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AGROFORESTRY NOTES

Alley Cropping: An Agroforestry Practice

Kate MacFarland / Assistant Agroforester / USDA National Agroforestry Center

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Definition

Alley cropping is defined as the planting of rows of trees and/or shrubs to create alleys within which agricultural or horticultural crops are produced. The trees may include valuable hardwood veneer or lumber species, nut or other specialty crop trees/shrubs, or desirable softwood species for wood fiber production.

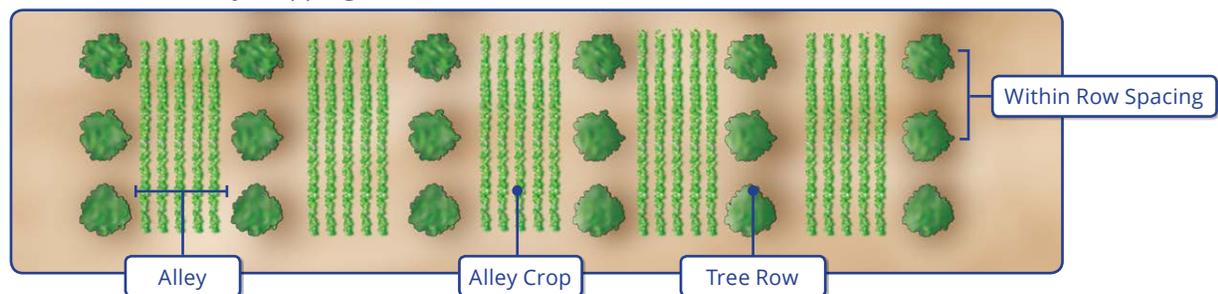
Introduction

Alley cropping is an agroforestry practice that places trees within agricultural cropland systems. This system is sometimes called intercropping, especially in tropical areas. It is especially attractive to producers interested in growing multiple crops on the same acreage to improve whole-farm yield. Growing a variety of crops in close proximity to each other can create significant benefits to producers and help them manage risk. Alley cropping systems change over time. As trees and shrubs grow, they influence the light, water, and nutrient regimes in the field. These interactions are what sets alley cropping apart from more common monocropping systems.

Some producers plan alley cropping systems to provide additional functions that support and enhance other aspects of their operation. For example, a livestock producer might grow crops that supply fodder, bedding, or mast crops for their livestock. Other producers may want to produce biomass for on-farm use. Organic producers may choose tree species that fix nitrogen. Like all agroforestry systems, alley cropping systems should be considered as part of the whole farm operation.

Figure 1

Some common alley cropping terms.



Design Considerations

General Considerations:

- The tree and crop species should be suited to the soils, climate, and the site.
- Species and spacing should ensure accessibility for timely management activities such as spraying, pruning, or harvesting.
- The size of available equipment used for the alley cropping will in part dictate the width of the alleys.
- Take into account growth in both height and width of trees and shrubs on either side of the alleys.
- Optimal tree row orientation depends on the specific alley crop and alley width. Tree rows planted on contours or aligned in a keyline system can help reduce soil erosion.
- Managing the light for crops is important. As trees and shrubs grow they will create more shade on the companion crops. To address this change, trees can be thinned or crops can be planted that are more shade-tolerant or have a complementary growing season with the trees.
- Some plants, most notably black walnut, smooth brome, and some fescue grasses, produce chemicals that inhibit the growth of other plants. Find out which plants are most susceptible to any allelopathic species under consideration.
- Competition for space, water, and nutrients in the soil is also an issue. Try to choose plants that have root structures that are less likely to compete for valuable resources.
- Understand the producer's goals for the system. Most producers have other goals beyond optimizing or maximizing income. Wildlife and water quality are also common interests of producers.

