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Agroforestry: An Overview

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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. Such "agroforestry" systems include alleycropping, silvopasture, windbreaks, forest farming for nontimber forest products, and riparian buffer strips. While they clearly offer economic and ecological advantages, these agroforestry systems also involve complex interactions that complicate their management. When designing an agroforestry enterprise, you should research the marketing possibilities and include the agroforestry system in the total business plan for the farm. 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. New opportunities related to climate change include renewable-energy production and the potential for earning carbon credits.

Planting riparian buffer strips, one of several possible agroforestry practices, protects water quality and helps prevent stream bank erosion. They also provide wildlife habitat and can be managed to produce specialty forest products. Photo: Courtesy of U.S. Department of Agriculture Natural Resources Conservation Service

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Introduction

Agroforestry is a working-tree farming system that integrates crops or livestock—or both—with trees and shrubs. A well-designed agroforestry system results in biological interactions that provide multiple benefits, including diversified income sources, increased biological production, better water quality, and improved habitat for both humans and wildlife. Farmers usually adopt agroforestry practices for two reasons:

- Increase their economic stability
- Improve their management of the natural resources under their care

While trees mature, crops provide income. Photo: Courtesy of Sandra Hodge

A traditional tree farm or nut plantation managed as a single-purpose monocrop operation is not an agroforestry system. Neither is a woodlot when it's managed for wood products only. Agroforestry involves combining a tree planting with another enterprise—such as livestock or crop production—or managing a woodlot for a diversity of special forest products. For example, an agroforestry system might produce firewood, biomass feedstocks, pinestraw mulch, fodder for grazing animals, and other traditional forestry products. At the same time, the trees would shelter livestock from wind or sun, provide wildlife habitat, control soil erosion, and—in the case of most leguminous species—fix nitrogen to improve soil fertility.

Agroforestry practices in use in the United States include alleycropping, silvopasture, windbreaks and shelterbelts, riparian buffer strips, and forest farming (special forest products). An overview of each of these major systems is presented below.

Agroforestry Practices

Alleycropping

Alleycropping involves growing crops (e.g., grains, forages, and vegetables) between trees planted in rows. The spacing between the rows is designed to accommodate the mature size of the trees while leaving room for the planned alley crops. When such sun-loving plants as corn or some herbs are alleycropped, the alleyways need to be wide enough to let in plenty of light even when the trees have matured.

Alternatively, the cropping sequence can be planned to change as the trees' growth decreases the available light. For example, soybeans or corn could be grown when the trees are very small. Then as the tree canopy closes, forages could be harvested for hay. And finally, when the trees are fully grown and the ground is more shaded, grazing livestock or shade-tolerant crops such as mushrooms or ornamental ferns could occupy the alleyways.

Like all integrated systems, alleycropping requires skillful management and careful planning. Both the crop and the trees have requirements that sometimes necessitate trade-offs between them. The design must allow sufficient room for the equipment needed to service each enterprise, for example. If either crop requires chemical herbicides or insecticides, the other must be tolerant of these treatments. In the case of livestock, there may be periods during and after the use of chemicals when animals must be withdrawn from the area. Animal manure is a problem when fruit or nuts are harvested from the alleyway floor. Also, livestock can cause damage even when the trees are fully grown; roots injured by hooves are susceptible to disease. And soil compaction is a danger during wet weather. These examples demonstrate how crucial planning is to the ultimate success of an agroforestry system.

Bob Carruthers, a former crop farmer in Morrilton, Arkansas, faced the choice of getting bigger or getting out of commodity-crop farming. He decided to plant pecans on his laser-leveled fields and continue cropping in the alleys while the trees grew. He chose several pecan varieties that have an extended ripening season and good market demand. He planted the trees 35 feet apart with 60-foot alleyways, installed microsprinklers for irrigation, and fertilized based on soil and leaf-tissue tests. For five years, Carruthers planted soybeans in the 60-foot alleyways and saw a 17% reduction in yield compared to his former monocropped fields. As the trees matured, and less light was available, he planted Bermuda grass. In a cooperative arrangement, a neighbor fertilizes the grass and harvests the hay. Carruthers gets free fertilizer for his trees, and the neighbor gets free hay.

Four years after establishment, Carruthers was harvesting a few pecans from the trees and selling them retail for $1.50 per pound. In year seven, he reported significant production—three years sooner than his original estimate. After several years of retail sales, he began selling his pecans wholesale, shipping them directly from the field in semi trucks.

At year 15, he thinned offset trees, leaving a 70-foot by 70-foot spacing. He has identified two potential markets for the trees that are removed: planks for hardwood flooring or hardwood chips for the export market. Having originally estimated that he would regain the establishment costs in 13 years, he broke even in year 10.

Trees are planted in straight rows in many alleycropping systems, sometimes with no regard for slope or contour. There are, however, advantages to planting the trees on the contour to slow surface-water movement and reduce soil erosion. The trees can be planted in single rows or in blocks of multiple rows between alleys. The first row in a block is planted on the contour line; subsequent rows are planted below the original line according to the slope of the land. The final row of trees in one block is planted parallel to the contour line on which the next block of trees will begin. The width of the tree blocks varies, but the cropping alleyways between them have parallel edges. This design avoids creating point rows within the alleys, thus simplifying the way equipment can be maneuvered among the crops. The width of the alleys is determined by the size of the equipment that will be used.

If planting on the contour is impractical, another option is to plant trees in curved zigzags so that water running downhill is captured, or at least slowed. Islands of trees can offer some of the same advantages if they don't interfere with cropping operations.

To ensure that the crop trees develop upright, unbranched trunks, fast-growing hardwoods or pines can be interplanted as trainers. Alternatively, the crop trees can be planted close together in the rows and thinned and pruned several times as they grow. Although the trees that are harvested early may have little market value, their presence during the first years of growth increases the main crop's value. In order to maximize the profit from the final harvest, the goal is to produce long, straight sawlogs with few lower branches. Regardless of the planting design, trees on the outside edge of a group may grow more side branches, or even a lopsided trunk, resulting in lower-value sawlogs.

Further information about alleycropping systems is available from the U.S. Department of Agriculture (USDA) National Agroforestry Center and other resources listed at the end of this publication.

Silvopasture

Trees, livestock, and forage growing together to create dual income from livestock and timber is considered silvopasture agroforestry. Hardwoods (including nut trees) or pines—or both—are planted in single or multiple rows, and livestock graze between them. Although both the trees and the livestock must be managed for production, some systems emphasize one over the other. In the early years of the trees' establishment, crops or hay are usually harvested from the planting. Grazing generally begins after two or three years or when the trees are large enough that the livestock can't damage them. In some instances, tree tubes and electric fencing are used to protect the young trees, and grazing begins immediately.

Grazing livestock on silvopasture eliminates some of the costs of tree maintenance. With good grazing management, for example, herbicides and

George Owens' farm is located in the panhandle of Florida in Washington County. In 1984, he decided to start a silvopasture system on a 50-acre field where he had unprofitably been growing a variety of row crops. Along with Pensacola bahaigrass and crimson clover, he planted slash pine in an east-west double-row orientation with a 4-foot by 8-foot by 40-foot spacing. The area was hayed during the first three years. When the trees' terminal buds were above grazing height, stocker calves were allowed to graze the site. Later, the silvopasture was grazed as part of a cow-calf operation. For a number of years, the Owens have raised longhorn cattle to diversify their livestock income.

