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Agroforestry: A Land Use Integration System

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The goal of agroforestry is to optimize productivity and conservation benefits within a set of integrated land use practices. Agroforestry combines trees, shrubs, forages, grasses, livestock, and crops in innovative, flexible combinations tailored to the needs of landowners. In our temperate climate, agroforestry consists of six main practices:

1. Whole-farm diversification
2. Silvopasture
3. Alley cropping
4. Riparian forest buffers
5. Windbreaks
6. Forest farming

When properly designed, these practices can result in reduced pest management inputs, increased crop production, diversification of farm income, reduced soil erosion, improved water quality, and enhanced wildlife habitat and biodiversity.

When designing and implementing any of these six practices, it is important to consider the compatibility of the species with the site, the compatibility among species, the farm equipment available, and potential markets. Local natural resource professionals in agriculture and forestry extension, the Natural Resources Conservation Service, local soil and water districts, the Oregon Department of Fish and Wildlife, and your Oregon Department of Forestry office can provide you with design and implementation assistance, as well as information regarding restrictions or requirements for streamside protection or maintaining wildlife habitat.

Whole-Farm Diversification with Woody Crops

Farm diversification requires a holistic, landscape approach. Diversifying a farm with woody crops involves intentionally integrating trees into the farming system using practices that are designed specifically for the conditions and needs of a specific parcel of land. Such plantings meet landscape integration criteria for agroforestry, but on a larger landscape scale. For example, converting 40 acres of marginal agricultural land to a hybrid poplar, hazelnut, or Christmas-tree plantation introduces trees and shrubs into the whole farm system. These woody perennials enhance biodiversity, diversify producer income sources as well as risk, may generate greater profits than annual crops, and create a more integrated, interesting, and visually appealing land use system that may be more environmentally, economically, and socially sustainable than the original farmscape.

Silvopasture

Silvopasture, which is defined as the intensive management and growing of perennial grasses or grass-legume mixes in a forest stand for livestock pasture, may be one of the most applicable agroforestry practices for most of Oregon (fig. 1). Just letting cows graze in a natural woodland area without any type of tree or forage management is not considered a silvopastoral practice. Rotationally grazing livestock, planting, pruning, and/or protecting trees, and monitoring forage quality are all part of silvopasture management. Proper design and planning, as well as a working knowledge of the

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silvopastoral components, can reduce the time and labor involved in both establishing the practice and managing the system.

Several benefits are realized by implementing a silvopasture practice. Trees protect livestock from temperature extremes by blocking cold wind and snow in winter and providing shade in summer. Livestock benefit from improved forage quality and reduce the need for chemical or mechanical vegetation control. Recent research findings in Lincoln County, Oregon, show that cattle can be integrated into thinned Douglas-fir forest plantations, especially on south-facing slopes. The researchers recommend stocking rates of 4 and 6.5 acres per cow/calf unit under 25- and 55-year-old Douglas-fir thinned-forest silvopastoral systems, respectively.

Forages recommended for silvopastoral systems in Oregon include perennial ryegrass, orchard grass, and tall fescue (with a mix of subterranean clover and white clover). These forages can perform well under 50% shade, depending on soil conditions and aspect (slope direction). The clovers serve as biological sources that fix nitrogen for use by both the grass and trees and provide the necessary crude protein component for the grazing livestock. By matching tree and forage selections, one will have more palatable forage, more efficient grazing, and more vegetation removal by the grazing animals.

For optimal performance, trees, livestock, and forages should be chosen that are compatible with the site and with each other, produce marketable products, meet landowner management objectives, and, if desired, provide wildlife or environmental benefits. Livestock chosen may include, but are not limited to, cattle, sheep, goats, horses, poultry, bison, and elk. During tree establishment stages, livestock should be excluded from the site or protection measures, such as electrified fencing, should be used to prevent damage to young trees. When livestock are excluded, forage can be produced to sell or to feed livestock.

Alley Cropping

Alley cropping combines trees, planted in widely spaced single or grouped rows, with adjacent agricultural or horticultural crops cultivated in the wide alleys between the trees (fig. 2). Usually, high-value trees or fast-growing species such as hybrid poplar or red alder are potential species for alley-cropping systems. Annual crops (e.g., row crops, forages, and vegetables) cultivated between rows of nut or fruit trees are an alternative arrangement that can provide extra income before the trees come into bearing. Alley cropping provides an opportunity to convert marginal cropland to woodland while continuing to earn income from annual crops during the initial years of the planting.

