



HILL AGRICULTURE: PROSPECTS AND PROBLEMS IN THE SOILS OF ARUNACHAL PRADESH

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Arunachal Pradesh is one of the largest mountainous state of India, which is situated in the north-eastern part of the Himalayan region. The state is characterized by high annual rainfall, forest vegetation, diversity in soils, and haphazardous hills. The National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) classified the state into four distinct zones. These zones include snow-capped mountains (5500 m AMSL); lower Himalayan ranges (3500 m AMSL); the sub-Himalayan Siwalik hills (700 m AMSL); and the eastern Assam plains (Maji et al., 2001). The wide and narrow valleys exist in between these hills along with several rivers and streams results in geographical isolation of many human-inhabited

areas. As these down flowing rivers and streams deposit different kinds of organic matter at various places of the foothills, it is difficult to generalize soil types. Broad nomenclature like soils of hills, valleys, mid-hills, and foothills are exists.

SOILS: PHYSICAL AND CHEMICAL PROPERTIES

Soil Nitrogen: In general, nitrogen is the most limiting nutrient for plant growth and yield in most agricultural production systems. Nitrogen in crop residues, soil organic matter, manures, and composts is present in complex organic form (e.g., proteins) and is not directly available to plants. Diverse microorganisms, such as



bacteria, archaea, and fungi in the soil convert this organic nitrogen into the ammonium and nitrate forms that plant roots can utilize. Thungon et al. (2018) reported that 23.0 percent of soil samples of the state belongs to the low category with respect to available nitrogen status, and 40 percent of soil samples fall in the category medium and high. The available nitrogen content ranges from 119 to 367 kg/ha.

Soil Acidity: Major parts of the Arunachal Pradesh are characterized by low pH due to excessive rainfall and leaching of bases. The availability of soil nutrients to plants is largely altered by soil pH. The availability of the plant nutrients viz nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, and molybdenum significantly reduced in the acidic soil. However, the availability of iron, manganese, copper, zinc, and aluminium is increased in acidic soils. Manganese toxicity can also be found in acidic soil of the hilly region of Arunachal Pradesh. The growth and reproduction of the soil microbes, primarily bacteria and fungi is reduced due to the acidic condition of the soil. Further, the breakdown of organic matter and nutrient cycling also decreased significantly in the acidic environment. The rate of mineralization of nutrients by soil microbes into the plant-available forms is slower, hence limiting plant uptake of the soil nutrient and also inhibits the nodule formation in legume crops. Under favorable conditions, nitrogen-fixing rhizobium bacteria form a symbiosis with crop and pasture legumes in root nodules. In acidic soils, the population of rhizobia bacteria is too low to create a functioning symbiosis, thereby resulting in nitrogen deficiency. The classification of acidic soil and its distribution in Arunachal Pradesh is in table 1.

Table 1. Class of soil acidity and extent of area (%)

S no	Class	% area
1	Extremely acidic (pH < 4.5)	1.4
2	Very strong acidic (pH <4.5 -5.0)	21.9
3	Strong acidic (pH <5.1 -5.5)	39.3
4	Moderately acidic (pH <5.6 -6.0)	12.2
5	Slightly acidic (pH <6.1 -6.5)	10.1
6	Neutral (pH 6.6 -7.3)	3.8
7	Slightly alkaline (pH 7.4-7.8)	0.5
8	Others	10

(Source: Soils of Arunachal Pradesh, NBSSLUP)

Soil Texture: The soils of Arunachal Pradesh can be categorized from gravelly to clay soil. The NBSS&LUP classified the state soil as gravelly (47%), loamy (27%), clayey (12%), and 2.8% of soil as sandy. This soil of state is mostly suitable for horticultural crops such as citrus, banana, kiwi, peach, plum and agroforestry systems.

Soil Organic Carbon: Soil organic carbon is vital for enhancing soil fertility and sustaining crop productivity. Inappropriate management practices, coupled with deforestation and desertification, have reduced SOC by 50–70% across most agricultural soils, leaving them prone to further degradation. However, In Arunachal Pradesh, owing to native vegetation, most of the soil showed high organic carbon content (Table 2).

Table. 2. Soil organic carbon in some selected district of Arunachal Pradesh

S no	District	Soil Organic Carbon
1	Tawang	21.8 to 81.4 g/kg
2	West Kameng	6 to 56.6 g/kg
3	West Siang	9 to 47.7 g/kg

WATER RESOURCE

The average rainfall of the state is 2100 mm, and the highest runoff of 350 Billion cubic meters (BCM) is reported in a year. The major river basin of the state is the Brahmaputra, and 82.8 % of its area falls in Arunachal Pradesh. About 80% of the mean annual flow of River Brahmaputra is contributed by more than 3,000 small and big river tributaries. Glaciers are found in the Kameng Basin (52 glaciers covering an area of 66 km²), Subansiri Basin (91 glaciers covering an area of 146 km²), and Dibang Basin (14 glaciers covering an area of 11 km²).

Arunachal Pradesh has 2.56 (BCM) annual replenishable groundwater resources. The development of groundwater potential in the state is negligible. With the depletion of surface water resources in the foothill areas of Arunachal Pradesh, especially Changlang, Lohit, Lower Dibang Valley, East Siang, Papum Pare, and East Kameng Districts, decency on groundwater for meeting the requirements of drinking water and irrigation are increasing day by day.



The Command Area Development Water Management (CADWM) program envisages the utilization of irrigation potential. It is estimated that about 55% of created potential is utilized, and 45% remains unutilized due to poor resource support. Flood is a recurring phenomenon in the state due to high precipitation. The magnitude of floods and riverbank erosion problems is increasing every year in the state.

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

The soil erosion is one of the significant problems in hilly terrain; therefore, anti-erosive cultural practices may be recommended for sustainable agricultural production. Some of these practices include hillside contour ditches, terracing cultivation, straw mulch treatment, alley cropping, grass-strip barriers, and surface mulching with different biodegradable materials. These practices are being developed and successfully used by the state's farmers (Figure 1-3). The primary technological options available for resilient hill agriculture are (a) agroforestry, (b) horticulture, (c) Integrated farming system, (d) Integrated watershed development, (e) medicinal and aromatic plant production, and (f) yak and Mithun husbandry.

SUMMARY

To sustain the hill ecosystem with constraints of soil fertility, acidity, high rainfall, low winter temperature, undulating terrain shifting cultivation, etc., and the best choice of

agricultural practices is to adopt diversified agriculture that can diversify the farm income. Some of the best practices could be the horticulture based farming system and integrated farming system. These practices not only have great potential to generate employment and revenue for the state but also sustain the soil health and crop production.



Figure 1. Vegetable production on Terrace



Figure 2 Pineapple cultivation on Terrace



Figure 3. Jhum cultivation in Hilly terrain

**FURTHER READING**

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Arunachal Pradesh state Action Plan on Climate Change

Soils of Arunachal Pradesh NBSSLUP

<http://arunachalpradesh.gov.in/department.htm>
