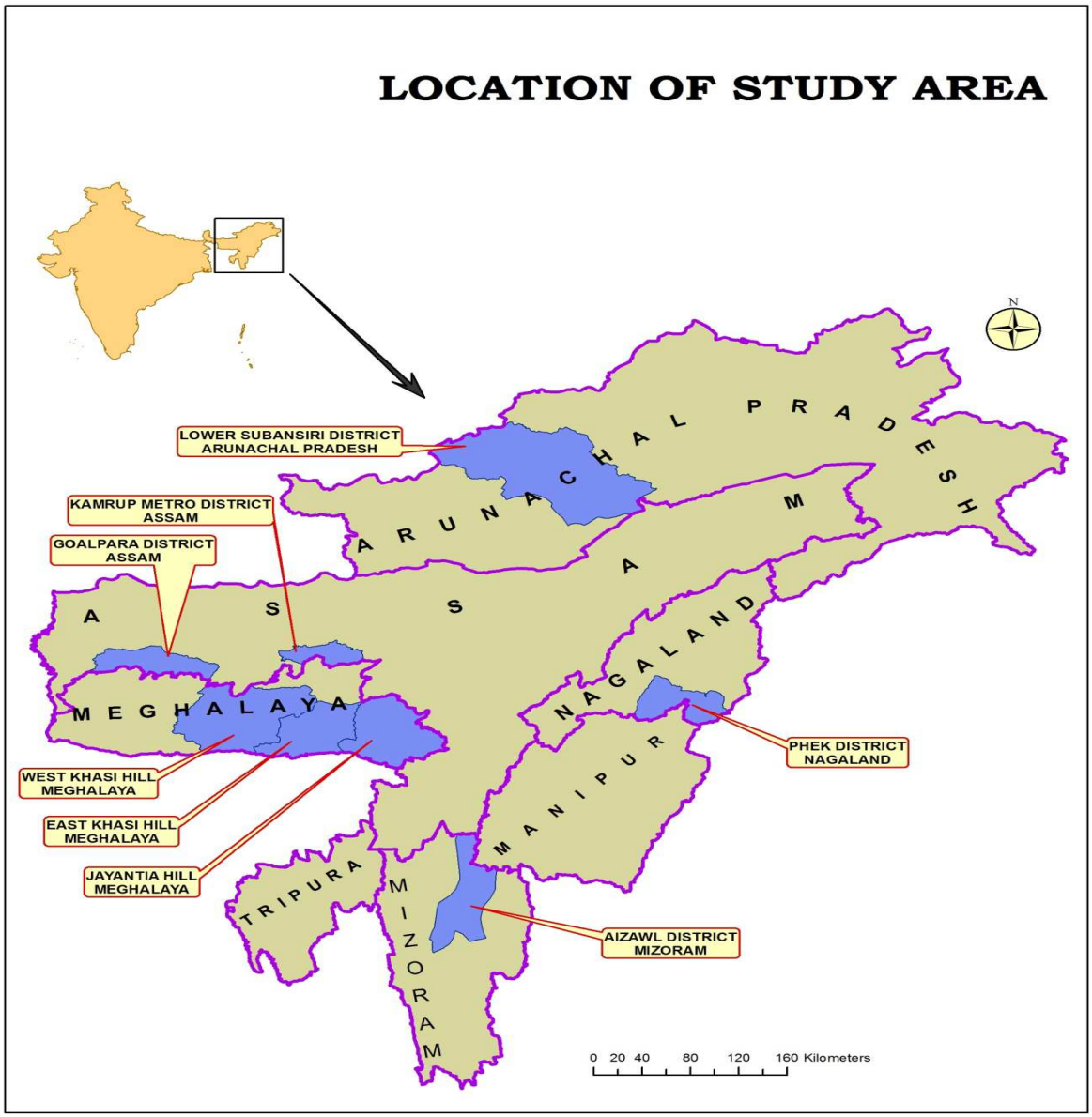


**Fig 1- Location map of study area**

***WET RICE CUM FISH CULTIVATION SYSTEM OF ZIRO VALLEY***

The Ziro valley which is located at an altitude of 1564m is home to the Apatani tribe of Arunachal Pradesh. Apatanis have highly evolved indigenous system of farming which is unique in cultivation of both rice and fish together. The Apatanis are surrounded by Nyishis on the NW and S, the hill Miris on the N and Siyajuli and Dolungmukh on the East. [2].