The benefits realized in alley-cropping practices include increased income diversity and biological diversity, improved aesthetics, and reduced negative environmental impacts. Alley-cropping practices are designed according to the site's characteristics, the tree products desired (e.g., nuts or timber), the growth requirements of the selected tree, the crop being grown in the alley, the farm equipment

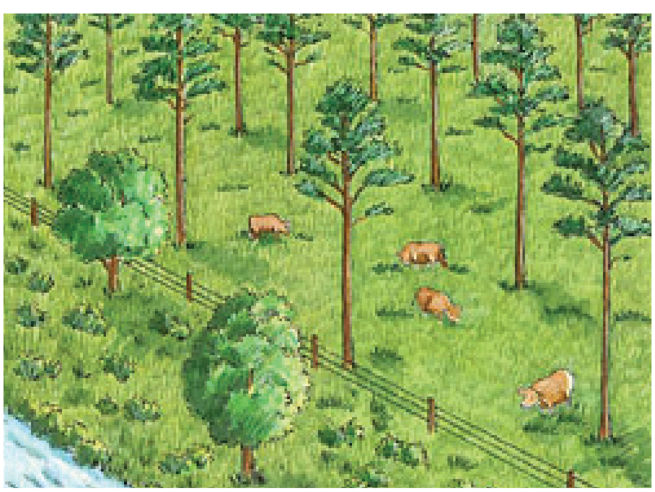

Figure 1. Integrated silvopasture system. Reproduced by permission of the University of Minnesota Extension.

Figure 2. Alley cropping. Reproduced by permission of the University of Minnesota Extension.

available, and the landowner's objectives. For example, alleys can be arranged in straight rows and on diagonals to allow equipment to travel in various directions, reducing soil compaction. On sloping land, it may be necessary to plant the rows on the contour, creating a terrace to reduce soil erosion due to water runoff.

While designs for an alley-cropping practice will vary depending on landowner objectives, there are several basic considerations. Spacing between the trees within the row and between the rows of trees must be considered when designing an alley-cropping practice. Selected trees should be deep rooted, create a light shade, and produce one or more products (timber, nuts, and fruit). The distance between the rows is determined by the following:

- Growth requirements of the companion crop
- Width of the available farm equipment
- Type of trees grown
- Desired product or products
- Duration or length of time the landowner wishes to grow a light-demanding crop in the alley

Shrubs or coniferous trees can be used in multiple tree rows to provide additional products and to train hardwood species to grow straight and tall, producing high-value timber products. Growing trees for timber or nuts may require pruning of young trees. Pruning young nut trees to a height of 8 feet allows equipment to pass below the branches for mowing and harvesting of nuts while retaining much of the crown area. Greater pruning heights, to reduce defects in the wood caused by low branches, may be required for production of quality timber.

Traditional row crops, as well as horticultural, medicinal, and vegetable crops, can be incorporated into an alley-cropping practice. As the trees grow and produce more shade in the alleys, companion crop selections may change. Over time, competition for water can limit the width of the area in the alley that can be cropped. Deep trenching with a ripper, trencher, or chisel plow between the tree row and the crop to sever lateral tree roots may be necessary to minimize production losses in the alley crops. Wider alleys will accommodate crops that require full sun, such as corn and beans. When shade becomes limiting, there will need to be a shift to a more shade-tolerant crop, such as shade-tolerant forages or berry-producing shrubs.

Riparian Forest Buffers

Riparian buffers consist of strips of perennial vegetation (tree/shrub/grass) planted between crop or pastureland and streams, lakes, wetlands, ponds, or drainage ditches. Riparian buffers reduce runoff and non-point-source pollution from agricultural activities on adjacent lands by trapping sediment, filtering excess nutrients, and intercepting and degrading pesticides (fig. 3). They can also stabilize stream banks, protect floodplains and flood-control structures, enhance wildlife habitat, and provide a harvestable and salable product such as timber and pulpwood, fruits, nuts, or floral products.

