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Use this document in conjunction with the companion website:

Links for New Farmers
http://www.ctahr.hawaii.edu/sustainag/newFarmer/links.asp

hosted by the Sustainable Agriculture Program at the University of Hawaii College of Tropical Agriculture and Human Resources. Extensive additional information and updates are posted there.
Pacific islanders have depended on tree-based farming systems for millennia. Agroforests or tree gardens produce breadfruit, a staple crop on many islands, yams, sweet potatoes, fruits, kava, and many other medicinal and useful plants. Agroforestry, the practice of integrating trees into a farming system, is an ancient practice that is enjoying a revival today. On the mainland of the United States, farmers are using simpler agroforestry systems that are amenable to mechanization and suit the economic demands of modern agriculture. Mainland agroforestry systems often include planting windbreaks for crop and livestock protection and growing field crops in alleys between rows of high-value timber trees such as walnuts.

In all agroforestry systems, the trees have some influence on the crops. Integrating trees into a cropping system can help conserve soil, prevent wind damage, improve soil fertility, and provide wildlife habitat. Tree crops can provide an additional source of income. However, trees will also compete with crops for light, water, and nutrients, may provide a hiding place for crop pests, and can complicate farm operations. Whether agroforestry is successful depends on whether the economic and ecological benefits of integrating trees into the farming system outweigh the drawbacks.

Agroforestry is a sophisticated way of farming and involves complex interactions between sunlight, soil, and water and plants and animals. Far less formal research has been conducted on agroforestry systems than on traditional cropping systems, so relatively little information is available. Farmers and tree growers must rely on on-farm experimentation and research to determine what works best for them.

Hawaii is unique in having a tropical climate but a developed country economy. While the same plants may grow in Hawaii as in other tropical countries, highly labor-intensive agroforestry systems may not be economically viable in Hawaii, with the high cost of local labor.

One other important precaution is to ensure that trees used in agroforestry farms in Hawaii do not escape and become problem weeds in native forests. The same properties which make multiple-purpose trees useful on farms, for example the abilities to grow rapidly, fix nitrogen, and reproduce quickly, also make them likely to become invasive weeds.

For information on whether a tree species is likely to become an invasive weed in Hawaii, see the Hawaii Weed Risk Assessment, on the internet at <www.botany.hawaii.edu/faculty/daehler/WRA/>.
Many forms of agroforestry are used in Hawaii and the Pacific. **MULTI-PURPOSE WINDBREAKS AND BORDER PLANTINGS**

Hawaii’s tradewinds can damage certain crops, reducing yields and crop quality. Good farmers here in the islands long ago learned to use plants of all heights to create optimal conditions for growing their crops. From towering *Erthyrina* trees grown along field borders on Moloka’i to rows of tall sudangrass planted to shelter upland taro in Waimanalo, windbreaks have many benefits for the farm:

- Windbreaks protect vegetable, orchard, vine, cereal and row crops from wind damage as well as improve water use by the protected crop. This results in higher crop yields (ranging from 5-45%) and in higher quality fruits and vegetables (which bring a price premium).
- Windbreaks can be designed to grow products such as fruit, nuts, timber, and other forest-based products, diversifying farm revenue. In addition, animal fodder, mulch, fuel wood and poles can be harvested from windbreaks for sale or on-farm use.
- Livestock windbreaks can help reduce animal stress while providing a visual barrier for neighbors. Buildings used to shelter animals can be kept cooled by a well-designed windbreak.
- Windbreaks reduce wind erosion and can provide habitat for beneficial insects and for wildlife.
- Rural residences, farm and ranch buildings can be sheltered from the wind and cooled by their shade making work and living conditions more comfortable for farm families and farm workers.
- Windbreaks and border plantings can serve as screens and buffers. They can divide conflicting land uses, such as residential areas and industrial zones, serving as visual and noise screens. Salt spray from the ocean or dust and pesticide drift from agricultural lands can be reduced with windbreaks.

