NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ALLEY CROPPING

(Acre)

CODE 311

DEFINITION

Trees or shrubs planted in sets of single or multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products.

PURPOSE

- Enhance microclimatic conditions to improve crop or forage quality and quantity.
- Reduce surface water runoff and erosion.
- Improve soil quality by increasing utilization and cycling of nutrients.
- Alter subsurface water quantity or water table depths.
- Enhance wildlife and beneficial insect habitat.
- Increase crop diversity
- Decrease offsite movement of nutrients or chemicals.
- Increase carbon storage in plant biomass and soils.
- Develop renewable energy systems
- Improve air quality.

CONDITIONS WHERE PRACTICE APPLIES

On all cropland and hayland where trees, shrubs, crops and/or forages can be grown in combination.

CRITERIA

General Criteria Applicable to All Purposes

Plant Selection - Combinations of crops or forages and woody plants shall be compatible and complementary, ***and provide the products and crops that meet landowner objectives and financial goals.***

All traditional crops can be grown with alley cropping. The primary factors determining which crops can be grown are the canopy density and sunlight requirement for the agronomic, horticultural, or forage crop.

Alley cropping practices utilize four basic groups of companion crops between tree/shrub rows:

- ***Row/Cereal Crops – corn, soybeans, wheat barley, oats, potatoes, peas, beans***

- ***Forage Crops – fescue, orchardgrass, bluegrass, ryegrass, brome, timothy, clover, alfalfa***
- ***Specialty Crops – landscape plants like blue spruce, dogwood, redbud, Christmas trees, small fruit trees, goldenseal, ginseng***
- ***Biomass Crops – poplars, willows, silver maple, birches***

The desirable characteristics of trees will vary depending on the goals, objectives and priorities of the user. 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 crops. The following are some of the more desirable characteristics:

- ***Produce high-value product or multiple high-value products such as wood, fruit, nuts and/or chemicals, and have an acceptable local market.***
- ***Be relatively fast growing***
- ***Be adapted to soil and site conditions***
- ***Produce appropriate shade for the companion crop***
- ***Have minimal roots at the soil surface to minimize competition with crops in the alleyway***
- ***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,***
- ***Have a growing season that complements the companion crop's growth period***
- ***Produce wildlife benefits***

Woody plants are typically selected for their potential value for wood, nut, or fruit crops and/or the benefits they can provide to the crops grown in the alleys.

Planting more than one species in each strip reduces the risk from disease and insects.

Including conifers in the strips provides cover for wildlife and helps train high-value hardwoods into straighter trees of higher quality.

Common tree species are black walnut, ash, and oak. There are many other compatible species, depending upon location, value and markets.

See Table 1 for examples of potential tree species for alley cropping.

Plants shall be adapted to the climatic region and the soil resource.

See West Virginia standard Tree/Shrub establishment (612) for species information.

Crop or forage sequence and woody species selection shall be determined using an acceptable nutrient balance procedure. Plants selected will maximize the utilization and cycling of soil nutrients and plant residues to maintain soil organic matter content.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species.

Select pest resistant plant varieties.

Avoid selecting tree or shrub species, which provide habitat to pests of the accompanying crop or forage.

Select crop, forage, tree and/or shrub varieties based on their tolerance to agriculture chemicals that will be used at the site.

Design - The distance between the sets of trees or shrubs will be determined by the following:

- Tree or shrub management objectives;
- Light requirements and growth period of the crops or forages in the alleys;
- Erosion control needs;
- Machinery widths and turning areas.

Soil erosion will be controlled by vegetative or other means until the alley cropping design is fully functional.

Refer to Tree/Shrub Establishment, 612 for further guidance on planting trees and shrubs.

See Figure 1. Design Elements of Alley Cropping Systems.

Trees or shrubs are generally planted in a single- or multiple-row set or series. The spacing between sets is determined by the primary purpose of the alley cropping and the agronomic, horticultural, or forage crop grown.