The cause behind this highly evolved system is the limited resources available to them. So they have to develop a system through which they can utilise their limited resources perfectly. For maximum utilisation of their land they cultivate both fish and rice in the same field. For this field preparation starts after harvesting and continues till the end of the spring. Weeding is done three to five times and the weeds are dumped in the field to decompose. They prepare the field by dumping household wastes, chicken and pig excreta, crop residue etc. Inorganic fertilizers are not used. They burn the rice stubbles that are left in the field after harvesting. Vermicompost is also used by some farmers. Sometimes cow dung is used at a rate of $1000 kgha^{-1}$. [3]

Paddy cultivation is started in the month of February-March in special nursery and is transplanted to the field from April-May up to June-July. Within one month of transplantation fingerlings are stocked in the field. The nurseries are kept wet before plantation. The streams coming up from the mountain are diverted towards the paddy fields through artificially prepared earthen channels. The levels of water in the fields are maintained by flooding or

draining the excess water through the inlet/outlet duct called 'Hubur' made of bamboo. Water flows through the 'Hubur' from the fields at the upper elevation to the lower fields automatically through the network of channels and meet the major stream at the lowest level. In each terrace small pits are dug where these fingerlings are stocked.

**Fig 2- Earthen bunds in paddy field of Ziro**

Latter when the whole field is flooded due to rain the fingerlings come out of the pits and swim the whole field. During water scarcity period fishes again go back to the pits where water still remains. Tali ngiyi (Channa sp) and aji ngiyi (Punitus sp) are naturally available in the field. Other variety stocked is aji ngiyi i.e Common carp viz *Cyprinus carpo*, *Cyprinus carpio* var. *communis* (Scale carp), *Cyprinus carpio* var. *specularis* (Mirror carp) , *Cyperinus carpio var. nudus* (Leather carp) and *Ctenopharyngodon idell*a (grass carp). Grass carp species feeds on the leaves of paddy plants and so this variety is stocked when the paddy plants grow above the water level. Rice varieties are Mipya which is harvested in the month of July and Empo which is harvested in October. Both of these are indigenous variety. The first fish harvesting starts after 30-40 days of initial stocking of fishes and can be continued in the same gap for several times. Sometimes double harvesting is done at a gap of 2-3 month. The total production of fishes is 300-350kg per hector per year. The rice production is 3-4 t per hector. [4]

This paddy cum fish cultivation system was started by a Govt. fishery officer in 1965 on an experimental basis. At that time no of plots was 23 and total production of fishes was 150 kg $h^{-1}y^{-1}$. Generally about 10,000 fingerlings are released per hector. In each terrace small pits of size one foot in breadth and on 2-3 feet in depth are dug where these fingerlings are stocked.

They feed on a periphytoplankton that originates in the lower stem portion of paddy plant which remain under water. Fishes also eat harmful insects like water beetle, grasshooper and others. 'Lemna minor' and 'azolla' are also eaten by fishes that originate in the root portion which fixes $N_2$ in the field. In turn the waste material of fishes acts as manure to the plant.

The fields are separated by earthen bunds which are called 'dykes' are about ·5-1·5 m in breath and ·2-1m in height. Sarse that is millet is cultivated on the bunds. So no portion of the field is wasted.

The Apatanis integrated fish cum paddy culture is a totally organic farming. They produce rice and fishes by properly utilising their limited resources without wastage and pollution by using locally available material and unutilised materials in a productive way at a low cost which makes this system highly sustainable.

**Fig 3- Pits for fingerlings in the paddy field**

**ZABO**

In the Kikruma village of the Phek district of Nagaland an indigenous system of farming is found which is called Zabo. 'Zabo' means impounding of water. It is a century old farming system which is a combination of forest, land and water management along with agriculture. The whole system covers an area of 957.9 ha under which forest covers an area of about 1.5 ha, water harvesting tank covers an area of .2 ha and paddy fields which are individually owned cover an area of .2 to .8 ha. [5]

In the Zabo system of farming forest covers the area on the hill top which is the catchment area of rain water. This area is not disturbed by cutting trees. As this area is extremely steep water flows downward and are collected in water harvesting tanks. Water harvesting tanks consist of siltation tank and main storage tank. These are earthen tanks the bottom of which are rammed and compacted with mud and straw to avoid seepage with capacity of 300-600 cubic metre depending on the catchment area. Below the forest cover siltation tanks are present. Soil and organic matters accumulate in these tanks before the water enter into the main tank. These tanks are desilted annually and the organic matters are used in the paddy field to increase fertility. [6]

After siltation tank the water enters into the main storage tank. Cattle enclosures are constructed on the lower side of the tanks which are made with bamboo and woods. . Reared animals are buffaloes, pigs and cows which are kept in these enclosures on a rotation basis. The water from the main tank passes through the animal enclosure which carries animal excreta to the field which increases the fertility of the soil. Leaves and branches of Alder trees are used which decompose and increases the fertility. The whole system is organic farming as no inorganic fertilisers are used. Paddy cum fish cultivation is also practised by some farmers. Generally local variety of rice named 'Tanyekemucah' is cultivated. Annual yield of rice is 3-4 ton per hector and annual yield of fish is 50/60 kg / hector.