The decision to use a silvopasture system was an easy one for George. He had read some silvopasture-research papers about the economic stability and productivity that comes from diversifying farm income by combining forage production and long-term tree production. George noticed, like many other producers, that timber and cattle markets tend to cycle. However, since the two markets have distinct and separate drivers, they don't usually cycle down at the same time.

Using rotational grazing, the silvopasture produced nearly as much beef as an open-pasture system. At the same time, the site produced high-value veneer timber as well; after six years, the trees were pruned on a regular basis to produce two 8-foot veneer-quality logs per tree. At the time of this writing, the planting had been thinned twice. The second time was a salvage cut, the result of a hurricane, and was economically premature.

Even so, the initial silvopasture was so productive that George decided to plant an additional 50 acres of pasture into a silvopasture design.

mowing may become unnecessary. Grazing also enhances nutrient cycling and reduces commercial fertilizer costs; the animals remove few nutrients, and their waste is a valuable input for the trees. Well-managed grazing will increase organic matter and improve soil health. However, controlling the number of animals per acre, limiting the number of days those animals remain on each site, and avoiding compaction are critical for a successful silvopasture system.

Competition for water between the pasture and the trees may be a concern. In a silvopasture with nut trees, for example, seasonal water shortages during late summer can negatively affect nut fill and the simultaneous production of fruit buds for the next year's harvest. Irrigation is justified in such a situation if the trees are being managed for nut production. Water competition may not be as critical of an issue for timber silvopastures.

Grazing sheep replace the mower, moving among Christmas trees. Photo: Courtesy of Sandra Hodge

Further information about silvopasture systems is available from the USDA National Agroforestry Center and other resources listed at the end of this publication.

Farmers in the upper Midwest are investing in hybrid hazelnut or poplar trees as part of their crop-and-livestock systems. They are integrating the plantings to provide such benefits as windbreaks, terraces, or riparian forest buffers. Some are using livestock wastes as a part of their farms' fertility program.

The hybrid hazelnut is a bush that is resistant or tolerant to eastern filbert blight, which is a serious threat to the current industry in the Northwest. The demand for the nut is established, and the oil has potential for biodiesel production as well. Midwestern farmers are exploring cooperative marketing options, and harvesting equipment appropriate for these plantings has been tested.

Cattle profits offset walnut-tree establishment costs. Photo: Courtesy of Sandra Hodge

Windbreaks and Shelterbelts

Extensive research on field, farmstead, and livestock windbreaks—also called shelterbelts—has been carried out in the U.S. and Canada. The terms refer to trees planted in multiple rows along the edge of a field to reduce the effects of wind on crops or livestock. Windbreaks have been shown to reduce the impact of wind over a horizontal distance equaling at least 10 times the height of the trees. Wind and water erosion are reduced, creating a moister, more favorable, microclimate for the crop and for pollinating insects. In the winter, the windbreak traps snow and protects livestock from chilling winds. Also, beneficial insects and birds find permanent habitat in windbreaks, enhancing crop protection. See the ATTRA publication *Farmscaping to Enhance Biological Control* for more information.

Although the trees compete for available water along the edges between the windbreak and the crop rows— potentially reducing the crop yield near the windbreak—the net effect on productivity is positive. Pruning roots along the interface of the trees and the crops can reduce the competition for water. In fact, even on land that's well suited for high-value crops, a windbreak can increase the crop yield of the entire downwind field by as much as 20%—even when the windbreak area is included in the acreage total.

If windbreaks were planted on 5% of the 210 million acres in the north-central U.S. that are currently unprotected, an estimated 215 million metric tons of CO_2 would be sequestered in the first 20 years. Likewise, shelterbelts for homesteads and snow fencing for roads would sequester an estimated 13 million and 175,000 metric tons of CO_2, respectively, within 20 years (USDA National Agroforestry Center, no date).

Windbreaks can be designed specifically for sheltering livestock. Studies have shown that sheltering animals living outside during winter from the major stress caused by windchill results in reduced feed bills, increased milk production, and weight gain. Windbreaks also have been shown to improve calving success.

In a more recent development concerning the use of windbreaks, working trees placed around livestock-production facilities have been found to help reduce the movement of the odors and dust generated by these operations. Windbreaks alone will not prevent these odor problems, but they can provide farmers and ranchers with a new tool to help in this area.

- The USDA National Agroforestry Center offers a series of booklets on windbreak technology as well as a publication entitled *Outdoor Living Barns*.
- Canada's Agri-Environment Services Branch Agroforestry Development Centre (formerly known as the Prairie Farm Rehabilitation Administration Shelterbelt Centre) provides an array of publications on establishing and maintaining shelterbelts designed to benefit livestock, wildlife, or cropland. The publications are available from the center's website at *www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1186517615847&lang=eng*.
- The book *Shelter and Shade* by John and Bunny Mortimer focuses specifically on incorporating trees into family farms (Mortimer and Mortimer, 1996).

For more details on these and other sources of information about windbreaks, see the Further Resources section of this publication.

Windbreaks offer advantages besides providing protection for crops and livestock. They benefit wildlife, especially by serving as continuous corridors along which animals can safely move. Farmers can even develop windbreaks into additional profit centers for the farm—hunting leases, selective timber harvests, firewood sales, and special forest products are some of the possibilities. These marketing options are discussed below.

Any tree species can be used in a windbreak as long as it is suited to the site and the purpose of the planting. However, deciduous species, even in multiple rows, will lose some effectiveness when they drop their leaves. For year-round use, some of the species selected should be evergreens. Fast-growing trees should be included; it's best to plant deep-rooted, noncompetitive species along the edges. Regular deep chisel-plowing along the windbreak's edges will keep roots from spreading into the crop rows. Additional benefits can be gained by incorporating specialty forest products that can be marketed and sold, such as fruit trees or decorative shrub florals, into the design of the windbreak.

Forest Farming and Special Forest Products

When a natural forested area is managed both for wood products and an additional enterprise, it becomes a forest farming system. For help with the management of woodlots, county Extension agents can refer farmers to Extension forestry specialists and state forestry-agency personnel. These specialists are qualified to give advice on thinning, pruning, and harvesting practices, as well as on marketing options. They may or may not be able to visit the farm for an on-site consultation. The Association of Consulting Foresters of America (ACFA) can refer you to private forestry consultants in your area. For more information on ACFA, visit their website at *www.acf-foresters.org//AM/Template.cfm?Section=Home*.

Ginseng thrives under a mature forest. Photo: Courtesy of Sandra Hodge

Woodlands can generate income from many products other than timber and pulpwood. Established forests offer many nontimber special forest products that can contribute to cash flow without requiring the one-time harvest of old trees. For example, landowners can manage established woods to encourage naturally occurring patches of berries or bittersweet. Or they might plant understory crops such as ginseng or goldenseal that are adapted to the forest type and climate. Growing mushrooms on logs is another, more labor-intensive, possibility; a canopy of either hardwoods or pine will provide the shade needed to maintain moisture for fruiting. See the ATTRA publication *Mushroom Cultivation and Marketing* for more information.

