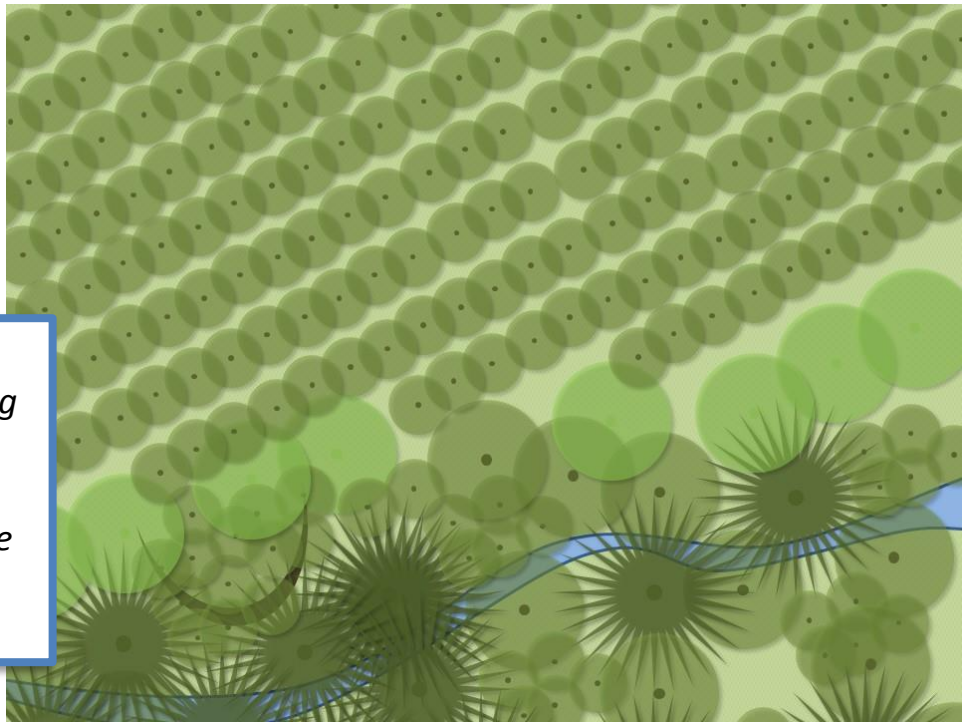
Short Rotation Biomass



> *"**Short rotation biomass** is planting of fast-growing woody tree or shrub species that are rotationally cut to provide biomass."*

Description:

Fast-growing woody shrub or tree species can be grown densely and harvested for biomass in the Short Rotation Biomass technique. The species recommended for this approach can re-sprout from stumps or roots and are harvested through coppicing, cutting them off near the base of the plant, or pollarding, cutting of the upper branches to promote dense heading on the trunk. On the landscape, these dense shrub zones serve to reduce concentrated flow paths, infiltrate water, filter out pollutants and absorb nutrients (Abrahamson et al., 2012). They may be prescribed to expand the width of a traditional riparian buffer or along seasonal ditches where shrubs and smaller trees are able to provide sufficient canopy cover to shade the surface water. Many of the recommended species are shrubs that can be grown adjacent to crop fields without having a significant shading effect. While some recommended species are taller growing trees, these are usually coppiced before reaching 15-30ft, depending on the selected species.

Biomass harvested from these fast-growing species can be used in biomass combustion for heat production, biofuels, paper production, timber, livestock bedding material, and feedstock among other emerging markets. In addition, several native willow, dogwood, and cottonwood species can be grown to produce livestakes for the nursery market. Livestakes are coppiced from plants and are sold for restoration planting projects on the local market.

Placement and management of short rotational biomass systems is specific to site conditions and landowner needs. This strategy is not intended to replace a properly functioning, closed canopy riparian buffer, rather, the goal is to provide a way for the landowner to increase the buffer size and function while at the same time

realizing economic benefits. This technique 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:

Short rotational biomass systems are incorporated into a comprehensive approach to managing for natural resource conservation on a farm. While taller riparian buffers may be prescribed along fish-bearing streams to realize the habitat benefits needed, biomass production zones can be a valuable tool used along smaller seasonal ditches, in lower seasonally wet zones, in areas where flow concentrates, and alongside traditional crops where tall shade trees would limit crop production. Biomass should be harvested in zones and in rotation, providing a diverse range of buffer age and function to minimize the effects of harvest and maximize conservation values. Environmental benefits include:

- Incorporating deep rooting woody trees and shrubs into an annual crop or forage system diversifies rooting depths and increases nutrient and water uptake (Hooper and Vitousek, 1997).
- Fast growing shrub and trees species take up nutrients quickly which are then removed with harvest. This technique is an effective way of removing nutrients from agricultural runoff before they reach the stream and can aid in remediating contaminated groundwater flows (Licht, 1990).
- Deciduous trees and shrubs build soil organic matter content increasing soil infiltration rates, biological activity, and pollutant degradation and filtration capacity.
- From a structural perspective, during flood or winter storm events, trees and shrubs 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 or shrubs planted either on contour or parallel to the riparian channel can provide a physical barrier to pollutants moving toward a waterway.
- The dense stem count of short rotational biomass systems results in flow dispersal across the landscape. Reducing concentrated flow pathways allows for improved infiltration rates and pollutant filtration functions of riparian buffers.
- On smaller streams or agricultural ditches, narrow buffers can provide similar effective shading and above-stream air temperature reductions as wider buffers (Benedict and Shaw, 2012), maintaining cool water temperatures for fish.
- Incorporating woody vegetation into the agricultural landscape increases carbon sequestration both above and below ground (Schoeneberger et al., 2012).