***Dongs*** are water canals constructed by the local people of Assam to harvest water for irrigation in the paddy field. These are mainly found in the Bodo populated area. In Bodo language it is called Doisa. These are individually owned with no community involvement. The sources of dongs are natural streams from which canals are cut to divert water to the fields. Water in the field is accumulated in a pond like structure from where water is lifted and taken in to the necessary portion by an instrument called "*LAHONI*". Another structure called "*KOON*" is also used to harvest water from pond to the field. Koon is a wooden boat like structure handled with leg. With the help of Koon about 25Lof water is harvested per time. This is sufficient to irrigate a plot of land of 4-5 beegha in one day. With Lahoni about 10L of water can be harvested per time and a plot of 2 beegha can be irrigated in a day. The sources of dong are natural streams and most of the dongs are perennial. Some of the existing dongs are Bordong, Salana dong, Lungsoom dong of Dimoria block, Suti doisa, Nepalpara to Narabari doisa, Jumfoi-Bima dong, Jorakia-Buri dong, Kungreb doisa of Kokrajhar district. Most of the villages through which these dongs are passing are populated with SC, ST, general caste people and ex tea garden labours.

**Fig 4- Koon to lift water from dong**

The occupation of these people is mainly cultivation. The Kokrajhar district is mainly Bodo populated area. The 'Nepalpara to Narabari doisa' is unique as its source of water is rain water. The poor cultivators of about six villages constructed this canal as they are solely depended on cultivation. The head work of this canal is located at village Hazarika under Dotoma development block in Kokrajhar district of Bodoland Territorial Council. They used to trap rain water by constructing a pond at the northern side of the village Hazarika. The rain water so accumulated has been distributed by the canal system to the vast agricultural fields of the villages Hazarika, Baladonga, 1 no Nepalpara, 2 no Nepalpara, 1no Narabari, 2 no Narabari under Dotoma development block. But after every heavy rainfall, this canal is destructed as huge run off enter the canal. Now the irrigation department has constructed the regulator to control the flow of water to the canal.

**Fig 5- bamboo drip irrigation**

Dongs are traditional canals that carry water from the streams to the fields. Use of deep tube well water for irrigating fields can carry Iron and so may degrade the land. But dongs carry surface water and rain water and so these harmful effects can be ignored.

In Meghalaya a century old system named 'Bamboo drip irrigation' is used by Khasis and Jayantias to irrigate the betel nut and black pepper cultivation. It is mainly found in Dawki, Muktapur, Hatmawdon and Lynkhat area where this cultivation done. They trap natural stream water using bamboo pipes. They have to repair these pipes yearly. They use this system mainly in dry season when rainfall is scanty. About 18-20 litre of water per minute enter at the starting point and is transported through the system over several hundred meters and at the site water amount is reduced to 20-80 drops per minute. [7]

Bamboo is locally available there. Bamboos have to replace yearly due to damage. Govt. is still not providing irrigation facility to these areas and thus they manage the irrigation problem.

**RAIN WATER HARVESTING**

Rain water harvesting is practised in Meghalaya, Mizoram and Nagaland. The zabo system of Kikruma village of Nagaland is a system to trap rain water. Rain water harvesting is practised in Mizoram in a wide range. In Aijwal rooftop harvesting is practised in almost every household. A village named Reik , 12 km away from Aijawl where every household trap rain water and use it. Gutters are placed along the roof to collect the runoff from the roof and are opened to a well from which water is used for various purposes. In Meghalaya also rain water is used for various household activities. They collect the rain water using gutters and store them in earthen ponds. These ponds are covered by opaque plastics, straw or any locally available material to check evaporation. The floor of the pond is compacted to avoid seepage. The side of the tank is framed with bamboo. All these things are done in low cost. They use rain water for drinking purpose also.

**Fig 6- Underground tanks to store rain water**

For this they use 'Teraffil filter' which checks bacteria and ions. For household activity the water is passed through a filter system made of brick, river sand, coir and charcoal. At the bottom of this filter river sand are placed which is covered by coir. Coir is then covered by charcoal. It is again covered by coir, river sand and coir accordingly. At the top it is covered by bricks. The water passes through this system and become suitable for household activity. Coir, sand and charcoal are replaced from time to time.