Benefits and Limitations for Alley Cropping Systems

Benefits

Alley cropping is supported by many conservation programs. Compared with monoculture systems alley cropping can provide:

- Increased economic diversity, land use efficiency, and overall farm yield
- Ability to transition to a new enterprise gradually rather than all at once
- Reduced wind and water erosion
- Improved pollinator and wildlife habitat
- Potential for reduced incidence of pests and disease
- Increased air and soil moisture
- Increased carbon sequestration
- Reduced nutrient leaching to groundwater

Limitations

Compared with monoculture cropping systems, alley cropping systems involve:

- More complex pesticide application
- Competition between trees and crops for water and nutrients
- Longer time-horizon for cash flow
- A more diverse skill set
- Possible challenges for equipment use
- Changing the alley crop over time
- Lower crop yields for some commodity crops
- Capital investment for initial tree and shrub establishment
- Long-term, secure land tenure

Economic Considerations:

- The producer should consider the value of the tree and crop products, as well as their primary markets.
- Alley cropping takes advantage of the beneficial interactions between crops. As a result, the yields from growing two crops together can be greater than growing the same crops in monocultures or pure stands. For example, while crop yield in an alley cropping system may be 70% of the crop yield if that land was monocropped, the producer also receives income from the tree crop that makes up for or can exceed this difference.

Alley Crop Options:

There are a number of factors to consider when selecting alley crops, including light requirements throughout the year, nutrient needs of companion crops, and the possibility of increasing undesirable wildlife populations. Different crops will be more or less affected by these factors. Alley cropping systems utilize five basic groups of companion crops between rows, with many types of crops in each group. The five basic groups, with a few examples, are:

- Row/cereal crops (corn, soybeans, wheat, barley, oats, potatoes, peas, beans)
- Forage crops (fescue, orchardgrass, desmodium, bluegrass, ryegrass, brome, timothy, clover, alfalfa). The production of some types of forage, such as orchardgrass, red clover, or timothy, may be enhanced by the shade of tree rows.
- **Specialty crops** (landscape or decorative woody floral plants like blue spruce, dogwood, redbud; Christmas trees; small fruit and nut trees or shrubs; or medicinal crops like goldenseal or ginseng). The production of some specialty crops may be enhanced in the shade of the tree rows.
- Short rotation shrub or coppice biomass crops (trees including poplars, willows, silver maple, birches; herbaceous crops like switchgrass)
- Vegetable crops (squash, cabbage, beans, asparagus, pepper, melon, tomato)

In general, as shade levels increase, cool season crops will perform better than warm season crops. Some of the trees and shrubs used as alley crops can also be tree and shrub options for tree rows, including biomass crops and some specialty crops.

Examples of Alley Cropping Systems

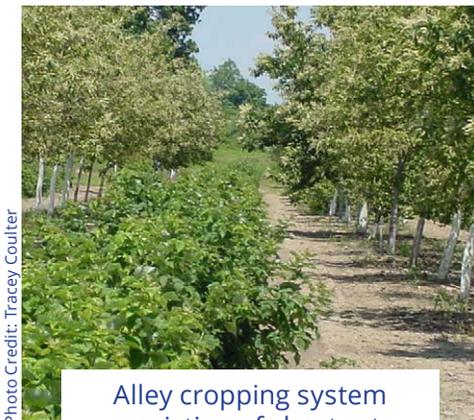


Photo Credit: Tracey Coulter

Alley cropping system consisting of chestnuts and raspberries.

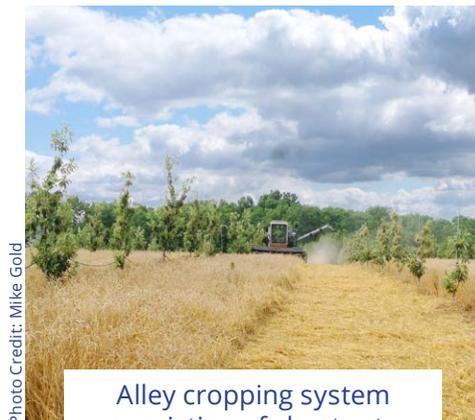


Photo Credit: Mike Gold

Alley cropping system consisting of chestnuts and winter wheat.

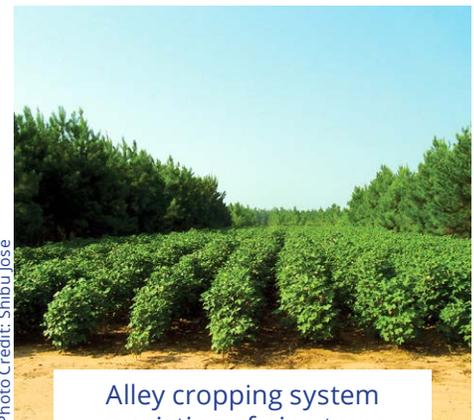


Photo Credit: Shibu Jose

Alley cropping system consisting of pine trees and cotton.

