Practical approaches to species selection

Trees for Improving Sustainability, Resource Conservation, and Profitability on Farms and Ranches

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In Hawai‘i there are about 300 species of native trees. About 1000 species of non-native or exotic trees have been tested for forestry and agroforestry. One way of selecting among all these species is to run potential choices through a series of questions or filters to help select trees that will work in a particular situation.

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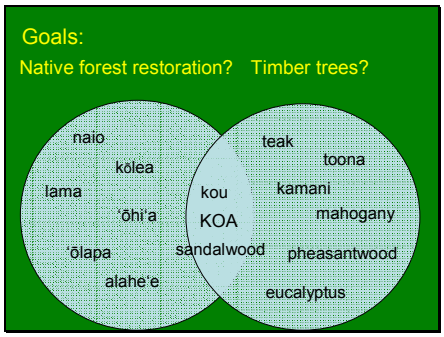

The first question should be ‘what are your goals for planting trees?’ Do you want to restore native forests? Do you want to grow timber? Few native Hawaiian trees are suitable for timber. Koa (*Acacia koa*) is the main species that serves both purposes. In some areas, kou (*Cordia subcordata*) and sandalwoods (*Santalum spp.*) may also work as native trees that yield marketable wood. Other than those species, your choices are limited to native trees that don’t yield marketable timber or exotic trees. Of course, many different tree species can be grown on one farm.

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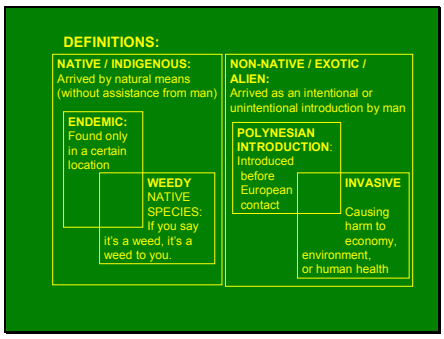

Some definitions are in order. Native or indigenous trees arrived by natural means (hitchhiking on birds, blown on the wind, or carried in the ocean waves) without assistance of man. ‘A‘ali‘i, *Dodonea viscosa*, is an example of an indigenous tree that is native both to Hawai‘i and many other places in the tropics. Endemic trees are a subset of indigenous trees. These evolved in a certain location and are found only there. Koa and ‘ōhi‘a are both endemic to Hawaii and found nowhere else. Native trees may be weeds, if they interfere with agriculture or other land uses. Non-native, alien, or exotic trees are those that people brought to a place. A special subset of these trees are those like kukui (*Aleurites moluccana*) and kamani (*Calophyllum inophyllum*) in Hawaii that the aboriginal Polynesian settlers brought with them. Invasive plants are those non-native plants which cause either economic or ecological harm. Most alien species are not invasive.

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Trees may be part of a cropping system on a farm in an agroforestry system where they provide services such as windbreaks or shade for coffee. Trees may also be part of a farming system, where they are not in proximity to other crops but are another potential source of farm income.

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You goals may also include creating a beautiful place to live.

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The next set of questions to help narrow down tree choices are about what trees can grow on your land. Most trees are adapted to wetter or drier locations. While we think of elevation as important, really elevation stands in as a proxy for temperature and rainfall. Hawai‘i is at a relatively high latitude in the tropics and therefore relatively cool, so trees that grow at higher elevations near the equator might only grow well at lower elevations here. While most soils in Hawaii are acidic clay soils, on the Big Island

many soils are very young and over either ʻaʻā or pāhoehoe lava. Many species of trees do not do well on young, thin soils. Since the world literature holds little information on performance of trees on lava soils, your best bet is to rely on Hawaiʻi experiences. Pests and diseases such as koa wilt or nematodes may be more severe at lower, warmer elevations.

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What can sell?

