

# **An Introduction to Agroforestry**

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## **Introduction**

Although its name suggests a new agricultural fad, agroforestry is actually one of the oldest and most successful agricultural practices around the world. It is the result of generations of trial and error and depends heavily on the farmer's knowledge of the land and the plants and animals living in it.

Nothing in agroforestry is new. In fact, much of it is common sense. But in an agriculture focused on big production, agroforestry and diverse crop production have largely been replaced with monoculture.

So what is agroforestry? According to the USDA, the most basic definition is, "the intentional growing of trees and shrubs in combination with crops or forage. Agroforestry also includes tree and shrub plantings on the farm or ranch that improve habitat value or access by humans and wildlife, or that provide woody plant products in addition to agricultural crops or forage. Agroforestry is distinguished from traditional forestry by having the additional aspect of a closely associated agricultural or forage crop."

The purpose of this paper is to increase awareness and knowledge of agroforestry practices in order to help farmers and ranchers, especially those with small acreage, generate new ideas about ways they can increase productivity, profit and conserve resources.

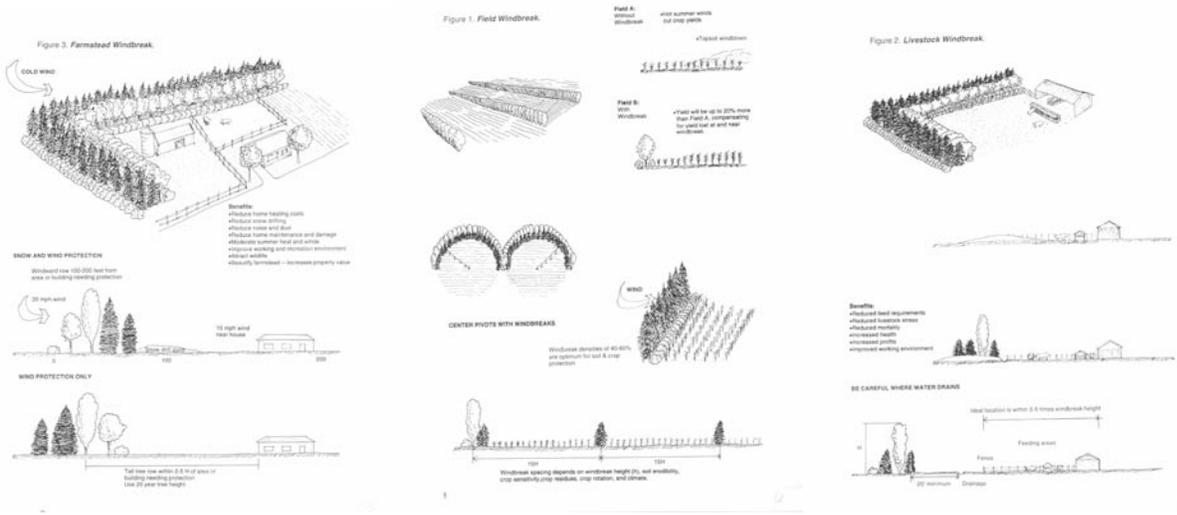
## **What is Agroforestry?**

In the most basic sense, agroforestry means planting trees in agricultural or foraging areas. But in many parts of the world, agroforestry is the traditional method of farming. However, traditional methods are being lost and forgotten due to the push toward high production and continuous planting made possible with chemical fertilizers and pesticides. But the land cannot sustain this kind of intense production. What makes this dangerous is that farmers will be unable to return to traditional methods or at least incorporate them because they no longer have the knowledge to do so. The right combinations of plants and timing are crucial to success.