- Flowering trees and shrubs provides for pollinator habitat when compared to open pasture systems (Varah et al., 2013).

Landowner Benefits:

Short rotational biomass systems provide a way for farmers to reduce economic risk by diversifying their production model on a much shorter timeframe than many of the other working buffer techniques. Incorporating zones of fast-growing trees and shrubs can result in many benefits to farmers:

- Diversifying agricultural revenue sources can provide economic security in the face of potential floods and droughts due to climate change (Schoeneberger et al., 2012).
- Trees and woody vegetation 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 that can positively affect adjacent agricultural fields. Planting of nitrogen fixing trees or shrubs can reduce fertilization needs (Cleugh, 1998).
- During floods, trees and shrubs act as a "fence" to trap large wood from the river that would otherwise be deposited on fields or damage fencing.
- 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.
- Short rotational coppicing can provide nesting habitat for both pollinators and predatory insects thus improving the yields of annual crops and reducing the need for pesticides.
- Rows planted perpendicular to surface or groundwater flow can trap runoff of topsoil and nutrient inputs which, over time, can reduce fertilizer requirements.
- Most recommended species do well in poorly drained soils and can be an added source of income in areas where crop production rates are poor or pastures are degraded and muddy.

Design and Implementation:

Short rotation coppicing production is ideally suited to marginal lands, such as drained or disturbed wetlands, low elevation depressions within a floodplain, hydric soils or any marginally productive farmland. We recommend that this practice be implemented along smaller, non-fish bearing streams or in conjunction with permanent buffers along fish-bearing streams to maintain stream temperatures post-harvest of biomass crops. Surface or sub-surface drainage (tile drains, field ditches, etc.) can be re-routed to short rotation biomass planting zones where these rapidly growing species can sequester pollutants and excess nutrients that are then removed through harvest. Short rotation biomass may be used as part of an alley cropping model, where singular or multiple rows of coppiced trees and shrubs are grown alongside more traditional crops or forage. Many of the recommended species are coppiced before reaching 15-30 feet in height so do not provide significant shading to adjacent crops.

Short-rotation biomass cropping has a tremendous amount of opportunity to enhance farm economic diversity, though species selection and production models should be well researched to match market

demands, site specific growing conditions and availability of equipment and infrastructure needs. For production of homesteading materials such as livestock bedding, firewood, mulch or timber, landowners can manage a diverse array of species to match their production needs. Landowners interested in producing for the renewable energy markets (biofuels or biomass combustion) or paper production are strongly encouraged to seek partnerships with other producers, research agencies, and buyers before implementing their production plan.

Site selection for short-rotation biomass production is critical as site conditions may impact a farmer's ability to harvest the material. For most species harvested as sources of renewable energy, harvest typically takes place during the species dormant period prior to budding in the spring, similar to livestake nursery cutting. Extremely wet areas, therefore, may not allow for equipment access at this time of year. Livestock bedding material could be harvested year-round, while livestock feed harvest would likely take place in the fall. Planning for timing and equipment access for harvest and management should be part of your working buffer management plan.

Below is a table of selected perennial species, ideally suited to marketable or farmstead resource production for short-rotation biomass systems in the Puget Sound region:

Suitable Tree and Shrub Species for PNW Short Rotation Biomass				
Common Name	**Family**	**Genus**	**Harvestable Material**	**Notes**
Willow	*Salicaceae*	*Salix*	Biomass (bedding, mulch, livestock feed), nursery livestakes	Currently being researched for silage production
Hybrid Poplar	*Salicaceae*	*Populus*	Biomass, paper pulp	Research project for biofuels underway
Cottonwood	*Salicaceae*	*Populus*	Biomass, nursery livestakes	Native species related to hybrid poplar
Alder	*Betulaceae*	*Alnus*	Biomass, timber, bedding, mulch	Ideal for early succession reforestation, nitrogen fixer
Birch	*Betulaceae*	*Betula*	Bedding, mulch	Ideal for livestock bedding
Oregon Ash	*Oleaceae*	*Fraxinus*	Biomass, bedding, mulch	Native species, rapid growth

Pacific Northwest Production Models:

In the Pacific Northwest, there are a number of opportunities for landowners to realize economic gain on marginal lands using native or closely related species for short rotational coppicing and forestry. Several species can be used for homesteading products on farm, and several can be sold on the local market. Below are a few examples of marketable species gaining popularity and research interests in the Puget Sound region.

