

Mollisols of Sikkim: The Unique Soils of the Humid Temperate Zone of India

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Abstract: Brown Forest Soils (Mollisols) from Sikkim state of northeastern India developed from the Daling group and granite gneiss parent rock. These soils are common under humid temperate climates with varying altitudes and vegetation in the Eastern Himalayas. These soils are mostly coarse-loamy to fine-loamy at the surface, and the clay content increases with soil depth. Soils are extremely to very strongly acidic at the surface with high content of organic matter, low in CEC with high base saturation. Clay CEC of these soils indicates mixed mineralogy with kaolin and smectite clay minerals. An advanced stage of weathering of the parent rocks and the presence of Ca-bearing weatherable minerals in the parent rocks, along with the temperate climate, might have helped in the formation and persistence of Mollisols in Sikkim. Besides the supply of bases through the decomposition of organic matter from the upper reaches, the basic volcanic lava in the form of basic rocks in the upper Paleozoic (Lower Gondwana) sequences in the Sikkim Himalayas continuously supplies the bases. This maintains the required base saturation (>50%) of soil to qualify for Mollisols, even in the humid temperate climate of Sikkim. These soils are precious and taxonomically represent Mollisol. This soil order is based on the characteristics of the surface diagnostic horizon and is the primary source of soil organic carbon, which helps to increase the SOC stock and, in turn, improves soil health. The occurrence of these soils also helps in carbon cycling in the terrestrial ecosystem mitigating the greenhouse gases from the environment and providing better ecosystem services. The high SOC content of Mollisols is a boon for agriculture in Sikkim, indicating better stabilization of organic matter in this temperate climate. Increased organic matter is beneficial in growing crops in these soils and perhaps justifies declaring Sikkim as an organic state. In Sikkim, brown forest soils (Mollisols) cover about 9.56 percent area out of which 2.51 percent area falls in the humid temperate climate under highly eroded/degraded conditions.

Keywords: Acid rock weathering; eco-system services; forest soils; granite gneiss parent rock; north-east India; SOC stock; vegetation effect on soil formation.