Riparian forest buffers can have positive impacts on water quality. One popular design consists of three zones (fig. 3):

1. Zone 1, undisturbed forest, closest to the water
2. Zone 2, managed forest, next to the undisturbed forest
3. Zone 3, grasses, farthest from the water

The roots of the undisturbed vegetation (trees and shrubs) in zone 1 stabilize stream banks and hold soil in place. Shade from the trees helps moderate the temperature of the water, benefiting aquatic life, including spawning areas for fish. Roots and woody debris provide food and habitat for aquatic life and slow the velocity of the water. In zone 2, the managed forest can be planted with fast-growing trees and/or shrubs that produce marketable products, which can be harvested for profit. In this zone, nutrients in the runoff water are absorbed in

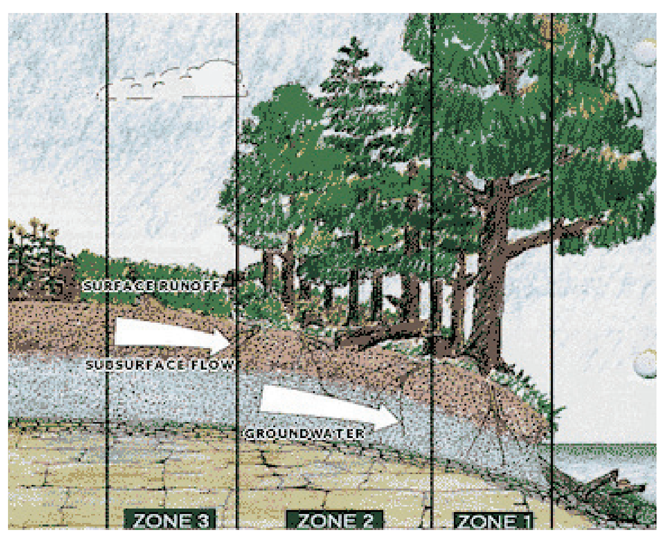

Figure 3. Riparian forest buffer zones. Reproduced with permission by the Chesapeake Bay Program.

the soil and used by trees and shrubs. When flooded, forested zones also serve as recharge areas for groundwater aquifers, depending on grade. Grasses and other herbaceous vegetation in zone 3 tend to increase soil porosity, allowing greater infiltration and water storage potential. Dense grasses slow the flow of surface water and spread the flow more evenly over the landscape. Reducing the velocity of the water flow allows sediment to settle out, allows time for pesticides to degrade, and permits increased uptake of excess nutrients. Grasses can potentially be used for forage, hay, or other products.

Not all areas along a stream can accommodate these three zones. Allocation and implementation of these zones will depend on landowner objectives and state mandates and restrictions. Owners of nonfederal land in Oregon are subject to the Forest Practices Act and Rules. Streams, particularly where fish and domestic water supplies are involved, are restricted as to harvest activities within a certain distance from the stream banks depending on the particular stream. In addition, application of herbicides and fertilizer is restricted near streams. If your forest activities occur near a stream, see the Oregon Department of Forestry's Web site (http://www.oregon.gov/ODF) to learn more about the Oregon Forest Practices Act and Rules.

Windbreaks

Windbreaks are plantings of single or multiple rows of trees or shrubs in farm fields to minimize negative impacts from excessive wind. Windbreaks protect crops and livestock from strong winds, reduce wind erosion, improve irrigation efficiency, expand wildlife habitat, improve aesthetics, manage snow, and provide marketable products (fig. 4). Windbreaks provide shade and protection from temperature extremes in pastures and around feedlots, thereby improving livestock health, feeding efficiency, and reproductive success. Increased plant and wildlife diversity have the potential to reduce fertilizer and pesticide inputs by increasing natural pest predators and nutrient cycling.

Multiple-row windbreaks allow harvesting of marketable trees and products without reducing the effectiveness of the shelter. Windbreaks can also protection dwelling places from extreme winter winds. Trees, shrubs, and/or herbaceous vegetation, selected for the products they produce (nuts, pulp for paper, botanicals) and their windbreak effectiveness, are planted perpendicular to the prevailing wind at wider spacing. Selection of the tree species will depend on location and adaptability, as well as marketability, of the species.

The area protected by and the effectiveness of a windbreak are determined by height, density, width, orientation, length, and species composition. Wind speeds are reduced on the windward side of a windbreak to a distance of 2 to 5 times the height of the tallest row. On the leeward side, wind speeds are reduced for a distance of 10 to 20 times the height (*H*) of the trees. Windbreak density (the ratio of the solid portion to the total area; table 1) determines the amount of wind that flows through the windbreak. Densities of 40% to 60% provide the greatest leeward area of protection. Livestock windbreaks and crop windbreaks require different densities as well as orientation for optimal protection during sensitive seasons. Windbreaks are oriented perpendicular to hot, dry summer winds to protect field crops during the growing season, perpendicular