Berries and vines for crafts or basketry are examples of products that can be harvested and marketed without any costs of establishment; on the production end, they may require only that the canopy be managed for optimal light conditions. Some other examples of nontimber forest products are listed in the box below. For more information on special forest products, see the ATTRA publication *Woodlot Enterprises* and visit the websites listed below in the Further Resources section of this publication.

The number of products that woodland can generate is limited only by the owners' imaginations and their ability to identify and exploit profitable markets. Here are a few examples:

- Fruits, nuts, and berries
- Maple syrup
- Honey and other hive products
- Aromatics
- Mushrooms
- Fence posts, firewood, and smoke wood
- Herbs and medicinal plants
- Decorative or odd wood such as burls
- Materials for basket-making or chair-caning
- Dye materials
- Pine straw, boughs, and pinecones
- Charcoal
- Plant materials such as dried or fresh ornamentals
- Tree and shrub seeds, seedlings, and cuttings

Buffers protect water quality. Photo: Courtesy of Sandra Hodge

Riparian Forest Buffers

Trees and shrubs planted in areas along streams or rivers are called riparian forest buffers. These plantings are designed to catch soil, excess nutrients, and chemical pesticides moving over the land's surface and near subsurface before they enter waterways. Such plantings also physically stabilize stream banks.

In addition, forested areas along streams can fulfill many other needs of the community at large. Besides protecting water quality, they enhance the aquatic environment by keeping it cooler, an essential condition for many desirable aquatic species. Buffer strips also provide wildlife habitat, sequester carbon, and can be managed to generate income through recreation, special forest products, and biomass production. They might produce marketable food products such as nuts, or harbor predators of crop pests to enhance pest management for nearby acreage.

Rob Miller of Mount Jefferson Farms owns 3,000 acres of land in Marion and Linn counties in west-central Oregon. The farm's production is diversified under a series of partnership arrangements with several farmers. It produces mint, grass seed, bush beans, sweet corn and other vegetable crops, nursery crops for agroforestry and bioengineering, and wood products.

Over the past 30 years, Miller has planted miles of riparian forest buffers along the North Santiam River and its tributaries, which divide his farmland. The buffers have, over time, saved hundreds of acres from flooding loss, improved the water quality in the river, made use of some unproductive farmland, reduced erosion, and enhanced wildlife habitat on the farm. He has sold cottonwood veneer and lumber as well as cottonwood, willow, and red osier dogwood cuttings for bioengineering applications. These sales alone have provided enough additional income to pay the buffer-installation costs.

New Agroforestry Opportunities

People have always depended on the land for food and fiber. In recent years, however, even more has come to be expected from farmland. Society is now looking to rural America to also reduce the national dependence on foreign oil, provide carbon storage, and help in the adjustment to climate change. As urban and suburban areas expand onto prime agricultural land, these growing needs will have to be met on a more limited land base.

How can agricultural landscapes provide more products and services on a shrinking base? Agroforestry systems offer new ways for farmers to respond to the need for more food and fiber and for diverse, renewable sources of energy as well as the challenges of climate change. Working trees can serve multiple functions and help to meet increased demands on limited agricultural land.

Here are some possible strategies that can make use of agroforestry systems:

- Incorporate multiple vertical levels of crop production in the same space
- Grow perennial crops to use more seasons of the year for production
- Use the same cropping system to perform several functions

Biomass/Bioenergy

Alternative-energy opportunities vary by locality based on policies, community needs, and available facilities, as well as differing climates, environments, and land resources. In general, there are two main tree- and shrub-related prospects:

- Produce oil from seeds or nuts for biodiesel
- Grow woody or herbaceous crops that are high in cellulose for biomass

Nuts or seeds can be pressed for their oil, which is then processed to make biodiesel. The technology for farm-scale biodiesel production and use is already available. Farmers can use nuts from buffers or windbreaks on their own land to produce fuel for their diesel engines. Larger-scale processing plants would provide a stable market for a much larger crop. However, this infrastructure is just developing in many areas of the U.S. You can call ATTRA to learn whether there is a biodiesel market in your area. See *Biodiesel: Do-it-Yourself Production Basics* and other ATTRA publications for more information.

Short-rotation wood crops grown in riparian forest buffers or in alleycrop systems; thinnings from forestry or agroforestry plantings; and even high-cellulose perennial crops such as switchgrass can all be marketed as biomass. This type of biomass can be used as a cofiring feedstock with coal, in pyrolosis systems for the production of cellulosic ethanol, and for other uses. For more information on opportunities related to biomass, refer to ATTRA's *An Introduction to Bioenergy: Feedstocks, Processes, and Products.*

Because most kinds of biomass-energy production are still relatively new industries, the opportunity to sell biomass varies across the country.

Oil-producing seeds and nuts have extensive marketing opportunities for human consumption, biodiesel production, and as livestock feed. Cellulosic biomass has marketing opportunities that are more limited—cofiring, pelletizing, and use in biomass-fired power-generating facilities. The markets for both oil-producing crops and cellulose production will grow as federal and state policies require the use of fuels like biodiesel, as fuel costs increase, and as developing technologies in industries such as cellulosic ethanol mature.

Short-Rotation Woody Crops

Fast-growing trees such as hybrid poplars, locusts, and willows can be planted in most of the agroforestry practices described above. Called short-rotation woody crops, they are planted as riparian buffers, windbreaks, alley-crops, or even in blocks on their own. To achieve rapid initial growth, the site should have an appropriate soil type, adequate water, and competition controls (e.g., mulch or weed barriers). Deer and other wildlife can be another challenge to early growth. However, such intensive management can lead to harvest in 10 years or less.

In some systems, one of the sprouts that grow from the stump after a tree is cut is chosen as the replacement trunk, and the other sprouts are removed. Because it is growing from an established root system, the sprout quickly produces another tree; it is harvested, and the process is repeated. This practice of cutting and resprouting trees from the same root system is called coppicing.

Alternatively, trees are simply harvested once, and new trees are planted as replacements. Since new hybrids are continually being developed for use as short-rotation woody crops, producers often choose to completely replant in order to take advantage of newer genetic lines. Trees can be planted in rotation to generate regular income or as an all-in, all-out system. Either way, the short-rotation trees supplement the farm's income from regular annual crops.

Short-rotation woody crops are of increasing interest to the energy and fiber industries, although they can also be used as solid wood. When well designed, the planting can provide ecosystem services while also growing a saleable product.

In regions where there currently isn't a biomass market, it is risky, of course, for farmers to plant trees for an industry that's not yet in place. Conversely, no one is likely to build a facility without some assurance that feedstock will be available when it's needed. Policymakers have begun to create programs to provide incentives to landowners and potential processors in order to coordinate the development of these new industries. Local USDA Service Centers have information about government programs that can be used for establishing a biomass planting on the farm. To locate the local office, look in the phone book under "USDA" or go to this website: *http://offices.sc.egov.usda.gov/locator/app*.