## **Windbreaks**

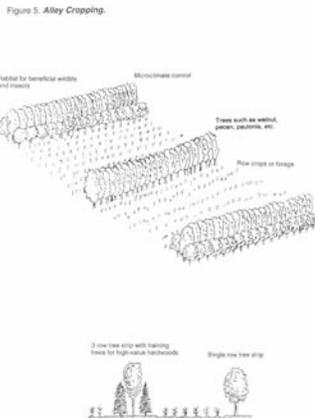
Windbreaks are created by strategically planting trees and shrubs along property lines or in fields. Strong winds and hard rain can destroy crops and overexposure can make livestock ill or even kill them. For this reason, several rows of plants may be planted in order to ensure that crops and animals are protected. Windbreaks are most effective when planted perpendicular to strong winds and are generally more than 200 feet long. Windbreaks aid in the absorption of water after rain and keep it from accumulating in subterranean waterways. They also help distribute water, which increases crop productivity. Planting windbreaks also control soil erosion, run-off and keep snow from accumulating in certain areas of a field or on a road. They distribute snow evenly so that it can be easily absorbed into the soil. On the contrary, windbreaks may also be designed to trap snow in drifts away from homes and roads. Windbreaks can be altered for many uses. For example, windbreaks near feedlots provide shade and

protect animals from wind, rain and snow where they are not free to search for shelter. Windbreaks are also used to protect homesteads and property.



## Alley Cropping

This is a way to protect crops and animals by planting trees and shrubs in lines across fields. These should be planted at multiples of the width of the widest field equipment so that the land can be easily worked.

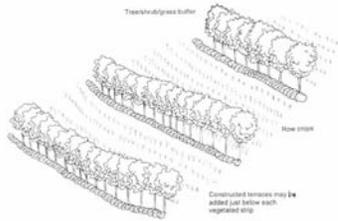


## Contour Buffering

Buffers are created by planting trees and shrubs in rows on a contour or cross-slope. Rows are often planted along with crops and leaf litter provides soil cover and fertilizer. Most importantly for contoured areas, buffers reduce sheet and rill water

erosion, and even increase soil levels by trapping sediment within the rows. Spaces between rows should be in multiples of the widest field equipment.

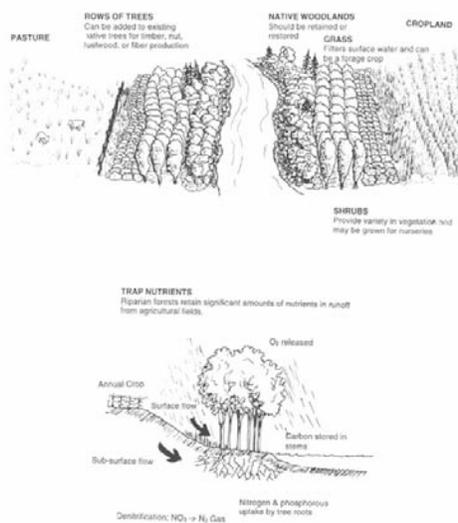
Figure 6. Contour Buffer Strips.



## Riparian Buffer

This buffer is used specifically to protect wetlands and to filter water. It is created by planting a corridor of trees and/or shrubs adjacent to a river, stream, wetland or body of water. Plants must be of sufficient width and should be placed up-gradient near the water. Riparian buffers protect near-stream soils from over-bank flows, trap harmful chemicals or sediment transported by surface and subsurface flows from adjacent land uses, or provide shade, detritus and increase biodiversity by harboring wildlife. Corridors should be planted adjacent to or parallel to the stream bank.

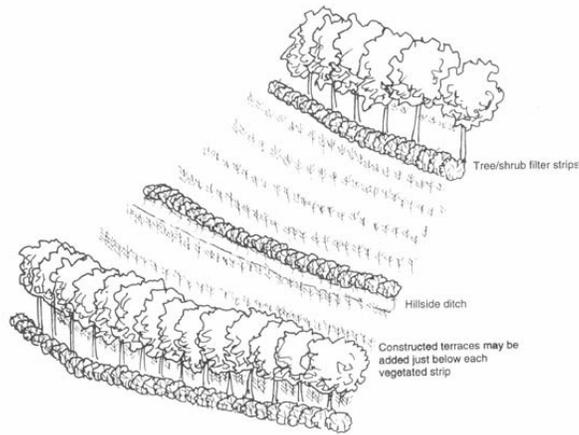
Figure 7. Riparian Forest Buffer.