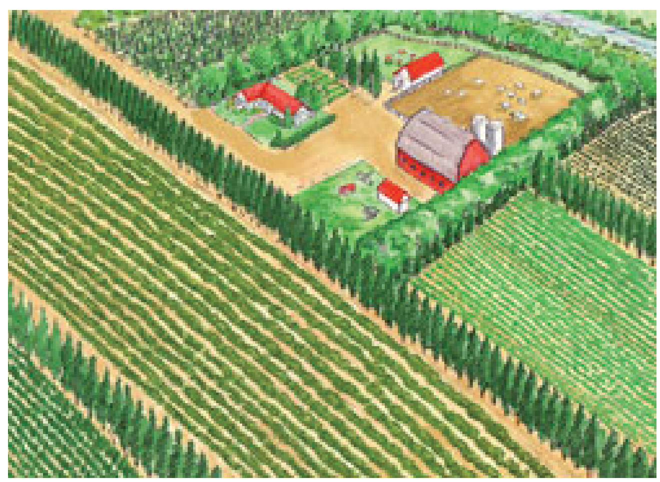

Figure 4. Windbreaks protecting the home, livestock, and crops. Reproduced by permission of the University of Minnesota Extension.

Table 1. Wind speed reductions to the lee of a windbreak for conifers at 40% to 60% density

	Distance from windbreak				
	5*H*	**10*H***	**15*H***	**20*H***	**30*H***
Miles per hour	6	10	12	15	19
Fraction of open wind speed	30%	50%	60%	75%	95%

Notes: *H* = height of trees. Adapted from the National Agroforestry Center.

to cold winter winds to protect livestock during calving season, and perpendicular to winter and early spring winds to reduce erosion when soil is exposed.

The most effective length of a windbreak is 10 times the height of the crop being protected, to reduce the influence of end turbulence (i.e., turbulent winds at either end). Gaps in the windbreak create areas of high wind velocity that reduce the effectiveness of the windbreak and should be avoided. Management is the key to an effective windbreak. Gaps resulting from tree harvest, damage, or mortality must be replanted. Pruning may be required if one is producing timber or for the general health of the trees and shrubs. Windbreaks can also control the spread of pathogens and increase temperature and humidity on the leeward side of the trees compared with open ground during the early growing season.

For areas with heavy snowfall, windbreaks can also function as living snow fences to capture and disperse snow more evenly across cropland and prevent drifting over roads and driveways. Shrubs or trees used in living snow fences and windbreaks should preferably include species that produce salable products (e.g., hazelnuts).

Forest Farming

Forest farming is a unique practice in which existing forest stands are managed to create an appropriate environment for growing potentially high-value understory crops (fig. 5). Many medicinal and botanical plants that are currently wild-crafted (harvested from wild sources) from public and private lands are becoming scarce. Forest farming can mitigate overharvesting by managing for these scarce, high-value species.

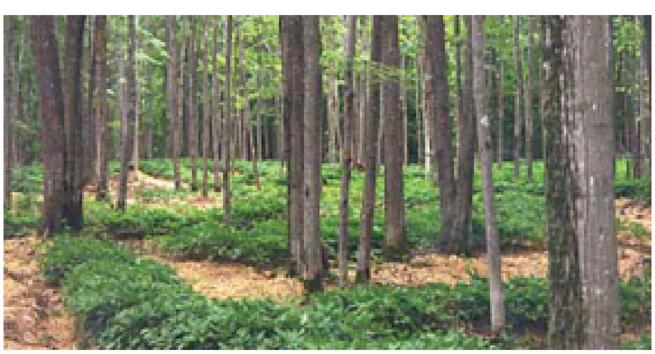

Figure 5. Forest farming. Reproduced by permission of the National Agroforestry Center.

Many crops can be sold for medicinal, ornamental handicraft, or culinary uses. Shade-tolerant crops such as ginseng, golden-seal, wintergreen, bloodroot, decorative ferns, and shiitake and morel mushrooms, as well as fruit and nut crops, can be intensively cultivated under a forest cover modified to provide the correct level of shade (fig. 5). Some existing practices combine growing ginseng, goldenseal, and mushrooms, as they have similar light requirements. Specialty products can also be produced in other agroforestry systems, such as windbreaks and forested riparian buffers.

Markets exist for many of these products, although they may be more typical of niche markets that can take some time to develop. Anyone interested in undertaking forest farming or producing special forest products should thoroughly research the crop, including the growing requirements, and the markets available or the potential for developing markets. Depending on the crop and the production and marketing skills of the landowner, forest farming can provide considerable annual/regular income either before or as an alternative to harvesting the trees for wood products.

These practices are relatively labor intensive compared with typical agriculture and forestry practices. It is always a good idea to start small to see if the practice is actually going to meet your objective.

For More Information

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