Farming The Environmen

Spatial Variation and Economic Efficien Policies for Carbon Sequestration and

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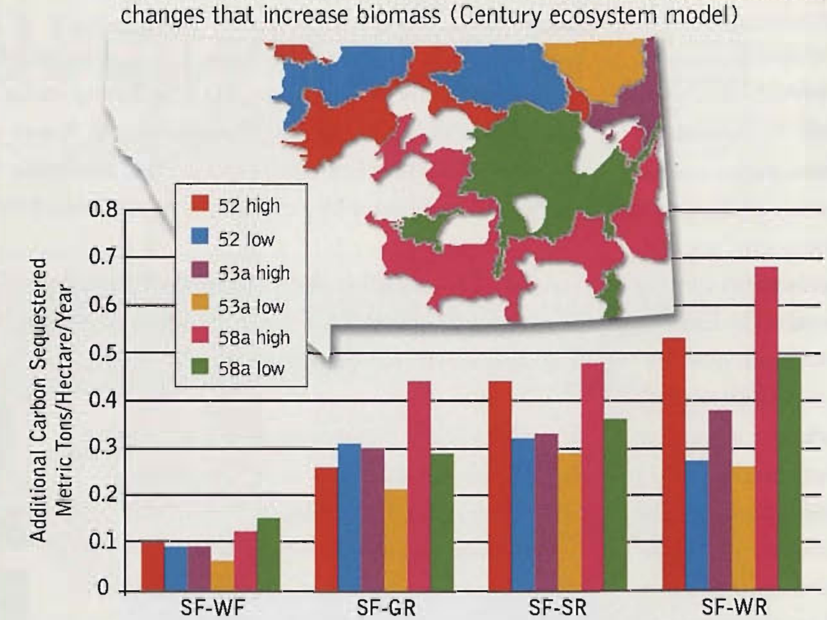
Many industrialized counties are looking at ways to reduce their net emissions of greenhouse gases such as carbon dioxide. The Kyoto protocol of the United Nations Framework Convention on Climate Change introduces the idea of a C (carbon) credit trading scheme that would give credit to participating countries for reducing emissions domestically or purchasing them internationally. This potential new market could be beneficial to agricultural producers if they can provide C credits at a cost that is economically competitive with other sources. Recent research suggests that U.S. emissions could be reduced by up to 8 percent through sequestering C in agricultural soils (Lal et al.1998).

Soil C can be increased by adopting management practices that reduce soil disturbance (and thus C oxidation) and/or increase biomass production. A mix of practices is likely under a market for C reflecting the spatial variability of resource endowments and economic considerations. Figure 1 presents the annual increase in C resulting from a change to cropping systems that increase biomass production in six different "agroecozones" within Montana. C estimates are predicted using the Century ecosystem model (Antle et al. 2001). Figure 1 shows that the quantity of C sequestered varies across space, thus all management practices are not equally suited to each area. Based on Figure 1, ecozone 58a-high has the greatest technical potential to sequester soil C. Examining only the technical potential ignores a key economic question: what level of incentive or compensation is required to encourage producers to adopt practices that increase soil C?

Figure 1. Average annual rate of carbon accumulation for selected crop system changes that increase biomass (Century ecosystem model)



SF-WF Spring wheat fallow to winter wheat fallow
SF-GR Spring wheat fallow to grass
SF-SR Spring wheat fallow to continuous spring wheat
SF-WR Spring wheat fallow to continuous winter wheat

A producer will participate in a policy or market to sequester additional C if the net returns from production changes plus the market value of C produced exceed the net returns from existing production practices. Figure 2 presents C supply curves for each region, reflecting the opportunity cost per metric ton of C incurred by producers that switch to a system that sequesters additional soil C.

For example, 3 million metric tons of C can be supplied from ecozone 52-high for approximately $45 per metric ton, while the same quantity in ecozone 58a-high could be supplied for approximately $60 per metric ton.

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Figure 2. Supply of carbon at payments ranging between $10 to $100 per metric ton

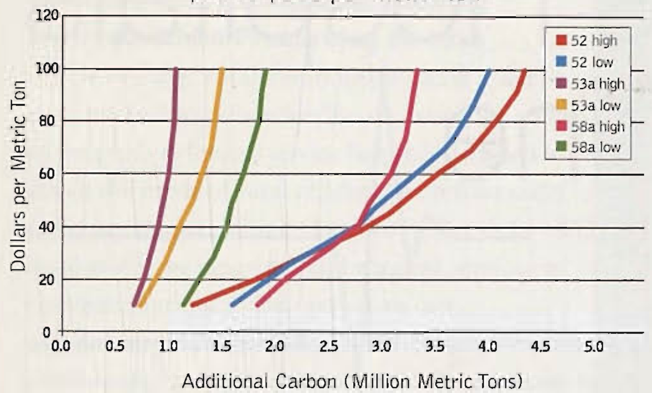

Figure 3. Proportion of eligible land area entering a carbon payment program at payments ranging between $10 to $100 per metric ton

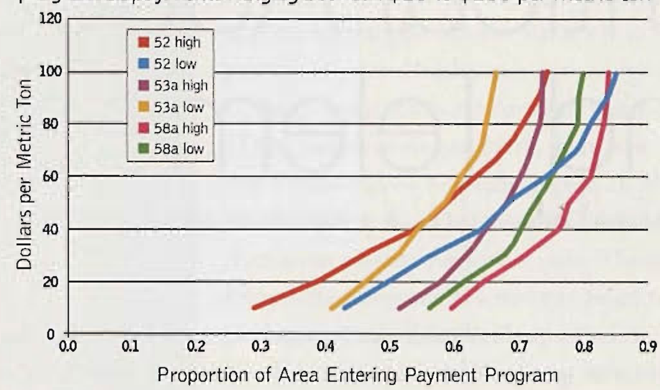

Figure 2 demonstrates that the efficiency of soil C sequestration varies spatially and is dependent on both the biophysical rates of C accumulation and the site-specific opportunity costs of changing production practices.

Figure 3 shows that as the price per metric ton of C increases, participation in C sequestration also increases. These shares are simulated using a model for dryland grain production in Montana (Antle et al. 2001). The model reflects both site-specific net returns and the biophysical potential to sequester C. At low payment levels, only producers with the lowest opportunity cost per metric ton C will participate. As payments increase, producers with higher opportunity costs can enter the market increasing the percentage of producers and land area that are engaged in the market and the benefits that accrue to agriculture.

Implications for agriculture

Biophysical and economic conditions that vary by location have two important implications. First, a market for C will be beneficial to regions that have the lowest opportunity costs per metric ton of C sequestered, and as the demand for C increases, there will be more opportunities for more producers to enter the market. Second, C can be sequestered in agricultural soils of the Northern Great Plains at a cost competitive with other sources. Related work by Stavins (1999) and IPCC (2000) show that forest practices can sequester C at costs that range from $3 per metric ton to over $100 per metric ton. These figures suggest that C sequestration could provide new economic opportunities for U.S. agricultural producers.

For More Information

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