

Section A: Research Summaries from Briefing Paper Topics (Afforestation Theme)

U.S. forestry can play a substantial role in climate change mitigation through carbon sequestration-- tree, litter, soil, and understory, and harvested wood products--and bioenergy feedstocks. Mitigation activities generally are quite competitive compared to opportunities in agriculture, including afforestation of agricultural land, affected by regional differences, dynamics of forest growth and carbon sequestration, forest ownership differences, and interactions with other sectors of the economy. To aid USDA policy makers, the USDA Forest Service has asked researchers to help develop information to respond to and/or analyze the economic consequences of policy options and better understand the role of forests and agriculture in mitigating climate change. Next are example research findings, followed by more detailed summaries for the first two items. Other research findings are contained in eight briefing papers which will be available on our web site.

1. A recent national analysis (Alig et al. 2009) projected about 25 million acres of afforestation at \$25 CO₂ prices and more than double that area with \$50 CO₂ prices. The majority would be in the South Central region, Corn Belt, and the Southeast. The South has some of the lower cost afforestation opportunities, reported in studies going back several decades such as in the Study of the South 4th Forest by the USDA Forest Service. The projected afforestation would be “additional,” as relatively little afforestation is projected in a base case without carbon payments. Two decades of research supports the conclusion that afforestation can be used to offset CO₂ emissions at costs that are comparable or lower than those with energy-based approaches such as energy efficiency and fuel switching. An econometric approach produces higher cost estimates than engineering and optimization methods, reflecting a number of factors that affect land-use decisions in practice but which are difficult to measure explicitly and include in engineering and optimization models. These include landowner uncertainty in the face of irreversible investments, non-monetary returns to landowners from forest and agricultural uses of land, liquidity constraints, and other private or market costs or benefits.

2. Adding another 125 million people in the United States over the next half century may lead to a net reduction in the area of private timberland available for carbon sequestration and increase forest carbon sequestration costs, with conversions to urban and developed uses outweighing timberland area additions from agriculture in the Business as Usual case. Area of developed area, which would hold relatively little carbon in vegetation, is projected to increase from 39.5 million ha in 1997 in the United States to 72.8 million ha by 2025.

3. Carbon sequestration through forest management also offers substantial offset potential (Adams et al. 1999, Alig et al. 2009). The large NIPF timberland base has many opportunities for intensified forest management and increased forest carbon sequestration. Potential to expand timber production and carbon storage in forests is large for this ownership (Alig et al. 1999, Vasievich and Alig 1996, Alig et al 2009). Many implementation issues still must be carefully addressed before a large-scale carbon sequestration program can be put into effect, e.g., landowners have more information about their opportunity costs than the government.

4. Demand for timber products will continue to grow. The United States has fairly stable per capita consumption of wood and paper products, at one of the highest levels in the world.

Storage of carbon in wood and paper products is substantial, as in 1990 approximately 145 Tg of carbon, or 11% of the level of U.S. emissions was harvested and removed from forests for products (Skog and Nicholson 2000). If a substantial proportion of this carbon could be prevented from returning to the atmosphere, it could make a notable contribution to mitigating carbon build-up in the atmosphere.

5. The South is a key region from a carbon sequestration perspective, both in terms of potential expanded afforestation and offsets from forest management. The South has the potential to afforest millions of hectares of marginal agricultural land, as well as to economically and substantially increase growth on existing timberlands (Vasievich and Alig 1996). Afforestation in the Corn Belt could also contribute significantly, although the forestry infrastructure and landowner familiarity and behavioral tendencies can differ markedly from those in the South.

6. Private owners tend to retain a large majority of government-subsidized afforestation and other plantations well beyond the program life (Alig et al. 1980, Noweg et al. 1996), across all regions surveyed. This means that most carbon in such forest ecosystems is in place for at least several decades. The plantations also generally are well stocked with trees, and are often regenerated back to forest after harvest.

7. External benefits from increased afforestation could include water quality improvements, reduced forest fragmentation, enhanced biodiversity, and other benefits. Longer rotations in forest management could also have some beneficial ecological effects. Private owners often manage their lands for multiple objectives (Birch 1994, Kline et al. 2001). The diversity of private owners has led to many patterns of behavior and resultant forest conditions. Carbon sequestration is a relatively new objective and carbon markets are typically lacking or just emerging.

8. Unintended consequences of climate change policies should be considered, given previous experiences with other government programs. An example of where forest carbon-related outcomes could vary from the intended aims is leakage when market forces at relatively large scales include price changes in land markets that lead to less net tree planting or forest area than envisioned by program planners (Alig et al. 1997). Afforestation policy might alter the use of forest plantations rather than natural forest establishment methods, as well as changing the use of irrigation in agriculture or tillage practices in agriculture if relative costs of carbon storage in the two sectors are altered.

9. Public timberlands also contain many young stands that can sequester large amounts of forest carbon (Depro et al. 2006, Thompson and Alig 2009).

10. Currently, much of the interest in forests centers on the opportunity to sequester carbon as part of a cap and trade policy. In addition to sequestering emitted carbon, forest resources reduce carbon emissions at the source when substituted for the fossil fuels currently used to generate heat, electricity, and transportation fuels. Woody biomass can be used to generate heat or electricity solely or in combination in a combined heat and power plant.

