NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TREE/SHRUB ESTABLISHMENT

(Ac.)

CODE 612

DEFINITION

Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

PURPOSE

Establish woody plants for:

- forest products such as timber, pulpwood, etc.
- wildlife habitat
- long-term erosion control and improvement of water quality
- treating waste
- storing carbon in biomass
- reduce energy use
- develop renewable energy systems
- improving or restoring natural diversity
- enhancing aesthetics.

CONDITIONS WHERE PRACTICE APPLIES

Tree/shrub establishment can be applied on any appropriately prepared site where woody plants can be grown.

Refer to other practice standards for specialized tree/shrub establishment situations, e.g., Riparian Forest Buffer (391), Alley Cropping (311), Windbreak/Shelterbelt Establishment, (380); Critical Area Planting (342), Hedgerow Planting (422).

CRITERIA

General Criteria Applicable to All Purposes

Species will be adapted to site conditions and suitable for the planned purpose(s).

Species considered invasive or noxious for the planting area shall not be used.

Planting or seeding rates will be adequate to accomplish the planned purpose.

Planting dates, and care in handling and planting of the seed, cuttings or woody plants will ensure that planted materials have an acceptable rate of survival.

Only viable, high quality and adapted planting stock or seed will be used.

Site preparation shall be sufficient for establishment and growth of selected species.

Adequate seed or advanced reproduction needs to be present or provided for when using natural regeneration to establish a stand.

Selection of planting technique, equipment and timing will be appropriate for the site and soil conditions to maintain site productivity and minimize soil rutting, erosion, displacement, and compaction. Hand planting of seedlings will be done when saturated soils are susceptible to damage by mechanical equipment.

The acceptability and timing of coppice regeneration shall be based on species, age and diameter.

The planting will be protected from adverse impacts from livestock, wildlife, pests and fire.

The planting shall not compromise the integrity of property lines, utilities, fences, right-of-ways, drainage tiles, or buildings.

Comply with applicable federal, state, and local laws and regulations during the installation, operation and maintenance of this practice.

A precondition for tree/shrub establishment is appropriately prepared sites for sufficient establishment and growth of selected species.

Refer to practice standard Tree/Shrub Site Preparation (490).

Additional Criteria for Wildlife Habitat

Use multiple native species (minimum of 3 or more species). No single species should make up more than 33% of the total number of species planted.

Select species which best meet wildlife and ecosystem needs.

Species selected will be indigenous to the site and will reflect species composition of the desired stands.

Additional Criteria for Providing Erosion Control

Plants should be evenly distributed over the planting site. Place plants on the contour.

Use non-competitive cover crops between planted rows on critical erosive slopes.

Additional Criteria for Improving Water Quality

Use species that are native to the area, medium to fast growing, and deep rooting.

For riparian areas, use species adapted to local flooding conditions and soil wetness.

Additional Criteria for Treating Waste

Species used to treat waste shall have fast growth characteristics, extensive root systems, high nutrient uptake capacity and tolerance of the planned effluent.

Additional Criteria for Improving or Restoring Natural Diversity

Composition of species selected for planting or those favored for natural regeneration will be native to the site and create a successional stage or state that can progress to the potential natural plant community.

Additional Criteria for Storing Carbon in Biomass

Select plant species that are adapted to the site to assure strong health and vigor. Plant at the highest recommended general stocking rate for the site and purpose (See Planting Rates and Spacing).

For optimal carbon sequestration, select plants that have higher rates of sequestration in biomass and soils.

When using trees and shrubs for greenhouse gas reductions, prediction of carbon sequestration rates shall be made using current, approved carbon sequestration modeling technology or accepted national protocols.

Additional Criteria to Reduce Energy Use

Orient trees to shade a building to reduce summer energy usage. The first priority is placement on the building's west side where the greatest daily heat gain occurs. The second priority is the east side.

Select plants with a potential height growth that will be taller than the structure or facility being protected.

Use proper plant densities to optimize the shade produced and meet energy reduction needs.

Trees planted within 30 to 50 feet of the building generally provide effective shade to windows and walls depending on tree height potential.

Keep trees at least 10 feet or further from the structure depending on mature crown and root spread, to avoid damage to foundations or restrict maintenance access to windows and walls. Consider 10 feet as an absolute minimum.

Additional Criteria for Developing Renewable Energy Systems

Select plants that can 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.

