Agroforestry

Agroforestry means growing woody species – trees and shrubs – together with crops, livestock, or both in a farming system. The woody plants can help maintain air, water and soil quality; diversify income sources; conserve energy; improve wildlife habitats; and improve total productivity of the farm.

Energy Savings from Windbreaks

How much can you save on energy bills by having windbreaks or shelterbelts around your home? Research in Canada indicated a 27% fuel savings from having good shelter around a mobile home. Anecdotal evidence suggests the savings over time may be as high as 40%. The USDA-NRCS estimates a 10% to 25% energy savings from having a good windbreak around your house (1). Exact energy savings depend on the size and density of the windbreak, the insulation in the home, and the fuel source.

The majority of homes in Minnesota (68%), Iowa (67%), and Wisconsin (66%) use natural gas as their heating fuel (2), and average residential gas usage for the northern Midwest is around 100 mCF (mCF = 1,000 Cubic Feet)(3). Cost of natural gas for residential use in 2012 averaged $10.66 per mCF (4).

Assuming a 20% fuel savings from having a good windbreak, use of natural gas as the fuel, and an average home:

- $10.66/mCF x 100 mCF = $1,066 winter heating cost.
- $1,066 x 0.20 = $213 annual household fuel savings

References:

(1) **Conservation Practices that Save: Windbreaks and Shelterbelts**. November 2006. USDA Natural Resources Conservation Service. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_023631.pdf (accessed 8/12/13).
(2) **Clean Energy in My State**. United States Department of Energy; Energy Efficiency and Renewable Energy. http://apps1.eere.energy.gov/states/ (accessed 8/12/13).
(3) **Trends in U.S. Residential Natural Gas Consumpti**on. June 2010. U.S. Energy Information Administration, Office of Oil and Gas. www.eia.gov/ftproot/features/ngtrendsresidcon.pdf
(4) **Short-Term Energy Outlook**. August 6, 2013. U.S. Energy Information Administration. www.eia.gov/forecasts/steo/report/natgas.cfm

The National Agroforestry Laboratory calls agroforestry plantings “working trees” and defines them as “The right trees planted in the right places for the right reasons. (1)” Some types of agroforestry systems (1,2) :

- Silvopasture: This is a system of growing trees for various purposes, and managing the space between the tree trunks for grazing by livestock. One example is fruit or nut orchards where cattle or sheep graze between the trees. It also applies to woodlots or other types of forests where cattle graze.

- Alley cropping: An agricultural crop that produces annual income is grown in the alleys between widely spaced rows of trees, while the trees themselves are an investment that will produce revenue over the long term. The trees might be Christmas trees or nut trees or fruit trees; or trees grown to eventually produce lumber or firewood.

- Windbreaks: Planting rows of trees and shrubs strategically to block wind is an agroforestry strategy that can be applied in several useful places on the farm. Along roadways, they act as living snow fences to reduce drifting soil or snow. Around the farm buildings they provide energy savings and around livestock feeding areas they reduce environmental stress on livestock by blocking cold winds in winter and providing shade in summer. Planted in crop fields, windbreaks reduce soil erosion due to wind and protect young crops from wind damage. The trees and shrubs used for windbreaks can include fruit or nut trees or trees with high-value lumber, which generate income for the farm as well as provide the benefits of a windbreak.

- Buffer strips, filter strips, riparian buffers: These types of plantings are given different names depending on where they are placed on the landscape and their specific intention. As a broad group, these types of agroforestry practices are used to achieve soil and water conservation goals. They may not produce a crop that can be harvested or sold, but they have a benefit to the farm system as a whole. Buffer strips and filter strips, or “block” plantings that are wider than strips, can be used between crop fields or livestock areas and surface waters like streams, rivers and lakes to reduce the soil and chemical runoff that reaches the water.

- Forest farming: Tree plantings are managed for lumber or other wood products, and the ground between the trees is planted to a harvestable crop such as ginseng. This is different from alley cropping because the trees are not in rows with annual crops between the rows. The appearance of the area is like a forest and the crops grown are specialty crops that grow in woodlands.

- Agroforestry also includes plantings of woody species that are intended to be the sole crop from those planted acres. Hybrid poplar and hybrid willow plantings, for example, are done with the intent of letting the trees grow for one to several decades, and then harvesting them for industrial uses like biofuel or paper production. These types of plantings are often called “plantations.”

Considerations for Landowners

Agroforestry practices can be very beneficial to the farm as a whole and to the environment, but the up-front costs to establish agroforestry plantings can be high and they do take some land away from row-crop or livestock production. If you want to see agroforestry practices happen on your land in the future, here are some things to consider:

- Correct placement of these practices on the landscape is important to achieve maximum benefits. You may be able to put them on acres that are not the most productive for row crops. Either you or the future farm operator needs to do some research and planning to figure out where to plant the trees, and you may want to enlist help from your local Natural Resources Conservation Service (NRCS) office. Find your local office: http://offices.sc.egov.usda.gov/locator/app?agency=nrcs

- The NRCS encourages agroforestry and has cost-sharing available for establishment and upkeep of many of the practices (2). This is another good reason to work with your local NRCS office.

