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LATEST NEWS

Potential of afforested agricultural lands for carbon sequestration

Role of forest ecosystems in carbon sequestration

Forest ecosystems are among the most important carbon pools in the terrestrial biosphere. Although estimates vary among data sources, forests store a substantial share of terrestrial carbon, both in biomass and soils.

At the same time, it is generally accepted that soils store approximately twice as much carbon as vegetation globally, and even in forest ecosystems, more than half of the total carbon stock is located in the soil compartment. Forest soils, therefore, play an important role in global carbon sequestration and dynamics.

A significant carbon pool is formed in newly developed surface humus, while considerable amounts of carbon are also stabilized in mineral soil horizons over longer time scales. The rate and magnitude of this sequestration are the main focus of the present contribution, based on both published and unpublished data from the author's research team.

Source of data

For Central European conditions, several studies dealing with carbon stock changes under typical conditions—namely, the afforestation of marginal agricultural soils (figure 1) —were evaluated. These sites are generally located at middle and higher altitudes and involve commonly used commercial tree species (Norway spruce, Scots pine, native broadleaves, and Douglas-fir).

Figure 1 - Afforestation of marginal agricultural soils,
a suitable measure for climate change mitigation

The afforested areas include marginal agricultural lands (both arable land and grasslands) with limited productivity. The analysis focused on the accumulation of newly formed surface humus and differences in total carbon content in mineral soil horizons down to a depth of 20 cm.
Standard soil analytical methods were applied. Surface (holorganic) horizons were sampled quantitatively, while carbon stocks in mineral soil horizons were estimated using bulk density and carbon content values. The age of the forest stands (30–50 years) was taken into account when quantifying changes in carbon stock. Differences compared to adjacent active agricultural land were also considered.

Results

A simplified model of carbon sequestration on selected afforested agricultural areas provides estimates of average annual carbon sequestration rates. Although the results should be regarded as indicative, they offer a useful approximation of the intensity and dynamics of this process.

In newly developing forest soils, carbon sequestration rates in the range of 0.5 to 1.0 t C ha^{-1} yr^{-1} can be expected during the first decades. A considerable proportion of this carbon is relatively rapidly incorporated into more stable humus fractions in the upper mineral soil layers. The restoration of forest soil characteristics and associated carbon sequestration can therefore proceed relatively quickly.

Few remarks

- Carbon accumulation is not a linear process and varies depending on site conditions and tree species composition.
- The results depend on whether grasslands or arable land are afforested.
- In this study, the skeleton fraction was not considered; in arable soils, it is assumed to be minimal.
- A bulk density value of 1 g cm^{-3} was used; measured values ranged between 0.9 and 1.2 g cm^{-3}, implying an uncertainty of approximately 10–15%, which is acceptable for a first estimate.

Conclusion

Although the results are indicative, they provide a reasonable estimate of the carbon sequestration potential of newly afforested agricultural land. On degraded sites, and with appropriate tree species selection, even higher sequestration rates may be expected.

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