Carbon Credits and Climate Change

Carbon sequestration is part of an emerging market that pays landowners for certain environmental services. In the case of carbon sequestration, that service is to reduce the excess levels of CO_2 in the atmosphere that are contributing to climate change. However, the lack of federal-government support for such markets is currently hampering the development of this market. Even attempts at creating private voluntary markets are waning, as demonstrated by the closure of the Chicago Climate Exchange (Lavelle, 2010).

Plants naturally absorb CO_2 in the air and, through photosynthesis, turn it into carbon in their leaves, branches, trunk, and roots. Often, it eventually becomes soil organic matter. Carbon dioxide that is removed from the atmosphere and stored for a long period in a stable form can qualify landowners for "carbon credits." A carbon credit refers to the payment to landowners for capturing and storing CO_2. But not all CO_2 stored as carbon stays put. Carbon may oxidize or decay over time when trees are disturbed by such events as disease, fire, pests, or harvest. Therefore, depending on how forests are managed and affected by natural events, they will both sequester carbon and release carbon, creating either a net positive or net negative contribution to CO_2 in the atmosphere.

On farmlands, operations such as conservation tillage have been included as qualifying practices in these fledgling markets because they contribute to sequestering more carbon in the

soil. Agroforestry has particular promise as a strategy in a carbon market because it can be managed to sequester significant amounts of carbon while it is in place doing other jobs for the landowner and others (Nair et al., 2010). Of the five agroforestry practices, windbreaks and riparian forest buffers present the best opportunity in carbon markets.

The USDA Natural Resources Conservation Service (NRCS) recently released an enhanced online tool for estimating farm-level greenhouse-gas emissions, COMET-VR 2.0, which is available at *www.comet2.colostate.edu*. It provides a limited means for farmers to estimate the impact of agroforestry, along with other farm operations, on carbon sequestration and other greenhouse-gas emissions. If a carbon market matures, other research and calculating protocols will develop to further account for the benefits farmers provide through agroforestry. Although federal legislation to create a mandatory carbon market was defeated in 2010, the North Dakota Farmers Union Carbon Credit Program is still operating for farms that are already enrolled.

While not specific to carbon-market development, the USDA NRCS does support conservation practices that can help develop agroforestry that has climate benefits. See the ATTRA publication *Federal Conservation Resources for Sustainable Farming and Ranching* for more details.

Compare two hypothetical no-till grain farms, one of which incorporates 5% of its cropland into windbreaks to protect the crops. After 50 years, the farm with the windbreaks will be able to sequester an estimated 50% more carbon than the other farm, while the farmer also benefits from the windbreaks' crop and soil protection and from the added biodiversity they provide (Schoeneberger, 2009).

Although a voluntary carbon-credit market already exists, it has not been consistent due to a lack of strong policy direction. Currently, different carbon credits are offered both for newly established plantings and for existing mature forests that are already growing at a steady rate.

Individual farmers or ranchers who want to take part in this market must work with an "aggregator." The aggregator combines the participation of many individual landholders in order to have enough acreage to take advantage of the market. For a current list of aggregators, contact ATTRA. There are many explanations about how carbon credits work. Here is one example: *www.forestrycarbon.com/how-does-it-work.php*.

Agroforestry is gaining added attention, nationally and internationally, as a means to provide farmlands and farmers with greater resiliency and flexibility under the potential effects of a shifting climate—a role that goes beyond just sequestering CO_2. Even though many agroforestry practices actually occupy only a small portion of a farm's acreage, they provide a high level of diversity on the landscape. This diversity helps meet societal demands for energy and environmental services as well as the demand for traditional agricultural products.

The Business of Agroforestry

Integrating perennials such as trees and shrubs into an annual cropping system creates a more complex farming system. This increased complexity requires more management by the farmer or rancher. Especially during their early establishment years, new plantings require protection, monitoring, and care. However, this extra management can pay dividends by creating a farming system that offers many benefits, as noted above, compared to a less complex system.

In contrast to an annual cropping system, it might be years or even decades from planting until harvest in the more complex system. The economic cycle becomes longer as well. Although there are programs that might help defray some of the expenses of establishment, other costs must be carefully weighed during the design stage, including the management and labor required for interim and final products.

Establishment Costs and Interim Income

Depending on the type of project, establishment costs can be considerable. For any agroforestry system, the destruction of existing vegetation and good site preparation are minimal requirements. Adequate weed control with chemicals, mulch, or landscape cloth will reduce early competition for water and nutrients, encouraging quick, healthy tree growth. Irrigation in the early years will further increase the survival rates of any trees and shrubs included in plantings.

Lending institutions will likely require a business plan in order to fund a large project, especially for someone just beginning an agroforestry practice. Of course, a solid business plan is a good idea for anyone considering adding a new enterprise to a farm or ranch. The Minnesota Institute for Sustainable Agriculture offers an excellent guide for developing a business plan for farms and rural businesses. It is available in print and electronically at *www.misa.umn.edu/Publications/index.htm#business*.

There are government support programs that can be used to pay establishment and maintenance costs. The publication *Building Sustainable Farms, Ranches and Communities* is a collection of all the agriculture and forestry funding opportunities in the 2008 Farm Bill. It is available online at the ATTRA website *http://attra.ncat.org/guide/index.html* or in hard copy by calling ATTRA at 800-346-9140. Spanish speakers can call 800-411-3222.

A chart showing USDA programs from the 2008 Farm Bill that can be applied to each agroforestry practice can be found in the appendix to this publication. Consult with your local USDA Service Center to see if these programs apply to the agroforestry practice you are planning and for assistance with application procedures. *http://offices.sc.egov.usda.gov/locator/app*

Raspberries planted between young pecan trees. Photo: Courtesy of Sandra Hodge

For most landowners, the fact that a new planting doesn't pay back the initial investment for some time is a serious consideration. With planning, however, some income can be generated early in the life of the planting. This income can be critical to the cash-flow situation of the farm.

Alley crops and silvopastures provide income from cropping or grazing the area between tree rows in this early stage. In addition, as a stand of same-age trees grows, some trees are harvested to provide more space for the others to mature. Although the early thinnings are not likely to be worth very much, the later ones may have considerable value, especially if there is a market for biomass in the area. It pays to investigate all marketing options, including selling value-added products directly. See the Marketing section of this publication for more information.

A very useful publication on developing a cash-flow plan by combining multiple enterprise budgets over the life of an agroforestry planting, *Economic Budgeting for Agroforestry Practice,* is available online from The University of Missouri's Center for Agroforestry website at *www.centerforagroforestry.org/pubs/economichandbook.pdf*. The website also offers several other publications, including *Tax Considerations for the Establishment of Agroforestry Practices* at *www.centerforagroforestry.org/pubs/agrotaxcons.pdf*. See the Further Resources section below for more information on what the center offers.

For more general business-planning tools, explore the "Beginning Farmer" section of the ATTRA website at *www.attra.ncat.org/attra-pub/local_food/startup.html*.

Because agroforestry systems in temperate climates have not been studied through multiple complete rotations, landowners will work with incomplete data during the initial evaluation process. Yield data from same-age tree plantations must be adjusted for an agroforestry system. Understory competition for water and nutrients, as well as light effects on both understory and tree edges, should be taken into account when projecting yields and expected market values.