Tree Arrangement:

Alley cropping designs are highly diverse and can range from simple to complex. The growth characteristics of trees and companion crops, as well as the goals of the producer, will help determine whether trees should be planted in single or multiple rows, and whether single or mixed species should be used. Some trees have a stronger response to light than others. For example, pecan and black walnut trees planted in single rows with wide row spacing tend to grow branches outward, while with a much closer spacing they will grow upward in response to limited light. Consequently, there is a trade-off between nut production and quality wood production. Widely-spaced trees planted in single rows favor nut production, while closely-spaced trees planted in multiple rows (potentially rows of other trees) favor high quality wood production.

Producers also need to understand growth characteristics of juvenile trees. Growth rates of different species may conflict, especially when species are mixed in the same tree row. If not properly designed, one or more species may dominate the site and have a negative effect in mixed species plantings.

Tree and Shrub Options:

Producers should think about the following questions when selecting tree or shrub species:

- How quickly will the tree or shrub grow? How soon will it be harvestable?
- Will the trees alter the soil pH?
- Does the tree or shrub fix nitrogen? How will this interact with the crop?
- Does the tree or shrub produce wildlife benefits?

Examples of Potential Tree and Shrub Species for Alley Cropping

	Shade Produced*			Root Competition**			Special Remarks
	Low	Medium	High	Low	Medium	High	
Black Walnut	X				X		High value. Contains growth inhibitor that affects some companion crops
Elderberry	X			X			Several suitable species. Good in combination with trees.
Willow	X			X			Provides early season pollen and nectar.
Apple		X			X		Some varieties require frequent pesticide application for diseases.
Pecan		X			X		High value both nuts and wood.
Poplar		X				X	Lower value but fast growing
Chestnut			X		X		Some varieties susceptible to chestnut blight.
Oak			X		X		White oaks most valuable. Slow growing.
Pine			X		X	X	Several suitable species.

* Shade can be reduced by high pruning the stem.

** Root competition can be reduced through deep plowing or ripping at the outer edge of the tree line (drip line). See **Management Considerations**.

Figure 2

Alley cropping systems have a number of environmental effects, including those that influence the interactions between the trees and crops.