## Filter Strips

These are created in order to remove sediment, organic matter and other pollutants from runoff and wastewater. They remove pollutants from runoff by filtration, deposition, infiltration, and plant uptake. Strips should be planted on cross-slopes or on the contour downhill from the source of pollutants.

Figure 8. *Filter Strip.*

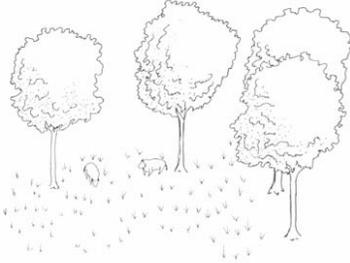


### **Multistorey Cropping**

In this system, farmers and ranchers harvest trees, crops and livestock to make the most of their land. This method is especially popular outside the U.S. and is also known as "forest farming." In many countries native forests are managed in order to produce crops or forage. The system yields wood or tree products in addition to agronomic crops or forage, improves crop or forage quality and improves soil nutrient recycling for crop or forage use. It also reduces excess subsurface water and provides favorable habitat for beneficial plant and animal species. Trees should be planted or native forests thinned to allow adequate light into the under story crops or forage. Tree canopies range from 5 to 40 percent crown cover. Combining forested areas with livestock forage is also known as silviculture or silvopasture.

Figure 9 *Multistory Cropping.*

MULTI-STORY CROPPING: INTRODUCED FORAGE



Canopy does not exceed a planned percent cover

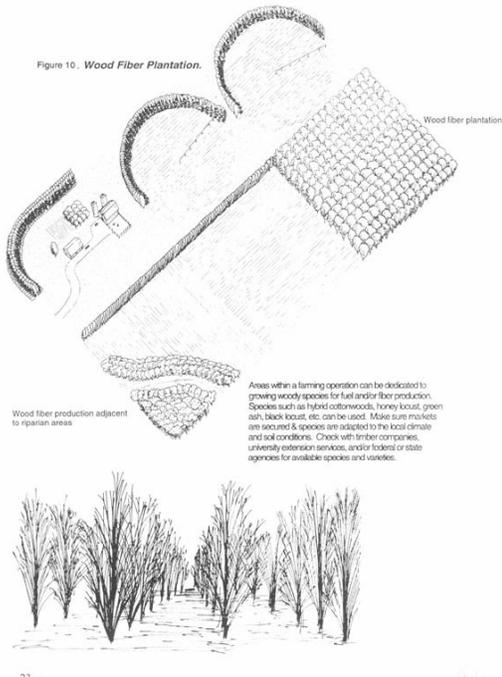
MULTI-STORY CROPPING: SPECIALTY CROPS



## Wood Fiber Plantation

The plantation system is created by planning trees in a block on a separate field within a farm or ranch. Distance between trees is adjusted to produce optimum amounts of wood during rotations of less than 10 years. One of the main goals of this method is to diversify farm and ranch productivity. The tree canopy cover ranges from 70 to 100 percent crown cover.

Figure 10. *Wood Fiber Plantation.*



Agroforestry is not, however, limited to these methods outlined by the USDA. Agroforestry ranges from planting a few trees in fields and pastures to crops planted randomly underneath the forest canopy. And there are other methods that usually accompany agroforestry, such as crop rotation.

### **Partnership Cropping**

This is achieved when two crops are partnered, enhancing the growth and productivity of one or both.

### **Polyculture**

The practice of planting two or more crops in order to create competition or complementation between crop species. There are several different types of polycultures outlined by Miguel A. Altieri in his book *Agroecology: The Scientific Basis of Alternative Agriculture*.

Commensalistic: Interaction between crop species that has a positive effect on one species and no observable effect on the other, such as cacao and coconut or rubber and coffee planted in the same area.

