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Alley Cropping: An Agroforestry Practice

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Purpose of Note

- Describe the practice of alley cropping and its benefits
- Discuss basic design information and planning considerations

Introduction

Alley cropping is an agroforestry practice intended to place trees within agricultural cropland systems. The purpose is to enhance or add income diversity (both long and short range), reduce wind and water erosion, improve crop production, improve utilization of nutrients, improve wildlife habitat or aesthetics, and/or convert cropland to forest. The practice is especially attractive to landowners wishing to add economic stability to their farming system while protecting soil from erosion, water from contamination, and improving wildlife habitat.

Definition

Alley cropping is broadly defined as the planting of rows of trees and/or shrubs (single or multiple) at wide spacing, creating alleyways within which agricultural crops 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.

In an alley cropping practice an agricultural crop is grown simultaneously with a long-term tree crop to provide annual income while the tree crop matures. Fine hardwoods like walnut, oak, ash, and pecan are favored species and can potentially provide high-value lumber or veneer logs. Nut crops can be another intermediate product.

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Benefits

- Improved economic stability
- Increased cash flow
- Improved plant/animal diversity
- Sustainable agricultural systems
- Improved aesthetics

Design Considerations

When designing an alley cropping practice, considerable thought must be given to which trees and crops will be grown together and at what spacing. Because of the interaction between the tree and crop components and the goal of optimizing economic gain, a mix of trees and companion crops should be created that provides the highest return on the landowner's investment. For example, a typical tree/row crop alley cropping practice might begin with walnut/soybeans and eventually convert to walnut/cool-season grass. The trees might be planted 15 feet apart within the rows with 70 feet between rows to accomodate crops. Of course, there are many different tree and crop combinations, as well as many different spacing possibilities.

Companion Crops

Alley cropping practices utilize four basic groups of companion crops between tree rows. There are many types of crops in each group. Examples include:

- **Row/cereal crops** (corn, soybeans, wheat, barley, oats, potatoes, peas, beans)
- **Forage crops** (fescue, orchard grass, desmodium, bluegrass, ryegrass, brome, timothy, clover, alfalfa). The production of many forages may be enhanced in the shade of an alley cropping practice
- **Specialty crops** (landscape plants like blue spruce, dogwood, redbud; Christmas trees; small fruit trees; or crops like goldenseal or ginseng)
- **Biomass crops** (trees including poplars, willows, silver maple, birches) (herbaceous crops like switchgrass)

Factors to Consider

- Maintenance programs (timing & methods)
- Size of farming equipment (affects spacing requirements)
- Possibility of increasing undesirable wildlife populations
- Direction of sun
- Light requirements of companion crops
- Chemical interactions between trees and companion crops

Desirable Characteristics of Trees

The desirable characteristics of trees will vary depending on the goals, objectives and priorities of the user. A first consideration is to make sure the soil (site) is suitable for the tree species chosen. Also, ideally, the tree species should have high commercial or environmental value and the physical characteristics of the trees must create suitable microenvironments for the companion agricultural crops. Following are some of the more desirable characteristics for trees being considered. While not all of these characteristics will be present in all trees, they should be considered. Generally, trees should:

- Produce a high-value product or multiple high-value products such as wood, fruit, nuts, and chemicals, and have an acceptable local market
- Be relatively fast growing (medium growth rate on high value trees might be acceptable)
- Be adapted to site and soil conditions
- Produce appropriate shade for the companion crop (i.e., grain and some forage crops have low shade tolerance)
- Have minimal roots at the soil surface to minimize competition with crops in the alleyway.

Table 1: Examples of Potential Tree Species for Alley Cropping

Tree Species	Generalized Effects on Companion Crops						Special Remarks
	* Shade Produced			** Root Competition			
	Low	Medium	High	Low	Medium	High	
Black Walnut	X			X			High value. Contains growth inhibitor that affects some companion crops.
Pecan		X			X		High value both nuts and wood.
Chestnut			X		X		Some varieties susceptible to chestnut blight.
Ash		X			X		Can be susceptible to borers and ash yellow disease.
Oak			X		X		White oaks most valuable. Slow growing.
Pine			X		X	X	Several suitable species.
Poplar		X				X	Lower value but fast growing.
Nut/Fruit Shrubs	X			X			Several suitable species. Good in combination with trees.
Paulownia			X	X			Asian market. Susceptable to insect, disease, and cold.

* Shade can be reduced by high pruning the stem (up to 18 feet).
** Root competition can be reduced through deep plowing or ripping at the outer edge of the tree line (drip line).

- Have foliage with minimal acid-generating potential as most companion crops prefer a pH neutral soil
- Not produce growth-inhibitory chemicals (allelochemicals) that would prevent some crops from growing near them. However, some species, such as black walnut, have such high value for both nuts and wood that it may still be selected. By understanding which crops are effected by the specific allelochemical, compatible companion crops can be chosen.
- Have a growing season that complements the companion crop's growth period
- Produce wildlife benefits

Tree Arrangement

Alley cropping is unique compared to traditional agriculture or traditional forestry because, through the interaction of trees and crops, the goal is to maximize the economic gain based on the combination of the two. Alley cropping practices are highly diverse and range from simple to complex. When deciding the best tree arrangement, consider:

- The growth characteristics of potential tree species
- Whether single or multiple rows should be planted
- Whether single or mixed species should be used
- What the spacing should be both within the tree rows and between the rows
- Light requirements of companion crops

Having knowledge of the growth characteristics of trees and the companion crops 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 planted in single rows under open conditions requires intensive management to produce a quality saw log. The tree tends to grow out instead of up, responding to light on all sides and requires extensive pruning. This is fine if the end product is a pecan orchard but not for pecan logs. If veneer or sawlogs are a desired product, extensive pruning will be needed. However, when

grown in the center of a triple row configuration with different species on either side which are not as responsive to light (e.g. hazelnut), pecan can be "trained" to produce a less-branched, high-value log.

Growers 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.

Spacing

Spacing between rows and between individual trees is critical in designing an alley cropping practice.

- Between-row spacing varies depending upon a variety of management decisions. For example: Trees planted for wood fiber production will require less between-row spacing than if nut production is emphasized.
- Within row spacing varies with the intent of the alley cropping program. For example: 1) for erosion control, plant trees on close spacing to provide an immediate effect; 2) for nut tree production, plant on a wider spacing to allow sufficient space for trees to fully develop their crowns for nut development.
- To grow shade intolerant crops in alleys for more than a few years (five to10) requires wide alleys to allow for expanding tree crowns and for moisture competition from the trees.
- Alley widths should be planned in conjunction with the size of the equipment being used to maximize the efficiency of the management, maintenance and harvesting operation.

Maintenance Considerations

- Fence, or use other means, to protect tree seedlings from grazing and/or browsing
- Control weeds during initial years until trees reach adequate size to survive on their own
- Apply fertilizer according to soil tests (usually not recommended for the crop)
- Apply pesticides as needed

Additional Information

"Alley Cropping. In: North American Agroforestry: An Integrated Science and Practice." 1999. Garrett, H. E. and R.L. McGraw. Garrett, H.E., W.J. Rietveld, and R. F. Fisher (Eds.). American Society of Agronomy. (In Press).

Plants Projects Website: *http://plants.usda.gov.* Plant information available for a variety of plants under the Plant Materials and VegSpec buttons

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