Section B: Expanded afforestation topics

A) Background on Forest Area Trends and Projections for United States--Forest area in the United States dropped by more than 31 million acres or 5 percent in the 20th century, according to FIA data. More recent historically according to the NRI surveys, 11 million acres of forest, cropland, and open space were converted to urban and other developed uses from 1992 to 1997, with forestland the largest source of land converted to developed uses. Urban and other developed areas are projected to continue to grow substantially, in line with a projected U.S. population increase of more than 125 million people over the next 50 years, which will affect costs of forest-based carbon sequestration. Some forestland is projected to be deforested for agriculture use, part of possible two-ways land-use changes. Under "Business as Usual," area of forest-land cover in the United States is projected to decline over the next half-century, with a 6-percent reduction by 2062, from the 2010 RPA Assessment (PNW GTR in press). RPA-based projections of forest area did not differ significantly under the three IPCC socio-economic scenarios chosen for examination in the 2010 RPA Assessment. This is consistent with past Assessment analyses, where substantial growth in land-use drivers such as population and personal incomes is already included in the base level projection. Supplementary analyses indicate that urban and developed uses typically command much higher land prices or values than forest use and that substantial changes in land use policy would likely be necessary to significantly reduce or temper deforestation to urban and developed uses in the future. Deforestation to agriculture could be markedly altered by supplementing per acre incomes for forest owners, as through forest carbon payments. For example, Alig et al. (2009) indicate that U.S. forest area could be increased significantly with a \$50 CO₂ price; at a \$25 CO₂ price, the BAU projected decline in forest area would be greatly reduced, but forest payments of at least \$30 would be required in most regions to reverse projected BAU reductions. Significant amounts of forest-based carbon could be either retained through tempering deforestation to developed uses or agriculture, although the latter route may be less costly. With substantial carbon payments, afforesting additional agricultural land could result in carbon storage in forest ecosystems to offset the projected decline under the BAU scenario and lead to much higher levels than currently with prices as high as \$50 per tonne. One important implication of increasing net forest sequestration through the use of CO₂ pricing is that timber harvest (timber supply) will be reduced in the short term when timber inventories build up in the forest to sequester more carbon. Longer run effects may also include reductions in timber harvest, compared to the case without CO₂ prices.

B) AFFORESTATION POTENTIAL, RESPONSE TO INCENTIVES, AND RETENTION--

History--Active afforestation on NIPF lands in general has been fairly low historically, outside of government incentive programs such as CRP. Spikes in tree planting under major government programs that subsidized tree planting on private lands (see chart in Alig 2003). Most U.S. afforestation in recent decades has been passive, such as seeding in of old fields. Examples are abandoned pasture lands when dairy production shifted elsewhere as in parts of the North. The natural expansion rather than purposeful afforestation has primarily involved pastureland, according to NRI stats. Per the issue of additionality, there hasn't been a lot of active afforestation occurring without external incentives.

No one agency has precise estimates of historical tree planting for the 2000s but educated guesses center around a tree planting estimate of roughly 400,000 acres per year, including

reforestation. That translates into about 0.1% of NIPF timberlands annually for all planting and direct seeding.

Projections of Potential—A recent national analysis (Alig et al. 2009) projected about 25 million acres of afforestation at \$25 CO₂ prices and more than double that area with \$50 CO₂ prices. The majority would be in the South Central region, Corn Belt, and the Southeast. The South has some of the lower cost afforestation opportunities, reported in studies going back several decades such as in the Study of the South 4th Forest by the USDA Forest Service. Note that this is potential, not necessarily likely afforestation. This is particularly true for regions such as the Corn Belt, which does not have the traditional forestry infrastructure or landowner familiarity with forest growing and markets.

Responses to Incentives—NIPF owners have responded to incentives for afforestation on agricultural land in earlier programs such as the Soil Bank, Agricultural Conservation Program, and Conservation Reserve Program. Most actual afforestation under such programs was in the South. The Soil Bank program resulted in about two million acres in the late 1950s and early 1960s. The Conservation Reserve Program to date has been the nation's largest tree planting program, resulting in more than 2.5 million acres planted to trees to help improve environmental conditions involving agricultural use of land, such as reducing erosion. Afforestation through federal government programs has typically been designed not directly for forestry objectives, as the Soil Bank program contributed key stands for later harvest in the South, although that was not the intent of the agricultural-based legislation. Landowner response to tree planting programs has typically not matched financial attractiveness potential, as S&PF expected about the double amount of tree planting compared to what was actually accomplished in the Conservation Reserve Program. Cultural influences and other tendencies and unfamiliarity with forestry practices are thought to contribute to this behavior (Alig 2003).

Fate of Government Subsidized Tree Planting--Several studies have noted the relatively high retention rates of such plantations, 10-15 years after establishment. This ran counter to expectations by some farm groups that farmers would quickly convert back to agriculture after the incentive program ended. Owners recognized potential value of young plantations after establishment. A number of stands were in need of silvicultural treatment according to timber prescriptions, often having overstocked conditions as owners applied relatively little management after establishment.