Agricultural Greenhouse Gases Program (AGGP)

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Carbon Pool Size and Stability Are Affected by Perennial Vegetation within Agroforestry Systems

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The Motivation

Agricultural production often depletes/reduces soil organic carbon (C) content; this in turn creates opportunities for increasing soil C storage if the process can be reversed. Reducing the frequency of physical disturbance to the soil, such as the use of no till or minimum tillage, can help increase soil C storage. Another effective method to reverse the decreasing trend of soil C is to plant trees and other types of perennial plant species. Developing land use systems that reduce GHG emissions from agriculture has a large role to play in reducing GHG emissions from the agriculture landscape. This study thus evaluated the role of three agroforestry systems in increasing C sequestration and reducing GHG emissions in central Alberta.

Methods

We selected 36 sites for three agroforestry systems: 12 each of hedgerow, shelterbelt (white spruce dominated) and silvopasture (aspen dominated) sites. The sites were distributed across a 250 x 300 km area centered around Edmonton, spanning from the Dark Brown Chernozemic to the Dark Gray Chernozemic soil zones. In each site, plots were set up in the forested area and in the agriculture production area (herbland, including grazed pasture and annual crop production areas). Soil samples were collected from the 0-10 and 10-30 cm depth and were analyzed for their C concentrations and distribution in different density fractions: light (<1.6), occluded (ultrasonic dispersion and density <1.6), and heavy fractions (>1.6 g cm^{-3}).

The Result

In the 0–10 cm layer, soil organic C stock was greater ($P<0.05$) in silvopasture (101) than in either the hedgerow (77) or shelterbelt system (67 Mg C ha^{-1}).

Soil organic C stock in both soil layers was greater ($P<0.05$) in the forested area (89 and119 Mg C ha^{-1} for the 0-10 and 10-30 cm layers, respectively) than in adjacent herbland (76 and 77 Mg C ha^{-1}, respectively). The soil organic C pool in the more stable heavy fraction in both the 0–10 and 10–30 cm depth was the largest in the shelterbelt (33 and 35 Mg C ha^{-1}, respectively), but was the smallest in the silvopasture system(26 and 20 Mg C ha^{-1}, respectively).

Implications

Aspen based silvopasture systems can effectively increase soil organic C accumulation in surface mineral soils, particularly in the labile light fraction of soil organic matter, and spruce based shelterbelt systems are effective in enhancing the size of stable soil organic C pools in agricultural lands of central Alberta.

Maintaining perennial vegetation cover should be encouraged to increase carbon sequestration in the agricultural landscape in central Alberta.

Further Reading

Baah-Acheamfour, M., Chang, S.X., Carlyle, C.N. and Bork, E.W. 2015. Carbon pool size and stability are affected by trees and grassland cover types within agroforestry systems of western Canada. Agriculture, Ecosystems and Environment 213: 105-113.

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