Shrub Willow (Salix Spp.): In recent years, much research has been conducted on the use of shrub willow species for hardwood biomass production for the renewable energy sector. This includes heat, power, biofuels and/or bioproducts. Research conducted in the Northeast U.S. estimates current production at 12 odt (oven dry tons)/hectare/year with a delivered price of $60/odt paid to the producer (Abrahamson et al., 2012). Coppicing willow for the energy industry is typically done in 3-5 years rotations allowing producers to plan for annual harvests throughout several zones of their production system. There are currently no biorefineries in

Washington State making this a speculative emerging product. As an alternative to the biofuels industry, researchers in the UK have been assessing this same production model as a source for ensiled livestock feed (Smith et al., 2014). Livestock producers may find these developments particularly intriguing in producing on-farm feed on marginal production sites while mitigating water quality concerns from their operations.

Hybrid Poplar/Cottonwood (Populus Spp.): Hybrid poplars are a cross between American cottonwoods and European poplars with a number of breeding programs developing further cultivars for the use as a renewable energy source worldwide. The Advanced Hardwood Biofuels Northwest program is a research initiative sponsored by the USDA to look into the opportunities available in the PNW for poplars as a renewable energy source. Recent studies indicate a rate of $60-$80/ton paid for poplar woodchips with a goal of 10 tons/acre harvested every two to five years depending on site conditions. Much like willow, poplars are extremely fast growing with multiple market opportunities, such as pulp wood, timber, bedding and highly nutritious livestock feed (Isebrands, 2007). As market fluctuations increase in the coal and fossil fuel markets, renewable biofuels from poplars and other hardwoods could become more profitable (Abrahamson et al., 2012). Operators as strongly encouraged to seek contracts or partnerships with local buyers and research groups prior to implementation. There are currently no biorefineries in Washington State making this a speculative emerging product though teams of researchers at Advanced Harwood Biofuels Northwest are actively seeking to develop local opportunities.

Agricultural Production

Tree and shrub crops:

- *Timber*
- *Paper pulp*
- *Biomass for combustion*
- *Biofuels*
- *Nursery cuttings*
- *Bedding material*
- *Livestock feed*

Alder (Alnus Spp.): Alder is an ideal candidate for short rotation production because it can rapidly produce high amounts of biomass in disturbed or marginally productive sites. Preferring disturbed and wet soils, alder can be used along riparian corridors, drained wetlands, or floodplains with shallow water tables. The nitrogen fixing capability of alder makes this species well suited for restoring highly degraded pastures or grasslands that are poor in fertility and soil structure. In addition to site restoration, alder has a multitude of potential on and off farm uses with economic potential. As timber, alder has been desired as a cabinetry or furniture wood currently valued at over $800/thousand board feet (MBF) for logs greater than 12 inches in diameter, achievable in a 25 year time frame (Wick, 2015; Scott, 2003). On a shorter rotation, alder can be used for mulch (on-farm), packaged as green shavings for horse and livestock bedding (retail $38 for 1/3 cubic yard on smallcrop.com), "value-added" for smoking meats, or used to cultivate mushrooms from plug spawn (branches) or sawdust inoculations ($7.50/10 lb bag on Fungi.com). Due to the low tannin and lignin structure found in alder sawdust, livestock operators, large-scale composters and mushroom producers are seeking alder sawdust resources nationwide.

Financial Assistance and Cost Share Opportunities

Financial assistance in the form of cost-share funds or public subsidies can aid landowners interested in implementing short rotational biomass 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/
- Farm Service Agency (FSA) – A federal agency that manages the Conservation Reserve Enhancement Program (CREP) and the Biomass Crop Assistance Program for the USDA. Contact your local Conservation District or FSA representative for application details: http://www.fsa.usda.gov

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:

Forage and Biomass Planting (512): Provides technical assistance, planning and resources for establishing plantings for the purpose of feedstock for biofuel or energy production. This practice seeks to implement these plantings in a manner to reduce soil erosion, improve soil and water quality and increase carbon sequestration

Riparian Forest Buffer (391): Establishing plantings along riparian corridors. The standard encourages "tree and shrub species that have multiple values such as those suited for timber, biomass, nuts, fruits, browse, nesting, aesthetic and tolerance to locally used herbicides (NRCS, 2007)."

Hedgerow Planting (422): Establishing a dense and linear planting of woody shrubs along a narrow waterway, slope contours, or other features of a farm. This practice seeks to provide food and cover for wildlife, improve water quality, increase carbon storage and serve as barriers to dust, airborne particulates and chemical drift.

Tree/Shrub Establishment (612): Establishing the planting of trees and shrubs for a multitude of conservation and agricultural purposes. Within this practice standard, priority has been established for the development of renewable energy systems.

USDA Biomass Crop Assistance Program: Serviced by the Farm Service Agency (FSA), USDA's BCAP project provides landowners with cost share assistance for implementing biomass production for heat, power, bio-based products and biofuels nationwide. See the 2014 Conservation Fact Sheet at: https://www.fsa.usda.gov/Internet/FSA_File/bcap_fact_sht_2014.pdf

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