Marketing

Before committing to any agroforestry enterprise, it is absolutely essential to do thorough research into the markets available for each type of tree product that you might sell. For many forestry products, the buyer must be relatively close to the site. Otherwise, the transportation costs will override potential profits. For timber production, this is key.

For other forest products (e.g., wood chips, sawdust, and pulpwood), marketing prospects may be changing. Regions where infrastructure is well established still offer the best opportunities for getting started. However, because private lands are becoming a more important source of tree products, new markets will probably develop in new regions. It is, of course, difficult to predict where that may happen, especially when planning for harvests 20 years or more into the future. Recently, government programs

designed to bridge this gap have been started. Check with your local Farm Services Agency for these opportunities.

In addition, new market-research projects are evaluating the established transport systems used to move grain as a means of moving some wood products. For example, using river barges to carry wood-chip biomass could prove to be an economically feasible way to feed a downstream power plant. Although short-rotation woody crops are a relatively new type of forestry, it is likely that regional markets will develop near ethanol producers, electric power plants, and the fiber industry.

If nut trees are a part of the agroforestry planting, they will produce income from the nuts long before the timber can be harvested. In fact, over the life of the planting, the value of the nut harvest from well-managed improved varieties is liable to surpass the value of the wood at the final harvest. Black walnut is a valuable timber and nut tree, but it requires a good site and takes a long time (often 80 years) before timber harvest can begin. Early training and pruning, as well as managing fertility and pests, will maximize the value of both crops. Pecans, either native or named cultivars, have some of the same advantages and disadvantages. However, pecan trees are seldom harvested for timber while they are still producing because of the high value of the nut.

In some cases, landowners can add value and market wood products themselves. Hardwood chips can be sold to a landscaping firm, for instance, and firewood and fence posts may have ready customers nearby. Access to a portable sawmill might enable landowners to saw their own logs into lumber, air dry it, and sell it directly to specialty woodworkers.

Other options, such as selling pine thinnings as Christmas decorations, require imagination and marketing know-how. ATTRA publications on direct marketing and adding value can offer assistance in this area. Fee hunting or wildlife photography, possibly combined with camping or bed-and-breakfast facilities, might also be avenues to consider. See ATTRA's *Woodlot Enterprises* and *Entertainment Farming and Agri-Tourism* for further information on these opportunities. Another source of ideas for potential uses, especially of thinnings, is the Smallwood Utilization Network's email newsletter. Located in Montana, the network also offers information on its website *http://smallwoodnews.com*.

Market analyses have been conducted by the Center for Agroforestry at the University of Missouri on several agroforestry products, including shiitake mushrooms, chestnuts, and Eastern Red Cedar. See *www.centerforagroforestry.org/pubs/index.asp#pubs* for more information. Check with your own university for other market analyses.

The marketing plan isn't the only factor that must be given careful consideration when you are planning the harvest; the harvest itself takes planning. The planting design must accommodate harvesting equipment and leave room to conduct maintenance operations—both for trees and crops. Young trees are easily wounded, and these wounds provide an entrance for pest organisms. Wounds may also compromise the quality of the end product.

Designing a New Agroforestry Planting

Farms and ranchlands take on a new look when trees are integrated into a landscape that formerly was used for livestock alone or for one or two annual crops. The benefits are many and wide ranging:

- Less wind- and water-caused soil erosion
- Lower fuel and feed costs
- Reduced economic reliance on one or two crops
- Multistory crops from the same acreage
- Additional profit centers providing economic stability
- A more beautiful, diverse landscape

However, it's often difficult for farmers to look at land that's familiar to them from years of having worked it and identify areas to use differently. Perhaps areas that have required extra attention in order to perform adequately as monocropped acreage might actually have good potential to produce something else. Trees or shrubs might thrive in that low, wet place where the dominant crop has struggled. Maybe a windbreak would protect the high clay hills from further wind erosion, increase yields on the protected acreage, and even add income from a government program or carbon credits.

Agroforestry practices are typically planned and implemented for sites on individual farms and ranches. Although a single farm may not have much impact on such regional problems as overall water or air quality in the area, several farmers cooperating can make a big difference. Such landscape-level impacts depend on looking beyond the fence line at how local farms affect the surrounding ecosystem.

Regional watershed initiatives—created by farmers and other members of a community to protect downstream areas—are active in some parts of the country. An example is The Mississippi River Basin Initiative. For information on that initiative, go online at *www.nrcs.usda.gov/programs/mrbi/mrbi_overview.html*.

Incentives are available to groups of interested landowners who commit to working together to achieve water quality, flood control, and other specified goals. The USDA's Service Centers can provide details about this and other regional projects.

A natural-resource planner can help landowners design agroforestry systems that achieve their own goals as well as help address landscape-scale problems. Local NRCS offices can help identify such planners as well as any programs available to finance the effort.

Here are some examples of natural-resource problems that can be addressed by planning at a landscape scale:

- Excess sediment and nutrients in water
- Limited and fragmented wildlife habitat
- Degraded aquatic habitat
- Stream bank erosion
- Blowing dust and snow
- Monotonous and undesirable scenery

Farmers and ranchers should make decisions about adding trees, shrubs, or combinations of the two to their land based on their long-term goals and vision as well as the options available locally. Careful planning and design are critical, and there are numerous questions landowners will need to consider:

- How could trees enhance the long-term sustainability of the operation?
- What problem areas might grow trees better than the current annual crop?
- Would financed alleycropping or wind- or waterbreaks be a better use of a field of highly erodible land?
- Would a wide buffer along a river or creek using biomass-producing trees be worth considering?
- Could such a buffer also be used for additional controlled grazing?
- Might adding woody ornamentals or small fruit trees increase diversity and profitability?
- Are there watershed or landscape-scale needs or requirements?
- What services are expected of the new planting?
- Will the new planting use livestock wastes for tree production or filter excess crop nutrients?
- Will the new planting use land that is otherwise marginal for crop production?
- Is the goal to sequester carbon or to produce bioenergy or wood products?

One of the key benefits of agroforestry plantings is that they provide multiple services at the same time. For instance, an alleycropping system can provide long- and short-term marketable products, an enhanced microclimate for growing the crop between the trees, biological pest control, wind-erosion control, and wildlife habitat. Through a planning process like the one described below, a producer and planner can design a comprehensive agroforestry planting that accomplishes many goals.

Because agroforestry systems are much more complex than single-purpose farm or forestry enterprises, they require a thorough planning process. Each component of the system—the trees as well as the crops or livestock—must undergo a series of evaluation procedures:

1. Consider the farm or family goals. Is diversifying the farm's enterprises or the landscape part of your mission? Do the environmental or economic benefits appeal to you? What are your overall objectives?
2. Take a comprehensive look at the land itself. It's useful to have aerial maps that show features such as streams, existing woodland, and roadways. Do you have a soil map? (They're free from local USDA Service Centers.) The producer's knowledge of areas that tend to be wet or dry or have other special characteristics is essential to the process.
3. Look at the land as a part of the watershed. Are there watershed issues that can be addressed through multiple-farm activities? Would a continuous riparian buffer protect water quality and provide a

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continuous wildlife corridor? Are there flooding issues that could be cooperatively solved?