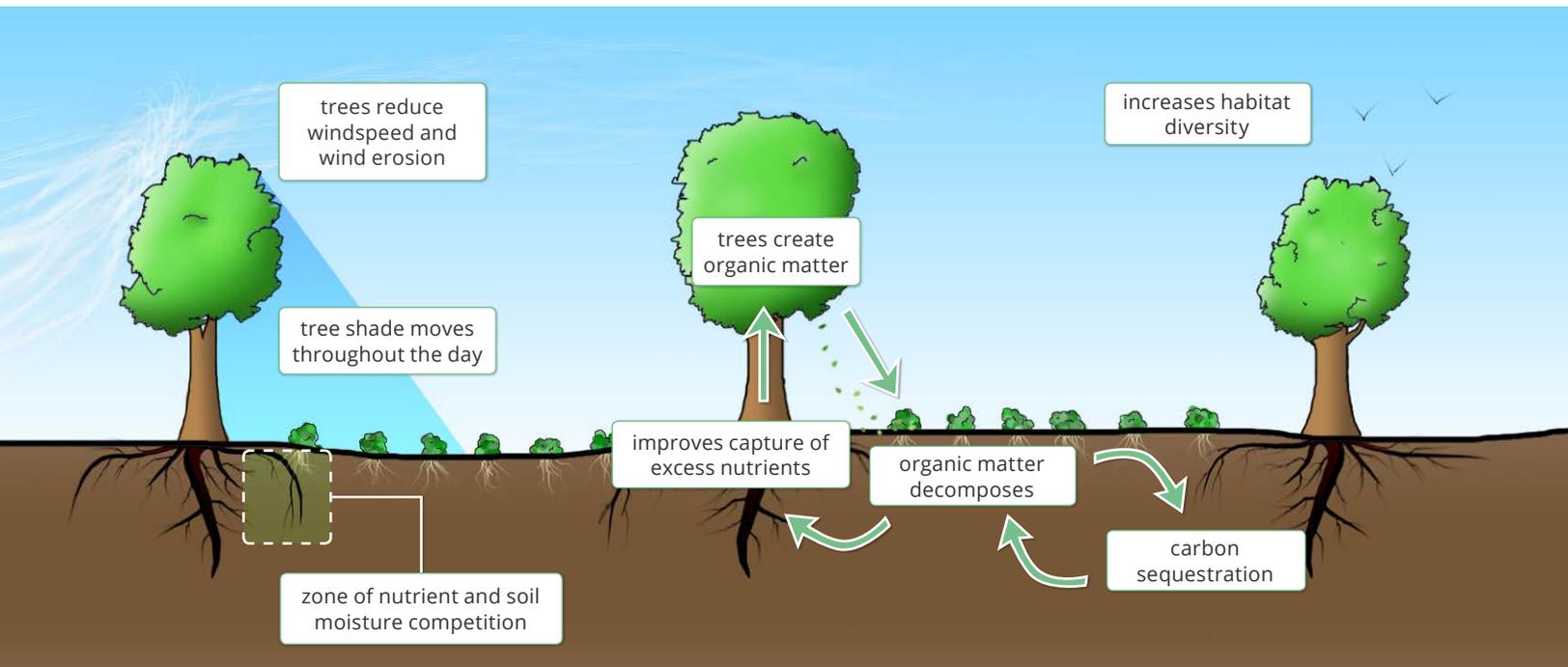


Illustration: National Agroforestry Center

Management Considerations

While the alley cropping system is getting established, there are a number of management needs to consider:

- Fencing, or other mechanisms, to protect tree seedlings from grazing and/or browsing
- Weed control, during initial years, until trees reach adequate size to survive on their own
- Fertilizer application, when soil tests indicate the need
- Regular inspection of crops for insects and diseases along with the use of Integrated Pest Management (IPM) practices
- Inspection of trees and shrubs for damage, along with corrective pruning if needed
- Root pruning to reduce root competition between trees and crops

As the alley cropping system grows, tree and shrub forms will change, potentially affecting alley width and shade. Changes occur below ground as well, with the potential for root competition developing between the rows and the alleys. Root pruning, which involves subsoil ripping at the outer edge of the tree canopy during tree development, may reduce root competition. Producers may shift crops grown in the alley to those more suited to new alley width and shade levels. While understanding markets for unfamiliar crops can be challenging, the ability to shift crops may also provide an opportunity to take advantage of new markets. Some producers even use alley cropping as an intermediate step in creating another agroforestry system. For example, a producer could take open cropland or a field with windbreaks and plant trees in rows to create an alley cropping system. During this period, the producer would get income from both the alley crop and the tree crop. In time, the trees will grow larger and the system could be used for silvopasture.

Conclusions

Alley cropping is a way to diversify crop production and increase economic and environmental resilience. This approach to agriculture takes advantage of the interactions between trees and shrubs, and the crops in the alleys. However, multi-cropping systems also create complexities when it comes to some management activities. Alley cropping can also be used to transition to other forms of perennial agriculture. Alley cropping provides producers with an exciting way to improve the whole-farm yield on their farms and is increasingly being adopted by farmers in temperate areas.

Additional Information

Establishing Hedgerows on Farms in California: <http://anrcatalog.ucanr.edu/pdf/8390.pdf>

National Agroforestry Center Website: <https://nac.unl.edu/practices/alleycropping>

NRCS PLANTS Database: <https://plants.usda.gov>

NRCS Alley Cropping Practice Overview:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1254944.pdf

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*Adapted from Agroforestry Note #12: Alley Cropping: An Agroforestry Practice
by Sandra Hodge, H.E. Garrett, and Jerry Bratton. January 1999.*



Contact: USDA National Agroforestry Center, 402.437.5178 ext. 4011, 1945 N. 38th St., Lincoln, Nebraska 68583-0822. <https://nac.unl.edu>

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