CONSIDERATIONS

Consideration will be given to plant materials that have been selected and tested in tree improvement programs.

All plant materials should comply with minimum standards such as those as established by the

American Nursery and Landscape Association, Forest Service, or state-approved nursery.

When underplanting prior to a harvest, trees should be planted sufficiently in advance of overstory removal to ensure full establishment. If the underplanting of seedlings or planting of seed is to supplement the recruitment for a woodland restoration (i.e., add shortleaf pine component), the available light in the understory should be sufficient to meet the needs of the seedlings.

Plans for landscape and beautification plantings should consider foliage color, color and season of flowering, and mature plant height.

Consider using diverse species combinations which best meet locally native wildlife and pollinator needs.

Tree arrangement and spacing should allow for needed access lanes and stand management.

Residual chemical carryover should be evaluated prior to planting and alter species selection and/or timing of planting/seedling.

Applications of nutrients may be needed to maintain plant vigor or improve planting survival.

Use of locally adapted seed, seedlings or cuttings is recommended.

PLANS AND SPECIFICATIONS

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.

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life.

If needed, competing vegetation will be controlled until the woody plants are established.

Noxious weeds will be controlled.

Check for insect and disease damage with annual inspections.

Supplemental water will be provided as needed.

Replanting will be required when survival is inadequate (See Table 1. For survival guidelines).

Trees and shrubs will be protected from wildfire, insects, disease, and animals.

PRACTICE SPECIFICATIONS

The following table can be used as a guide in choosing suitable planting stock or seed:

Site	Planting Stock
Open Fields	1,2,3,5
Understocked Woodland	1,2,5
Landscaping	1,2,3,4,5
Environmental	1,2,3,5

1 = Seedlings; 2 = Container grown; 3 = Cutting; 4 = Balled & burlap; 5 = Direct seeding

Seedlings: Plant seedlings with well-branched, fibrous root systems. Discard any diseased or damaged seedlings. For underplanting hardwoods or shortleaf pine, use stock at least 3/8 inch in stem diameter.

Container grown: Use healthy, well-developed plants. Discard any diseased or damaged material. Included as container plants are potted, air root-pruned plants.

Cuttings: Use cuttings prepared during the dormant season from wood of the previous season's growth. The cuttings should be taken from healthy, vigorous stock plants growing in full sunlight. At least two nodes should be included in the cutting. The minimum size of cuttings should be 1/4 inch in diameter and 8 inches in length.

Balled and burlap: Use plant stock that is 18 inches or more in height for shrubs and 36 inches or more in height for trees. Do not use plants with cracked or broken rootballs. Avoid plants with root systems that are visible on the rootball surface and that circle the ball.

Direct seeding: Use viable, mature seed.

Care of planting stock

Protect stock from desiccation during temporary storage and delivery to the planting site. Keep all types of planting stock, except the ones needed immediately for a supply during planting, stored in a cool environment (< 50 degrees F)

out of direct sunlight and wind. Do not plant into frozen soil. Avoid planting on hot, windy days. A cool, cloudy day is preferred.

Seedlings: Seedlings should be promptly examined in the shipping container and watered or re-wrapped in moist packing material. Survival can be increased by dipping roots in a commercial water-absorbing gel before planting or by soaking seedlings in water 1 to 2 hours before planting.

Plant as soon as possible after materials arrive, preferably the day of delivery. If planting will be delayed for more than 5 days, keep seedlings in shipping container and place in cold storage at 35 to 45 degrees F. If cold storage is not feasible or available, seedlings should be heeled-in. Dig a trench a little deeper than the root systems and spread roots against the back of the trench. Cover roots completely with soil, tamped to eliminate air spaces. Water as needed to keep roots moist but not wet.

Container grown: Container grown stock should be kept in its container and its soil kept moist (field capacity). Thoroughly water plants 2 days before planting. This will facilitate removal from containers during planting.

Cuttings: Plant cuttings within 2 days of collection or shipping arrival. If planting will be delayed, place cuttings in moist sand/paper, sphagnum moss, or plastic bags and store in a cool (34-40 degrees F) place.

Balled and burlap: Keep the rootball moist by watering slowly from the top. Wet the foliage occasionally. Balled planting stock can be held temporarily by placing soil or mulch around the entire ball of the tree and keeping it moist.

