Soil quality index under two prominent agroforestry species of the western Himalayan region

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Soil degradation poses a significant challenge in the fragile ecosystems of the western Himalaya and is a serious threat to productivity and ecological stability. The present study evaluates the ability of *Bauhinia variegata* and *Celtis australis* to enhance soil health. The study is innovative in that it integrates soil physical, chemical, and biological parameters to develop a comprehensive soil quality index (SQI) that assesses soil improvement in a holistic manner. To evaluate the impact on soil quality, soil samples were collected under each species and compared with a control (non-agroforestry) site. The findings revealed that both species enhanced soil quality. *C. australis* significantly enhanced water-stable aggregates, soil pH, organic carbon, available macronutrients, and bacterial population while *B. variegata* improved infiltration and supported higher populations of fungi and actinomycetes. The higher SQI was observed under *C. australis* indicating that the species can be a good choice for improving soil health and land restoration. Overall, the present study underscores the importance of species selection when designing agroforestry solutions for the rehabilitation of degraded lands.

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especially in degraded areas[1]. Monitoring soil quality in agroforestry can help assess the effectiveness of agroforestry interventions in improving soil fertility, reducing soil erosion, and enhancing moisture retention. The study on soil quality in agroforestry can provide valuable insights into the sustainability and long-term productivity. In recent years, there has been a growing focus on evaluating soil quality as a key indicator of agricultural sustainability[2,3].

Despite the growing emphasis on agroforestry, studies on soil quality in agroforestry, especially involving native species in the Himalayan region, remain under-researched. The majority of the published studies focus on generalised effects of agroforestry or commercial species, considering a few soil parameters in isolation. Addressing these gaps is important in developing resilient site-specific sustainable agroforestry systems that promote higher productivity and address major issues pertaining to the environment and land degradation. To address these gaps, a study was conducted to assess the soil improvement potential of two native Himalayan species—*Bauhinia variegata* and *Celtis australis*. Both the chosen species are widely planted in the mid-Himalayan region because of their ecological significance[4]. These species are preferred by farmers due to their multipurpose uses. While *B. variegata* provides fodder, fuelwood, medicine, and is known for its nitrogen-fixing ability. On the other hand, *C. australis* provides a variety of benefits to local communities, including fodder for livestock, fuelwood, and small timber