Evaluation of Agroforestry for Carbon Sequestration

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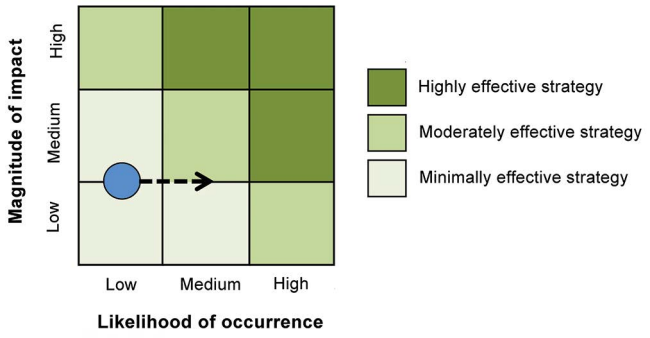
Implementation of agroforestry practices can help moderate effects of climate change through sequestration of carbon (C). Trees in agroforestry practices absorb and store larger quantities of atmospheric carbon dioxide (CO_2) than do the herbaceous annual crops they would replace. This case study assessment indicates that the potential impact of agroforestry implementation on concentration of CO_2 in the atmosphere is likely to be small but measurable if implemented extensively but that the likelihood of widespread adoption under current economic conditions is low (fig. B.5).

Figure B.5. Likelihood of occurrence and impact of agroforestry implementation on U.S. farmlands on global atmospheric CO_2 concentration. The impact will be low but measurable if implemented on 10 percent of U.S. farmland and along 5 percent of river miles, but the likelihood of achieving that level of implementation (circle) is low under current market conditions and program incentives, among other factors that affect adoption by landowners. The likelihood of occurrence would rise (arrow) if those factors become more favorable for adoption of agroforestry and the aerial extent of implementation increases.



Atmospheric concentrations of greenhouse gases, of which CO_2 is a major component, are rising and are considered to be largely responsible for a changing global climate. The absorption and sequestration of the C in CO_2 are viewed as strategies for limiting the increase of atmospheric CO_2, climate change, and the effects of a changing climate on Earth's systems and resources. Total global C emissions as CO_2 in 2012 were estimated to be 9,825 million metric tons (GCP 2014). That emission rate is raising the concentration of atmospheric CO_2 by approximately 2 parts per million (ppm) per year, which stood at 391 ppm in 2012 (NOAA ESRL 2014). Total U.S. C emissions as CO_2 in 2012 was estimated to be 1,460 million metric tons of C (U.S. EPA 2014), or about 15 percent of the global total.

Forests can be important contributors to C sequestration. Forest vegetation absorbs and converts atmospheric CO_2 into C compounds in plant biomass. The C is stored for long periods in wood and recalcitrant degradation products like soil organic matter. Afforestation (i.e., the conversion of herbaceous cover to forest cover) has the capability of increasing the total amount of C that can be stored on the land. Agroforestry implementation on agricultural land can be viewed as a form of afforestation. A risk-based framework can be used to assess the C sequestration potential of afforesting agricultural lands with agroforestry practices.

Agroforestry implementation can mitigate climate change to the extent that its rate of C sequestration is significant compared with total C (as CO_2) emissions. Potential C sequestration rates after adopting agroforestry practices in the United States (including silvopasture, alley cropping, windbreaks, and riparian forest buffers) on 10 percent of current U.S. cropland and pastureland and 5 percent of total river length (42 mega hectares, or an area about the size of the State of California) have been estimated to be 90 to 219 million metric tons of C per year (Nair and Nair 2003, Udawatta and Jose 2012). These estimates put the potential agroforestry sequestration rate at about 1 to 2 percent of the global CO_2 emission rate in 2012 and 6 to 15 percent of the U.S. CO_2 emission rate. At most, then, the rate of increase in global atmospheric CO_2 concentration would be slowed by about 2 percent of the 2012 rate or 0.045 ppm per year. Assuming that current agricultural systems have been in place long enough to have reached a steady state of C stocks (net C sequestration rate = 0), then these values fairly represent the potential effect of implementing agroforestry on agricultural lands in the United States.

A high C sequestration rate is unlikely to be sustainable in the long term without active management. Rates can be expected to fall as agroforests mature and approach a natural steady state of aboveground and belowground C stocks—possibly within 50 to 100 years of implementation. A high sequestration rate can be partially sustained for a longer term to the extent that the standing stock of plant biomass is harvested and preserved in the form of wood products like structural lumber.

Based on this analysis, the potential for agroforestry implementation in the United States to moderate global atmospheric CO_2 concentrations is probably small but still significant (fig. B.5). Agroforestry could contribute substantially toward reducing the U.S. footprint (by 6 to 15 percent) on the global increase of atmospheric CO_2. Furthermore, this rate could contribute substantively to a global effort that includes additional mitigation approaches. Its impact, however, will depend largely on how widely agroforestry is implemented. There are substantial technical and sociological headwinds for achieving the implementation rates that are assumed in this analysis.

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