Amensalistic: Interaction between crop species that has a negative effect on one and no effect on another. For example, annuals planted among perennials.

Monopolistic: Interaction that has a positive affect on one and a negative effect on the other, such as the use of cover crops.

Inhibitory: interaction that has a net negative effect on all species such as intercropping with sugarcane.

### **Relay Cropping**

The practice of planting crops in succession with up to three or four crops in a single year.

### **Companion Cropping**

The practice of planting a long and short season crops together with the intent of harvesting the short season crops to make room for long-season crops to grow and take over fields.

### **Intercropping**

This is generally associated with small farms and is achieved by planting short crops in between rows of tall ones. It is a highly efficient use of land, but makes cultivation difficult due to a lack of space.

### **Why Agroforestry?**

Agroforestry practices have many benefits to society, farmers and ranchers, and the ecosystem. Because agroforestry is based on natural ecosystems, it uses natural relationships and replenishment to make land both productive and sustainable. While monoculture encourages pests, erosion, disease, and inefficient water use, requires chemical fertilizers and pesticides, and reduces local wildlife, agroforestry promotes the growth of multiple species of crops and wildlife, harbors pest enemies, promotes soil

health, and reduces costs. Trees are an important part of almost every natural ecosystem, so why not incorporate them into crop and animal production to keep agricultural land healthy?

In conjunction with crop rotation, planting trees reduces soil pathogens and starves out crop pests while harboring pest enemies. When legumes such as clover are planted with elms, they improve soil quality by replenishing nitrogen content. Trees also replenish other nutrients needed for healthy soil by bringing them up from the ground and depositing them on the surface through leaf litter. Leaf litter is also important because it acts as a crop cover, shades crops and forage and increases humus content. The litter and trees also help choke out weeds.

Tree growth improves microclimates, a term which refers to soil and the organisms living in it. Trees also rid soil of toxins and filter pollutants out of water. Roots help develop soil aggregates.

Trees keep animals comfortable in heat and cold by shading them and protecting them from wind so that they can gain weight and produce at their best. Because animals can find shade and protection wherever they forage, they can graze a pasture evenly instead of standing in a clump of shade, refusing to wander out despite a lack of grazing material.

Trees also control dust, runoff, and reduce evaporation so all the water that hits a field stays in that field. Because they manage water so effectively, trees also mitigate the effects of drought.

When used as windbreaks for orchards, mulberry, hackberry and other berry trees attract birds away from orchard fruits. The windbreak also ensures that work can be done in the field or orchard even on windy days. Because fruits and vegetables are protected from wind and harsh weather, their size and quality is better. Growing windbreaks in orchards also keeps trees straight in high wind areas without the use of poles.

Trees are invaluable for soil health and water use efficiency, and they diversify economic avenues. Not only can trees be harvested for wood and fruit, they are also a beautiful way to enhance crop and animal performance and to encourage farm and ranch visitors with scenery, protection and shade. Putting trees back into the ecosystem keeps the cost of chemical fertilizers and pesticides low as well. The brush and tree cover supports wild populations of deer, turkey, waterfowl, and a number of other beneficial animals. Whether trees are reducing erosion, solving water management problems, or acting as a “bio shield” against wind or natural disasters, what is best about this system is that it uses already established biological interactions, enhances beneficial relationships, and makes the most of land and resources.

### **Things to Think About Before Beginning**

Agroforestry is highly specific to each area. It must be founded in existing local plant and animal populations or be carefully examined and planned. What works in North Carolina does not work in Colorado. What works in Mexico does not work in the Andes. The good news is that this encourages local food production and growth. It also encourages biodiversity.

However, this means that careful planning is essential. Planting the wrong species can be disastrous. It is often best to modify local crops than to bring in new ones. It has been found that imported plants and animals, brought in to be super producers, are often out-produced by local varieties. One reason for this is that these exotic varieties may die

in unfamiliar climates or areas. So if there is a local variety of tree or crop that will serve your purpose, plant it instead of bringing in a wonder tree that may die or under produce in your climate.

