JUST AGRICULTURE
multidisciplinary e-Newsletter

Soil and water conservation in Meghalaya

Bantisha Diengngan, MM Shulee Ariina, Kivi H Yeptho, Nrithung Kikon, Moni Geyi
School of Agricultural Sciences and Rural Development, Nagaland University
ARTICLE ID: 022

Introduction:

Meghalaya meaning "abode of clouds" is a state in north-eastern India. As of 2016, Meghalaya covers is estimated to be an area of approximately 22,430 square kilometers, with a length to breadth ratio of about 3:1.

Agriculture:

- ✓ 81% state population depends on agriculture.
- ✓ Main crops – rice, wheat, maize and pulses, etc.
- ✓ Climate – neither too warm in summer nor too cold in winter but in the plains of Garo hills, the climate is warm and humid in summer.
- ✓ Soil – loamy to fine loamy, rich in organic carbon, base saturation of soil is less than 35%.
- ✓ pH – 4.5 to 6.0 that varies with altitude.

Soil erosion in Meghalaya

- Meghalaya is highly susceptible to acute soil erosion problems due to its undulating topography and highly intensive rainfall.
- Shifting cultivation: Shifting cultivation or slash and burn agriculture is common practice in Meghalaya, where a piece of land or hill is selected and trees or bushes are cut down partially or fully left to dry and then burnt *in-situ*. These practices have led to land degradation causing soil erosion and finally coverting forest land to the wasteland.
- Mining

JUST AGRICULTURE
multidisciplinary e-Newsletter

- Deforestation
- Human settlement
- Construction of roads

- It has been reported that soil erosion from the hill slopes of 60-70% is as follows: -

  1st year of Jhum - 146.6 tonnes/ha/yr

  2nd year of Jhum - 170.2 tonnes/ha/yr

  Abandoned Jhum - 30.2 tonnes/ha/yr (1st year)

  Bamboo forest - 8.2 tonnes/ha/yr

  (Source Agriculture in NER - D.N.Borthakur)

Soil and water conservation practices in Meghalaya

1. **Terrace or bun cultivation**

Bun cultivation on hill slope and valley is the settled cultivation system being practiced for many decades to provide improved production system to conserve soil moisture and also prevent land degradation and soil erosion. In this system, bench terraces are constructed on hill slopes running across the slopes. Such measures help to prevent soil erosion and retain maximum rainwater within the slopes and safely dispose of the excess runoff from the slopes to the foothills.

In bench terraces, irrigation stones and gunny bags help in the maintenance of terraces and prevent soil erosion. Submergence of water up to 5-8cm is maintained throughout the year.

2. **Bamboo drip irrigation**

✓ 200 yr. old traditional irrigation system.

✓ Used by tribal farmers of Khasi and Jiantia hills

✓ 18-20 litres of water entering the bamboo pipe system per minute gets transported over several hundred meters and finally gets reduced to 20-30 drops per minute at the site of plants.

✓ Pepper vines, beetle leaves are irrigated in such a way.

JUST AGRICULTURE
multidisciplinary e-Newsletter

- ✓ Since the water is carried through bamboo culms in the indigenous farming areas, the system indirectly helps the forest areas. No cutting of trees and shrubs is required to clear the land for making channels through the forest areas on hills. The farmers go for settled cultivation when bamboo drip irrigation helps in conserving the environment and preserving the prestigious natural resources in the hilly terrain of Meghalaya.

3. Rooftop rainwater harvesting

Rooftop rain water harvesting is the technique through which rainwater is captured from the roof catchments and stored in reservoirs. Harvested rainwater can be stored in sub-surface groundwater reservoirs by adopting artificial recharge techniques to meet the household needs through storage in tanks.

The main objective of rooftop rainwater harvesting is to make water available for future use. Capturing and storing rainwater for use is particularly important in dry land, hilly, urban and coastal areas.