- Timber: volume/value tradeoff
- Hypothetical example for a small Hawaiʻi tree farm; 7% discount rate

Species	Stumpage $/mbf	Rotation	Volume, mbf/acre	NPV, $/acre
Tallowwood	$800	20	47	$6188
Rainbow eucalyptus	$800	25	42	$2726
Teak	$1750	30	18	$243

The next set of questions should be about economics, if you're going into the business of growing timber. There is usually a volume vs value tradeoff, where trees that grow rapidly are worth less than trees that grow slowly. For economic production, sometimes more rapidly growing trees can be more profitable in the long run than trees that yield more valuable wood but grow slower. The hypothetical example above assumes typical establishment costs for a small Hawaiʻi tree farm, relatively high stumpage rates, and a 7% discount rate. In this case, it would be far more profitable to grow tallowwood (*Eucalyptus micorcorys*) than either teak or rainbow eucalyptus (*Eucalyptus deglupta*). While the stumpage for teak is more than double that of the *Eucalyptus* species, teak's lower volume per acre production and longer rotation give it a lower net present value.

For a discussion of how to calculate net present values for tree farms and a model

spreadsheet, see “Financial Analysis for Tree Farming in Hawai‘i”, which can be downloaded from the UH CTAHR Forestry Extension publications website http://www.ctahr.hawaii.edu/forestry/Data/publications.asp.

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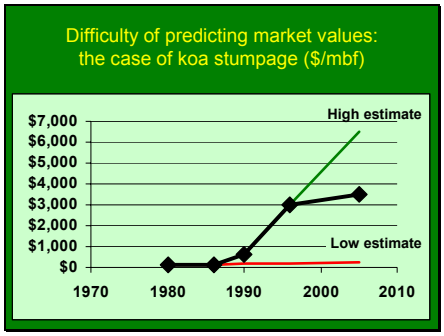

It is difficult to predict market values for timber far into the future. For example, koa stumpage prices rose sharply in the 1990s but were level in the 1980s and leveled out after about 1995. If you had predicted the value of koa in 2005 back in 1985 drawing a straight line, you would have predicted a price far to low (and not had much of an incentive to grow koa.) If you had extrapolated the price rise of the 1990s through 2005, you would have predicted a price far too high (and lost money if you had spent a lot to establish your koa trees expecting high future prices.)

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In the forestry business there are large economies of scale. Growers need to think about what markets they can supply. A single kou (*Cordia subcordata*) tree may have value for its wood, whereas you need tens of thousands of acres of eucalyptus to enter the chip market. Small acreages of high value cabinet timber find local markets in Hawai‘i today. Markets will improve as better technology for harvesting and processing wood becomes available, but competition from other tropical countries will also increase.

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Trees are good for more than timber. Trees on farms can provide many other products and services, such as shade for coffee and other shade loving crops, forage for animals, soil fertility improvements, and service as windbreaks. Start by asking what agroforestry products and services are needed on your farm, then what species of trees can provide these.

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The work isn't done once a species is chosen. Within species, it is important to choose trees with the best genetics. If genetically improved stock is available it is worth the cost. If you are collecting your own seed, collect seed from genetically superior trees. Characteristics such as height, straightness, and growth rate are inherited from the parent trees, so if the seed is collected from superior trees the progeny will inherit those characteristics. Reputable nurseries will take care to plant trees from good genetic sources. The higher cost of superior seedlings will be worth it many times over when the trees are harvested.

The photo shows a Eucalyptus plantation in Hawai‘i.

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Native species too show great variation from place to place within Hawai‘i. The photo shows a koa tree from the Big Island on the right and from one of the other Hawaiian islands on the left. Different populations of trees are also adapted to different environments. When obtaining planting stock, it is important to obtain seed sources from areas similar in climate, soils, and temperature to the planting area.