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

- ***Between-row spacing varies depending upon a variety of management decisions. For example: Trees planted for wood fiber 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, for erosion control plant trees closer for an immediate effect. 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 (5-10) 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.***

Sufficient room must be allowed in crop strips to provide for movement of planting, weed control and harvesting equipment.

Generally row crop strips are the same width for their entire length in order to provide for maximum efficiency in using farm equipment.

When tree/shrub sets are spaced at relatively close intervals (40 feet or less), shade –intolerant crops can be grown for several years until the woody canopy creates significant shading. At that point, several options may be considered:

1) Replace shade-intolerant crops with shade-tolerant crops;

2) Thin and/or prune the woody vegetation to reduce shading so long as functions or future products are not impaired; or

3) Harvest the sets and reestablish woody plants (requires woody species that produce products quickly).

Most alley cropping systems use a single row of trees in each tree/shrub strip, although strips that include training trees for high-value hardwoods may have three or more rows. Initial widths of tree strips will range from 10 to 30 feet. As the tree crop matures, strip widths usually increase and trees are thinned to accommodate the developing tree crowns.

Avoid layouts that may shade out a crop needing full or near-full sunlight.

Avoid planting trees or shrubs where they will interfere with structures and above or below ground utilities.

Installation - Only viable and high quality planting stock or seed will be used for establishing the tree or shrub rows.

Planting dates, care in handling, and planting the seed, seedlings, or cuttings will be accomplished to assure acceptable plant survival. See West Virginia standard for Tree/Shrub Establishment (612).

Site preparation shall be sufficient for establishment and growth of selected species and appropriate for the site. See West Virginia standard for Tree/Shrub Site Preparation (490).

Comply with applicable federal, state and local laws and regulations, during the installation, operation (including product harvesting), and maintenance of this practice.

Additional Criteria to Reduce Surface Water Runoff and Erosion

Tree or shrub rows will be oriented on or near the contour to reduce water erosion.

To reduce surface water runoff and erosion, herbaceous ground cover will be established in conjunction with the tree or shrub rows.

If wind erosion ***is a concern***, tree or shrub rows will be oriented as close as possible perpendicular to erosive winds.

Selected species of trees and shrubs will be relatively deep rooted to encourage infiltration.

Additional Criteria to Increase Carbon Storage

Select tree and shrubs species with rapid growth rates.

Plant/manage the appropriate density for the site that will maximize above and below ground biomass production

Minimize soil disturbance through use of no-till methods.

Additional Criteria to Develop Renewable Energy Systems

Select plants that provide adequate kinds and amounts of plant biomass to supply identified bioenergy needs.

Intensity and frequency of energy biomass removals will be managed to prevent long-term negative impacts on the system.

The harvesting of energy biomass shall be accomplished in a manner that will not compromise the other intended purpose(s) and functions.

Additional Criteria to Improve Air Quality

Residue from the alley-crop shall be left on the surface.

Select and maintain tree/shrub species with foliar and structural characteristics that optimize interception, adsorption and absorption of particulates.

Tree or shrub rows will be oriented as close to perpendicular as possible to prevailing wind direction during the critical air period.

CONSIDERATIONS

Species diversity including use of native species should be considered to avoid loss of function due to species-specific pests or enhance wildlife needs.

Alley cropped areas are appropriate places to establish pollinator habitats. Desirable species should be selected that encourage use by pollinators and bloom throughout as much of the season as possible. Since trees and shrubs typically are available prior to the bloom period of most herbaceous plants, they are often the most visited of plants by bees early in the season. Conversely, woody species stop blooming earlier in the growing season and the floral resources are not available throughout the growing season. Therefore, it is not advisable to depend solely upon woody species to provide pollinator resources. For this reason, it is acceptable when installing exclusively woody species enhancements to utilize bloom periods of very early, early and mid-season.

A woody pollinator mix must contain at least three species in each of the three blooming periods as discussed above (very early, early and mid). Trees and shrubs should be planted at a close spacing to aid in pollinator access but also allow for maximum crown development and bloom.

See the West Virginia Pollinator handbook for a listing of trees and shrubs that benefit pollinators.