Advantages of rain water harvesting:

1. Provides self-sufficiency to your water supply.
2. Reduces the cost for pumping of groundwater.
3. Provides high-quality water, soft and low in minerals.
4. Improves the quality of groundwater through dilution when recharged to groundwater.
5. Reduces soil erosion in urban areas.
6. The rooftop rainwater harvesting is less expensive.
7. Rainwater harvesting systems are simple which can be adopted by individuals.
8. Rooftop rainwater harvesting systems are easy to construct, operate and maintain.
9. In hilly terrains, rainwater harvesting is preferred.

4. Gabions

Gabions are an element in the form of blocks made of wire mesh nettings of twisted hexagonal opening or welded square or rectangular openings, which are filled with natural stone for the river, hill protection, or construction.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Their function provides a barrier to retard and slow erosion processes caused by water or excessive seepage on steep or mild slopes. Gabions have several beneficial advantages to the environment.

Gabion walls can be used in the formation of the pond and damn walls, as well as cladding for building structures. Cement caps can be placed on top of gabion walls, similar to the way sidewalks cap the top of wall structures due to the pebble and gravel construction of gabion walls, the permeability remains good, allowing sufficient natural drainage of runoff while decreasing the water velocity by breaking it up and dispersing the pressure over a wide area.

5. Agroforestry

Agroforestry is a land-use management system in which trees or shrubs are grown around or among crops or pastureland. This diversification of the farming system initiates an agro-ecological succession, like that in natural ecosystems, and so starts a chain of events that enhance the functionality and sustainability of the farming system. Trees also produce a wide range of useful and marketable products from fruits/nuts, medicines, wood products, etc. This intentional combination of agriculture and forestry has multiple benefits, such as

- Enhanced yields from staple food crops, enhanced farmer livelihoods from income generation.
- Increased biodiversity, improved soil structure and health, reduced erosion.
- Control runoff and soil erosion.
- Maintained soil health and fertility of the soil.
- Agroforestry as an alternative to jhum cultivation.
- Agri horticulture system

  NEH region has ample potential for horticulture-based agroforestry systems.
- MPT based agroforestry system

  NEH region is characterized by the presence of a vast tract of forest areas. Therefore, the livelihood of the population is also strongly influenced by the forest wealth especially the tree resources. Farmers deliberately keep some of the multipurpose trees (MPTs) in their fields to meet their multifarious requirements.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Therefore, some of the MPT-based agroforestry systems were also evaluated at the ICAR Research Complex at Umiam for their suitability for the region. Indigenous trees of the region like *Alnusnepalensis, Gmelina arborea, Micheliaoblonga, Parkiaroxburghii, Prunus cerasoides* and *Symingtoniapopulnia* were planted at a density of 416 trees per hectares.

6. Tillage

Zero Tillage Pea enhanced income of farmers in Meghalaya, Nongthymmai village in Ribhoi district of Meghalaya under the subtropical hill agro-climatic zone is a climatically vulnerable area mostly affected by an acute scarcity of water during Rabi season.

- In Meghalaya minimum tillage or zero tillage is followed.
- At ICAR research complex for the NE region, it was found that maize could be successfully grown under no-till conditions.

7. Watersheds

It is an area or region drained by a river, river system, or other body of water. Rainfed agriculture is complex, diverse and risk-prone and is characterized by low levels of productivity and low input usage variability in rainfall results in a wide variation of instability in yields. The challenge before Indian agriculture is to transform rainfed farming into more sustainable and productive systems and to better support the population dependent upon it.

At present very high priority has been accorded by the government of India to the holistic and sustainable development of rainfed areas based on the Watershed approach. Indeed, the watershed approach represents the principal vehicle for the transfer of rainfed agricultural technology. A watershed (or catchment) is a geographic area that drains to a common point, which makes it an ideal planning unit for the conservation of soil and water. A watershed may comprise one or several villages, contain both arable and non-arable lands, various categories of land-holdings and farmers whose actions may impact each other's interests. The watershed approach enables holistic development of agriculture and allied activities in the area taking into account various kinds of land use based on crops, horticulture, agroforestry, silvi-pasture and forests. This system-based approach is the special feature that distinguishes watershed development from the earlier plot/field-based approach to soil and water management.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Effect on soil hydrological properties

Tree species improved the moisture retention capacity of soil as compared to the control (Table 1). At -0.03 M Pa suction, soil moisture under different tree species was 21 to 36 percent more than that of the control. Similar was also the trend in available water under the different tree-based systems.