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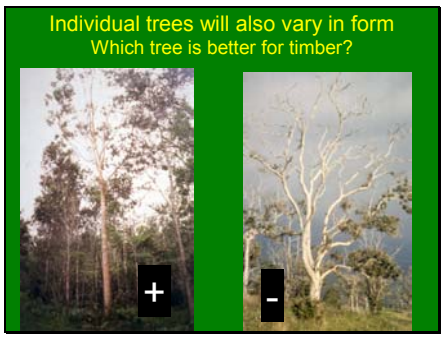

In a given location, individual trees may vary greatly in form. Seed should be collected from the best trees available. The photos show two koa trees growing in the Kona region. The tall, straight tree on the left will likely produce tall, straight offspring if all goes well with the plantation. The tree on the right may be crooked because it was damaged as a young tree, or it may have poor genetics. If it is genetically crooked, the seedlings will likewise tend to be crooked.

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The last decision to make about what trees to plant is whether the chosen species are likely to escape cultivation and become weeds. Of the hundreds of trees introduced to Hawai‘i for forestry, several dozen have become weed that are serious pests of natural ecosystems and range lands. One of the worst is albizia, *Falcataria moluccana*.

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Albizia was planted because it is one of the fastest growing trees in the world and was thought to have the potential to make a contribution to Hawai‘i forestry. It is an important pulp species in Asia. It fixes nitrogen and improves the soil fertility. It is not a bad tree. But in Hawai‘i…

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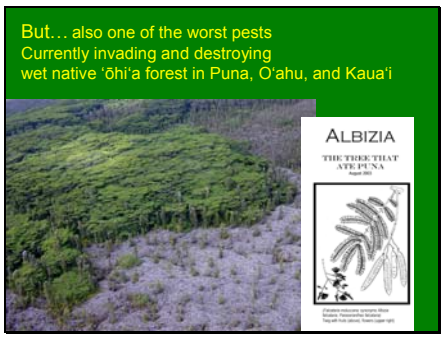

Albizia has become one of Hawaii’s worst invasive species. It has the ability to invade intact ‘ōhi‘a forests in Puna, O‘ahu, and Kaua‘i, where it overtops the native trees and shades them out. It facilitates invasion of strawberry guava (*Psidium cattlianum*) in the understory and may even create habitat for coqui frogs. It is also an economic burden. Huge albizia trees that break easily in storms are a hazard for nearby houses and roads.

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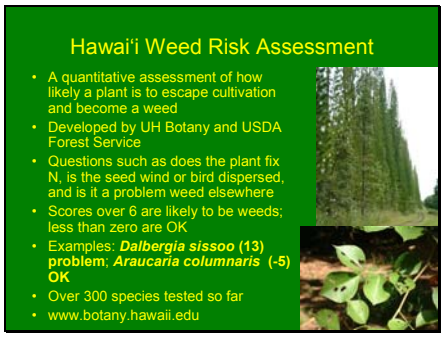

The best single tool to help you decide whether a tree is an invasive species, aside from your own experience, is the Hawaii Weed Risk Assessment system. This system, developed by the Curt Daehler at the UH Botany Department and Julie Denslow at the USDA Forest Service, creates a numerical score for each species based on answers to questions such as whether the species fixes nitrogen, is wind or bird dispersed, and most importantly whether it is a problem weed elsewhere in the world. The scores for each question are totaled and compared to a standard. Scores over 6 indicate that the tree is likely to become an invasive weed and should be avoided. Scores below 0 mean the tree is probably ok. Some trees fall in the middle and need further evaluation. Examples are the Indian rosewood, *Dalbergia sissoo*, which scores a 13 and indeed is a pest in Florida and Queensland, and Cook Island

Pine, *Araucaria columnaris*, which has been safely grow in Hawaii for decades and scores a low -5.

More than 300 plant species have been scored so far, including many tree species. The scores and more about the system can be seen on the UH Botany website, http://www.botany.hawaii.edu/faculty/daehler/wra/.