Planting only one species of tree can also result in loss of the entire windbreak, buffer, etc when disease or pests strike. Planting two or more varieties will keep this from happening. But make sure all species are compatible with other crops, animals and purposes. When the wrong species is chosen, it can attract pests and trap them inside. Some trees are poisonous to livestock or encourage disease. Planting trees too close to crops will mean no water for cultivation. Planting too many trees can turn a windbreak in to a wind stop, making fields too cold and too shady for crops and foraging. Another problem is unpreparedness. Agroforestry is not a quick fix; it is a long term, sustainable solution that makes the ecosystem stable so crops and animals can flourish. It manages pest and other problems when properly applied, but it is not a way to deal with pests once they've already arrived.

However, all of these scenarios can be avoided with good selections, planning and implementation.

### **Case Studies**

The following examples are intended to get farmers and ranchers thinking about ways to increase their productivity and profit. As farmer Dean Smith says, "The future of agriculture is brighter today than ever before- large or small. The markets abound for anyone willing to exert the effort."

### **Multi-Tier Crops**

In arid climates, the dominant agricultural practices involve growing cacao, coffee, tea, and wood. The trees intended for wood harvest produce nitrogen, which helps the soil, and provide shade to these shade-tolerant crops on the second tier. Of course, multi-tier methods vary from place to place, but are viable in almost any area or climate. The Kerr Center has experimented with shiitake mushroom production and found that it can be profitable when marketed and managed properly. At the end of their ten year program, the Kerr Center found that mushrooms turned a profit in year three and positive cumulative net revenues were seen in year four. Mushroom production is one way to enhance ranch or farm land that already has forested areas.

### **Pecans and Livestock**

In Oklahoma, native pecans have been grown in pastureland to provide nuts, wood, and shade for cattle. They also make up \$15 million of the state's agricultural economy. Pecans from silvopastures make up a significant part of pecan production in the region. A study performed by the University of Kansas showed that silvopastures in southeastern Kansas producing cattle and pecans were profitable and that profits could be greatly increased with better management and marketing. However, pecan trees do require considerable care and are not recommended for those who don't have the time.

For those who do have the time and interest, there's good news. Dr. Dean McCraw, the fruit and pecan specialist at Oklahoma State University in Stillwater, states that native pecans are much hardier and produce better than imported species. Non-native species require more fertilization and pesticides. And production of native pecan trees can be increased even more through modification. Grafting seedlings onto known producers and removing poor quality trees has been shown to improve overall production. In his paper, Dr McCraw also cites research performed by Oklahoma State

University and New Mexico State University which finds that pecans, in conjunction with a heart healthy diet, help reduce cholesterol. They also found that the benefits of pecan oil outweigh those of olive oil. Information such as this could be used to market pecans and pecan oil. Measures taken to preserve their shelf life could also help expand their marketability. It is known that pecans keep well at low temperatures, up to ten years if kept at zero degrees.

Thinning trees is also important to pecan yield and felled trees can be sold for timber. Thinning reduces the need to apply fungicides, increases yields (though not for several years), and increases forage. Carefully managing tree thinning is crucial. Crowding can sneak up on growers and affect yield in the coming years before outward signs begin to show.

Research has also been conducted on the effect of legume plants on pecan tree growth. They were found to increase the trees' yield and growth and also provide high quality forage for rapid weight gain in cattle.

Cattle aren't the only animals that can benefit from foraging pecan orchards. Geese weed orchards and sheep have also become popular in the western U.S.

### **Christmas Tree Production**

Christmas tree sales total more than a billion dollars every year and can be a profitable way to keep land productive and beautiful. Schilling Christmas Tree Farm in Arkansas has recently developed a tree shearing device which has greatly enhanced worker safety and helped to prevent exhaustion, muscle fatigue and overexposure. Their walk-behind operation, which supports a regular tree-shearer, can also be used in other areas as a sprayer, harvester, and weeder.

