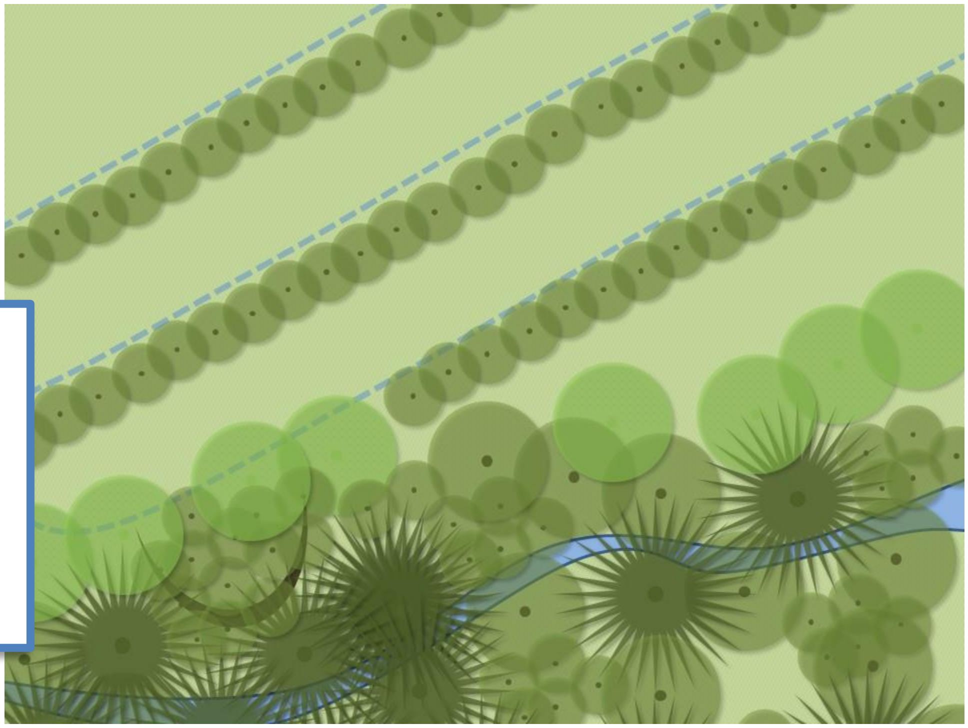
Alley Cropping



> *"**Alley Cropping** is the planting of trees in rows with agronomic, horticultural, or forage crops cultivated in the alleys between the rows."*

Description:

Alley cropping is a production model where a tree crop is grown in rows that are wide enough to simultaneously allow for cultivation of ground-level crops. Rows of highly productive tree or shrub species can be managed for fruit, nut, medicinal, timber, and/or ornamental production while allowing for continued production of cultivated crops (small grains, vegetables, ground cover fruits) or forage (hay, silage, etc.). Stacking these two production systems allows farmers to better cope with market fluctuations or crop failures by diversifying outputs while providing the ecosystem services to meet environmental conservation goals.

Placement and management of alley cropping systems is specific to site conditions and landowner needs. This strategy is not intended to replace a properly functioning, closed canopy riparian buffer, rather, its goal is to provide a way for the landowner to increase the buffer size and function while at the same time realizing economic benefits. Alley cropping can be a long-term management strategy or it can be a short-term approach to maximizing farm production during establishment of a forest canopy.

Conservation Benefits:

Alley cropping systems provide the opportunity for farmers to continue cultivation of their land while realizing the environmental benefits associated with the incorporation of trees near stream corridors: shade, leaf litter, carbon storage, and pollutant filtration. Though traditional soil cultivation can create sediment, nutrient, and chemical pollution if managed improperly, proper integration of alley cropping techniques alongside riparian buffers can provide numerous environmental benefits:

- Incorporating deep rooting trees into an annual crop or forage system diversifies rooting depths and increases nutrient and water uptake (Hooper and Vitousek, 1997; Licht, 1990).
- From a structural perspective, during flood or winter storm events, trees within cultivated fields slow moving surface water and encourage infiltration thereby reducing sediment, nutrient, and chemical pollutant runoff (Michel et al., 2007; Jose, 2009). Rows of trees planted either on contour or parallel to the riparian channel can provide a physical barrier to pollutants moving toward a waterway.
- Rows of trees also provide a windbreak that can reduce the drift of air-borne pesticide and herbicide applications used to manage pests and weeds within the annual cropping management framework (Ucar and Hall, 2001).
- Tall trees provide shade to the stream, maintaining cool water temperatures for fish.
- Incorporating trees into the agricultural landscape increases carbon sequestration both above and below ground (Schoeneberger et al., 2012).
- A forest with an open understory creates a unique natural habitat that can enhance nesting site potential (ground and aerial nesting sites), movement of migratory mammals, and increases flowering of trees and shrubs for pollinator habitat when compared to open field systems (Garrett et al., 2004; Hinsely and Bellamy, 2000; Varah et al., 2013). Trees provide birds with refuge, shelter and forage sites. Bald eagles feeding on salmon carcasses can bring salmon and their nutrients further into the fields aiding in upland fertility.