Table 1: Effect of various multipurpose

Tree species	Available water ($m^3 m^{-3}$)	Infiltration rate (mm h^{-1})	Hydraulic conductivity (mm h^{-1})	Profile moisture storage (cm/60 cm)	
				In dry season	In rainy season
Pinus kesiya	0.220 ± 0.03	8.04 ± 1.28	5.44 ± 2.02	20.45 ± 3.22	24.60 ± 1.04
Alnus nepalensis	0.201 ± 0.02	7.28 ± 0.95	4.82 ± 1.46	19.44 ± 2.50	22.68 ± 0.98
Parkia roxburghii	0.192 ± 0.01	4.85 ± 0.56	3.23 ± 2.11	13.85 ± 3.61	18.52 ± 0.62
Michelia oblonga	0.210 ± 0.02	6.10 ± 1.23	4.84 ± 1.54	18.54 ± 2.37	21.66 ± 1.10
Gmelina arboria	0.183 ± 0.01	5.36 ± 0.82	3.50 ± 1.65	14.60 ± 2.11	19.41 ± 0.24
Control (No tree)	0.151 ± 0.02	3.84 ± 1.46	2.12 ± 2.35	11.45 ± 2.05	15.34 ± 0.72
LSD ($P < 0.05$)	0.11	1.06	0.18	2.17	2.30

Values for soil parameters are the means of three replications under two soil depths (0–15 and 15–30 cm) and two seasons across the year

Effect on soil physico-chemical properties

Tree species ameliorate soil by adding both above and below ground biomass into the soil system. However, variations do exist in the inherent capacity of different tree species in rehabilitating degraded lands. Five different trees species suitable for agroforestry systems were studied at ICAR research complex for NEH Region at Umiam, Meghalaya by Shah *et al* (2007). Soil samples were collected from 0-15 cm and 15-30 cm soil depth under five multipurpose tree species such as Khasi pine (*Pinus kesiya*), Alder (*Alnus nepalensis*), Tree bean (*Parkia roxburghii*), Champak (*Michelia oblonga*) and Gambhar (*Gmelina arborea*). A control plot in the form of natural fallow was also maintained near these tree-based land-use systems for the purpose of comparison. The effect of tree species on bulk density (BD), organic carbon (OC) and porosity of the soil was significant. All the tree species lowered BD and increased OC and porosity as compared to the natural fallow.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Table 2: Effect of various multi-purpose trees on soil physical properties

Tree species	Organic C ($g\ kg^{-1}$)	Bulk density ($mg\ m^{-3}$)	Total porosity (%)	Micro aggregates (<0.25 mm)	Dispersion ratio	Erosion ratio	Erosion index
Pinus kesiya	3.54 ± 0.33	1.04 ± 0.12	54.3 ± 6.22	17.6 ± 5.68	0.21 ± 0.09	0.20 ± 0.03	0.11 ± 0.01
Alnus nepalensis	3.22 ± 0.47	1.09 ± 0.09	55.6 ± 5.87	22.4 ± 3.30	0.23 ± 0.05	0.23 ± 0.01	0.12 ± 0.02
Parkia roxburghii	2.31 ± 0.61	1.23 ± 0.20	52.2 ± 3.20	28.8 ± 8.22	0.26 ± 0.11	0.30 ± 0.04	0.14 ± 0.01
Michelia oblonga	3.36 ± 0.96	1.05 ± 0.32	55.5 ± 4.58	21.5 ± 7.45	0.23 ± 0.03	0.22 ± 0.03	0.11 ± 0.03
Gmelina arborea	2.86 ± 1.24	1.14 ± 0.09	52.4 ± 6.04	38.0 ± 8.69	0.25 ± 0.04	0.24 ± 0.02	0.12 ± 0.02
Control (no tree)	1.56 ± 0.92	1.32 ± 0.11	48.7 ± 8.09	44.2 ± 6.02	0.35 ± 0.06	0.39 ± 0.03	0.15 ± 0.03
LSD (P<0.05)	**0.39**	**0.15**	**5.06**	**3.05**	**0.06**	**0.05**	**0.03**