4. Generate and investigate a list of potential agroforestry enterprises. Could the trees be the end product (timber or energy) or would they provide permanent habitat or forest products? Imagine as many options as possible.
5. Choose the most promising ideas that will fit the landscape.
6. Design the new planting with the help of the tools listed below and USDA service providers or other natural-resource experts.
7. Implement the plan.
8. Monitor progress.
9. Make adaptations as necessary.

Here is a checklist of information to collect or generate when evaluating an agroforestry option (Knowles and Middlemiss, 1999):

- **Farm accounts** — income and expenditures for existing enterprises and potential ones, including fixed and variable costs.
- **Planting and felling areas** — the program of harvest and planting for each year of the project.
- **Labor and materials** — includes the costs of seedlings, fertilizer, herbicides, and insurance, as well as planting, pruning, and thinning expenses.
- **Wood yields** — predicted wood-product values by log grade, including the cost of harvest and transport.
- **Understory profiles** — crop or livestock products, including harvested tree products (e.g., nuts or pine straw); how production will change through the tree rotation; and the effects of canopy closure and windbreak benefits.
- **Environmental Impacts** — water yield, erosion reduction, carbon sequestration, and wildlife.
- **Social effects** — family and farm goals, support of the rural community, and improved visual aesthetics.

Planning Tools

Tools are available for landowners and resource professionals to evaluate and design agroforestry plantings:

- **Web Soil Survey** provides information about soil types and soil interpretations for the entire U.S. *http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*
- **Buffer-suitability assessments** are GIS-based programs designed to determine where buffers can achieve goals related to a number of factors:
  - Water quality *www.unl.edu/nac/research/2006soilsurveys.pdf*
  - Riparian connectivity *www.unl.edu/nac/research/2004ripar ianconnectivity.pdf*
  - Specialty products *www.unl.edu/nac/research/2002agroforestrygis.pdf*
- **Buffer$** offers a spreadsheet to weigh the costs and benefits of converting cropland to a buffer. *www.unl.edu/nac/buffer$.htm*
- **CanVis** is a program for showing how design alternatives will look immediately and as a planting ages. *www.unl.edu/nac/simulation/index.htm*
- **Conservation Buffers** is an illustrated field guide for designing buffers for corridors or greenways in urban or rural settings. *www.unl.edu/nac/bufferguidelines/*
- **COMET-VR** is a decision-support tool for agricultural producers, land managers, soil scientists, and other agricultural interests. COMET-VR provides an interface to a database containing land-use data from the Carbon Sequestration Rural Appraisal and calculates carbon changes for a farm or enterprise. *www.cometvr.colostate.edu*

Plant Guides

These databases and hard-copy resources describe characteristics of trees, shrubs, and other perennials to help choose which plants to include in an agroforestry system:

- The **Plants for a Future** website has a plants database that can be searched using multiple criteria. *www.pfaf.org/user/plantsearch.aspx*
- **Edible Forest Gardens** is a book in two volumes. Each has appendices with listings of plants organized by different criteria. This resource includes perennials and vegetables as well as trees and shrubs.
- The **USDA NRCS** maintains an extensive database. In the column on the left, there are several ways to find plants that meet different criteria. "Characteristics" might be a good place to start. Later, the Fact Sheets and Plant Guides can give you more information on specific choices. *http://plants.usda.gov/index.html*
- **Conservation Trees and Shrubs** is an older NRCS publication containing useful information for plant identification. *http://plant-materials.nrcs.usda.gov/technical/plantid/woodyIDguide.html*
- **Arbor Day Foundation** has a Tree Guide with many helpful tools. *www.arborday.org/treeguide*

Conclusion

Integrating several enterprises necessarily involves multiple interactions. How will each component affect the other—for better or worse? How can all the enterprise operations be managed while taking the other parts of the system into consideration? Despite every effort at predicting, there will be unforeseen consequences. Advantages and disadvantages will become apparent in time. It is therefore critical to continually observe what's happening on the site. If certain indicators are identified as early warning signs during planning, it will lead to better monitoring. Alert managers will avoid losses if they notice problems as soon as they occur.

Agroforestry systems, especially for temperate climates, have not traditionally received much attention from either the agricultural or the forestry community. Nevertheless, implementing designs that use trees and bushes to enhance crop or livestock production, waste management, and natural-resource protection is a step toward a permanent, stable agriculture. Farmers have pioneered many of these systems. Each requires a careful initial design adapted to the site and the farm operation, continuous observation, and a commitment to a long timeline. The resulting farmscape will be beautiful as well as productive, and it can be a source of pride for the family and the community.

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Knowles, Leith and Phillip Middlemiss. 1999. Evaluating Agroforestry Options. A Continuing Professional Development course held June 12, 1999, at Hot Springs, AR.

Lavelle, Marianne. 2010. A U.S. cap-and-trade experiment to end. National Geographic Daily News website. November 3. *http://news.nationalgeographic.com/news/news/energy/2010/11/101103-chicago-climate-exchange-cap-and-trade-election*

Mortimer, John and Bunny Mortimer. 1996. Shelter & Shade: Creating a Healthy and Profitable Environment for Our Livestock with Trees. Green Park Press, Jackson, MS.

Nair, P.K.R., V.D. Nair, B.M. Kumar, and J.M. Showalter. 2010. Carbon sequestration in agroforestry systems. In: D. Sparks (ed.). Advances in Agronomy. Vol. 108. Academic Press, San Diego, CA. p. 237-307.

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USDA National Agroforestry Center. No date. Working trees for carbon: Windbreaks in the U.S. Lincoln, NE. *www.unl.edu/nac/brochures/wbcarbon/wbcarbon.pdf*

Further Resources

Helpful ATTRA Website Resources

Building Sustainable Farms, Ranches, and Communities: Federal Programs for Sustainable Agriculture, Forestry Entrepreneurship, Conservation, and Community Development.

www.attra.ncat.org/guide/index.html

A guide addressing federal program resources in community development, sustainable land management, and value-added and diversified agriculture and forestry.

Farm Energy Resources

www.attra.ncat.org/attra-pub/farm_energy

Contains links to publications explaining how to make farm buildings more energy efficient, use the sun's energy to heat greenhouses and pump water, choose and put up wind turbines, make and use biofuels, and more.

Beginning Farmer

www.attra.ncat.org/attra-pub/local_food/startup.html

Information about running a farm, transitioning to an organic operation, business management, marketing, and other topics. It includes links to other resources outside of ATTRA.

Journals, Periodicals, and Newsletters

Agroforestry Abstracts

www.cabi.org/default.aspx?site=170&page=1016&pid=33

Available on the Internet with a fully searchable 13-year archive of worldwide agroforestry information and weekly updates. Reduced subscription price for Association for Temperate Agroforestry (AFTA) members. Free 30-day trial of the online version is available.

Agroforestry Systems

www.springer.com/life+sciences/forestry/journal/10457

International scientific journal that publishes results of original research, critical reviews, and short communications on any aspect of agroforestry, including biophysical and socioeconomic aspects. Reduced subscription price for AFTA members.