- Establishment cost-sharing and annual payments may be available from agencies other than NRCS for some agroforestry practices. For instance, Minnesota Department of Transportation (MN-DOT) pays for living snow fence establishment along some roadways affected by blowing snow (3).

- The new farmer on your land can put "sweat equity" into getting these practices established and then maintaining them. Consider valuing that effort as part of the purchase price of the land or finding another way to credit it in a long-term lease.

- Establishment is a major effort that involves site preparation; planting and installation of a weed barrier; and then about three years of fairly intensive mowing, watering, spot spraying, and replanting of dead trees (3).

- Since agroforestry practices do remove land from annual crop production, that loss of potential cash-crop income needs to be figured into the overall lease or sale price of the land. The benefits of the agroforestry practices go to the farm operator, the landowner, and to society; so your plan for determining the sale or lease price should similarly divide the cost of the practice. As mentioned above, cost-sharing from the NRCS can help with establishment and upkeep costs.

- Some agroforestry practices have the potential to generate income for several years to several decades, and there should be a plan for who will profit from that in the future. If establishment costs and risks and upkeep costs are shared between landowner and farm operator, then the income rewards should also be shared.

Agroforestry			
	- Column	**+ Column**	
Qualitative Benefits of the Practice	**Cost of Implementation and Potential Income Loss**	**Potential Income Gain and Reduced/Avoided Costs**	**Your Judgment: Value Per Acre of This Practice on Your Land**
Helps landowner and farm operator diversify income sources through sales of nuts, wood, fruit, biofuels, etc. Enhance the productivity of crops and livestock by providing shade and protection from harsh winds (4) Reduce soil erosion due to wind Enhance wildlife habitat Trees capture & store carbon dioxide from the air Improve water quality by trapping sediment and other run-off before it reaches surface waters	Establishment costs for living snow fence (also applicable to buffer strips, windbreaks, shelterbelts, including those used in alley cropping): $2,260/acre *(see Establishment & Maintenance Costs textbox)* Range of establishment costs: $1,500 to $3,000 (3); or up to $7,000 for hazelnuts (9) Average yearly costs for first three years of maintenance (establishment phase): $280/acre/year *(see Establishment & Maintenance Costs text box)* Maintenance costs beyond 3rd year: $24/acre/year for spot spraying (3)	Income from black walnut crop, years 11-60: $255/year (6) Income from hazelnut crop, years 5-10: $313/acre/year (261 lbs./acre/year x $1.20/lb.) (7,8) Net gain of $240/year in crop income per acre of windbreak (see *Yield Gain/Loss from Windbreak* text box) $210/year energy savings for home heating due to windbreak around farm house (see *Energy Savings from Windbreaks* text box) Cost-sharing for establishment from state or federal agency (such as NRCS or MN-DOT) may cover up to 90% of cost Annual payment for conservation contract with state or federal agency or private organization (varies)	Potential income gain and costs avoided: + Potential income loss and costs to pay: - Your judgment on value to your farm of qualitative benefits: + Value to society or environment: + Add up the total net value per acre per year: Multiply by number of acres devoted to the practice: Multiply by a time frame (5 years? 10 years?) Total value over time:

The numbers in this table are broad estimates, and you should adjust them for your farm's conditions.	Loss of net income from cash crop on the agroforestry acres: $230/acre/year *(See Corn and Soybean Profitability text box in the Crop Rotation section).* Reduce this number if planting on less-productive acres. $30/acre/year cost for the acreage of the windbreak, for extra time and hassle in field operations (tillage, spraying, and harvesting) to maneuver around the area (3) ****Note**: See "Economic Budgeting for Agroforestry Practices" (6) for a sample budget for black walnut establishment.	MN-DOT estimates $17 benefit in avoided snow removal and vehicle accident costs for every $1 invested in living snow fence (3). This is a benefit to society but also to the landowner and/or farm operator if the improved roads are ones they frequently drive. Benefits of reduced drifting could also apply to windbreaks established along driveways and field roads within the farm itself.	

References:

(1) **Working Trees.** USDA National Agroforestry Center and United States Forest Service. http://nac.unl.edu/Working_Trees/infosheets.htm (accessed 8/12/13).

(2) **Sustaining Agroforestry Systems for Farms and Ranches**. USDA Natural Resources Conservation Service**.** www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/forestry/sustain/ (accessed 8/12/13).