Woody pollinator plantings greater than one-half acre (0.5 acres) in size are exponentially more beneficial.

Consider the invasive potential when selecting plant species.

High value trees or shrubs should be selected to maximize economic returns.

Coppice ability of selected species of trees and shrubs should be considered when they are to be pruned or harvested periodically.

Select crops, forages and woody plants for water requirements not to exceed available soil water.

Select crops, forages and woody plants with compatible rooting depths to better utilize available soil moisture.

Consider modifying microclimatic conditions and habitat to enhance biological pest management.

Select crop, forage, tree and/or shrub varieties based on their tolerance to agriculture chemicals that will be used at the site.

Consider cultural resources when planning this practice to ensure that the timing and methods of maintenance operations are compatible.

Alley cropping provides excellent opportunities to improve wildlife habitat for some species by creating travel lanes connecting important habitat areas or infield cover. See Upland Wildlife Habitat Management (645), however, the possibility of increasing undesirable wildlife populations should also be considered.

PLANS AND SPECIFICATIONS

Plans and Specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

See West Virginia standards Tree/Shrub Establishment-612 and Tree/Shrub Site Preparation-490 for guidance when establishing woody components of an alley cropping system.

Substrate material and site preparation necessary for proper establishment of the selected plant/seed shall be included in the design.

At a minimum the following will be identified in the conservation plan (as appropriate):

- ***Purpose of planting/seeding***

- ***Field location/plan view***
- ***Acreage to be planted***
- ***Site conditions prior to planting***
- ***Soil amendments (if needed)***
- ***Site preparation methods (if used)***
- ***Analysis of required spacing between tree/shrub sets to achieve intended purpose(s) and facilitate the use of machinery and equipment***
- ***Species to be used***

  - Plant Guides/Plant Sheets
- ***Stock size***
- ***Spacing***
- ***Orientation of tree/shrub sets to achieve intended purpose(s)***
- ***Planting method(s)***
- ***Planting dates***
- ***Protective measures for plants to ensure desired function including access control***
- ***Additional provisions, as required, to control soil erosion by surface water and to improve air quality***
- ***Cultural practices (i.e. pruning, forest stand improvement, etc.) (if any)***
- ***Operation and maintenance plan***
- ***Replacement strategies***
- ***An environmental evaluation to include the CPA-052 or other acceptable environmental documentation***
- ***Operation and maintenance plan for required supplemental practices incorporated into those specifications, and if required, any necessary operation and maintenance resulting from installation of the overall system of practices***

OPERATION AND MAINTENANCE

The trees, shrubs, crops, and/or forages will be inspected periodically and protected from adverse impacts including insects, diseases or competing vegetation. ***Apply pesticides as needed being careful to follow all label directions. Care must be taken to utilize pesticides that are compatible with both the tree crop and the alley crop.***

The trees or shrubs will also be protected from fire and damage from livestock or wildlife. ***Fence, or use other means, to protect tree seedlings from grazing and/or browsing. See West Virginia standards for Access Control, 472 and Fence, 378.***

All other specified maintenance measures and techniques of tree/shrub establishment will continue until plant survival and establishment are assured. This includes replacement of dead and dying trees or shrubs, pruning of dead or damaged branches for safety reasons, periodic pruning of selected branches for control of product quality, and control of undesirable competing vegetation.

Control weeds during initial years until trees reach adequate size.

When row sets are spaced at relatively close intervals (40 feet or less), row crops can be grown for several years until the tree canopy begins to compete for sunlight. Management options include:

- ***Change the crop grown in the alleys from row crop to small grain to forage and potentially to tree plantation as the trees mature and the canopy shades the alley crop.***
- ***Plan for a specific crop rotation and manage the trees to keep the canopy (competition for light) within the requirements of the crops grown.***

Any removals of tree or shrub products, use of agricultural chemicals, and maintenance operations shall be consistent with the intended purpose of the practice. Avoid damaging the site and soil and comply with applicable federal, state and local regulations pertaining to on-site and off-site effects.