Temperate Agroforester

www.aftaweb.org

Quarterly newsletter of AFTA, free to members.

Agroforestry Newsline

www.aftaweb.org/resources1.php?page=7

Online newsletter with periodic updates on developments in North America.

Inside Agroforestry

www.unl.edu/nac/insideagroforestry.htm

Newsletter of the USDA National Agroforestry Center. Published three times per year. Each issue focuses on a theme related to agroforestry in the United States.

Action in Agroforestry

www.centerforagroforestry.org

Monthly electronic newsletter of the Center for Agroforestry at the University of Missouri. The newsletter reports on center staff, outreach, and research. Archives are available. To subscribe to the newsletter, call 573-882-9866.

The Overstory

www.agroforestry.net/overstory/index.html

A free email journal focused on design concepts for agricultural systems that integrate trees and other perennial plants.

Books

Design Principles for Farm Forestry. 1997. Anon. RIRDC/LWRRDC/FWPRDC Joint Venture Agroforestry Program. Australia. *www.mtg.unimelb.edu.au/publications/design.htm*. Publication number 97/48.

A guide to help farmers create their own agroforestry design. Seven basic reasons for planting trees provide the theme for each chapter, including basic design principles to achieve

that objective. Each chapter also provides hints for adapting a design to capture multiple benefits. Available for downloading at the website, or in hard copy from RIRDC.
publications@rirdc.gov.au

Edible Forest Gardens, Vol. 1. 2005. By Dave Jacke and Eric Toensmeier. Ecological Vision and Theory for Temperate Climate Permaculture. Chelsea Green Publishing Co., White River Junction, VT.

Introduces historic and visionary bases of edible forest gardens. It describes ecological relationships, structures, and succession. Useful diagrams, photos, appendices, and further resources included.

Edible Forest Gardens, Vol. 2. 2005. By Dave Jacke and Eric Toensmeier. Ecological Design and Practice for Temperate Climate Permaculture. Chelsea Green Publishing Co., White River Junction, VT.

Details the design process, site preparation and establishment, and maintenance of the edible forest garden. It includes illustrations, tables, tools, and very extensive appendices of appropriate plant materials.

Enhancing Wildlife Habitats: A Practical Guide for Forest Landowners. 1993. By Scott S. Hobson, John S. Barclay, and Stephen H. Broderick. NRAES-64. Northeast Regional Agricultural Engineering Service, Ithaca, NY.

Contains recommendations and field exercises for landowners who want to ensure quality habitats for wildlife. It includes sections on forest wildlife ecology, wetlands, and understanding wildlife habitats, as well as specific guidelines for enhancing the habitats of woodcock, ruffed grouse, white-tailed deer, wild turkey, and other upland and wetland animals.

Northeast Regional Agricultural Engineering Service
152 Riley-Robb Hall
Ithaca, NY 14853-5701
607-255-7654
www.nraes.org

Forest Gardening: Cultivating an Edible Landscape. 1996. By Robert Hart. Chelsea Green Publishing, White River Junction, VT.

Describes how to transform even a small cottage garden into a hospitable diverse habitat for songbirds, butterflies, and other wildlife by using a wide variety of useful plants, including fruit and nut trees, perennial herbs, and vegetables.

Nontimber Forest Products in the United States. 2002. Edited by Eric Jones, Rebecca McLain, and James Weigand. University Press of Kansas, Lawrence, KS.

Describes the range of products being produced in woodlands, including traditional uses and users of the forest — both commercial and noncommercial; discussion of sustainable management; and policy, economics, and future research needs.

North American Agroforestry: An Integrated Science and Practice. 2nd Edition. 2009. Edited by H. E. Garrett. American Society of Agronomy, WI. ISBN: 978-0-89118-163-7.

Covers the fundamentals of the main agroforestry practices, with detailed case studies and examples as well as strategies for addressing the financial aspects of the practices.

Restoration Forestry: An International Guide to Sustainable Forestry Practices. 1994. Edited by Michael Pilarski. Kivaki Press, Durango, CO.

An encyclopedia of sustainable forestry with an international scope, including temperate and tropical applications. This is an important reference book, although many entries are out of date.

Silvopastoralism and Sustainable Land Management. 2005. Edited by M. R. Mosquera-Losada, A. Rigueiro-Rodríguez, and J. McAdam. CABI Publishing, Wallingford, Oxfordshire, U.K.

Examines the productivity and quality of silvopastoral systems and outlines successful ways of managing forestry and agronomic areas. It includes ecological benefits and cultural, economic, and social implications.

Tree Crops: A Permanent Agriculture. 1987. By J. Russell Smith. Island Press, Covelo, CA.

Visionary classic describing the use of temperate-zone trees to produce food for people and livestock without the erosion associated with annual cropping systems.

Creating a Forest Garden—Working with Nature to Grow Edible Crops. 2010. By Martin Crawford. Green Books, UK. ISBN: 978-1-900322-62-1.

Tells you everything you need to know, whether you want to plant a small area in your back garden or develop a larger plot. It includes advice on planning, design, planting, and maintenance, as well as a detailed directory of more than 500 edible plants.

The Woodland Steward. 2nd Edition. 1994. By James R. Fazio. The Woodland Press, Moscow, ID.

Woodland management, including inventory and planning, harvesting, and improving the woodlot, as well as chapters on Christmas trees, hollies as a business, and maple sugaring.

The Woodland Year. 2008. By Ben Law. The Sustainability Centre, Hampshire, England.

Managing a British woodland through the year using traditional methods. It describes coppicing, laying hedge, making charcoal, and many wood products.

The Overstory Book: Cultivating Connections with Trees. 2001. Edited by Craig R. Elevitch and Kim Wilkinson. Permanent Agriculture Resources, HI. ISBN: 0-9702544-1-5.

Distills essential information about working with trees into 72 short easy-to-read chapters on planting and protecting trees, gardens, and forests.

Agroforestry-Related Organizations

Association for Temperate Agroforestry (AFTA)
School of Natural Resources
1-30 Agriculture Building
University of Missouri
Columbia, MO 65211
www.aftaweb.org

The professional organization devoted to agroforestry research, demonstration, and information dissemination in North America. The annual membership fee includes a subscription to The Temperate Agroforester*, a quarterly newsletter, and Agroforestry Newsline, an electronic newsletter, as well as discounts on association events and on many agroforestry books and periodicals. AFTA sponsors a biennial international conference for researchers and practitioners. Proceedings are available for most of the past conferences.*

USDA National Agroforestry Center (NAC)
University of Nebraska, East Campus
Lincoln, NE 68583-0822
402-437-5178
www.unl.edu/nac

A U.S. Forest Service and Natural Resources Conservation Service partnership to develop and apply agroforestry technologies in appropriate conservation and/or production systems for farms, ranches, and communities. NAC offers a free quarterly newsletter, Inside Agroforestry*, to anyone who requests it, along with many publications on agroforestry practices and products, all at no cost.*

World Agroforestry Centre
Nairobi, Kenya
www.worldagroforestry.org

Provides access to research and extension materials for agroforestry in the developing world. Headquartered in Nairobi, Kenya, the organization has five regional offices, located in India, Indonesia, Kenya, Malawi, and Mali. Research is conducted in 18 other countries as well.