(3) **Economic and Environmental Costs and Benefits of Living Snow Fences: Safety, Mobility, and Transportation Authority Benefits, Farmer Costs, and Carbon Impacts**. February 2012. Gary Wyatt, University of Minnesota Extension; Minnesota Department of Transportation Research Services. www.lrrb.org/media/reports/201203.pdf (accessed 8/12/13).

(4) **What does it take to earn a living on the farm?** April, 2013. Gary Hachfeld, University of Minnesota Extension. http://swroc.cfans.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_440374.pdf (accessed 8/06/13)

(5) **Energy and Economic Returns by Crop Rotation.** September 2012. Ann M. Johanns, Craig Chase, and Matt Liebmann. Iowa State University Extension. www.extension.iastate.edu/agdm/crops/html/a1-90.html (accessed 8/12/13).

(6) **Economic Budgeting for Agroforestry Practices**. 2012. Larry Godsey. Center for Agroforestry, University of Missouri. www.centerforagroforestry.org/pubs/economichandbook.pdf (accessed 8/12/13).

(7) **Hazelnut Production Potential in the Upper Midwest: A Report on Hybrid Hazelnut Yields**. 2011. Jason Fischbach, Lois Braun, Mike Demchik, and Don Wyse. University of Wisconsin Extension. www.midwesthazelnuts.org/assets/files/Research%20Bulletin%2017_hybrid%20hazelnut%20yields.pdf (accessed 8/12/13).

(8) **Fruit and Tree Nut Yearbook**. 2011. USDA Economic Research Service. Table E-10: Hazelnuts: Production, Price, Value, U.S. 80-to date. http://usda.mannlib.cornell.edu/MannUsda/viewStaticPage.do?url=http://usda01.library.cornell.edu/usda/ers/./89022/2011/index.html (accessed 8/12/13).

(9) **Setting a Yield Goal for Hazelnut Breeding in the Upper Midwest**. 2012. Jason Fischbach and Lois Braun. University of Wisconsin Extension. www.midwesthazelnuts.org/assets/files/breeding%20goals_final.pdf (accessed 8/12/13).

Further Resources:

Agroforestry: An Overview: ATTRA
https://attra.ncat.org/attra-pub/summaries/summary.php?pub=62
Integrating trees and shrubs with other enterprises on a farm can create additional sources of income, spread farm labor throughout the year, and increase the productivity of those other enterprises — all while protecting soil, water, and wildlife. This publication presents an overview of common agroforestry practices, evaluating and planning considerations, marketing opportunities, several case studies, and an extensive list of further resources.

Mid-American Agroforestry Working Group (MAAWG)
http://midamericanagroforestry.net/
The purpose of the Mid-American Agroforestry Working Group (MAAWG) is to provide an organization for advancing the science, practice, and adoption of agroforestry by landowners and natural resource managers in the Midwest region of the U.S.

Profitable Farms and Woodlands: USDA National Agroforestry Center and Tennessee State University, 2012.
http://nac.unl.edu/documents/morepublications/profitable_farms.pdf
Manual (108 pages) to help landowners develop best management technologies in managing agroforestry projects.

Tree as a Crop: Rodale Center
http://rodaleinstitute.org/our-work/tree-as-a-crop/tree-as-a-crop-how-it-works/
A major project of this well-known research center, "Tree as a Crop" offers a way to put trees to work to improve ecosystems while helping to create a healthy prosperity for farmers and small forest landowners. "Tree as a Crop" shows farmers and other landowners how to maximize the potential of trees to improve biodiversity on forested and agricultural land, to capture carbon and to provide a diversified income stream for landowners.

Establishment & Maintenance Costs for a Living Snow Fence
(also applicable to windbreaks, shelterbelts and buffer strips with similar establishment procedures)

These figures were collected from interviews with farmers in southern Minnesota; also interviews and surveys of staff with Minnesota Department of Transportation (MN-DOT), Farm Service Agency, Natural Resources Conservation Service, and Soil and Water Conservation Districts.

Establishment costs:

- Land preparation, tillage + herbicide: $60 to $82 per acre; average $71/acre
- Planting trees and shrubs: $282 to $872 per acre, depending on tree species and other plants selected; average $464/acre
- Geotextile fabric purchase and installation as a weed barrier: $950 to $2,500 per acre; average $1,725/acre

Average establishment cost per acre: $71 + $464 + $1,725 = $2,260

Maintenance costs during 3-year establishment phase:

Years 1 & 2:

- $37 to $50 per acre per year for mowing; average $43/acre/year
- $200 to $400 per acre per year for watering; average $300/acre/year
- $20 to $50 per acre one-time replanting; average $15/acre/year
- $24/acre/year for spot spraying

Total average maintenance cost per year for first two years: $43 + $300 + $15 + $24 = $382