### **Making the Most of Wildlife**

Other projects utilize wildlife for hunting or tourism. Many landowners in the U.S. lease property for hunting, or charge fees to allow hunters access to game, deer stands and feeders. The Coffey Ranch in Marietta, Oklahoma, is one. By carefully maintaining the health and numbers of local deer, taking advantage of local advertising, as well as implementing strong management, the Coffey Ranch has made profits through its leasing program. In the coming years, they plan to increase food plots for deer to create "hot spots" for hunters as well as tripod stands.

In parts of Africa, local animals have helped build up a tourist economy. As concern about animal rights becomes more widespread, hunting becomes less so. Locals are finding that there is now a market for safari photographers instead of safari hunters. In these communities, wild animals open up the possibility of other economic ventures including hotels, restaurants, wildlife tours and local craft sellers. The economic benefits from such projects also encourage locals to adopt wildlife stewardship practices. Protecting and increasing their native animal populations and forests is no longer a hassle or expense; it is a livelihood. But animals don't need to be especially exotic to draw tourists. Local animal sightings are always exciting to out-of-town tourists. Hundreds of people stop cars in traffic or head out into the woods to photograph Rocky Mountain moose.

Managing and enhancing riparian areas can also bring in a number of wildlife from big game to turkeys, owls, frogs and songbirds. Protection in riparian areas may also promote the growth of fish, shellfish, and invertebrates in the water. Completely exposed water can become too hot to support fish or other water animals. Digging dens or watering holes will also promote animal habitats. Simple acts like this promote

growth and enhance the ability of land to support a healthy ecosystem unlike restocking, which can be unsuccessful if efforts are not also taken to ensure that the land can sustain the number of animals residing in it. Leased hunting land could become more profitable when accompanied by fishing ponds.

Simply increasing the beauty and natural habitat of an area not only diversifies animal and plant species, but also economic opportunities.

### **Kerr Center Projects**

The Kerr Center currently has several agroforestry projects in progress. They planted hundreds of loblolly pines on some of their “useless” sloped land. Although the trees are only two years old, they are showing amazing growth thanks to some unconventional planting methods. Originally trenches were dug two feet deep where the trees were to be planted. The trenches were left exposed to catch rainwater and store up nutrients for a year. When the trees were planted, hay was used around the trees to keep weeds and other plants from competing with the seedlings.

The Kerr Center has also planted 40 acres of trees in rows in a small hayfield. The grass between the rows of trees can be grazed by cattle or baled. The shade provided by the trees keeps the grass temperature lower so it can grow better and also keeps the cattle comfortable so they can properly gain weight.

Another measure taken to keep cattle comfortable is the “living barn.” This is a forested area where the floor is kept clear of brush and is bedded with hay. It serves as a shelter in bad weather and also provides a comfortable place for birthing.

The Kerr Center has also planted several pecan trees. The biggest problem they have had to face in these projects is beavers. However, planting softwood trees closer to waterways and putting fences around trees has stopped beavers from cutting down their other trees.

### **Ideas in Agroforestry for Small Landholders**

Most professionals advise starting out small when beginning any new endeavor. Agroforestry may be just the right kind of project. As the USDA states, agroforestry is “ideally suited to the small farm where it can enhance productivity, encourage commodity diversification and minimize environmental impact.” So while small farms cannot outproduce larger farms in monoculture, they can turn a profit by cutting costs and diversifying their products.

Polyculture is an important element of agroforestry and is especially useful to small farmers who need to produce as much as possible in a limited area. There are literally hundreds of ways to increase productivity through diversity. Farmers can cut costs with trees; they lessen the need for fertilizers and pesticides as well as irrigation.