Landowner Benefits:

Alley cropping research for temperate systems in the mid-western U.S. and Canada has shown a multitude of benefits that support the farmers' long-term economic goals. Alley cropping provides farmers reduced economic risk by managing for both a tree crop and annual crop on the same land. In addition:

- Producers seeking to transition into full canopy coverage or intensive tree crops can cultivate annuals within the alleys for economic gain until trees reach canopy closure or maturation.
- Diversifying agricultural revenue sources can provide economic security in the face of potential floods and droughts due to climate change (Schoeneberger et al., 2012).
- Depending on the system, the timing of management, harvest and labor can be staggered throughout the year to provide for year-round income and farm labor employment.
- Rows of taller trees can increase soil moisture by reducing the evapotranspiration effects of wind, providing shade at certain times of the day, and increasing soil organic matter inputs (Cleugh, 1998).
- Planting of nitrogen fixing trees or shrubs can reduce fertilization needs (Cleugh, 1998).
- Rows planted perpendicular to surface or groundwater flow can trap runoff of topsoil and nutrient inputs which, over time, can reduce fertilizer requirements (Licht, 1990).

- Alley cropping typically integrates flowering species and provides rows of undisturbed soil. These rows provide nesting habitat for both pollinators and predatory insects thus improving the yields of annual crops and reducing the need for pesticides.

Design and Implementation:

Proper planning and design is critical for the success of any alley cropping system. A wealth of integrative tree/shrub and annual production systems are available to the producer in the Puget Sound region. Producers should match their current cropping and management practices with their alley cropping plan and take into account site conditions, access to needed equipment and infrastructure, impact of tree management on annual cropping, and potential markets. Choosing tree species that compliment, rather than compete with, annual crops is key. Things to consider here are shade, increased soil moisture or competition for soil moisture, nitrogen fixation or competition for soil nutrients, soil condition requirements such as pH and soil depth and habitat quality for providing predator-pest relationships as needed.

Tree Selection:

- *Marketability*
- *High Quality*
- *Fast Growing*
- *Deep Rooted*
- *Site and Climate Tolerant*
- *Produces Light Shade*

Some landowners may choose to maintain annual cropping or forage production in the alleys permanently, while others may choose to phase out of annual production as the canopy of perennial tree crops begin to mature. Deciding on the long-term goal of the tree crop is, therefore, critical when selecting species and row spacing. A landowner may also choose to install rows of perennial species within the alleys, either immediately or to transition out of annual cropping at a later time (e.g. installing trellised Kiwi berries between rows of apples).

The success of alley cropping systems in maximizing natural resource conservation objectives (nutrient retention, soil enhancement, wildlife habitat) is dependent on locating the rows of perennial production on contour or in ways that spread or block concentrated runoff flows. Making careful observations on surface water flows before designing your site plan is, therefore, a critical first step.

Nitrogen fixation characteristics and/or high biomass producing tree species are recommended in many cases where nutrients and organic matter inputs will reduce fertilizer needs and enhance soil health in the alleys. Diversity of flowering species and their respective bloom time should be considered for enhancing pollinator, pest-prey interactions and wildlife habitat. Mulching the rows of trees and practicing conservation tillage within the alleys will better serve insects and other wildlife that rely on undisturbed soil as habitat which can also reduce the need for herbicide and pesticide sprays.

Below is a table of selected perennial species, ideally suited to marketable production for alley cropping systems in the Puget Sound Region:

Suitable Tree/Shrub Species for PNW Alley Cropping				
Common Name	**Family**	**Genus**	**Harvestable Material**	**Notes**
Trees				
Chestnuts	*Fagaceae*	*Castanea*	Nuts	High value nut and timber
Butternuts	*Junglandaceae*	*Juglans*	Nuts	High value nut and timber
Walnuts	*Junglandaceae*	*Juglans*	Nuts	High value nut and timber
Pine Nuts	*Pinaceae*	*Pinus*	Nuts	High value nut
Alder	*Betulaceae*	*Alnus*	Timber and Syrup	Furniture, firewood and syrup
Birch	*Betulaceae*	*Betula*	Timber and Syrup	Furniture, firewood and syrup
Hybrid Poplar/Cottonwood	*Salicaceae*	*Populus*	Timber and Syrup	Biomass, firewood and syrup
Cascara	*Rhamnaceae*	*Rhamnus*	Medicinal Bark	Large market and distribution available
Apple	Roseaceae	*Malus*	Fruit	Cider production source
Crabapple	*Roseaceae*	*Malus*	Rootstock	Graft to high value fruit
Pear	*Roseaceae*	*Pyrus*	Fruit	Cider production source
Plum	*Roseaceae*	*Prunus*	Fruit	Local high value fruit
Cherry	*Roseaceae*	*Prunus*	Fruit and Timber	High value fruit and hardwood
Quince	*Roseaceae*	*Cydonia*	Fruit	High value fruit
Fig	*Moraceae*	*Ficus*	Fruit	High value fruit
Mulberries	*Moraceae*	*Morus*	Fruit	Great mast crop and high value fruit
Shrubs				
Willow	*Salicaceae*	*Salix*	Woody biomass	Livestock feed, biomass, medicinal markets, nursery cuttings
Curly Willow	*Salicaceae*	*Salix*	Ornamental branches	Ornamental market opportunities
Red Osier Dogwood	*Cornaceae*	*Cornus*	Ornamental branches	Ornamental market or nursery cuttings
Tea Plant	*Theaceae*	*Camellia*	Leaves	New local niche market
Filberts	*Betulaceae*	*Corylus*	Nuts	High value nut crop
Elderberry	*Caprifoliaceae*	*Sambucus*	Fruit	High value fruit, medicinal and edible
Saskatoon	*Roseaceae*	*Amelanchier*	Fruit	High value fruit, superfood
Blueberry	*Ericaceae*	*Vaccinium*	Fruit	High value fruit
Strawberry Tree	*Ericaceae*	*Arbutus*	Fruit	Related to Madrone, great juice/jams
Aronia	*Roseaceae*	*Aronia*	Fruit	High value fruit, superfood
American Cranberry	*Adoxaceae*	*Viburnum*	Fruit	Highly productive native w/ marketability
Buffalo Berry	*Elaeagnaceae*	*Shepherdia*	Fruit	High market potential, superfood
Sea Buckthorn	*Elaeagnaceae*	*Hippophae*	Fruit	High market potential, superfood
Goumi	*Elaeagnaceae*	Elaeagnus	Fruit	High value fruit
Currants	*Grossulariaceae*	*Ribes*	Fruit	High value fruit
Gooseberries	*Grossulariaceae*	*Ribes*	Fruit	High value fruit
Jostaberry	*Grossulariaceae*	*Ribes*	Fruit	High value fruit
Wolfberry/Goji Berry	Solanaceae	Lycium	Fruit	High value fruit
Vines				
Kiwi Berry	*Actinidiaceae*	*Actinidua*	Fruit	Highly productive and marketable
Grapes	*Viticeae*	*Vitis*	Fruit	Ample processing potential

Pacific Northwest Production Models:

The opportunities to integrate perennial trees and shrubs with cultivated annuals are numerous in the Pacific Northwest. The examples below demonstrate a few of the possibilities for tree crops that are well-suited to climate conditions on the west side of the Cascades and have established markets. These examples represent harvest of fruits and nuts whereas other systems could include timber production for sawlogs, veneer, firewood or biomass production for mulch, livestock bedding, biomass combustion, etc.

Saskatoon (Amelanchier Spp.): Also known as Serviceberry or June berry, this is a native shrub with a rich history of use by indigenous peoples and recent European settlers. More recently, areas of Canada and the northern areas of the mid-western United States have turned to this highly productive shrub for its prized sweet and highly nutritional fruit as an agricultural crop for the fresh and processed food markets. Commercial production has not been able to meet demand in Canada as the market has been growing rapidly since the turn of the century. *Amelanchier alnifolia*, the native species west of the cascades, is the main commercially viable species grown, making this an ideal crop for the alley cropping scenario seeking to enhance on farm and regional conservation goals. Research in Canada has shown full production within 7-10 years, grossing 3,500 lbs of berries per acre (St. Pierre, 1997; Faye, 2008). Direct market pricing in Alberta ranged from $2.40-4.50/lb. for U-pick while retail ranged from $2.50- 5.25/lb. (Spencer and Morton, 2014).