Proceedings

Proceedings of Past North American Agroforestry Conferences (AFTA)

The biennial North American Agroforestry Conference series, initiated in 1989. The conference has been a forum for researchers, teachers, extensionists, and practitioners to share up-to-date information about temperate agroforestry. The papers and poster abstracts presented at each conference are collected in either a printed or electronic format. These proceedings are available from AFTA. Order online at www.aftaweb.org/resources1.php?page=8.

Proceedings of the North American Conference on Enterprise Development through Agroforestry: Farming the Agroforest for Specialty Products. Held in October 1998. Proceedings published in 1999. Edited by Scott J. Josiah. The Center for Integrated Natural Resources and Agriculture Management, University of Minnesota, St. Paul, MN.

Includes sections on marketing, medicinals and botanicals, handicrafts, specialty woods and decorative florals, forest-based food products, unique challenges of specialty forest products, and emerging issues in forest farming. Contact CINRAM for ordering information.

The Center for Integrated Natural Resources & Agricultural Management (CINRAM) University of Minnesota
115 Green Hall
1530 Cleveland Avenue North
Saint Paul, MN 55108
612-624-4299, extensions 7418 and 4296
CINRAM@umn.edu

Agroforestry and Sustainable Systems: Symposium Proceedings. Held in August 1994 in Fort Collins, CO. Proceedings published in 1995. Edited by W. J. Rietveld. General Technical Report RM-GTR-261. USDA-Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Topics include the use of dormant woody planting for slope protection, living snowfences, agroforestry and wildlife, agroforestry-enhanced biodiversity, conservation trees, and a report on the status of agroforestry in five agroclimatic regions of the U.S. Organized and sponsored by the USDA. Out of print. See your librarian for help in obtaining a copy.

World Congresses of Agroforestry

International gatherings of agroforestry professionals designed for the exchange of knowledge, experiences, and ideas. Each of the two gatherings held to date have different websites with extensive materials generated at each event.

First World Congress of Agroforestry
June 27 through July 2, 2004
Orlando, FL, USA
http://conference.ifas.ufl.edu/wca

Second World Congress of Agroforestry
August 23 through August 28, 2009
Nairobi, Kenya
www.worldagroforestry.org/wca2009

Agroforestry Websites

Some of these websites may change. If they can't be found at the addresses listed, a web-browser search will help you find their current locations.

Forest Landowners Guide to Internet Resources
Index of online publications covering a wide range of topics related to owning and managing woodlands. Topics include special forest products, riparian buffers and windbreaks, forest tourism, and many others. It includes direct online links. Designated as materials appropriate to the USDA's Northeastern region, they may be of interest to other regions as well.

Resources for Tropical Forestry and Agroforestry
Source of The Overstory*, a free email journal. Although the focus is on tropical regions, it includes considerable information relevant to temperate-zone agroforestry.*

Farm, Community, and Tree Network (FACT Net)
Fact sheets on many nitrogen-fixing trees—many of them tropical. Research reports and past publications also are available. It is somewhat dated, but a valuable focus.

Websites Related to Special Forest Products

USDA Forest Service — Special Forest Products
www.sfp.forprod.vt.edu/special_fp.htm
Contains several articles about nontimber forest products.

The Center for Integrated Natural Resources & Agricultural Management (CINRAM), University of Minnesota
www.cinram.umn.edu
Good general agroforestry information as well as publications on special forest products.

WoodWeb
www.woodweb.com
Woodworking industry homepage with information on lumber sales, furniture and cabinet-making, business, and many other topics related to this industry.

Cornell University—Special Forest Products
http://mushrooms.cals.cornell.edu/cornellagfo.htm
Considerable information about mushroom cultivation, sugar maples, nuts, and forest farming, as well as access to Cornell's Agroforestry Resource Center.

Other University Resource Sites

University of Minnesota Extension—Agroforestry
www.extension.umn.edu/Agroforestry
Information and resources for all agroforestry practices. It also includes biomass resources.

Center for Agroforestry at the University of Missouri
www.centerforagroforestry.org
Extensive information from an active research program on production and marketing of agroforestry products. The site also includes videos on agroforestry practices and many useful publications, including budgeting tools. It also has links to related sites.

Agroforestry for Rural Living – Nebraska Forest Service
www.nfs.unl.edu/RuralForestry/agroforestryintro.asp
A general summary of agroforestry. It provides access to Nebraska resources.

New Mexico State University—Agroforestry/Reforestation
http://morasc.nmsu.edu/agroforestryreforestatio.html
Agroforestry and reforestation research reports and other New Mexico resources.

Canadian Resource Sites

Ontario—Ministry of Agriculture Food & Rural Affairs
www.omafra.gov.on.ca/english/crops/hort/agrofore.html
Agroforestry statistics, materials on maple syrup production and processing, and materials on growing nut trees and Christmas trees. It also provides windbreak and tree-pest information.

Agriculture and Agri-Food Canada—Prairie Farm Rehabilitation Administration Shelterbelt Centre
www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1186517615847&lang=eng
Premier information source for windbreaks and shelterbelts, including many aspects of design, establishment, and maintenance. Carbon and biomass information also is available.

Subtropical and Tropical Resource Sites

University of Florida IFAS Extension
www.sfrc.ufl.edu/Extension/florida_forestry_information/forest_management/agroforestry.html
Agroforestry practices and publications as well as silvopasture information for the southeastern United States.

University of Florida—Center for Subtropical Agroforestry
http://cstaf.ifas.ufl.edu
Research, extension, and training in agroforestry for subtropical areas.

Sustainable and Organic Agriculture Program—College of Tropical Agriculture and Human Resources
www.ctahr.hawaii.edu/SustainAg/links/agroforestry.html
Many resources on agroforestry and forestry for Hawaii are provided as well as links to more general sites.

Appendix

USDA Conservation Programs are voluntary and available to all landowners. Many are competitive, and all involve multiple-year contracts. The kind of reimbursement varies with the program: establishment costs, practice incentives, or annual rental payments. Technical and planning services are free, and sign-up is available at USDA Service Centers.

USDA Programs for Agroforestry (2008 Farm Bill)*						
	Alley Cropping	Riparian Forest Buffer	Windbreak	Silvopasture	Multi-Story Cropping	Special Applications (Tree Plantings)
NRCS						
EQIP	C	C	C	C	C	C
WHIP	C	C	C	C	C	C
CSP		U	U	U	U	U
WRP		C/E		C/E	C/E	C/E
FSA						
CRP						C/R
CCRP		C/I/R	C/I/R			C/I/R
BCAP						C/I/R

EQIP - Environmental Quality Incentives Program

WHIP - Wildlife Habitat Incentives Program

CSP - Conservation Stewardship Program

CRP - Conservation Reserve Program

WRP - Wetland Reserve Program

BCAP - Biomass Crop Assistance Program

C = Practice payment; I = Incentive payment; R = Rental payment; E = Easement payment; U = Land use payment
* Not all combinations will be available in all states.

Source: Adapted from an article by Doug Wallace,* Inside Agroforestry*, Vol. 18, Issue 1, page 5.

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