References

"Alley Cropping: An Agrofrorestry Practice." January 1999. Agroforestry Note 12, USDA National Agroforestry Center, east Campus-UNL, Lincoln, Nebraska

"Alley Cropping." Conservation Trees, National Arbor Day Foundation, Nebraska City, Nebraska

Note: Bold italics represents information added to the national standard.

Table 1: Examples of Potential Tree Species for Alley Cropping							
	Generalized Effects on Companion Crops						
	** Shade Produced*			***Root Competition*			
Tree Species	*Low*	*Medium*	*High*	*Low*	*Medium*	*High*	*Remarks*
Black Walnut	*X*			*X*			*High value. Contains growth inhibitor that affects some companion crops.*
Chestnut			*X*		*X*		*Some varieties susceptible to chestnut blight.*
Ash		*X*			*X*		*Can be susceptible to ash yellows and borers/*
Oak			*X*		*X*		*High Value. Slow growing.*
Yellow poplar		*X*			*X*		*Timber value.*
Hybrid poplar	*X*				*X*		*Fast growing.*
****Pine*			*X*		*X*	*X*	*Several suitable species.*
*****Small Nut/Fruit Trees/Shrubs*	*X*			*X*			*Several suitable species. Good in combination with trees.*

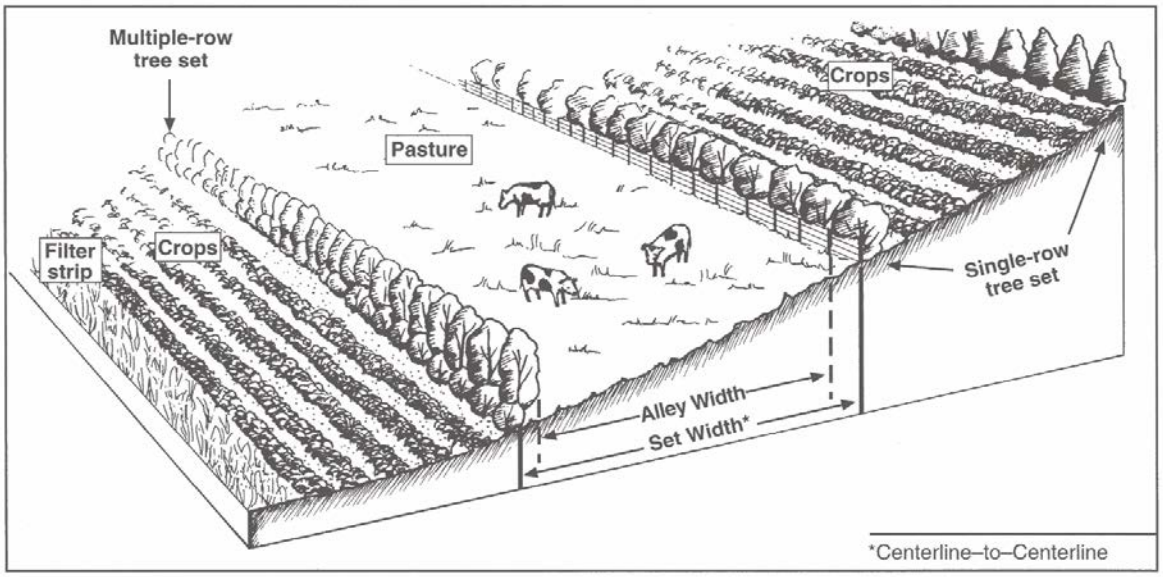
* *Shade can be reduced by high pruning the stem (up to 18 feet).*

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

*** *Species may include: Concolor fir, Eastern red cedar, Loblolly pine, Shortleaf pine, White pine*

**** *Species may include: Black locust, Plum, Apple, Pear, Cherry, Blackberry, Raspberry, Blueberry, Crabapple, Hazelnut, Pawpaw, Serviceberry, St. John's-wort, and Witch hazel*

Figure 1 – Design elements of Alley Cropping Systems



Alley width depends on purpose, tree canopy, crop sensitivity, crop rotation, crop or forage grown.