Direct seeding: Keep seeds cool. Maintain a seed moisture content of 30-50%. Do not allow seed to mold. If seeds are field collected, place seeds in porous bags to prevent heat buildup. Keep seeds cool and stratify if necessary. For further information on seed collection and handling, refer to Woody Seed Collection, Conservation Practice Information Sheet (IS-MO612sc).

Planting Dates

Seedlings and cuttings: Use the following guidelines for bare-root stock and cuttings:

Planting Zone 1: March 1 – June 1*
Planting Zone 2: February 15 – May 15*
Planting Zone 3: December 1 – May 15*
A two-week variance in the above dates may be used if the ground is not frozen and/or adequate soil moisture is present.

* All Planting Zones - *Soil map units with frequent, long or very long duration flooding* (Use Section II, Water Features of the eFOTG for guidance.): Planting may be extended to **July 1** because of spring flooding. (Adequate soil moisture must be present at the time of planting)

See **Figure 1** for woody planting Zones.

Balled and burlap and container grown stock. Plant at any time of the year that the ground is not frozen and adequate soil moisture is present.

Direct seeding. Tree/shrub seed may be planted from November through April anytime that soil and site conditions allow (do not seed into frozen soil). For shrubs, the time of year mature seeds are produced is generally the best time to establish that species from seed. Non-stratified seed should be planted before January 1. Spring seeding can reduce rodent and insect damage. Fall seeding can eliminate the need for stratification. Acorns of most species in the white oak group have little or no dormancy and should be planted as soon as possible after collection in the fall.

Site preparation

Follow guidelines in TREE/SHRUB SITE PREPARATION (490).

Planting methods

Seedlings: Plant seedlings upright at the same depth or slightly deeper (1 inch) than the stock was growing in the nursery or container. Properly planted seedlings should resist gentle lifting pressure.

Check each planted row for proper planting depth and root position and for adequate soil packing around the roots.

Containerized/Balled and burlap: Dig a hole large enough to hold root ball or container volume. Remove plants from containers before placing in the ground. If plants are in tarpaper

pots, the tarpaper should be slit along each side or removed before placing in the ground. Straighten or cut all encircling roots to avoid future girdling problems. Place stock at same depth it grew at the nursery and firmly pack soil around roots to eliminate air pockets.

Cuttings: Plant cuttings at an angle of 45 to 60 degrees with buds pointing upward. (If cuttings are planted straight up, the soil often settles away from them in dry weather.) Leave 2 good buds above ground.

Direct seeding: Care must be taken to completely cover the seed and achieve good soil-seed contact. One or more of the following seeding methods should be used:

Broadcast: Broadcast the seed evenly over the planting area and cover seeds with mineral soil (1/2 to 1 inch). Firm the soil.

Strip: Broadcast the seed evenly over the prepared strips and cover with mineral soil (1/2 to 1 inch). Firm the soil.

Spot: Plant 2 to 3 seeds per spot, 1-2 inches deep. Seal planting hole.

Machine: Plant seeds 1 to 2 inches deep. Cover with mineral soil.

Natural regeneration: The use of a natural seed source may be used under any of the following conditions:

- Areas that experience frequent floods
- Depression areas too wet to machine or hand plant
- Sites likely to be invaded by soft-mast or light seed species
- Sites that are within 300 feet of existing mature woodlands and adjacent to desirable seed sources

Planting Rates and Spacing

General

Seedlings/cuttings,: The following planting rates shall be used for woody species. Adjust rates within listed ranges for desired objectives, site conditions, maintenance requirements, planting combinations and species needs.

Woody Species	Plant rate per acre
Hardwood trees	302 - 544
Shrubs	680- 1742
Conifer trees	538 - 726
Biofuels	680 - 1210

Container (>2 gallon): Plant 48 trees per acre (30 x 30 or equivalent). Adjust rates up or down to accommodate site conditions or desired objectives.

Direct Seeding: Use a minimum of 1500 seeds per machine or hand planted acre. Use 3000 seeds per acre for broadcast seeding.

Plants required per acre for selected spacing:

Spacing (feet)	Plants per acre
5 x 5	1742
6 x 6	1210
6 x 8	907
7 x 10	622
7 x 7	889
8 x 8	680
8 x 9	605
9 x 9	538
8 X 10	544
10 x 10	436
10 x 12	363
11 x 11	360
12 x 12	302
14 x 14	222
16 x 16	170
18 x 18	134
20 x 20	109
30 x 30	48

Underplanting Shortleaf Pine

To add or increase the shortleaf pine component in an existing oak or oak – pine woodland, follow the recommendations in RESTORATION AND MANAGEMENT OF RARE AND DECLINING HABITATS (643) for the planting and seeding rates.