**Windbreak Design**: Windbreaks have been well-researched and field-tested — information is plentiful about design considerations. In addition to selecting trees which will yield marketable products and are adapted to local soils and climate, the farmer will need to factor in windbreak height, length, continuity, density, and orientation. Here are some basic design considerations:

- Windbreaks should be oriented perpendicular to the prevailing winds.
- A windbreak protects at a distance of about ten times its height. Thus a 40 foot tall windbreak protects crops at ground level for about 400 feet, on flat land.
- Thin-canopied trees such as Norfolk Island pines (*Araucaria heterophylla*) and Cook pines (*Araucaria columnaris*) make good windbreaks because they filter the wind, reducing its velocity, rather than blocking wind altogether and causing turbu-
Canopy density in windbreaks should be 50% to 80%. Poorly designed windbreaks can cause wind damage if they funnel high winds through gaps in the windbreak. Refer to the references section for additional information.

**SILVO-PASTURE**

When animals and forage crops are introduced into a timber production system (or alternately, timber crops are introduced into a forage production system) to produce both timber and livestock products, this is called silvo-pasture. The short-term goal of this system is to have efficient forage and livestock production; the long-term goal is high-value timber and/or forest products. The rancher and tree farmer needs to understand and be able to manage the animals, the forage crop, and the timber crop.

In contrast to concentrated livestock operations, silvo-pastoral systems tend to cause fewer problems from odors, dust, noise, disease, and water pollution. In addition, when well-managed they can increase wildlife diversity, improve water quality, and reduce soil and wind erosion.

Before making a decision about adopting silvo-pasture, consider the following background advice:

**Livestock:** Be sure animal production is compatible with the land use regulations for your property. Choose marketable livestock and forage species compatible with your local climate conditions and the desired tree species. Cattle, sheep, goats, horses, turkeys, chickens, ostriches, emu, and rhea have been successfully raised in silvo-pasture. Your animals will also require clean water, feed and nutrient supplements, parasite control, and predator protection. Generally an evenly distributed tree canopy will provide adequate shelter from sun, wind and rain, however trees can be grouped into rows to form fence lines or clusters to serve as “outdoor living barns.”

**Forage:** Establish a nutritious forage ground cover that is compatible with site conditions and able to handle controlled grazing. In addition, it should not be very aggressive nor twine around trees (characteristics which suggest invasiveness). Shade-tolerance may be required as well, depending on the amount of light which will reach the ground through the tree canopy. Drought-tolerance is a plus as there generally is competition between the forage and trees for water, especially during dry periods. Plan to manage your animals intensely using a rotational grazing system that allows grazed plants a recovery period. Some forage and grass species currently being grown in Hawaii orchards include Tropic Lalo (*Paspalum hieronymii*), St. Augustine grass (*Stenotaphrum secundatum*), Carpetgrass (*Axonopus compressus*) and perennial peanut (*Arachis pintoi, A. glabrata*).

**Trees and Shrubs:** The timber component (or non-timber forest products) of the silvo-pasture system should be selected for high value, high quality and good marketability. Many farmers in Hawaii are grazing chickens and geese in the shade of their coffee, avocado, and fruit trees.

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**Grazing for Weed Control?**

- Forest tree plantations often have understories of escaped forage grasses such as kikuyu grass (*Pennisetum clandestinum*), meadow rice grass (*Ehrharta stipoides*), or guinea grass (*Panicum maximum*) at lower elevations.
- These grasses compete with the trees for water and nutrients and may provide fuel for wildfires. Grazing is one way of controlling undesirable grasses in tree plantations.
Management of Silvo-pastoral systems: Browsing animals (such as cattle, goats, and sheep) can debark and severely damage trees. Larger grazers (cattle) tend to damage small trees by stepping on them. While grazing animals will initially eat the grass or other forage crops under the trees, they will turn to the trees themselves once the groundcover forage is consumed in a given area, especially during dry spells. For successful silvo-pastoral systems, it is essential to be able to control the animals in a managed grazing system and remove them before the tree crops are damaged. Until the trees are well established, the farmer may have to limit animal access or install tree protection measures (electric fencing, protective wrap). However, with good grazing management certain costs for tree maintenance, such as herbicides and mowing, may be reduced or eliminated. Soil quality tends to improve, with increased fertility and organic matter, under good management (however compaction must be avoided).