**Feasibility of the traditional systems of farming and water harvesting**

The traditional systems are the best example to use the locally available materials perfectly and to cope with the environment. These systems were used by our ancestors and are still in use. One of the important factors is that these systems do not pollute the surroundings. Artificial irrigation like deep well water can increase the mineral content of the soil thus making the soil saline. Also due to climate change the pattern of rain fall is changing in the recent years.

**Table 1- Crop season wise average rainfall in Assam**

| Year | Kharif season | | | | Rabi season | | | | All season | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual | Normal | Deviation , % | Pattern | Actual | Normal | Deviation, % | Pattern | Actual | Normal | Deviation , % | Pattern |
| 2007 | 1816.6 | 2118.2 | -14.2 | normal | 259.7 | 313.6 | -1.7 | normal | 2076.3 | 2431.9 | -14.6 | normal |
| 2008 | 1773.0 | 2038.1 | -13.0 | normal | 275.1 | 314.8 | -12.6 | normal | 2048.1 | 2352.9 | -13.5 | normal |
| 2009 | 1512.4 | 1953.6 | -22.6 | deficit | 187.8 | 302.2 | -37.9 | deficit | 1700.2 | 2255.8 | -25.0 | deficit |
| 2010 | 2066.3 | 1976.0 | +4.6 | normal | 189.0 | 306.2 | -38.3 | deficit | 2255.3 | 2282.2 | -1.2 | normal |
| 2011 | 1411.1 | 2001.0 | -29.5 | deficit | 155.5 | 295.3 | -47.3 | deficit | 1566.6 | 2296.3 | -29.5 | deficit |

*Source- Director of Agriculture, Assam*

On the other hand due to increase of population, burden on underground water is increasing day by day. So rain water harvesting can be a solution to this problem. Harvesting of rain water can minimise the problem of flash flood and also can recharge the ground water. A micro-watershed project implemented in Ghelhar Choti village in Jhabua district Madhya Pradesh has led to recharging of ground water. [8] Because of this the cultivable area has increased and the yield per ha has doubled. Traditional systems are very fruitful to control flood and drought. During post independence period the destruction of flood water harvesting systems like Bengal's Inundation channel resulted havoc of flood. In Bengal this system not only prevented flood but also checked malaria as the fishes that swam through these channels feed on the larva of mosquitoes. [9]

In US, rooftop rainwater is collected and stored in sump. In India this includes Bawdis and johads, or ponds which collect the run-off from small streams in wide area. Recharging the groundwater in this way is claimed to not only improve the year-round availability of groundwater, but also lead to richer vegetation. Rajendra Singh, The water man of Rajasthan (1985), played a catalyzing role in the building of 5800 ***Johads*** (Water Harvesting Structures) and in rejuvenation of 2500 old structures in 1058 villages under the leadership of a voluntary organization Tarun Bharat Singh (TBS). Johads were built in the districts of Jaisalmer, Ajmer, Udaipur and Bharatpur. As a result the rivers Ruparal, Arvari, Sarsa, Bhagani and Jahaiwali that had nearly dried up have now become perennial. [10]

Construction of large dam is not suitable in this region as this region is an earthquake prone zone. Prinz and Singh (2000) have made a comparison between water harvesting systems and large or medium dams. They have stated that introduction of water harvesting systems in upstream can manage the watershed more efficiently. They also state that water harvesting can supplement irrigation during water scarcity period also. [11]

Water harvesting systems also help to maintain the nutrient of the soil and check soil erosion. For example the water harvesting systems made permanent agriculture in the arid region of the delta of river Nile possible before construction of Aswan dam. After the construction of the Aswan dam this was no longer possible. Now farmers have, besides advantages of greater water availability, big problems in keeping the land fertile. [12]

According to *Indian Journal of Hill Farming* the 'zabo' system in Nagaland is a combination of forest, agriculture and animal husbandry with a well founded conservation base, soil erosion control, water resource development and management and protection of environment. [13]

There is less chance of loss of water as it is collected and stored within accessible distance from the place of use and are constructed with locally available material and labour. North East Region of India is very rich in water resource. The surface water resource availability in the region amounts to 653 billion cubic meters (BCM). But there is considerable variability in the spatio-temporal distribution of this resource, the terrain conditions and human settlement. So this region has very high potentiality to develop traditional water harvesting systems through which resource can be more efficiently used than through conventional systems. [14]

## CONCLUSION

North east India is home to a large no of ethnic groups who are the masters to evolve such systems which are suitable to the environment and we should not feel shy to learn from them. When there is proper use of natural resources sustainability comes and when sustainability remains there comes progress.

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