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If the tree you want to plant has no Weed Risk Assessment score, you can still assess whether it is likely to become a weed by comparing it with other species in the genus. Since most *Acacia* species are potentially invasive, probably *Acacia mangium* would not be a good tree to plant in an area where it is not growing already.

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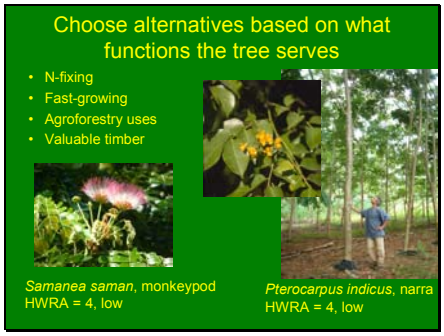

You should choose safer alternatives to potentially weedy species. Consider what products or services the trees you want provide and then ask what other trees may provide the same products and services. Monkeypod (*Samanea saman*) and narra (*Pterocarpus indicus*) are both fast-growing, N-fixing trees, but neither is likely to travel far from where they are cultivated and become weeds.

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An example serves to illustrate tree species selection. A typical small family farm in Hāmākua might be only 17 acres on former sugar cane lands. The landowners' goals might include growing marketable timber and raising sheep, but not restoring native forest. The land might be in an exposed, windy location and on deep, acidic soils with abundant rainfall. Usually such sites are weedy and in particular infested with guinea grass, a fast-growing bunch grass that out-competes most tree species. Since the landowners will want several species of trees, only a few acres of any one species will be planted. Therefore they need to select high-value species.

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The landowners might start with a list of many popular forestry trees they've seen growing elsewhere in Hawaii and heard about from their neighbors. *Eucalyptus saligna* is abundant in Hāmākua and seems to grow well. Honduran mahogany (*Swietenia macrophylla*), rosewood (*Dalbergia sissoo*) and teak (*Tectona grandis*) all sound good. A neighbor is growing tallowwood (*Eucalyptus microcorys*) and the local flooring mill has been buying that species. Of course being in Hawai‘i, maybe they should grow koa or ‘ōhi‘a (*Metrosideros polymorpha*). The landowners have heard that sandalwood (*Santalum ellipticum*) is native to Hawaii and extremely valuable. Other neighbors have windbreaks of *Eucalyptus dunnii*,

and a friend in Volcano has a stand of sugi pine (*Cryptomeria japonica*) around his house.

Once they start narrowing down the list most of these species will drop out. Since they are not working towards native forest restoration, they won't want to plant ʻōhiʻa. The site is probably too wet for sandalwood and too low elevation for koa. Sugi pine also grows at higher elevations. Saligna grows well, but there is no market for small quantities (only a few acres) of saligna. Lastly, rosewood (*Dalbergia sissoo*) should grow well at the site and has valuable wood, but it has become a serious weed problem in Florida and Queensland and so would not be recommended. (Other species of rosewood in the genus *Dalbergia* seem to be less weedy.) Good choices in this case would include *Eucalyptus dunnii* as a windbreak, tallowwood as a shorter rotation timber tree, and teak and mahogany as longer rotation timber trees.

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For information on various useful forestry and agroforestry trees in Hawaii, go to the "trees" page on the Hawaii Forestry Extension website, http://www.ctahr.hawaii.edu/forestry/Data/trees.asp. Here you will find photographs and information on many popular species in Hawaii and links to other web-based databases such as the Traditional Tree website (www.traditionaltree.org) and the World Agroforestry Centre

Agroforestree database (http://www.worldagroforestrycentre.org/Sites/TreeDBS/AFT/AFT.htm). Consult with the service foresters with the Hawai‘i Division of Forestry and Wildlife, with the UH Cooperative Extension Service, and the USDA Natural Resources Conservation Service. You might also want to employ a professional consulting forester to help you develop a management plan for your land which would include species to plant. Lastly, talk with your neighbors and see what is doing well on neighborhood farms. Small scale tree farming is relatively new in Hawai‘i and everyone is still learning.