Underplanting Hardwoods

The rate for underplanting will be determined by current stand conditions, the landowner objectives, desired species, and ecological site.

Christmas Trees

For Christmas tree production a minimum of 1210 plants/acre is recommended. Landowner

equipment and objectives must be considered in the planting design/layout.

Alley Cropping

Base planting rates and spacing upon the type of alley cropping system being developed. Use Table 2 for within row spacing guidance. Use Table 3 as a guide for woody planting rates when row sets and alley widths of 15 to 40 feet are used.

Silvopasture

Spacing distance between woody plants and row sets should be based on landowner objectives, tree and shrub environmental requirements, light requirements and growth periods of the forage, and machinery width needs.

Plant trees in single, double or triple row sets. Cluster plantings may also be used. When multiple row woody planting sets are used, stagger within row plantings. Use Table 2 for within row spacing guidance. Use Table 3 as a guide for woody planting rates when row sets and alley widths of 15 to 40 feet are used.

Wildlife Habitat

For tree species, use any of the minimum planting rates under **Planting Rates and Spacing**, *General.*

For seedling shrub plantings, refer to UPLAND WILDLIFE HABITAT MANAGEMENT (645) for specific guidance.

For direct seeding wildlife habitat development or wetland restoration, a minimum rate of 750 seeds per acre should be used, provided there is an adequate mature tree seed source of desired species within 300 feet. If a mature seed source is not close, use 1500 seeds per planted acre. To establish denser shrubby cover, increase planting rates based on the specie or species selected and the level of cover needed.

For specialized wildlife planting areas refer to the appropriate standard(s) for guidance.

Windbreaks/Shelterbelts

Per acre planting rates will vary according to the extent of the planting and individual site plans. See Table 2 for suggested tree and row spacing.

Use widest spacing when using container grown plants (≥2 gallon) or balled & burlap stock if site allows.

When multiple row woody plantings are used, stagger within row plantings.

Adapted Species

Base selection on soil type, site limitations, landowner objectives, landscape characteristics, geographic location, and ecological site.

For guidance on species selection refer to Missouri FOTG Section II, Conservation Tree/Shrub Suitability Groups and Ecological Site Descriptions. Also refer to Section IV, practice standards: WILDLIFE UPLAND HABITAT MANAGEMENT (645), HEDGEROW PLANTING (422), RIPARIAN FOREST BUFFER (391), ALLEY CROPPING (311), WINDBREAK/ SHELTERBELT ESTABLISHMENT (380), and RESTORATION AND MANAGEMENT OF DECLINING HABITATS (643).

Weed Control

Provide a 2-4 feet (diameter) competition free zone around all woody plantings.

If non-living mulches (including weed mats) are used, follow MULCHING (484).

If temporary cover is used, follow criteria to control erosion in COVER CROP (340).

If mechanical means are used, care should be taken to avoid physical damage to plantings.

Keep tillage depths shallow to avoid root damage.

If herbicides are used, apply them only when needed and handle with care. Follow all label directions and precautions. If herbicides are not handled or applied properly, they may be injurious to humans, animals, fish, wildlife, desirable plants, and pollinating insects and may contaminate water supplies. Refer to HERBACEOUS WEED CONTROL (315).

Use of living mulches may cause an increase in rodent or deer damage to the woody planting.

If living mulches are used, use one of the following species at the specified rates to control weed competition:

Species	***Rate - PLS/Ac***
Ladino clover	3.0 lbs
Alsike clover	3.2 lbs
Orchardgrass	6.2 lbs
Kentucky bluegrass	1.6 lbs
Timothy	2.3 lbs
Redtop	1.7 lbs
Virginia wild rye	15.0 lbs

Other species or mixes may be approved on a case by case basis. Follow practice specification VEGETATION ESTABLISHMENT, HERBACEOUS SEEDING (723) for site preparation, timing and manner of seeding, and facilitating practices for the establishment of living mulches.

REFERENCES

A Guide to Bottomland Hardwood Restoration; USGS/USDA Forest Service; General Technical Report SRS-40; 2001.

Trees for Conservation: Planning, Planting and Care; CSFS No. 114; Colorado State Forest Service; 1985.

Plant Propagation Principles and Practices, third edition; Prentice-Hall, Inc.; 1976.