Agricultural Production

Tree crops:

- *Timber*
- *Firewood*
- *Fruit/Nut crops*
- *Christmas trees/ornamental*

Annual crops:

- *Cultivated crops*
- *Forage*

Cider Apple (Malus Spp.): The production of cider apples and other fruits for fresh cider juice and hard cider is taking off nationwide as popularity gains for artisanal hard ciders. As of fall 2014, there are 40 cider producers in the Pacific Northwest alone, many facing challenges in locating the supply of specific varietals for hard cider. There are an incredible amount of cider specific apple varieties found around the world, so selection of specific varietals should be thoroughly researched for disease resistance, production and marketability. Production of apples for the cider market is particularly noted in this template for three reasons: 1) Cider apples do not require the demand for pristine appearance or shape, translating to less pesticide spray requirements, ease of management, and closer to 100% of production being marketable (Galinato and Gallardo, 2014), 2) Apples and other tree fruits can be espallied or trellised making them ideal for alley cropping scenarios, 3) Though most eating or cider producing apples are non-native and require well-drained soils not typically associated with riparian zones, they can be grafted onto the native pacific crabapple (*Malus fusca*), a species that thrives on seasonally inundated sites and has disease resistant rootstock. Currently, demand of cider specific varietals outweigh supply, leading 2014 season wholesale pricing to range between $800-$1000 per ton or $340-$425 per bin (Warner and Mullinax, 2014). In 2013, the median price in Western Washington for locally grown cider apples is described as $315/bin (Galinato and Gallardo, 2014). Average yield per acre varies greatly based on varietal choice and conditions. In a recent budget estimation publication by a WSU Extension researcher, however, Galinato and Gallardo (2014) describes average expected yield for mature orchards to be 46 bins per acre (not in an alley cropping system).

Walnut (Juglans Spp.): Western Washington and Oregon had a particularly rich history of Walnut production in the early to mid 1900's and remnant stands can still be found in many agricultural landscape or towns that grew up around existing farmland (Stebbins, 1993). Butternuts, Heartnuts, European Walnuts and even the American native Eastern Black Walnut (*Juglans nigra*) have a great potential to increase farm income through alley cropping for both nut and timber production (Goby, 2005). Black Walnut trees begin to come into commercial nut production around year 10 and average 2/3 of a ton per acre in the Pacific Northwest for a mature healthy orchard (Stebbins, 1993). Black Walnuts range in price for regional wholesale buyers from $0.13 – $0.45/lb for unprocessed nuts (Godsey, 2010) to $0.50 for processed nuts. Direct marketing of processed walnuts are often sold for over $12/lb (Jensen, 2014).

Christmas and Ornamental trees (Various species): Both native and non-native Christmas tree species can be integrated into alley cropping scenarios. Christmas tree production, ornamental and seasonal boughs, as well as pine/fir cones can diversify income, while also becoming a long-term canopy crop for timber, firewood as well as wildlife habitat. Douglas-fir trees reach a 6ft marketable height in 7 years and can be sold directly or on the wholesale market. The Pacific NW is the world's largest producer of Douglas-fir trees (PNW Christmas Tree Association).

Financial Assistance and Cost Share Opportunities

Financial assistance in the form of cost-share funds or public subsidies can aid landowners interested in implementing alley cropping management practices. Agencies currently equipped to provide this funding, including implementation funds and technical assistance, can be secured through the following agencies and programs:

- Conservation Districts – Local conservation districts can help to provide technical assistance and planning, and seek funds though the Washington State Conservation Commission and other local funding sources.
- National Resource Conservation Service (NRCS) – EQIP and CSP programs. Contact your regional NRCS Field technician for application details: http://www.nrcs.usda.gov/wps/portal/nrcs/main/wa/contact/local/

Sources of Funding and Assistance

- USDA Farm Service Agency – Conservation Reserve Enhancement Program (CREP)
- NRCS – Environmental Quality Improvement Program (EQIP)
- NRCS – Conservation Stewardship Program (CSP)
- Washington Conservation Commission – Livestock and Shellfish Funding Programs
- Department of Ecology – Pollution Identification and Correction (PIC) program
- Local Conservation District, NGO, and other Environmental Protection Partnerships

Approved WA NRCS Best Management Practice Standards:

The NRCS provides Best Management Practice (BMP) standards for Washington State to ensure cost-share subsidies are used appropriately for the natural resource concerns to be addressed. The following NRCS BMP standards have been developed in accordance to state environmental policy specifically addressing natural resources management within agricultural landscapes:

Alley Cropping (311): Establishing tree species in rows where agricultural, horticultural or forages are produced in the alleys with the intent to enhance microclimates, reduce surface runoff and erosion, decrease offsite movement of nutrients or chemicals, enhance wildlife and pollinator habitat, enhance soil health, increase carbon storage, improve air quality, increase crop diversity, develop renewable energy resources, etc.

Plant Enhancement Activity – PLT18 – Increasing on-farm food production with edible woody buffer landscapes: As part of the their Conservation Stewardship Program, NRCS has recently added this enhancement funding source to provide resources for enhancing windbreaks, alley cropping, silvopasture and riparian forested buffers with trees and shrubs that provide food for human and wildlife consumption.

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