3rd year:

- $37 to $50 per acre per year for mowing; average $43/acre/year
- $24/acre/year for spot spraying

Total cost for third year: $43 + $24 = $67/acre

Average cost per year for first three years: ($382 + $382 + $67)/3 = $277/acre/year
Rounded = $280/acre/year

continued on next page …

Establishment & Maintenance Costs for a Living Snow Fence (pg. 2)

Reference:

Economic and Environmental Costs and Benefits of Living Snow Fences: Safety, Mobility, and Transportation Authority Benefits, Farmer Costs, and Carbon Impacts. February 2012. Gary Wyatt, University of Minnesota Extension; Minnesota Department of Transportation Research Services. www.lrrb.org/media/reports/201203.pdf .

Yield Gain/Loss from Windbreak

Farmers in Minnesota estimate a 10% to 15% loss of crop yield in the areas right next to a Living Snow Fence (1). Similar yield reductions have been seen right next to windbreaks or shelterbelts. These losses are seen out to a distance equal to about twice the height of the windbreak.

On the leeward (downwind) side, however; beyond a distance equal to twice the height of the windbreak; the yield reductions end. From a distance of two times the height out to a distance of 12 times the height of the windbreak, there is a yield increase of 5% to 25%, depending on the crop. Beyond 12 times the height of the windbreak, yields return to the field average.

Corn yield loss from 1 acre of windbreak, 33 ft. wide x ¼ mile long, with tree height of 12 ft.:

- Area affected by yield reduction: ¼ mile (1,320 ft.) x 24 ft. = 31,680 ft^2 = 0.73 acres
- Assume a 12% yield reduction for corn in the 24-ft. wide yield reduction area.
- Assume yield of 194 bu./acre of corn and price of $4.35/bu. (4)
- Lost income from crop yield reduction, per acre: 194 bu./acre x 0.12 = 23 bu.; x $4.35/bu = $100/acre/year loss
- $100/acre/year x 0.73 acres = $73/year loss from the yield reduction area.

Corn yield gain from the same 1 acre of windbreak, 33 ft. wide x ¼ mile long, with tree height of 12 ft.:

- Area affected by yield gain: ¼ mile (1,320 ft.) x 120 ft. = 158,400 ft^2 = 3.64 acres
- Assume a 12% yield increase for corn in the 120-ft. wide yield increase area (3)
- Assume yield of 194 bu./acre of corn and price of $4.35/bu. (4)
- Gained income from crop yield increase, per acre: 194/bu./acre x 0.12 = 23 bu.; x $4.35/bu = $100/acre/year gain
- $100/acre/year x 3.64 acres = $364/year gain from the yield increase area

Net gain per year in corn income due to windbreak:

$364 gain - $73 loss = $291/year net gain (rounded to $290).

Yield Gain/Loss from Windbreak, continued (pg. 2)

Similar calculations for soybean, assuming a 13% yield loss or gain (3):

- Assume yield of 50 bu./acre of soybean and price of $9.95/bu (4).

Lost income from soybean crop yield reduction on 0.73 acres:

- 50 bu./acre x 0.13 = 6.5 bu.; x $9.95 = $65/acre/year loss
- $65/acre/year x 0.73 acres = $47/year loss from the yield reduction area.

Gained income from soybean crop yield increase on 3.64 acres:

- 50 bu./acre x 0.13 = 6.5 bu.; x $9.95 = $65/acre/year gain
- $65/acre/year x 3.64 acres = $237/year gain from the yield increase area.

Net gain per year in soybean income due to windbreak:
$237 gain - $47 loss = $190/year net gain

Average net gain per year from a 1-acre windbreak with a corn/soybean system:
($290 for corn +$190 for soybean)/2 = $240/year.

References:

(1) Economic and Environmental Costs and Benefits of Living Snow Fences: Safety, Mobility, and Transportation Authority Benefits, Farmer Costs, and Carbon Impacts. February 2012. Gary Wyatt, University of Minnesota Extension; Minnesota Department of Transportation Research Services. www.lrrb.org/media/reports/201203.pdf (accessed 8/12/13).

(2) Conservation Practices that Save: Windbreaks and Shelterbelts. November 2006. USDA Natural Resources Conservation Service. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_023631.pdf (accessed 8/12/13).

(3) Windbreaks. 2006. Chapter 6 in *Training Manual for Applied Agroforestry Practices*. Center for Agroforestry, University of Missouri. www.centerforagroforestry.org/pubs/training/sec6.pdf (accessed 8/12/13).

(4) Energy and Economic Returns by Crop Rotation. September 2012. Ann M. Johanns, Craig Chase, and Matt Liebmann. Iowa State University Extension. www.extension.iastate.edu/agdm/crops/html/a1-90.html (accessed 8/12/13).