Seeding and Planting Hardwoods; in Central Hardwood Notes; USDA Forest Service; 1989.

Seeding and Planting Pines; in Central Hardwood Notes; USDA Forest Service; 1989.

Planting Trees for Farmstead Shelter; Extension Bulletin 196; University of Minnesota; 1980.

Forestry Handbook - Second Edition: Society of American Foresters; Ronald Press; 1984.

Seeds of Woody Plants in the United States: Agricultural Handbook No.450; USDA Forest Service; 1974.

Care and Planting of Southern Pine Seedlings; USDA Forest Service; Management Bulletin R8-MB39; 1989.

Figure 1. Tree/shrub planting zones for Missouri.

Table 1. This table gives survival guidelines for tree/shrub plantings and presumes that the minimum number of trees and/or shrubs were originally planted based on acceptable design and site objectives. Required survivability of individual plants will vary with the purpose of the planting.

Survival Guidelines For Tree/Shrub Plantings (Inventoried after "leaf out" during spring or summer of the second year (% or number))	
Practice	***Survival Percent or Number***
380 - Windbreaks/Shelterbelt Establishment 311- Alley Cropping	90 % of all trees and shrubs planted with no two adjacent within row plants missing for all purposes.
391 - Riparian Forest Buffer 422 - Hedge Row Planting 612 - Tree/Shrub Establishment - General 580 - Streambank/Shoreline Protection 381 - Silvopasture Establishment 643 – Restoration and Management of Declining Habitats (oak savanna; bottomland forest)	200 plants/ac for basic cover requirements or 67% of the original planting rate if specific plant densities are needed*. Surviving plants should be evenly distributed over the planting area.
644 - Wetland Wildlife Habitat Management 645 - Wildlife Upland Habitat Management	150 plants/ac for basic cover requirements or 50% of the original planting rate if specific plant densities are needed*. Surviving plants should be evenly distributed over the planting area .

Direct seeding or natural regeneration survival plant levels should equal the percentage, noted above, for the equivalent seedling planting rate of the class or purpose of woody plantings listed under "Planting Rates and Spacing**" (see pages 4-5).*

Table 2. Plant Spacing for Alley Cropping, Silvopasture, Wildlife Habitat, and Windbreaks/Shelterbelts

Within Row Spacing		**Between Row Spacing***	
Small Shrubs (<8ft)	3-6 feet	Between shrub rows	3-12 feet
Large Shrubs	5-8 feet	Between tree rows	12-20 feet
Evergreens	8-12 feet	Between tree/shrub rows	10-20 feet
Deciduous Trees	8-15 feet	Between all rows (odor control)**	20-50 feet

**Use for Wildlife Habitat and Windbreaks Shelterbelts. For Alley Cropping and Silvopasture see Table 3.*
***Can be less than 20' if physical barriers such as roads, property lines, utilities, etc. are present.*

Table 3. Planting rates based on row set type and alleyway or lane widths *

	Single Row Set				Double Row Set				Triple Row Set			
Alley Width	Row Spacing	In Row Spacing 6 ft	8 ft	10 ft	Row Spacing	In Row Spacing 6 ft	8 ft	10 ft	Row Spacing	In Row Spacing 6 ft	8 ft	10 ft
15 feet	*Row spacing and alley width are the same for single row sets.*	484	363	290	6 feet	691	518	414	6 feet	807	607	484
					8 feet	631	473	378	8 feet	703	528	422
					10 feet	580	435	348	10 feet	622	468	374
					12 feet	537	403	322	12 feet	558	418	335
20 feet		363	272	218	6 feet	558	418	335	6 feet	680	512	409
					8 feet	518	388	311	8 feet	605	455	363
					10 feet	484	363	290	10 feet	545	409	327
					12 feet	454	340	272	12 feet	495	372	297
30 feet		242	182	145	6 feet	403	303	242	6 feet	512	390	311
					8 feet	382	28	229	8 feet	473	356	284
					10 feet	363	272	218	10 feet	435	328	262
					12 feet	345	259	207	12 feet	403	303	242
40 feet		182	136	109	6 feet	315	237	189	6 feet	419	315	252
					8 feet	303	227	182	8 feet	389	292	234
					10 feet	290	218	174	10 feet	363	273	218
					12 feet	279	209	167	12 feet	340	256	204

* Field shape and planting design may cause some variation in plants/acre.