### **Blue Meadow Farms**

The McGowans operate a three-acre farm in Massachusetts where they grow hundreds of thousands of perennials, shrubs and trees as ornamental plants. When they first moved to the area, they were set on vegetable farming, but quickly found that they could not compete with the many vegetable farmers of the area. When they introduced ornamental plants into their operation early on, they hadn’t expected it to do so well. Now 99% of the plants they sell are propagated on their three acres. The biggest challenge is pests, which they are effectively controlling, not with expensive chemicals, but with predator species. The McGowans believe it is feasible for traditional nursery owners to transition from chemicals to predator-pest control systems as well.

### **Walnut Meadows Enterprises**

While timber production can be risky because of the time it takes to turn a profit, Bill Slagle from West Virginia has found ways to diversify his land in order to have a source of steady income. Twenty-five years ago he began growing ginseng, a shade-loving plant that he says brings in more than corn or soybeans. Although it is a difficult plant to cultivate, he has made a success of it on his farm.

He also cultivates shiitake mushrooms, which he sells to a wholesale distributor for \$5 a pound. However, he has received as much as \$7 or \$8 a pound at farmers' markets. The full-grown fungi are prized for home and restaurant use and the spores sell for as much as \$10 an ounce, says Slagle.

In addition to diversifying, he is cutting costs by not using herbicides, fungicides or pesticides. He says that in a completely forested area, there isn't much need, anyway. He also has no need to till his fields. His land doesn't have problems with erosion or water problems, either. In fact, he has won several awards for his conservation practices.

Slagle even hosts vo-ag students for a three day project in which students, plant, cut and mill trees in order to make cabinets or furniture. He continues to bring kids out to the farm to learn about the tree-to-lumber process.

### **Conclusion**

Agroforestry is becoming more reliable as it becomes more practiced and researched. Farmers across the globe are discovering ways trees and polyculture can replace monoculture to make their land more sustainable and productive. Trees are a natural part of almost every ecosystem, so it makes sense that incorporating them into agriculture will maintain a healthy balance. They help keep costs low and make land more productive. They can become a profitable enterprise in and of themselves, especially on small acreage farms. Agroforestry is the most common traditional farming system in most of the world for a reason. It has evolved through trial and error as the best way to make land sustainable while providing the variety of foods demanded by local consumers. Agroforestry allows small farmers to make a living off their land. Of course big farming will be around, but there are alternatives. As E.F. Schumacher said, "The fundamental task is to achieve smallness within large scale organization... maybe what we really need is not either or but the-one-and-the-other-at-the-same-time."

### **Agroforestry Organizations**

Local conservation societies, university extension programs, the USDA, and organizations like the Kerr Center will always have up-to-date information and research publications available. Here's a list of other organizations that offer information, publications and research.

[www.srf.fs.esda.gov](http://www.srf.fs.esda.gov) This is the USDA Forestry Service's website. It has state-by-state information and projects.

[www.plant-trees.org](http://www.plant-trees.org) The "Trees For the Future" Organization is based in the U.S. but also has projects in Canada, Mexico, Africa, and South America.

[www.centerforagroforestry.org](http://www.centerforagroforestry.org) Created by the University of Missouri, this site has information about native species, value-added ventures, nut and fruits and is research-based.

[www.worldagroforestry.org](http://www.worldagroforestry.org) This site created by the World Agroforestry Center includes projects from all over the world and has a long list of publications, information, projects and research.

This is just a small part of the research base of agroforestry. For more details about agroforestry or small farming, see the annotated bibliography and the reading list.

*Chloe Johnson was an intern at the Kerr Center in 2006. As part of her internship, she developed this report on agroforestry.*

### **Annotated Bibliography**

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A detailed approach to agroforestry, highlighting case studies from outside the U.S., several of which are included in this report. A good introduction for those unfamiliar with agroforestry. Altieri supports his information with plenty of research and collaboration with colleagues.

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An excellent resource on everything regarding tree care and management. Includes chapters on soil erosion, seeds, mulch, tree doctoring, tree planting, pruning and creating trails. Highly recommended, especially for those with erosion problems. A surprisingly fun read.

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