Koa and cattle. Most cattle pastures in Hawaii were formerly koa (Acacia koa) forests, and some ranchers are interested in re-establishing koa in silvo-pastoral systems. Cattle eat koa leaves readily and must at all costs be kept out of young koa stands until the trees are above browse level. Cattle have been used in managed grazing systems to thin out dense koa stands which grow up naturally and to remove banana poka (Passiflora mollissima) vines from young koa stands. Wean-offs and horses have proved less damaging to trees than mature cattle. In times of drought cattle will ride down or debark even larger koa trees and therefore should not be allowed access to forested areas. On rocky soils, cattle’s hooves cause some damage to koa roots, and it is unknown whether injured roots could be entries for disease organisms.

The Cooperative Extension Service has professional foresters and rangeland specialists who can assist the beginning farmer with silvo-pasture systems suitable for Hawaii. In addition, the USDA Natural Resources Conservation Service also has information available at their service centers and within their technical field guides.

SHADE TREES

Many tree crops such as coffee, cacao, and tea are often grown under shade trees. Shade trees may reduce water stress in hotter areas and provide an additional source of nitrogen for the coffee if they are nitrogen-fixers. Most Hawaii coffee is fertilized, watered, and grown in full sun, but in countries where access to fertilizer is limited, growing coffee under shade trees reduces overbearing and the risk of dieback. Shade trees may also provide habitat for wildlife and an eventual timber crop. In choosing shade trees, it is important to avoid trees that are alternative hosts to crop pests, especially the black twig borer (Xylosandrus compactus.)
NON-TIMBER FOREST PRODUCTS

Forests and agroforests yield many products other than timber. On the mainland, forest-cultivated ginseng may sell for $200-$400 per pound, and shiitake mushrooms may bring in $3.50-10.00 wholesale ($9.00-$12.00 retail). In Hawaii, hula halau (schools) make trips into the forest to gather palapalai ferns (*Microlepia strigosa*) and maile vines (*Alyxia oliviformis*) to complete outfits for festivals and competitions. Kava or ‘awa (*Piper methysticum*) may be grown in partial shade or in forest clearings. The leaves of mamaki (*Pipturus albidus*) and kookoolau (*Bidens spp.*) make delicious teas and wood ear or pepeiao fungi (*Auricularia cornea*) are a popular addition to local dishes. The state tree, the kukui or candlenut (*Aleurites moluccana*), grows wild in local forests and produces an oil nut used in cosmetic manufacture. Any of these products might be raised in planted agroforests or planted within native forests. In other Pacific Islands, local people rely on their agroforests for plants for medicines, fibers, and building materials as they have for millennia.

ALLEY CROPPING

In the tropics, alley cropping systems involve planting hedgerows of nitrogen-fixing trees in crop fields or orchards. The trees are frequently pruned to provide mulch and green manure for crops and trees and fodder for livestock. On sloping lands the hedgerows are planted across slope to prevent erosion. These systems were initially designed to replace slash-and-burn farming systems and provide some nutrients for the crops. They are labor-intensive systems and must be managed carefully so that the competition from the tree hedgerows does not reduce crop yield. Trees used for tropical alley cropping should be nitrogen-fixing and able to withstand frequent cutting. *Leucaena (Leucaena leucocephala)*, *Calliandra calothyrsus*, and madre de cacao (*Gilricia sepium*) are the most popular species used in alley cropping worldwide, although the wild type of shrubby *Leucaena* has escaped and become a weed in many Pacific islands. On the mainland, farmers grow row crops between widely-spaced rows of high value trees such as walnut and pecans. The trees are allowed to grow to full size and are not pruned for mulch, and the alleys are wide enough that the crops receive almost full sunlight.