Three tier agroforestry system

Alder (*Alnus nepalensis* -promising nitrogen fixing tree species) was introduced as a tree crop during 1987 and tea (*Camellia sinensis*) was planted in 1993 as the second storey crop at a density of 12,350 plants ha^{-1}. The investment for Alder and tea was Rs 11,398 and Rs 36,035 ha^{-1}, respectively. Besides tea, large cardamom, turmeric, ginger, taro and black pepper were intercropped. Alder produced 8.5 q ha^{-1} biomass of pruned material and 24 q ha^{-1} biomass of foliage. Green bud production of tea ranged from 44 to 64 q ha^{-1} for a period of five years with an average production of 59 q ha^{-1}. The productivity of large cardamom was 6.4 q ha^{-1}. Ginger, turmeric and taro produced 79, 165 and 172 q ha^{-1}, respectively. Black pepper was found to be sensitive to frost injury. Therefore, no significant yield could be obtained from this crop. Among various crops, net benefit was maximum (Rs 33,111 ha^{-1}) through large cardamom, followed by tea and ginger. On average, the multi-storeyed agroforestry system could generate a net annual return of Rs 12,884 ha^{-1}.

Fish base agroforestry system

The composite unit of aquaculture consisted of paddy, vegetables, large cardamom and fish culture besides bean cultivation on bund area of pond. It was revealed that among various components, fish culture generated maximum monetary returns (Rs. 36,000 ha^{-1}), followed by radish (Rs. 33,850 ha^{-1}), cured large cardamom (Rs. 29,000 ha^{-1}) and brinjal (Rs.

JUST AGRICULTURE
multidisciplinary e-Newsletter

25,500 ha^{-1}) cultivation, respectively. The average income from aquaculture-based AFS was Rs. 16,976 ha^{-1}.

Conclusion

- Mawsynram receives the highest rainfall in the world.
- The first state to have a water policy in India.
- The State Water Policy of Meghalaya intends to "achieve sustainable development, management and use of Meghalaya's water resources with community participation to improve health and livelihoods, reduce vulnerability, while assuring good governance for the present and future generations by promoting Integrated Water Resources Management". Environmental sustainability and conservation, social inclusion and equity will be duly considered in relation to all aspects of governance, management and consumptive use of water resources to ensure inter-generational equity.
- Rainfed agriculture is complex, diverse and risk-prone and is characterized by low levels of productivity and low input usage variability in rainfall results in a wide variation of instability in yields. The bulk of the rural poor lives in the rainfed regions. The challenge before Indian agriculture is to transform rainfed farming into more sustainable and productive systems and to better support the population dependent upon it.
- Conservation and management of rainwater hold the key to sustainable agriculture in rainfed areas. In the case of water resource management, the focus is not merely on the development of new water resources but also on the efficient utilization of already developed resources particularly based on indigenous systems.
- The Soil & Water Conservation Department in the State, a major department in the state has been playing a commendable role in the conservation of natural resources particularly soil, water and vegetation. The efforts and programmes of the department are aimed not only at providing soil cover to mitigate accumulated soil erosion but also at providing the rural and farming communities with basic amenities, infrastructures and incentives for creating sustainable alternative farming systems with a view to wean them away from the destructive traditional methods of cultivation as well as uplifting the socio-economic status at large.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Reference

- https://theconstructor.org/geotechnical/gabion-types-uses/24459/
- http://megagriculture.gov.in/
- http://megwaterresources.gov.in/pdf/DSWP30_5_2019.pdf
- http://megsoil.gov.in/annualreport/annual_report2018-19.pdf