TREE FARMING

Farmers always have the option of growing trees on one part of their farms and crops on another. Although the trees and crops may not have any physical interactions, both may be part of the economic life of the farm. Tree farming is a very long-term option but may work well with other farm operations. Although timber harvests are far in the future, costs per acre to establish tree farms are very low in compared with costs to establish orchards or row crops. Labor needs for tree farms are also comparatively low and farmers can usually maintain their tree farms during seasons when they are not as busy with annual crops.
Only a few native Hawaiian trees are suited for timber production in tree farms. Koa, the most valuable timber in Hawaii for fine woodworking, is limited to higher elevations, generally above 2,500 feet. Kou (Cordia subcordata) is prized by bowl turners but grows only in coastal areas. Most tree farmers in Hawaii are planting non-native or exotic timber species such as mahogany (Swietenia macrophylla), teak (Tectona grandis), and Eucalyptus species. Milo (Thespesia populnea) and kamani (Calophyllum inophyllum) are coastal trees that were brought to Hawaii by the first Polynesian settlers and are highly valued for craft woods. Faster-growing trees tend to be less valuable than slower-growing hardwoods. Economic rotations for fast-growing timber trees may be as short as 12-15 years, whereas higher value hardwoods might best be left to grow for 30 to 50 years.

Currently the market for Hawaii-grown timber is from small local sawmills and craftspeople. Local woods supply furniture makers, cabinet makers, and woodworkers; lower-value timbers are milled into flooring and interior finishing elements. Hawaii-grown woods give local houses a Hawaiian sense of place. Markets for Hawaii-grown wood may improve in the future as technology improves, but local timber will always face competition from imported wood.

Some landowners devote a portion of their land to native forests or plantings on native trees and understory plants to provide watershed protection and habitat for rare and endangered plants and animals.

MARKETS
The beginning farmer with small acreage will most likely consider trying to produce multiple high-value specialty crops simultaneously. Tree farmers should be sure to have a market analysis and business plan before doing anything else ~ locate your market and crunch your production numbers first.


IS AGROFORESTRY RIGHT FOR YOUR FARM?
If agroforestry appeals to you, it’s always a good idea to begin small. Consider your existing farm business and physical resources and determine if there are areas on your property where you can try it out.

For example:

- Plant or enrich your windbreaks to include high-value trees.
- Grow understory forest products in an existing woodlot.
- Plant a riparian forest buffer with understory crops.
- Do some alley cropping field trials.
Add trees to your pasture areas.
Establish forage ground-covers beneath the trees in your orchard or woodlot.

COST-SHARE AND FINANCIAL ASSISTANCE PROGRAMS

- The Hawaii state Division of Forestry and Wildlife administers several programs to assist landowners in Hawaii who are restoring native forests or establishing tree farms, including the state Forest Stewardship Program, the Watershed Partnership Program, and the Landowner Incentive Program. The Kaulunani Urban and Community Forestry program assists community groups and non-profit organizations in urban forestry projects.
- The USDA Natural Resources Conservation Service in Hawaii runs several cost-share programs for private landowners in Hawaii for specific purposes, including enhancing environmental quality, improving wildlife habitat, and producing timber.
- The USDI Fish and Wildlife Service in Hawaii administers the Conservation Partnership Program for landowners who wish to restore and improve habitat for threatened, endangered, and rare native Hawaiian species, both plant and animal.

See: Government Incentive Programs for Tree-Planting or Forest Management on Private Lands
<http://www.ctahr.hawaii.edu/forestry/data/incentives.html>